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The Wildlife Management Institute expresses its appreciation to The Wildlife Society and the many organizations and individuals who contributed to the success of the 37th North American Wildlife and Natural Resources Conference.

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GENERAL SESSION

Monday Morning—March 13

Chairman: A. Starker Leopold
Professor, University of California, Berkeley

Vice Chairman: Bernardo Villa-R.
Director General de la Fauna Sylvestre, México, D. F., México

INTERNATIONAL CONSERVATION CHALLENGES

FORMAL OPENING

Daniel A. Poole
President, Wildlife Management Institute, Washington, D. C.

Good morning, ladies and gentlemen. Welcome to the opening session of the 37th North American Wildlife and Natural Resources Conference. It is a pleasure and a privilege to be in The United Mexican States and in historic and exciting Mexico City. This is the first meeting in the long history of the Conference to be held in Mexico. I trust it will not be the last.

Over the years, many of us in natural resources work have benefited from the sound counsel and warm friendship of some of Mexico's most prominent scientists and distinguished citizens. We are gratified, therefore, to be able to hold this 37th Conference in the homeland of such men as Dr. Enrique Beltran and Dr. Bernardo Villa. These gentlemen have made important contributions toward furthering conservation understanding here in Mexico, in our countries, and elsewhere. I want to thank Drs. Beltran and Villa, too, for their good advice and assistance in easing the many arrangements for this meeting.

As a guest and visitor to this great land, I will refrain from commenting on some of the pressing resource problems and environmental issues facing my own country. I will put that off until next year, when the Conference returns to the United States. Without question, many of the same problems and challenges will be with us then, for their solutions are not as cosmetic as some people appear to believe.

Improvements in our responses to the many threats to the environment clearly rest on our willingness to impose reasonable constraints and to accept changes in the ways we have become accustomed to handling our affairs. And the imposition of new laws alone will not suffice. No matter how sound, new laws may be mostly inoperative in the absence of changed public attitudes. The public says it wants a quality environment, but the public is largely untested in terms of the sacrifices required to attain that goal.

I wish to make two points in these opening remarks. The first is that citizens of many nations, from this hemisphere and elsewhere, are among the registered attendees at this Conference. The presence of each of us proves anew the universality of man's environmental concerns. While varying in detail and dimension, our problems have similar causes and patterns. Despite our national identities, we are, inescapably, a single and enlarging human population increasingly dependent on one planetary environment.

Secondly, because this is essentially a meeting of resource professionals and serious-minded laymen, all are urged to realize that an impatient public's rising interest in environmental issues poses serious challenges to the scientific foundations of our work. Increasingly better informed about what is happening to the environment, and anxious for early remedial and preventive action, concerned individuals and groups are challenging the organizational, administrative, and operational structures of resource programs.

These public demands raise serious questions about the professional conduct of resource work. Our authorities, institutions, policies, and practices must relate to public aspirations for environmental protection and enhancement. If they do not, or if the discrepancies cannot be explained, resource professionalism risks serious erosion of public support and confidence. Resource professionals must prove the social value of their work. No longer can they presume that the public will accept glowing generalities in the absence of tangible proof of accomplishment.

In closing, there are a few brief announcements. Conferees should keep in mind that the Conference is neither a convention nor an action body. It cannot adopt resolutions or take action of any kind either for or against any issue.

Time is provided in each session for questioning speakers and for relevant comments on the subjects under consideration. All discussions will be reported and published in the Transactions of the Conference.

Many of you have signed for headsets for use in the bilingual interpretation of the various papers and discussions. The headsets may be retained until Wednesday by those wishing to use them at later sessions. It is imperative, however, that these instruments be returned to the Conference registration desk before the close of the Conference and certainly not later than 5:00 p.m. on Wednesday.

The Ladies Luncheon will be held in the Oaxaca Room at noon today. Visiting ladies who wish to attend as guests of the Institute should pick up their tickets at the Conference registration desk.

The Wildlife Society's annual dinner will be held in this hotel tonight. Tickets must be purchased at the Society's desk in the registration area before noon today.

Those wishing to attend the conference banquet tomorrow evening are urged to purchase tickets as soon as possible. In keeping with long practice, The Wildlife Society's Leopold Medal honoree will be announced at the banquet. There will be no speeches, and an outstanding musical show is planned.

Finally, this year's Conference offers two other events of unusual importance. At the conclusion of this session this morning, officials of The United Mexican States and the United States of America will take part in a ceremony formalizing an amendment to the 1936 Convention for the Protection of Migratory Birds and Game Mammals.

And tomorrow afternoon in the Chapultepec Room, beginning at 1:00 p.m., a special panel will review the recommendations and implementation of the Council of Environmental Quality-Department of the Interior Predator Control Study. Two members of the Advisory Committee on Predator Control and representatives of the Department of the Interior and the Council on Environmental Quality will take part. The panel is scheduled to avoid interfering with the many related meetings also set for tomorrow afternoon.

I now wish to turn the meeting over to the opening session chairman, Dr. A. Starker Leopold, of the University of California.

PROGRAMS FOR RENEWABLE NATURAL RESOURCES IN MEXICO

ENRIQUE BELTRÁN
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When the first Europeans arrived in what is now the Republic of Mexico at the beginning of the sixteenth century, they received two basic impressions regarding the country's natural resources.

First, there was the great wealth of mineral deposits, particularly of gold and silver. These not only allowed the newcomers to grow rich quickly but also made possible fabulous shipments of precious treasures to the Mother Country, even though corsairs of various nations —mainly English, French, and Dutch—detoured much of this to their respective countries, often to finance wars against Spain itself.

Secondly, with regard to renewable resources, they were impressed by the enormous wealth of forests and, because of their exotic nature, by the prodigality of humid tropics on both coasts. The latter offered the most varied and appetizing fruits in their natural state and yielded tremendous amounts of them, when cultivated.

The conquerors' concept of what they called New Spain—a name which put the northernmost of their colonies in a privileged position, since there was no other to win a similar distinction—was that it was a territory of exceptional riches, capable of yielding the most varied and valuable products.

To prove this, Spanish ships unloaded dazzling cargoes onto the Old Continent, to the amazement of Europeans, who were astounded not only at their variety but at the multiple uses that could be made of them. Sometimes, they sent directly usable products or, when perishable, the plants or seeds that produced them.

Vegetables, such as corn, beans, cacao—which became universally used—tomatoes, and many others enriched the diet, while the "dye stick" or "campeche" contributed to the dyers' industry. Being of animal nature, the scarlet grain or cochineal occupied a place of preference, with the beautiful tones that it produced until the advent of anilines. The delicious American turkey (called *huexolotl* by the Aztecs) soon became known everywhere as the lord of the table on solemn occasions, such as Christmas. The inevitable conclusion was that the newly conquered territories were a real treasure chest.

Together with those items that represented the original wealth of our land, others coming from Spain—or parts of other continents with which the Spaniards had contact—came to take on an important role. Some of these were wheat and rice, among the cereals; such prized fruits as oranges or bananas; coffee, which soon became a favorite with the natives; and sugar cane. By growing and grinding the latter, Hernan Cortes initiated Mexico's industrial agriculture.

Furthermore, important species of work and food animals, nonexistent on this continent, were brought from across the seas and were soon naturalized, thus giving rise to huge fortunes. Such were the horse and donkey, cattle, goats, sheep, pigs, and the provident hen.

Spaniards were content to see how the cereals, fruits, and livestock that they introduced to New Spain were prospering. At times the transplant was so successful that the monopolistic interest of the Mother Country decided to hinder its cultivation. Such was the case of the vine, which permitted the preparation of excellent wines, whose competition with the imported ones was not desired; or the olive, which produced splendid oils and was equally as troublesome to the interest of Andalucian growers. Even today, in the pleasant little town of Tzintzuntzan, on the shores of beautiful Lake Patzcuaro, some centennial olive trees can be seen. The people attribute them to the king Caltzontzin. This monarch, who is said to have planted them, was ruling when the Spaniards arrived and was villainously assassinated by them after they had tortured him to get the secret of his treasures. Even the father of our Independence, Miguel Hidalgo y Costilla, in his fight for improving the Indians' lives, had to face harassments and defy penalties when planting vineyards and olive trees in his parishes.

It was believed that New Spain was an emporium of riches. Many of them, due to their exotic character, excited the curiosity of the studious, who wanted to know them better.

At the same time, practical men were thinking that, when expert eyes and educated minds (which were not abundant in the files of the coarse conquistadors) traveled the territory, they would surely discover many more items to enrich the Spanish crown.

This led Felipe II to send his chamber physician, Francisco Hernandez, to explore New Spain and study its vegetable, animal, and mineral products. Reed (1942) qualifies this mission as the first scientific expedition to be paid for by any government.

Seven long years (1570-1577) were used by Hernandez in his prolonged trips through mountain and valley, jungle and desert, coasts with burning climates or the cold slopes of snow-capped mountains. Upon returning to the Mother Country, he carried with him a treasure of minute descriptions and innumerable plates, beautifully executed by Indian painters, which astounded the erudite on the other side of the Ocean.

Unfortunately, in spite of the value given them, those originals were never published during the lifetime of their author. They were largely lost during a fire at El Escorial, so that it was at first believed that there was nothing left of them. Three successive editions, incomplete and defective though they were, made it possible to form a rough idea of Hernandez's work. They were the Ximenez (1615) edition in Mexico, the Recco (1651) edition in Rome, and that of Gomez Ortega (1790) in Madrid.

Scholars all longed to become completely and authoritatively familiar with the writings of Francisco Hernandez, but it was not until 1959, under the auspices of Mexico's National University, that a complete edition of them was begun. It is preceded by an erudite study of the conditions of Spain at that time and another detailed one concerning the life and work of the author. It concludes with an analysis and modern estimate of the sixteenth-century materials by a group of contemporary Mexican specialists. Seven beautiful, imposing volumes—of which four have appeared—will be the fruit of this great undertaking (Hernandez, 1959-).

Many years passed before the Mother Country again thought about studying the natural products of its American colony. This did not keep native investigators or European visitors from publishing partial studies, which not only stimulated the curiosity of their colleagues across the sea but awakened the interest of the authorities in carrying out research, from which they hoped to receive considerable economic benefits.

Therefore, within the progressive political framework—child of the Enlightenment—sustained by Charles III, an expedition was organized. It was headed by the Spanish doctor Martin Sesse—then resident in Mexico. Along with such brilliant Spanish investigators as as that of Mociño.

This expedition (Beltran, 1967) worked from 1788 to 1802, and its final phase coincided with the visit to New Spain by the encyclopaedist scholar Alexander von Humboldt. The latter, in his monumental work *Political Essay on the Kingdom of New Spain*, proclaimed unreservedly the enormous wealth of the territory, which only awaited a more intensive exploitation with advanced techniques to yield fruits which would be practically incalculable.

The incontrovertible weight which Humboldt's opinions carried throughout the world, and which in this case were planted in already fertilized soil, confirmed the proverbial idea of Mexican riches. Providential judgement even justified them with the shape of our territory as an inverted conucopia, able to pour forth the most varied gifts.

Twenty years after the visit of the German scientist, Mexico was separating itself from Spain after a bloody ten-year war; and in 1821, it was entering the forum of independent nations.

Mexico was born with an enormous territory of more than four million square kilometers and a population which was calculated at barely seven million people—few for such a great area.

The long struggle with the Mother Country had caused Mexico's resources to dwindle considerably. In the social arena, two opposed tendencies hurled the country into an interminable series of civil wars lasting more than half a century. One of these trends was that of stagnation or retrogression (the monarchic and centralist groups), and the other was that of revolutionary progress (the republican and federalist factions).

In 1876, the regime of Porfirio Diaz began (which was to last until 1910, when the Revolution violently overthrew it). It was then that a stage of dictatorial peace started. This made it possible to contemplate the country's panorama and to draw up plans for its development.

The development policy was set down in three postulates, which were thought of as irrefutable. They stated that, in order to achieve their goal, three obstacles had to be overcome: a) the low demographic density, which was to be remedied fundamentally by attracting European immigration; b) the lack of sufficient and adequate communications, which would be removed by improving highways and, above all, by the magic of the railways; and 3) the lack of the capital and technology required for industrial development. This, of course, would have to be imported from the countries which had it.

Unfortunately, the efforts made in these three directions, requiring many sacrifices and causing still persistent social tensions, failed to give the abundant fruits which were expected.

Attempts at colonization, mainly with French, Italian, and some American groups, never reached the sufficient proportions to affect our demography. They did not serve to incorporate broadly enough with new ways of life and work; they did not make meaningful contributions of economic resources; and at times they created situations that turned out to be undesirable.

Highway promotion was not given the impetus which it deserved, since the effort to construct railroads monopolized interest; and this aim was only realized at a great cost, without being laid out in true response to national development. Instead, it served the interests of the United States: the most important lines ran from north to south—at times unnecessarily parallel. Those of importance for the European nations ran along the line that connected the capital to the port of Veracruz. In both cases, they were used preferably for the exportation of raw materials sold at low prices and for the importation of manufactured articles, which were bought at a high cost.

As regards the importation of capital, though this was somewhat successful in attracting it by means of a policy which offered it too much protection and in the number of industries which arose, the result was to the advantage of foreign investors and not the harmonious development of the country. Even the fruits of the longed-for importation of technology were very meager. In order to implement the little technology that they needed, industrialists chose individuals of their own nationality and, except in rare cases, they jealously tried to keep them from passing their knowledge on to Mexicans.

During the colonial epoch and the first century of Independence, the use of natural resources—renewable and unrenewable—was generally irrational and destructive, as happens in all colonialistic types of exploitation, as they attempt to get the greatest benefits at a minimum cost in the least possible time. They leave only the crumbs of their yields to the country, although this represents the exhaustion and even total destruction of resources.

Thus, for example, the mining industry, which was the foundation of our economy for a long time, caused the total destruction of extensive, rich forest areas, which were irresponsibly exploited to produce the wood needed by mining companies in large amounts for various uses.

Then, in this century, the exploitation of minerals was joined by that of oil, and the same conditions recurred. Until 1938, when Mexico claimed its ownership of such an important resource, the companies made their shareholders—Englishmen, Dutchmen, and Americans—fabulously wealthy. However, they only produced insignificant fiscal income, disproportionate to the value of the profits obtained; and they did not leave works to benefit socially the zones where they operated.

Agricultural exploitation, shared with foreigners by national groups (prominent among them the extremely wealthy religious orders, which existed till the second half of the last century), was carried out by taking advantage of two conditions, which were favorable to large landowners, although socially disastrous to the country. The first was the huge size of the large states, some of which covered two and half million hectares. The second was the plentiful, cheap, and docile labor, which very often—in fact though not in right—was kept in a servile position.

Under these circumstances, landowners felt no desire to plan their exploitations rationally, since they always had more land than the rachitic economy in which they moved made them want to put into production. Neither were they willing to make large investments to mechanize and modernize their methods in order to cut down production costs, since the abundance of unbelievably cheap labor let them take most of the profits of their efforts.

Reflecting the desire to eradicate this slave structure, the National Agriculture School, when it changed locations in 1923, chose a motto to guide the agronomists whom it trained: "Exploit the land, not man."

The notion of fabulous wealth, which had dominated our appreciation of the country's natural resources, became a reason for reconsiderations, when the resources were more adequately explored. They brought many to the conclusion that we were extremely poor, an idea that began to take shape toward the end of the last century.

Nowadays we know that both these points of view are mistaken. Our situation in this regard can yet lead us to a considerable development, without blinding us to two adverse factors, among others. First, there is the relative scarcity of water and, above all, its irregular distribution: both geographically and as regards the periodic occurrence of rain. Although in many areas total precipitation is satisfactory, there are long dry spells.

Likewise, the broken configuration of much of our territory not only makes land communication difficult and costly, but also deprives us of major navigable waterways. It favors soil erosion and the formation of torrential run-offs.

The irrigation works that our government has been developing for almost half a century are opening up new zones to regular and productive crops; and soil and water conservation works, although as yet insignificant in proportion, show that we are paying attention to the problem.

Furthermore, a wooded area estimated at around 40 million hectares, along with more than 10,000 kilometers of coast, indicate two sources of wealth: forestry and fishing. These great potentials, which have so far only been used on a small scale, will be able to contribute substantially to our economy, as soon as we take complete and rational advantage of them.

This general panorama, which I have briefly summarized, was the basis for the 1910 Revolution: the foundation of our present socioeconomic structure, which determines the way in which we now handle our various natural resources.

One fruit of the Revolution is the Constitution, promulgated in 1917. Here we find the ideological and legal basis of the way in which we view our various natural resources—both renewable and unrenewable—and set up the legal and regulatory provisions governing their management.

Article 27 is the one principally concerned with resources. The paragraphs which I am now going to quote are of major importance in this regard:

> The ownership of the land and water found inside the boundaries of Mexican territory belong primordially to the nation, which has always had and still has the right to transfer their domain to private persons, making them into private property. . . The nation shall always have the right to impose on private property the rules dictated by public interest and to regulate the use of natural elements, susceptible to appropriation so as to distribute equitably the public wealth and to safeguard its conservation.

The rest of this article, which is quite long, contains other precepts pertinent to the subject, however, their transcription would take this discussion beyond its permissible limits.

The programs for renewable natural resources in Mexico, upon which alone I feel qualified to expound, can be confined to the areas discussed below. I consider them to be of greatest importance and shall limit myself to mentioning their most immediate background with special emphasis on the laws that regulate them and the official bodies to which their care has been entrusted.

In the following paragraphs the programs for basic renewable resources are given briefly and, therefore, only schematically and with a view to their most general features.

WATER

Since this resource is fundamental in the life of a nation which is largely arid and in some places (the Southeast) is exposed to floods, and whose broken terrain provides a good hydro-electrical potential, much attention has been placed on water problems for many years. In 1926, the National Irrigation Commission was created. Its functions are revealed in its name. Since 1947, this organism has acquired major importance and has become the Department of Hydraulic Resources, which is in charge of the maximum utilization of water. For this purpose the needed facilities are built and are used for various objectives, preferably irrigation, the production of electrical energy, water supply, and so forth. The same Department erects constructions for flood protection, as well as sewage and running water in towns and cities. Every day, more attention is being given to the rational use of water (even for recreation) and to the prevention of its contamination. A full Bureau for this specific purpose has been set up this year.

The Federal Electricity Commission, founded in 1937, is concerned with increasing energy production by all possible means. Among these is hydraulically generated energy, and so this organization is important with regard to the use of water.

SOIL

Due to the abrupt orography of much of Mexico and to the torrential rains which encourage water erosion in some regions, and due to the exposure of some semi-desert areas to intense wind erosion and the harmful results of the rapid deforestation of many areas, the country's soils have declined considerably.

Work presently being done in this respect goes back to 1942, when an office of Soil and Water Conservation was established within the National Irrigation Commission. When the Soil and Water Conservation Law was promulgated in 1946, this office was raised to the status of a full Bureau and became a dependency of the Department of Agriculture and Livestock, where it presently operates.

This Bureau, since its creation, has worked enthusiastically in the important field assigned to it. Not only has it built facilities for this purpose and directed farmers in these matters, but it has even called together some regional congresses, intended to spread ideas on the subject and study the problems of different regions.

Unfortunately, its assigned budget is completely insufficient; and so it cannot fulfill its important mission with the wide range and intensity needed to preserve Mexico's productive future.

The interesting study published in the *Journal of Soil and Water Conservation* (Conservation Foundation, 1954) concerning erosion in Latin America, offers some basic data about Mexico's situation. A wider and more up-to-date panorama can be found in the book by Blanco Macias and Ramirez Cervantes (1966) published by the Mexican Institute of Renewable Natural Resources.

FORESTS

Mexico's forest wealth was originally considerable. When Alexander von Humboldt visited us in 1802, he estimated that it covered more than half the nation's territory. Though it is notoriously smaller today, the National Forest Inventory calculates that it may have an area of some 40,000,000 hectares: both cold and temperate land and tropical zones.

The proportion of forests belonging to the nation is very small, and elsewhere (Beltrán, 1969-70) I have estimated it at around 5 percent of the total. Nevertheless, while the rest is fundamentally the property of peasants (common holdings or *ejidos*) or private property, its management offers no more difficulties than if it were national property, for Mexican legislation allows no forest exploitation that has not previously been approved and regulated by the Forest Service supervising the activity.

Mexican forests have been widely destroyed, mainly to provide wood for mining industries, to open up lands for agriculture, or as a result of irrational exploitation.

As a defense against these excesses, the government's attitude toward the exploitation of forests has unfortunately been basically restrictive. Instead of stimulating the rational use of our forest wealth, different obstacles have been placed in the way. The result is that our country is not only deprived of the income that could be obtained, but at the same time the destruction of woods has been encouraged, since there is no proper economic stimulus to protect them. I have amply analyzed this situation elsewhere (Beltrán, 1964).

Fortunately, this scene has begun to change favorably, though slowly, since 1958 (Beltrán, 1966a) when the need to change policies on this subject was categorically stated.

Besides this serious social obstacle—a mistaken attitude of public opinion toward forests—and the scarce resources provided to the Forest Service, the latter has received due official recognition for its importance. Its management is entrusted to a high-ranking official, with the title Undersecretary for Forests and Wildlife, working inside the Department of Agriculture and Livestock.

The present Forest Law, promulgated in 1960 (preceded by the laws of 1948, 1942, and 1926), is acceptable. At the same time, the National Forest Inventory is being brought to a close. It was initiated in 1961 jointly by the government of Mexico and the Special Fund of the United Nations. Later, it was continued by the former. There is a National Institute for Forest Research, and the training of professionals and subprofessionals, begun at the turn of the century, is presently entrusted to the National Agriculture School for the purpose of preparing forest engineers, who may also carry out postgraduate studies. Also, in Uruapan, Michoacan, there is the National School of Forest Rangers, who act as aids to the engineers, especially in supervising compliance with the Law.

As might be expected, the government is on the right path towards encouraging forest industry. If the public's mistaken opinion can be changed, it is to be expected that Mexico will receive an important contribution to the national income from its forests.

WILDLIFE

Mexico offers very favorable conditions for a varied wildlife, since in our territory the Neartic and Neotropical biogeographical regions are found, each having its peculiar representatives.

Unluckily this valuable natural wealth has been quite diminished. The principal causes, in order of present importance are these: a) ecological changes. b) indiscriminate capture by peasants and farmers for food purposes, and c) clandestine hunting.

The present Game Law was issued in 1940, and today it needs a careful revision, though it does include advanced concepts, such as the one that totally eliminates commercial hunting and absolutely prohibits trade in wild animals or spoils taken from them.

This field has always been one of the most unjustly forgotten. In 1940, it was entrusted to a office of very low category. In 1959, an effort was made to give it impetus by raising it to the rank of a full Bureau of Game, and in 1964 it was given a new orientation, when it was designated as Bureau of Wildlife. This was to indicate that its functions are broader than those it could have if only dedicated to game, without considering all the ecological importance of wildlife (Beltrán,1966b).

Under the Mexican agrarian reform, begun in 1917, the land has been mostly given to the peasants, who receive land holdings called *ejidos*. Frequently, for geographical reasons, these tend to be of little value from the agricultural point of view. However, they offer good conditions for wildlife, and, well administered, they could allow for a productive hunting use. Game farms could be set up and opened to duly authorized hunters, who would make the payments established by the owners. Both the Bureau of Wildlife and the National Tourist Department are developing programs for this.

The excellent book by A. Starker Leopold (1957) on Mexico's wildlife, originally published in English, and later in Spanish translation by the Mexican Institute of Renewable Natural Resources (Leopold, 1965), is presently the best reference work on the variety and potential value of Mexican fauna.

FISHING

Despite the considerable extent of our coasts—10,000 K—fishing in Mexico developed very shakily until recent times, especially because of the low demographic density of the coasts, their unhealthy conditions, and their distance from important consumption centers, which hindered the shipment of many perishable products.

Until rather recent times, the only area where fishing was practiced with any intensity was the peninsula of Lower California, both in the waters of its east coast and in the Gulf of California. This was almost entirely done by foreign ships with American registration.

A study by the author (Beltrán, 1929) shows the incredible backwardness of fishing activities in our country at that time. Another two (Beltrán 1952a, 1952b), which appeared almost a quarter of a century later, point out that the progress made during that period was not considerable.

Traditionally fisheries administration was linked to that of game, and both in turn to the forestry field. Hence, for a long time there was a Bureau of Forestry, Fish and Game. In 1940, the fishing branch was separated from the other two, to be administered by the Department of the Navy until 1959; and since that time by Department of Economy—nowadays of Industry and Commerce—on which it presently depends.

It has always been my belief that the union in only one branch of the fields of forests and wildlife—both aquatic and land animals—is highly desirable giving it the highest administrative rank of Department. If this is not the case, its present assignment to the Department of Industry and Commerce is less objectionable than its previous one to the Department of the Navy. Moreover, it is encouraging that, in order to give it a higher rank within the organization on which it depends, its highest official in charge has this year been named Undersecretary of Fisheries.

The first Fishing Law was promulgated in 1925, and the one presently in effect dates from 1950. The essential scientific research in the field has received some impetus, and now there are suitable scientific centers and two modern oceanographic ships, called the *Humboldt* and the *Alzate*.

Two important factors stimulating activities in this field were, on the one hand, the establishment of packing companies in Mexican territory and, on the other, the commencement of major shrimp fishing, which has proven to be of great economic importance since its beginnings, in spite of its oscillations.

As in other countries of the continent—and many found in other latitudes—one of the major problems that our fishing industry must face is the frequent violation of our territorial waters by foreign ships. This point has always worried Mexican authorities and caused different attempts to settle the problem.

Sport fishing offers excellent prospects; but although it has developed remarkably in the last twenty or thirty years, it is in my opinion something which has not been sufficiently promoted and which could be of major economic significance in the future.

RECREATION

The recreational value of natural resources, which offers the country so many possibilities, has not been stimulated enough. As I have already said, neither sport fishing nor hunting has received the attention required to become important sources of income.

Neither has there been a complete understanding of the high, diverse values of national parks. It goes without saying that they have always lacked the adequate resources for an efficient administration.

The Mexican national park tradition is quite old, and in fact—though not in right—it can be said that the germ for them was planted in 1876, when provisions were issued to protect the zone called "Desert of the Lions." This place, located near Mexico City, became a national park in 1917.

Also, in 1898, it was decided to protect a beautiful wooded region in the State of Hidalgo. It was declared as ***Monte Vedado del Mineral del Chico,*** and is also considered to be a national park nowadays.

The number of places now considered national parks is almost 50. Not all of them, however, meet the desirable, internationally accepted conditions. Many of them yet contain private properties or *ejidos*, and this creates continual problems and conflicts.

Likewise, the lack of sufficient understanding of what a national park is and should be has sometimes led to attempts against them, so as to use them partially for other purposes. An instance of this occurred in 1971, when the announcement was made that no less the Desert of the Lions—a place of such tradition—was to be mutilated in order to construct a new building for the Military School.

The Mexican Institute of Renewable Natural Resources immediately appealed to the authorities in protest against the project (*Beltrán y Vazquez de la Parra, 1971*). A crusade was carried out, which awakened the general sympathy and gained the support of many other organisms, as well as the government's willingness to listen to our arguments. Although there has been no official announcement on the subject, the fact that no mention has been made of the matter for several months leads us to hope that the authorities have given it careful thought, much to their credit, and that this lovely national park has been saved from the planned attempt against it.

POLLUTION

The important ecological problem of environmental deterioration, especially with regard to pollution, has received priority in recent times.

Although, due to our circumstances of a modest level of industrialization, the alarming effects of pollution have not reached the proportions of other more developed nations, they do not therefore cease to exist. In some cases, such as Mexico City, with its large population, industrial agglomeration, and adverse geographic conditions, this problem has already reached alarming levels.

Presently the problem is receiving the attention it deserves. We hope that, before it becomes greater, we shall have taken effective measures to abate it and, wherever possible, to control it.

Among the important aspects of this matter, we might mention—first, in the official area—the issuance of the Federal Law to Prevent and Control Environmental Pollution (March 23, 1971) and the Regulation for the Prevention and Control of Atmospheric Pollution Caused by the Emission of Smoke and Dust (September 17, 1971). Among the contributions from private organizations, there were the "Round Tables on Environmental Deterioration" (IMRNR, 1971), called by the Mexican Institute or Renewable Natural Resources in June, 1971, and the "First Seminar for the Evaluation of Pollution" (IMRNR-SMGE, in press), sponsored by the same Institute in October of that year, together with the Mexican Society of Geography and Statistics.

The most recent example of the State's interest in these problems is the creation in January, 1972, of the post of Undersecretary for the Improvement of the Environment, which is now working actively within the Department of Health and Welfare.

EDUCATION

The panorama of conservation education is not yet a very satisfactory one in Mexico, since it has not been given the intensity it needs. On the other hand, at practically all levels and in all areas, lesser or greater efforts have been made, which show a clear understanding of the problem and indicate that it will only be necessary to give it the economic support it requires for adequate development.

Possibly the first attempt made in the educational field to focus on the problems of administering natural resources was the establishment in 1934 of the course in "Game Zoology and Hydrobiology" at the National Agriculture School, as suggested by the author, who was the first professor of this subject. It was completed by another: on "Hunting and Fishing."

Later, in 1945, also due to the author's efforts, a course called "Conservation of Natural Resources" was included at what is today the Escuela Normal Superior. I taught it for almost fifteen years, and shortly thereafter I began another similar one at the National School of Biological Sciences.

Such courses have multiplied at similar institutions in other parts of the country, and at the School of Sciences and the School of Philosophy and Letters of Mexico's National University they are also currently being offered.

Likewise, in many elementary and secondary education programs, conservation subjects are included, without there being a specific course for them.

In the area of diffusion, some small, but very widely printed books may be mentioned. They are *Man and the Earth* (Vogt, 1944), *Mexico's Natural Resources and Their Conservation* (Beltrán, 1946), *Forests in Soil Conservation* (Wagner and Lenz, 1948), *The Protection of Nature: Principles and Problems* (Beltrán, 1949), and *Natural Resources and Mexico's Future* (Beltrán, 1958). The first four of them were published by the Department of Public Education, and the last one by the National Teachers Union.

In 1966, the Mexican Institute of Renewable Natural Resources prepared a series of three pamphlets: *Erosion and Agriculure, The Conservation and Use of Forests,* and *The Economic and Ecological Value of Forest Life.* They were of a comic-book nature, and a great number of them were printed, becoming very popular. In the same year, the Institute published a series of popularizations of forest matters, at advanced level, very well presented and illustrated. They were oriented to executive level readers, and their four subjects were: *Forests and Nature, Forests and Economy, Enemies of the Forest,* and *Forest Policy.*

The lectures continually offered by members of the Mexican Institute of Renewable Natural Resources, whether at its location or not, and the series of 37 pamphlets written so far, distributed at no charge, are other important educational contributions.

THE PRIVATE SECTOR

In Mexico, matters of research—especially in such fields as that of natural resources—have traditionally been handled by the government. This does not mean that in the private sector some important contributions have not been made, such as those carried out by the Mexican Society of Geography and Statistics, the Mexican Society of Natural History, the Mexican Forestry Society, the Association of Friends of the Soil, and others.

There can be no doubt, however, that the most serious contribution of this sort has been the foundation toward the end of 1962, of the Mexican Institute of Renewable Natural Resources. It began to work in 1953 and since then has labored unceasingly to carry out varied types of research.

Every year, Round Table Sessions are held on subjects of capital importance, related to natural resources. Last year the 15th one met. The Institute takes part in international conferences and does intensive editorial work, as shown in its 30 books—32 volumes—a series of 37 pamphlets, and its 19 Annual Reports which have appeared so far.

LITERATURE CITED

Beltrán, E.
1929, La pesca en los litorales del Golfo de México y la necesidad de los estudios de biología marina para desarrollar esa fuente de riqueza. Mem. Soc. Cient. A. Alzate 49:421-436.

———. 1946. Los recursos naturales de México y su conservación, Mexico City.

———. 1949. La protección de la naturaleza. Principios y problemas, Mexico City.

———. 1952a. La pesca en México, Mexico City.

———. 1952b. El panorama de la pesca en México, Rev. Soc. Mex. Hist. Nat. 13:219-230.

———. 1958. Los recursos naturales y el futuro de México, Mexico City.

———. 1964. La batalla forestal, Mexico City.

———. 1966a. Seis lustros de política forestal, Mexico City.

———. 1966b. La administracíon de la fauna silvestre IMRNR Mesas Redondas sobre problemas de caza y pesca deportivas, Mexico City.

———. 1967. "Las reales exptdiciones botánicas del siglo XVIII a Hispano América," Rev. Soc. Mex. Hist. Nat. 28:179-249.

Beltrán, E.
1969-70 Forestry and public domain. A Mexican point of view, American Forests, Dec. 1969, Jan. 1970.

———. and R. Vazquez de la Parra
1971. En defensa del Parque Nacional Desierto de los Leones, I.M.R.N.R. Foll. 36. Mexico City.

Blanco Macias, G. and G. Ramirez Cervantes
1966. La conservación del suelo y el agua en México, Mexico City.

Conservation Foundation-FAO
1954. "Soil erosion survey in Latin America," J. Soil and Water Cons., July, Sept., Nov.

Gomez Ortega, C.
1790. F. Hernandez Opera, cum edita, tum inedita . . . Madrid.

Hernandez, F.
1959. Obras completas, Mexico City.

I.M.R.N.R.
1971. Mesas Redonas sobre Contaminación del Ambiente, Mexico City.

Leopold, A. S.
1957. Wildlife in Mexico, Berkeley.

———. 1965. Fauna silvestre de México, Mexico City.

Reccho, N. A.
1651. Rerum medicarum, Novae Hispaniae thesaurus . . . Rome.

Reed, S.
1942. A short history of plant sciences, Waltham.

S.M.G.E.
1972. Primer Seminario sobre Evaluación de la Contaminación Ambiental, Mexico City (on the press).

Vogt, W.
1944. El hombre y la tierra, Mexico City.

Wagner, H. and H. Lenz
1948. El bosque en la conservación del suelo, Mexico City.

Ximenez, F.
1615. Quatro libros de la naturaleza . . . Mexico City.

HUMAN POPULATION, FOOD DEMANDS AND WILDLIFE NEEDS

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The scope of the title assigned to me cannot be covered, except superficially, in a short period of 30 minutes. None the less, I will do what I can to touch on some of the salient issues that must be dealt with in these complex inter-related problems, which threaten the survival of man and many other species.

GROWTH IN HUMAN NUMBERS

Man—and near man—is a late comer to the planet Earth. He is estimated to have arrived at somewhere between 5 and 15 minutes before midnight—5 to 15 million years ago—as measured on the 5-billion-year dial of the geologic clock of the Earth. He was preceeded by many millions of years by other mammalian species, and for even fantastically longer periods before by many other species.

Man's spectacular—perhaps temporary—success as a biologic entity coupled with his fecundity, currently threatens the survival of many other species, and even endangers the survival of his own civilization and his own species.

But competition among species on the planet Earth is not a new phenomenon. It undoubtedly began soon after the origin of life. Life is now documented with bacteria and blue-green algae fossil evidence to date back at least 3.2 billion years (Barghoorn, 1971). The competition and struggle for survival between species of plants, fishes, amphibians and reptiles had been going on for hundreds of millions of years before the appearance of mammalians and birds. Species either prospered or perished, depending upon their genetic ability or inability to respond to the natural imperative, *"evolve and adapt, or perish,"* imposed and executed by the relentless selection pressure of ever changing environments. More perished than prospered. Many millions of species flunked the biologic imperative before the appearance of man, and many others have disappeared since his arrival. Many that perished have left only their imprints in the book of fossil rocks and/or, indirectly, in a less conspicuous but much more vital and lasting way as imprints in the DNA and gene pools of surviving relatives.

Then came man, *Homo sapiens*. In the beginning there were only two. In this part of the world we know them as Adam and Eve; in other parts they are known by other names. In any event, their appearance probably provoked no fear and certainly gave no hint to the other species that then inhabited the Earth of the threat and impact they were to subsequently have on the planet Earth. In the first many thousands—or even hundreds of thousands—of years, their descendants made little or no impact on either the physical or biological environment of the Earth. Even though they were undoubtedly heeding the imperative given to Eve and her female descendants—"Be fruitful and multiply" they barely escaped extinction. More than once the survival of *Homo sapiens* must have hung in the balance, for he was poorly equipped to deal with survival in the hostile environment. He was a midget among giants. He had no control over his food supply, was poorly equipped to protect himself from both the elements and his stronger, better-equipped, biological predators. He had no protection against diseases and pests.

The increasing antiquity of Adam and Eve continues to unfold as anthropological and archeological studies continue. The development of techniques to measure the breakdown of radioactive elements, *i.e.* uranium-lead, potassium-argon, etc. during the past three decades has provided us with ever more accurate tools for measuring the antiquity of man.

Without getting involved in the semantics of trying to differentiate between modern *Homo sapiens*—Desmond Morris' naked ape—and certain closely related earlier species, it suffices to state that a growing body of evidence indicates that man is much older than we thought possible three decades ago.

Many anthropologists now agree that Adam and Eve and their descendants, for hundreds of thousands and perhaps for several millions of years, were vegetarians. There is considerable archeological evidence that indicates that about 5 million years ago a vegetarian, near-relative of the Naked Ape, emerged from the bush, somewhere in southeast Africa, stood up on his back legs and, with a rock in one hand and a club in the other, began to stalk small animals as an individual hunter, and thus became a carnivore (Ardrey, 1970; Pfeiffer, 1971). For a long time thereafter he struggled for survival as a hunter, while he continued to supplement his meat diet with wild fruits, nuts, grains and roots. By about 1.5 million years ago he had learned the benefits of group hunting, which permitted him to kill large animals. But human survival remained precarious and growth in human numbers remained slow until the discovery of agriculture and the domestication of animals, which took place only 9,000 to 10,000 years ago. At that time, it is estimated (Miles, 1971) the world population was approximately 10 million. These discoveries soon brought new hope to the Naked Ape. It ensured his food supply. It also brought in its wake the specialization of labor, the development of pottery making, weaving, metal working and other crafts and arts, and these products were exchanged for food. These events soon gave rise to trade, commerce and small industries. And so, in the process, villages, cities and city states and eventually our modern civilization evolved. Soon, however, it also resulted in the first "population explosion."

Since that time, world population has been growing at an ever-increasing rate. The time required for world population to double has been shortening progressively, especially since man learned to protect himself from diseases, thereby drastically reducing death rates without concurrently reducing his birth rate. This predicament becomes evident by examining the average annual increase in world population growth:

1650-1750—0.3 percent
1750-1950—0.4 percent
1950-1960—1.5 percent
1960-1965—2.0 percent

Within the next 37 years today's world population will double, thereby adding another 3.7 billion to the human "family"; a number equal to all that has accumulated since the time of Adam and Eve. It is frightening! (Table 1).

The explosive increase in human numbers in the last 20 centuries has brought about the world population crisis which today threatens world civilization on many fronts. The explosive increase in human numbers is a multi-headed monster that threatens man, not only on the food production and preservation of wildlife fronts, but on the housing, clothing, medical care, employment opportunity, education, transportation, communication, energy, "non-renewable" resources, recreation, environment, social disorder and political fronts. These problems are common to all systems of government.

Not only is there a pending world population crisis, but the crisis has already arrived in many countries. Moreover, we must recognize that the population pressure and population growth are not uniform worldwide. This is clearly evident from a glance at Table 2. Nor is population uniformly distributed within a country. The plight of the enormous megalopolises such as New York, Calcutta, Dacca, Mexico City, Tokyo, etc. indicate that they are all fast reaching a point where they are becoming ungovernable by any government.

It is both discouraging and tragic to see many developing countries, which are now making excellent progress in increasing their food

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TABLE 1. THE GROWTH IN HUMAN (OR NEAR HUMAN) NUMBERS AND THE PENDING WORLD POPULATION CRISIS

Prehistorical or Historical Period	Time of:	Estimated World Population	Years Required for Population to Double
1) Adam and Eve	Kenyapithecus (the Homonid) 14,500,000 Years Ago	2	
			?
2) The Early Hunter	Individual hunter "The Naked Ape" 5 Million Years Ago	?	
			?
3) Early Group Hunting	Clan hunting 1,500,000 Years Ago	?	
			?
4) "Corporate Hunting"	Tribal hunting. Following migrating herds. 40,000-50,000 Years Ago	?	
			—
5) Discovery of Agriculture & Domest. of Animals	Stone Age Man 9,000-10,000 Years Ago	10 million	
			?
6) Time of Christ	1 AD	250 million	
			1,650
7) Late European Renaissance	1650 AD	500 million	
			200
8) Beginning of Bacteriology & Medicine	1850 AD	1,000 million	
			80
9) Advent of Miracle Drugs	1930 AD	2,000 million	
			—
10) Present World Population	1971 AD	3,700 million	
			37
11) A Frightening Look Ahead	2008	7,400 million (Estimated at present rate of increase of 2% per year)	

production and in increasing their industrialization, have these benefits vastly diluted or even nullified because of exploding population growth. A number of the densely populated countries in Africa, Asia and Latin America have been increasing their total GNP by 5 to 7 percent per annum. Nevertheless, because of population growths of from 2.6 to 3.4 percent, only very modest improvement in standard of living on a per capita GNP basis accrues to the millions of hungry and impoverished. There is, moreover, growing unemployment and illiteracy in some of these countries. Were the population growth rates of these countries similar to those of a number of European countries, *i.e.* 0.5 percent, there would now be rapid improvement in standard of living. Even worse, the populations in many of these

TABLE 2. THE GRAVITY OF POPULATION PRESSURES AND DIFFERENTIAL POPULATION GROWTH ON LAND AND OTHER NATURAL RESOURCES IN A REPRESENTATIVE GROUP OF NATIONS[1]

Region or Country	1971 Population (Millions)	Annual Population Growth	Years for Population to Double
WORLD	3,706	2.0	37
A. AFRICA	354	2.7	26
1. Algeria	14.5	3.3	21
2. U.A.R.	34.9	2.8	25
3. Kenya	11.2	3.1	23
4. Uganda	8.8	2.6	27
5. Tanzania	13.6	2.6	27
B. ASIA	2,104.	2.3	31
1. China Mainland	772.9	1.8	39
2. India	569.5	2.6	27
3. Japan	104.7	1.1	63
C. NORTH AMERICA	229.0	1.2	58
1. U.S.A.	207.1	1.1	63
D. LATIN AMERICA	291	2.9	24
1. Brazil	95.7	2.8	25
2. Argentina	24.7	1.5	47
3. Peru	14.0	3.1	23
4. Mexico	50.9	3.4	21
5. Colombia	22.1	3.4	21
E. EUROPE	466.0	0.8	88
1. Finland	4.7	0.4	175
2. Sweden	8.1	0.5	140
3. France	51.5	0.7	100
4. Italy	54.1	0.8	88
5. Germany (East)	16.2	0.1	700
6. Germany (West)	58.9	0.4	175
F. USSR	245.0	1.0	70
G. AUSTRALIA	12.8	1.9	37

[1] Data from Population Reference Bureau Report, Revised Edition August 1971.

countries will double within the next 21 to 27 years, including Uganda, Kenya and Tanzania.

Unless the population growth monster can be slowed and tamed, there will be increasing trouble ahead on many fronts. We have no choice but to work imaginatively and aggressively on all of the fronts that threaten civilization, man and other species.

MAN'S NEVER-ENDING STRUGGLE FOR FOOD

Civilization, as it is known today, could not have evolved, nor can it survive, without an adequate, stable food supply. Man's struggle to ensure his daily food goes back to his first days on the planet Earth. Yet, food is something that is taken for granted by most world leaders, despite the fact that half of the population of the world is hungry. Man seems to insist on ignoring the lessons available from history and continues to relegate agriculture to the lowest rung on the social-economic scale. It is perhaps understandable that the vast percentages of the population living in megalopolises in the industrialized nations have lost their feel for agriculture since the production of their sustenance—food—is out of sight, far removed from their daily lives.

Man's survival, from the time of Adam and Eve, until the invention of agriculture and animal husbandry, must have been precarious because of his inability to ensure his food supply. During the long, obscure, dimly defined prehistoric period when man lived, first as a vegetarian and then as a hunter supplementing his meat diet with food gathering, frequent food shortages must have occurred. Man lived as a nomad and the development of village civilizations was impossible. The struggle for food was a full-time job for all.

In the misty, hazy past, as the Mesolithic Age gave way to the Neolithic, there suddenly appeared, in widely separated areas of the world, the most highly successful group of inventors and revolutionaries that the world has ever known. This group of Neolithic women and men, and almost certainly largely the former, domesticated all the major cereals, legumes and root crops, as well as all of the most important animals that to this day remain man's principal source of food. Scientific man has not to this day been able to match this achievement.

Apparently, nine thousand years ago, in the foothills of the Zagros Mountains—in what is today Iraq and Iran—man had already become both farmer and animal husbandryman. These discoveries soon permitted the specialization of labor and led to the development of village life. Similar discoveries and developments elsewhere soon laid the groundwork for all modern agriculture and animal industry and, in fact, the base on which all of the world's subsequent civilizations have evolved, within a short period of a few thousands of years.

The invention of agriculture and animal industry was a big step forward in expanding food production, but it did not permanently emancipate man from the fear of food shortages, hunger, and famine. Even in prehistoric times, after the discovery of agriculture, population growth must have threatened or exceeded man's ability to produce enough food. Then, when droughts, or outbreaks of diseases or insects ravaged crops, famine resulted. That such catastrophes occurred periodically in ancient times is amply clear from numerous biblical passages. That the reoccurring problem of food shortage persisted is further evident by Malthus's hypothesis on food and population, which was first published in 1793.

The first essential component of social justice is adequate food for all mankind. Food is the moral right for all who are born into this world. Without food man at most can live only a few weeks; without it all other components of social justice are meaningless. I am convinced world order or peace cannot be built on empty bellies. Yet today, 50 percent of the world population is undernourished and even a larger portion is malnourished. If we insist upon ignoring the world need for more food and fail to utilize our science and technology imaginatively and aggressively to expand production—and by so doing help to buy time while others fight on the population front to slow population growth—world order will collapse. The future of many species of wildlife is intricately entangled with the food production problems, not only indirectly so, as in the developed affluent nations, but even more directly so in the densely populated developing nations, which are frightfully hungry for animal protein. Agricultural scientists, animal scientists, wildlife biologists, game managers, foresters, demographers and recreation officials must all work together if we are to avoid disaster and solve the complex problems which threaten mankind.

It is a sad fact that on our planet Earth, at this late date, there are two different worlds, as far as food production and availability are concerned, namely the "privileged world" and the "forgotten world" (Borlaug, 1970). The privileged world consists of the affluent developed nations comprising about 33 percent of the world population. In these nations agriculture is efficient—and industrialization is well advanced—with only 5 to 20 percent of the population engaged in agriculture, but capable of producing sufficient food for their own nation's needs as well as surpluses for export. The consumer in these nations has an abundant and diverse food supply available at a low price; his entire food budget represents only 17 to 30 percent of his income after taxes. Most of the people in these nations live in a luxury never before experienced by man. The vast proportion of the population (70-80%) in these countries is urban. They take the abundant and cheap food for granted. Many of them think it comes from the supermarkets and fail to understand the investments, toil, struggle, risks and frustrations on the ranches and farms that are required to produce the abundance they take for granted.

The "forgotten world" is made up of the developing nations, where most of the people, comprising 50 percent of the world's population, live in poverty with hunger a frequent companion and fear of famine a constant menace. In these nations a vast segment of the total population—ranging from 60 to 80 percent—is tied to a small plot of land in an inefficient subsistence agriculture. In these nations food, and especially animal protein, is always in short supply and expensive. The urban consumer in such countries expends 60 to 80 percent of his income on food in normal times, and when droughts, floods, diseases or pests reduce the harvests, all of his earnings go for food, and even then he is unable to buy what he needs. Many of the subsistence farmers themselves are often short of food and even a larger proportion are suffering from protein malnutrition.

Why does this great discrepancy exist between the privileged and the forgotten nations in food production? Although many factors are involved, the four major causes are: the difference in per capita endowment of natural resources, *i.e.* good arable land, the availability or non-availability of proper modern technology developed by research for increasing yields, the presence or absence of strong economic and extension infrastructures and adequate or inadequate visionary policy supported by government. Of these, the two greatest problems of the developing countries are the small amount of arable land available on a per capita basis coupled with low and stagnant per hectare yields.

Table 3 illustrates the comparative food production capabilities of land exploited under hunting and various types of agriculture. It is apparent that modern American agriculture employing advanced technology is capable of producing much more food per unit of land than other methods of exploitation.

I have, with a team of scientific colleagues from many countries, spent the past 27 years trying to help many developing nations increase the efficiency of food production of their agriculture and, I hope, in the process, to also have at least in some small way alleviated temporarily human population pressure on some wildlife habitats.

TRANSFORMING A TRADITIONAL AGRICULTURE

In most of the hungry, densely populated nations of the world, agriculture is inefficient. Crop yields are low and stagnant and have been so for centuries. The soil is tired and "worn out," depleted of

TABLE 3. COMPARATIVE FOOD PRODUCTION CAPABILITIES OF LAND EXPLOITED UNDER HUNTING AND VARIOUS TYPES OF AGRICULTURE
(Storck and Teague, 1952)
(Productivity expressed in number of people that can be supported per unit of area)

System of Exploitation	Area Required	Number of People Fed
Hunting[1]	2500 hectares	1
Foraging[2]	250 hectares	1
Hoe agriculture[3]	250 hectares	3
Plow agriculture[4]	250 hectares	750
Modern agriculture[5]	250 hectares	2,000*

[1] Indians of the North American plains (before European influence).
[2] Californian Indians (before European influence).
[3] Eastern wood-land Indians of N. America (before European influence).
[4] Ancient Egyptian agriculture.
[5] Highly developed modern agriculture of the USA (based on 1950 yields).
* If 1970 yields were used this figure would increase by between 35 to 40 per cent.

one or more of the essential plant nutrients, after hundreds of years of continuous cropping. The cereal crop plant has a difficult time surviving and so do the weeds, the disease organisms and insects that feed on the cereal plant. Then imagine the plight of the peasant farmer trying to eke out a living under such conditions. But the entire system is in "balance with nature"—but what a balance.

To change such a system one must develop information through research which will permit the development of a package of new technological practices wherein all factors affecting yield and production can be manipulated.

There is no magic seed. One must begin with the soil and determine, through experimentation on each of the major soil types, which plant nutrients are limiting crop yields. In most soils it will be nitrogen and phosphorous, but others may also need potassium. Some may need in addition certain minor elements. Once the nutrient deficiencies have been determined and corrected by the addition of the right kind and amounts of chemical fertilizer, it is necessary to develop a set of improved cultural practices which will properly utilize the available moisture. Since weed growth will also flourish with the applications of fertilizer, mechanical and/or chemical control must be devised. Weeds do not produce food. Then a new variety with high genetic yield potential must be used to exploit efficiently the full value of the fertilizer and improved cultural practices, since the variety formerly grown by the peasant farmer is poorly adapted to the new conditions. The new variety must be, in so far as possible, resistant to the major disease and insect pests, since these organisms will now find a much more favorable environment in the lush growth. It must be pointed out that, although it is relatively easy to breed in or incorporate disease or insect resistance into a new variety, there is no assurance how long this resistance will remain functional. The micro-organisms and insects mutate and develop capabilities of attacking the resistant variety sooner or later. Therefore dynamic breeding programs must be maintained. Moreover, chemical and biological control measures for insects must be developed which can be used when emergencies arise.

Even when a new improved technological package is completed, it will not change food production until applied on vast numbers of the nation's farms.

The value of the new technology must be demonstrated on hundreds of farmers' fields in direct comparison with the peasant farmers' methods. Large yield differences of 100 to 300 percent, which is frequently possible, must be demonstrated if the farmer is to be convinced. Yield differences of 10 to 15 percent will convince no one.

Before the farmer can apply the new technology—even though he is convinced—government economic policy must be brought into line. Political stability is essential. The inputs such as chemical fertilizer and seed must be made available. Government credit for their purchase must be made available, since the peasant farmer has no capital. And finally, the government must establish and maintain a stimulatory and stable price for his grain.

We have had the satisfaction of seeing Mexican wheat production increase 7-fold, and per acre yields increase 4½-fold; in the process Mexico became self-sufficient in this cereal in 1956. Using the Mexican varieties—which were unique in having high-yielding ability combined with wide breadth of adaptation, because of the manner in which they were bred—and drawing on the Mexican agronomic and pathologic experience, combined with excellent, extensive, adaptive research conducted in India and Pakistan, a revolution in wheat production has occurred in these two countries. The popular press has referred to this rapid change in cereal production in the past four years as The Green Revolution. Wheat production in India has risen from a pre-Green Revolution 1965 high of 12 million metric tons to 23.3 million tons during the last harvest. Pakistan's production has risen from 4.3 million tons to more than 8 million. More significant, however, than even the increase in wheat production itself is that more than 90 percent of the increase in production resulted from increase in yields per hectare, particularly significant in a land hungry country. The Green Revolution, which began on wheat, is spreading to rice and maize. Some farmers in West Pakistan and Northern India, who use the new technology and new seeds to double crop of wheat and rice in one calendar year, are harvesting a total of 13 tons of grain per hectare instead of their former production of 2 tons. Although the progress is still modest compared to total need, it is a step in the right direction. Hope has at least temporarily displaced despair, but there is no time for complacency because the population monster grows relentlessly.

COMPETITION BETWEEN MAN AND WILDLIFE

Up until the last two decades, the population pressure of man on wildlife species had largely been confined to the temperate zone or to high elevation cool climate areas of tropical zones. The situation has begun to change since vaccines and/or insecticides have come into being that control yellow fever or the vectors of malaria, sleeping sickness, river blindness and chagas, etc.

The vast, diversified and fascinating reservoir of wildlife species in Central and East Africa will come under ever-increasing pressure (Borlaug, 1971 a). Myers in 1971 pointed out the need for extending the area in the game parks and game reserves so as to include wider habitats. He also indicated the increasing importance of tourism as a winner of foreign exchange to the governments of Uganda, Kenya and Tanzania. Moreover, he indicates the increasing problem with poaching in game reserves and parks.

The expansion of tourism will help solve the problem of foreign exchange but little benefit will accrue to the masses of rural hungry peoples. The amount of poaching will continue to increase despite controlled cropping and sale of meat from reserves. It would appear to me that it is important and urgent to use science and technology to increase the yields and production of both agriculture and animal husbandry in both the humid tropical band in Central Africa and in East Africa, if the wildlife is to be preserved. Unless this is done, human population pressure will soon build to a level where no government—regardless of their interest in preserving wildlife—will be able to withstand the demands and pressures of their hungry people.

The indirect value of science and technology in agriculture and animal husbandry toward assisting in the conservation of wildlife in the USA illustrates this principle. A recent study (Barrons, 1971) clearly indicates the increase in efficiency in food, feed, oil and fiber crops during the past 30 years. This study included all of the 17 food, feed, oil and fiber crops grown on a million acres or more during the 1968-70 period. The average figures for area sown, yield per acre, and total production for each of these crops were calculated. Comparable calculations were made for each of the same crops for the 1938-40 period.

Using the average yield and production figures for each of the crops in the 1968-70 period as a base, calculations were made for each crop to determine the area that would have been required to provide the same output using the 1938-40 figures. The results are startling. The area of 281 million acres cultivated to these crops in 1968-70 produced enough to meet the domestic needs of the USA, plus an additional amount of produce for export valued at 7.8 billion dollars. The amount of land that would have been required to produce the same quantities of these products, using 1938-40 yields and technology, would have been 572.9 million acres, more than double the area under cultivation in 1970. Much of the increase in yields and total production in 1970 over 1940 was due to the use of agricultural chemicals, especially fertilizers, weed killers, and insecticides. Improved cultural practices and improved seed also played important roles.

Within the past decade, because of improved technology and higher yields, it has been possible to remove 50 million acres from cultivation and still meet both the domestic and export needs for agricultural products. Were the country still relying on the 1940 technology, however, not only would the 50 million acres now held in reserve be back under the plow, but, moreover, an additional area of 241.9 million acres by necessity would have been opened to cultivation. In fact, it would have required considerably more than 241.9 million acres of additional land since the quality of the land would have been poorer than that now in cultivation. In order to have been able to have brought this additional area under the plow, it would have been necessary to have opened to cultivation lands that in a large part would have been rolling or semi-arid, and consequently vulnerable to erosion by water and wind. It would also have meant clearing the forests from large areas so as to meet the food, feed, oil and fiber needs of the nation. Now, reflect on the additional havoc that this expansion of cultivated area would have done to wildlife habitat, and especially to rare and endangered species of animals and birds that are already on the brink of extinction.

Looking at it from another angle, 291.9 million acres of land, an area roughly equivalent to the total land area of the USA east of the Mississippi River and South of the Ohio River is today available for other uses, because of the improvements in crop production technology that has taken place in the past 30 years. These uses include wildlife, forestry and recreation. Although Barrons' studies were made in the USA, it behooves all mankind to increase the efficiency of agriculture, animal industry and forestry, if we wish to alleviate human suffering, conserve wildlife, and improve recreational opportunities.

I marvel and admire the progress that you have made in wildlife biology and game management during the last few decades. You have re-established a number of species, such as the wild turkey that was nearly extinct. You have successfully introduced foreign species, among them the Chinese ring-necked pheasant, which has taken over the niche vacated by the prairie chicken, who could not adapt to the selection pressure of modern agriculture. Wildlife biologists have developed expertise for successfully rearing many species of fish and birds, for restocking rivers and lakes, and fields and woodlands. You have developed controls for certain diseases, parasites and predators of fish, birds and animals, all of which have contributed to helping wildlife programs. The research that led to the control of the lamprey which threatened the existence of the lake trout is monumental; equally fascinating have been the spectacular recent results of the introduction of Coho salmon into Lake Michigan and Lake Superior. Wildlife biologists have developed excellent systems for monitoring and understanding the population dynamics of many species. These data permit the establishment and implementation of realistic cropping or harvesting game laws. The result of all of this is that there is, in many parts of the USA, more game now than there was 20 or 40 years ago. One can only marvel at the resilience of wildlife when it is given reasonable protection. When I return now to the small farm in Iowa where I was born, I see deer, bobwhite quail, Chinese ringnecks, and opossum where there were none 40 years ago. In the vast, newly irrigated, highly productive agricultural areas of the coast of Sonora and Sinaloa there are large numbers of a diverse group of bird species that did not inhabit the coastal area 20 years ago.

Yet, despite this progress, there is trouble ahead for some species. In the USA, three to four dozen species each of mammals, birds and fish and about a dozen species of reptiles and amphibians are considered rare or endangered. There are probably several hundred species that are facing extinction in other parts of the world. Almost certainly some of these species are about to flunk the imperative "evolve and adapt or perish" as their habitat is destroyed by the relentless pressure of human numbers. I am of the opinion that wildlife biologists and game managers, and forest biologists and forest geneticists are at a great disadvantage compared to agricultural crop scientists and domestic animal scientists. The number of agricultural crop plants of major importance does not exceed 20 species, and the major animal species on which our modern civilization depends, does not exceed 10. Consequently they can concentrate their research budget and production effort on a few species. You have been unable to do this.

It would seem to me that wildlife biologists and game managers must prepare a list of the threatened species and establish an order or priority for research and protection. Unless this is done—with the limitations of budgets and trained scientists available—an attempt will be made to save all threatened species, with the end result that many rather than a few species will become extinct.

The same danger exists in the environmental movement. There is a tendency today to try to correct immediately all abuses of the environmental without establishing priorities. Within the past two years, 344 environmental bills have been passed and funded by state and federal governments. Almost certainly such poorly planned precipitous uncoordinated legislation will produce disappointing results; disenchantment will follow.

In closing, I urge you to make every effort to attempt to take advantage of the principles, methods, and techniques that have been developed and used successfully in domestic animal and human reproductive biology to increase reproduction. I refer to artificial insemination, the freeze-storage of semen, the inducement of estrus with hormones, diet and photoperiodism, the inducement of superovulation, and embryo transplant.

Artificial insemination is used today on 60 million cows, 50 million ewes, 125,000 mares, 56,000 goats, 4 million turkey hens and large numbers of sows and hens. I urge you to explore the feasibility of using one or more of these techniques to try to save some of our threatened rare species.

As the number of individuals in a rare species is reduced, it becomes increasingly more vulnerable to decimation by diseases and pests, because of the narrowing of the genetic base. Conceivably artificial insemination, employing semen from the rare individuals that are widely separated geographically, might be used to broaden the genetic base and minimize dangers from epidemics which might arise and threaten to eliminate the species.

Moreover, I urge you to attempt to use, not only artificial insemination, but also all of the other techniques imaginatively, without preconceived reservations. Artificial inducement of estrus and artificial insemination may help circumvent problems of breeding territorial animals in captivity. They may be useful both for zoos and for restocking. Do not be fearful of developing a strain that will only be adapted to life in a zoo and will not reproduce in nature. The mustang of the USA, the present "wild" asses of Egypt, the Chillingham "wild cattle" of Britain are all feral—animals which were once domesticated but have returned to the wild. All reproduce and survive normally in the wild. But to me, if there are any fears along this line, they can be dispelled by observing the evolution of the water buffalo. The domestic water buffalo is perhaps the most docile, lethargic, dull, spiritless and sluggish animal in "captivity"; yet, it has reverted successfully to the "wild" or feral state, and occurs in large numbers in northern Australia. Moreover, in Assam, the native home of the wild water buffalo, wild bulls often kill the domestic bulls and sometimes mate with the sluggish domestic cows of peasant farmers. The calves from such matings are more difficult to handle and are very difficult to make use of for plowing or pulling a cart (Gee, 1964).

There is also circumstantial evidence in plants that rust resistant genes can persist for hundreds or even perhaps hundreds of thousands of years in populations of maize (*Zea mays*) and western white pine (*Pinus monticola*) respectively in the absence of the selection pressure of their respective pathogens, *Puccinia polysora* and *Cronantium ribicola* (Borlaug, 1971 b). The persistence of genes in such populations, together with how well many domesticated animal species have "returned to the wild" should reassure us of the great flexibility in the genetic system.

I have learned from 27 years of experience in wheat breeding and wheat production that ultra-conservatism in methods is not recommendable. The non-conservative methods used in our wheat breeding program produced the high-yielding Mexican varieties that were equally as well adapted in India and Pakistan as they were in Mexico where they were bred. They gave rise to the so-called Green Revolution. We are now making good progress toward developing a new commercial cereal crop—Triticale—derived from a wide cross between wheat and rye. Many competent scientists, only five years ago, believed this field of research offered little promise of success. You too should at least dream about the feasibility of certain wide crosses, and dream about the introduction of rare wild species into some of the lesser crowded areas of the world.

I would also encourage you to attempt to establish close working international scientific teams, as we have done and found highly effective in our wheat work. I realize you have had excellent results already in international cooperative efforts on migratory waterfowl programs.

I am convinced you have a great future ahead in wildlife programs if we can all collectively convince the Naked Ape to use his brain and mind to anticipate the catastrophe that will result if he does not voluntarily restrict his increase in human numbers.

LITERATURE CITED

Ardrey, R.
1970. Social contract. Athenium Press. N. Y. 405 p.
Barghoorn, E. S.
1971. The oldest fossils. Scientific American 224(5):30-42.
Barrons, Keith C.
1971. Environmental benefits of intensive crop production. Agricultural Science Review 9(2):33-39.
Borlaug, N. E.
1970. The green revolution, peace and humanity. Nobel Lecture.
———. 1971a. Mankind and civilization at another cross road. The 1971 McDougall Memorial Lecture. F.A.O. c71/LIM/4.
———. 1971b. A cereal breeder and ex-forester's evaluation of the progress and problems involved in breeding rust resistant trees. In Proc. Advan. Study Inst. Basic Biol. Int. Aspects Rust Resistance in Forest Trees. U.S. Dept. Agr. Forest Serv. Misc. Publ. 615-42.
Gee, E. P.
1964. The wildlife of India. 192 p. Collins Clear-Type Press, London.
Miles, R. E.
1971. Man's population predicament. Population Bulletin 27(2): 39 p.
Myers, N.
1971. Wildlife and development in Uganda. Bioscience 21:1071-1075.
Pfeiffer, J.
1971. Man the hunter. Horizon 13(2):28-33.
Storck, J. and W. D. Teague.
1952. Flour for mans bread. 382 p. University of Minnesota Press.

DISCUSSION

DR. JOSEPH HICKEY: (University of Wisconsin): I was much interested to hear Dr. Borlaug's comment that an increase in efficient agriculture would help wildlife populations by the production of higher yields, which would in turn reduce the pressure to put more land into crops. It seems to me that the term "efficient agriculture" will be defined differently by different people. To some, efficient agriculture means the conquest of nature. To ecologists like members of The Wildlife Society efficient agriculture means living with and adjusting to nature and its complex ecosystems. Certainly, to us, good land use does not include the application of persistent insecticides which now contaminate most of the ecosystems of the earth. We feel the attempts on the part of agriculture to be as emotional as those of some environmentalists. There is a middle ground. We have to consider stopping the use of DDT at least in the temperate parts of the world. We want agriculture to look at us as rational, not emotional, people.

DR. BORLAUG: Until there is an effective substitute, we will have to continue using DDT . . . with common sense.

DR. HICKEY: Having studied pesticide pollution on three continents I cannot help being impressed by the global character of the contamination of our environment by DDT. I'm also impressed by the physiological changes that DDT residues have brought about in the bird populations of three continents. The effects of these DDT residues have been subjected to the most careful scrutiny by the scientific community.

This scrutiny included the analysis of residue levels in ecosystem after ecosystem, in the detection of reproductive failure brought about by eggshell thinning on two continents, in the correlation of these eggshell changes with residue levels of DDE (the environmental by-product of DDT) in the eggs of approximately 40 species of birds, and in the testing of these eggshell hypotheses by controlled experiments. It is by no means yet possible to report on all of the population effects of this eggshell disease. In the most extreme case DDE will cause the extinction of one subspecies of the peregrine falcon that breeds from Northern Mexico to Southern Canada; this extinction will take place in the present decade. A second subspecies breeding in the North American Arctic is widely displaying this disease from the Colville River in Alaska east to the Fort Chimo region of northeastern Canada. This subspecies certainly must be considered in danger. Other species of birds in North America and Europe display population effects on a regional level. I believe that the linkage of these population changes to environmental pollution may in time result in the identification of other chemicals that are similarly resulting in the degradation of our environments.

DR. BORLAUG: We should try to find the middle ground. I saw thin egg shells as a small boy in the local chickenhouse. Without selective pressures there wouldn't be any naked apes. Extremism developed not in agriculture but in other places.

DR. HICKEY: These ecological effects are the result of scientific inquiry which in my opinion has been devoid of emotionalism. In Wisconsin I believe that between 10 and 15 percent of the 300 species in the state probably display this disease. We are aware that poultry scientists can suggest many possible hypotheses as the cause of eggshell thinning: My students and I at the University of Wisconsin have examined close to 40,000 eggs that have been laid by wild birds. We believe that DDE must be accepted as the principal cause of this extracontinental phenomenon that began in 1947. To cast aspersions on these scientific studies by personal recollections of egg shell thinning in a poultry house, as Dr. Borlaug has done, seems to me to be sending up so much smoke screen.

DR. BORLAUG: I have no objection to using other chemicals but some of the people who do not understand the principles would do it without effective substitutes; 40,000 egg shells divided among a lot of species is not a good sample.

MR. ROLAND CLEMENT (Staff Biologist. National Audubon Society): Dr.

Borlaug made a valuable comment when he reminded us that we must not fragment our knowledge or our concerns. Certainly, the human dilemmas and conflicts of our day are a result of fragmented or compartmentalized nationality and morality. Doesn't Dr. Borlaug agree that it was exactly such fragmented policy that has resulted in the fact that the World Health Organization (WHO) boasts of having saved a billion lives from malaria while the Food and Agriculture Organization (FAO) properly complains that one and one half billion people are on the verge of starvation?

DR. CLARENCE COTTAM. (Welder Wildlife Foundation. Sinton, Texas): With respect to your contention that conservationists have made restraints on agriculture, emotionalism goes in two directions. There are examples of emotionalism on the wildlife and conservation side but, in my opinion, there is equally as much emotionalism on the other side and neither extreme is good. Much of agricultural failure has nothing to do with curtailment caused by conservationists but by excesses of pesticide applications. For example, there are vast areas in Mexico and other parts of the world where cotton cannot be raised, not because of restraints caused by conservationists but by excesses of applications of various pesticides. In many areas in the United States as well as in Mexico, DDT is now ineffective. DDT is used relatively little on both sides of Rio Grande Valley only because it has become ineffective. There are places in California where mosquitoes can't be controlled because of excesses in the use of pesticides and the development of genetic protection of mosquitoes against *any* pesticide. Again this is due to excesses in the control field. Conservationists have nothing to do with this.

BALANCING HUMAN POPULATIONS WITH LIFE SUPPORT SYSTEMS

PATRICIA DEE CARPIO WHITING

Zero Population Growth, Inc, Friends of the Earth, and Oregon Environmental Council, Tigard, Oregon

The innate consequences within a system of excessive human population numbers correlated to an equitable ratio of decreasing natural resources such as water, air, wildlife, and wilderness, brings into focus the assault on the life support systems needed for human life continuance at present levels of demand.

In illustrating a demographic correlation between excessive human propagation and diminishing life support systems, it becomes necessary to establish foundations for ideological change toward a balanced ecoexistence of all life forms.

My proposal is simple. Pollution is a human effluence. It is not air pollution, it is not water pollution. It is human pollution put into air and water that causes chemical imbalance and collapse of life support systems. We must recognize that man, in all his glory, is the basic confuser in the world scheme of natural balance supply and interdependence.

People—too many people—without regard for other species, have

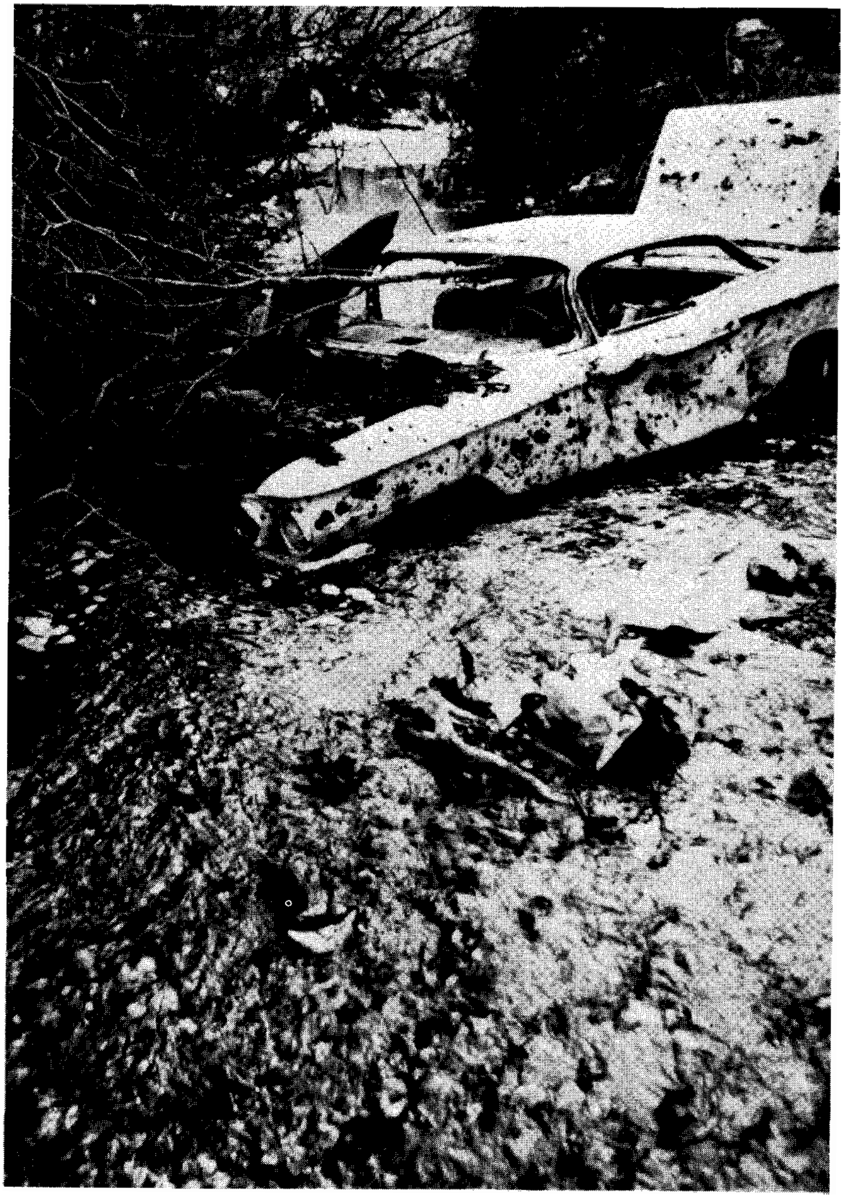


Figure 1.—Affluence and effluence of contemporary man—to survive, civilization must now change such distructive priorities.
Photo by Leon Castillo, San Jose, California

altered the freshness in a breath of air; people—too many people—have altered the free-running stream through rapids wild; people—too many people—are plugging up the heart of nature.

We, as a species, are continuously reproducing our own numbers and concurrently condemning hundreds of animal and plant species to extinction while at the same time we immaturely cling to the standing ovation of more, more, more.

We don't have a task here, we have a monumental immediate necessity—the balancing of our own human numbers with the remaining capacities of the life support systems. It is folly to ignore these systems and the interdependency of all species. If we continue to label a coyote a villain while we belch chemical concentrates into the air and water, any proposed solutions or rhetoric today won't be worth a damn. Where did we lose the nature ethic? When did we become a species unconcerned for the systems with which we once lived in harmony? A suggestion is that early in history human demand for supply manifested a philosophy of "subdue and multiply." The "subdue" attitude established disregard for natural limitations while the "multiply" concept, previously necessary for survival, has today contributed to degradation of the "quality perspective" of life. To exemplify the magnitude of past acceptance of this archaic "subdue and multiply" theory, we must examine aspects of world demography.

It has been estimated that in 8,000 B.C. the total world population was 5 million people. In 1650 A.D., a span of 9,000 years, the world population had increased to 500 million. However, in 1850, only two hundred years later, world population levels had increased to 1 billion people; and by 1930 "subdue and multiply" was heralded by 2 billion separate individuals, an increase of 1 billion people or a doubling of total world human populations within only 80 years. Demographically, this phenomena of population doubling will again occur in just 35 years[1] (Figure 2).

In other words, of all the people who have existed on this planet, one out of twenty-five is currently alive and demanding resource allocations. This rapid accumulation of human bodies and living demands persists. In fact, according to mid-1971 estimates there were 34 new births per every 1,000 individuals occupying this planet which aggravates an already imbalanced situation.

Of the world's current 3.7 billion people, 37 percent are under 15 years of age and the majority are still dedicated to the philosophy of eons past—"subdue and multiply." The very simple equation of

[1] Paul & Anne Ehrlich, *Population, Resources, Environment*. Freeman & Co. (San Francisco, 1970) pg. 6.

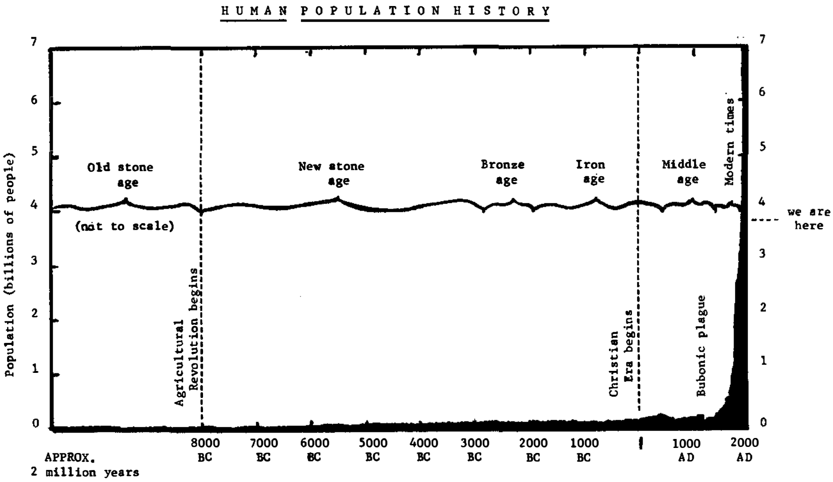


Figure 2.—Man's numbers were 5 million in 8000 B.C.; one billion in 1850 A.D.; and at current growth rates the human population will be 7 billion by 2000 A.D.
Source: Population Reference Bureau, Inc., *PRB Bulletin*, Vol. 27, no. 2. pg. 4. (chart is modified)

increased birth numbers in ratio to decreased death numbers within a closed eco-system results in unpleasant decreases in commodities available per capita in ratio to the increased demand.

The impact and consequences of the current people-pollution assault on a closed and limited bio-sphere, directs the necessity of reviewing current priorities and trends. These trends can be examined by considering facts about two of our representative nations, namely, the United States, a technically advanced and affluent nation using 54 percent of the world's natural resources with a population of 6 percent of the world population, and Mexico, a young industrial nation with a 3.4 percent annual population growth rate, are both faced with the need to curb the human population rate of growth for the sake of survival and quality life within each nation.

In 1900 the United States population was 76 million. By 1950 there were 152 million. In 1970, twenty years later, population numbers had increased to 205 million. (Population Reference Bureau, 1971b) However, it has been expressed that due to the United States' currently low population growth rate of 1.1 percent annually, the problem is being resolved! This is a fallacy. ". . . if present fertility and mortality trends continue, a long-range projection by the National Academy of Sciences foresees that in about 650 years there will be one person per square foot throughout the United States . . ."[2]

[2] David E. Lilienthal, "300,000,000 Americans would be wrong," *New York Times Magazine*. (New York, 1966) pg. 13.

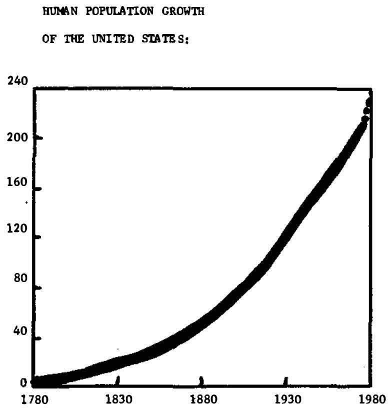
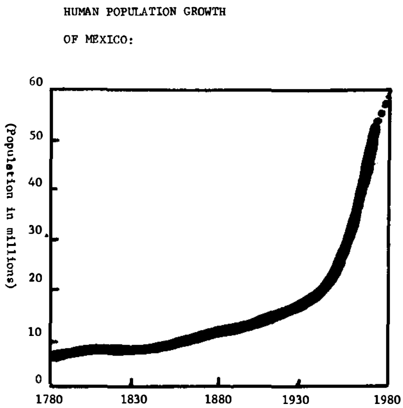


Figure 3.—U.S. population growth in 1850 was 23 million; by 1900 it was 76 million; and as of mid-1971—30 percent of the 207.1 million people are under 15 years of age. Of the total U.S. land area, only 8.7 percent is suitable agricultural land.
Sources: (1) PRB, "The future population of the United States," *Population Bulletin.* Vol. 27, no. 1. Feb. 1971, pg. 6 (modified). (2)PRB, "World population data sheet," Washington, D.C.



Mexico's population growth in 1870 was 9 million; by 1900 it was 13.6 million; and as of mid-1971—46 percent of Mexico's 52.5 million people are under 15 years of age. Of the total 487 million acres, only 7 percent is suitable agricultural land. Mexico is one quarter the size of the contiguous U.S.
(1) PRB, "Mexico, the problem of people," *Population Bulletin.* Vol. 20, no. 4. Nov. 1964. pg. 202. (modified and reduced in projections) (2) PRB, "World population data sheet," Washington, D.C.

Despite the fact that the current 1.1 percent growth rate of the United States is a record low; comparatively speaking, it has not approached the annual death rate, which is only nine per thousand of population. There are other contributing factors to such population explosions; but, the prime factor is the number of youths and the ratio of males to females. One out of three North Americans is under 15 years of age with a larger percentage female than male. This suggests predictable population surge in the United States within the coming decades. Since we have established the current and predictable population status of the United States, what is the population of Mexico in Central America?

Mexico has also begun to realize the pressure asserted by human expansion. In 1940 there were 19.0 million people in Mexico. By 1960 Mexico's population had soared to 35 million. Today, Mexico has 52.5 million people with a growth rate of 3.4 percent annually (Figure 3). Forty-six percent of her population is under 15 years of age. It is quite plausible to estimate that with Mexico's amazing new medical and social health programs, which have decreased death rates 300 percent in the last 42 years, she must prepare and provide for 70 million people in 1980.[3] At this current rate of population growth,

[3] Population Reference Bureau, "Mexico, the problem of people," *PRB Bulletin.* Vol. 20, no. 7. (Washington, D.C., 1964) pp. 173-180.

there will be a doubling of population within just 21 years. (PRB, 1971d)

Current available resources and limited untapped resources can not accommodate the staggeirng demand asserted by the populations of either the United States or Mexico. Nor can the limited life support systems of air, water, and land continue to cope with our growing populations, given the present level of growing effluence as a result of increased numbers of people and technical advancement.

THE SOIL

The most recent failure of man to understand his adverse influence in nature's scheme is related to our extensive reliance upon artificial chemical fertilizers. The nitrogen, phosphorous and potassium that are removed by plant growth have successfully been replaced into the soil by the use of commercial fertilizers. And, consequently, the introduction of artificial fertilization of soils has immensely stimulated crop production. Concurrently, it has also stimulated the growth of millions of people who are reliant upon this new productivity. Utopia ! No.

Investigations have now shown that "Heavy fertilization of soils with phosphates and nitrogens have contributed greatly to zinc deficiency of soils and thus to crops."[4] What significance does a loss of zinc in the soil have to us? Following World War II, animal study investigations have proven that lack of adequate zinc levels manifested in animals ". . . poor growth, loss of fertility, disorders of bones and joints and spontaneous skin lesions."[5]

In October, 1971, the International Symposium on Zinc Metabolism took place in the United States. Representatives from diverse scientific fields have concluded that: ". . . the average zinc intake from a mixed American diet is only little more than the minimum required to maintain balance under ideal conditions."[6] It was also established that zinc is essential in protein synthesis, DNA, RNA and basic polymer formation—the process basic to the regulation and formation of all animal cellular growth. Basically, no zinc, no growth. Zinc deficiency now occurs commonly in man and inhibits the ability for tissue to heal. It is most frequently observed in ". . . growing children, pregnant women, the aged, the poor, and hospital patients . . ."[7] We now know that United States soils are deficient in zinc; what

[4] Walter J. Pories, M.D. & William H. Strain "Once upon a trace metal: the zinc story," *Medical Opinion.* Vol. 7, no. 5. (1971) pg. 2.

[5] Ibid. pg. 1.

[6] Walter Mertz, M.D., "Possible causes of zinc deficiency," *Clinical Applications of Zinc Metabolism.* International Symposium, Case Western Reserve University Medical School. (Ohio, 1971) 1:30 p.m.

[7] Pories, *Medical Opinion,* pg. 3.

else is deficient in our soils? Man must understand that not everything accomplished artificially provides instant solutions.

AIR AND WATER

Just as we are depleting our agricultural soils, we are assaulting the air and water with chemical concentrates by overloading their capacity to absorb and transport away pollutant waste. Pollution is not transported away because there is no such place as "away." We merely "replace" it into our neighbor's backyard, into wildlife's stream, and into the bird's path of flight.

Currently, in the United States, there are efforts for air pollution abatement being considered and formulated into laws; but, what laws and by whom?

In August, 1971, the U.S. Office of Management and Budget, under the directive of the President with the blessings of the Defense Department and the Federal Power Commission, rearranged the proposed *1970 Clean Air Act* guidelines originally proposed by the U.S. Environmental Protection Agency. In just two months the OMB rewrote, without public review, the 1970 Clean Air guidelines and eliminated the "Appendix B Clause" which discouraged deteriora-

Figure 4.—Mercury poisoning of fish and water in California, USA.
Photo by Leon Castillo, San Jose, California

tion of air; established sample regulations dealing with permit systems, emissions, monitoring and air pollution emergencies and compliance schedules; and, also eliminated was the previously outlined requirements for permit systems governing construction and operation of pollution sources.[8]

Just what effect this new action will have on promotion of more air pollution in the United States is yet to be seen. One thing is clear, man is faced with unsurmountable health problems within the next 50 years if, for example, the ongoing nuclear power plant development is carried through without adequate environmental and health hazard studies, because, it has been found, exposure to certain amounts of nuclear radiation over a period of time can alter life patterns and interrupt cellular activity.

Radiation and chemical waste leakage have already seeped into our air, land, and water from nuclear energy activity in the United States and other countries. The U.S. Atomic Energy Commission by 1963 had reported 47 accidents in radiation waste shipments by public transport, 18 spills, and 15 severe impact accidents in the United States. "In 1966 there were 42 accidents at nuclear plants around the world, 37 of them in the United States."[9]

It is no wonder that in the last two years, Tamplin and Gofman, scientists at the California Lawrence Radiation Laboratory, using evidence from exposures to higher doses of radiation, specified that, after 30 years of continuous exposure to the maximum levels of radiation in our environment, now permitted by the AEC, there will be 32,000 additional cases of leukemia and cancer each year and over 150,000 additional deaths each year from chromosome changes caused by radiation. They urge that emissions of man-made radiation to our air and water be reduced to zero, if possible, and that standards be made ten times more strict.[10] Such precaution would be for the health of the people and the protection of life support systems in the United States but they would also establish international concern for neighboring nations. Yet, at the same time, air quality problems experienced in the United States have counterparts in other nations.

For example, according to the "Epidemiological aspects of air pollution" by Blanca Raquel Ordonez, serious air pollution situations in Mexico in 1970 were located in Mexico City, Guadalajara, Monterrey and Tepic. But, particularly important is the situation in Mexico City (Ordonez, 1970).

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[8] Environmental Action, "Clean air—dirty politics," *Environmental Action Bulletin.* Vol. 3, no. 11. (Washington, D.C., 1971) pp. 3-5.

[9] "Nuclear threat inside America," *Look Magazine.* Vol. 34, no. 25. (December 15, 1970) pp. 24-27.

[10] Arthur R. Tamplin & John Gofman, *Population Control through Nuclear Pollution.* (Chicago, 1970) 242 pp.

Mexico City, which is at an altitude of 7,100 feet, surrounded by mountains and which has many sunny days, has a natural air flow that is at a minimum. Result: photochemical smog, the product of radiant energy from the sun acting upon various concentrated polluting substances.

The Pan American Bureau of Health in 1967 to 1968 compared pollution measurements in Mexico City and other Latin American cities. "Dust measurement indicated that Mexico has the most serious problem compared to Argentina, Brazil, Colombia, Chile, and Peru; and Mexico City has the highest sulfur dioxide rate for Latin America. Chronic bronchitis, emphysema, and asthma in 1970 increased 12.7 percent in urban Mexico, 18.9 percent in rural Mexico, and 34.8 percent in Districo Federal."[11]

This is not just Mexico's problem, it is our problem collectively. The growing demand for supply and energy around the world is tremendously increasing. If we must have higher standards of living, if we must have higher energy levels for technology and national development, then we are going to have to recognize that if we disrupt the natural balance of this closed biosphere in which we live, we must begin now to limit our own numbers to the amounts that the life support systems available can carry without such systems being further assaulted by man-generated pollution.

Conservation and industry can not afford to continue to sit at opposite ends of the discussion table. We as individuals and as representative nations must for our survival develop international cooperation if we are going to curb this assault on our common interests. The GNP economic index of advancement can no longer be the sole measurement by which we gauge our advancement and standard of living.

We have at this conference many proposals to explore. Many of the proposals could enhance man's condition on this planet. But, actually, will they if basic limitations are not given consideration? Any proposal, therefore, must incorporate into its directive the understanding that human overpopulation can cancel any effective benefits over a given period of time.

HUMAN POPULATION ETHIC PROPOSAL

It is still possible to establish a quality living environment in the United States and in Mexico. However, internationally speaking, civic and governmental recognition as well as educational and parental recognition of our mutual over-population dilemma is an immediate

[11] Blanca Raquel Ordonez, "Epidemiological aspects of air pollution," *Air Pollution Abstract.* Vol. 2, no. 1. (Washington, D.C., 1970) pg. 92.

necessity. If the United States and Mexico, as two leading nations, would incorporate a "humane living ethic" into their laws and social patterns, we could, as representative nations in the world, project a sensible image for other nations who will be experiencing similar environmental problems.

In conjunction with the goals of this conference, concern with the quality of the environment, and directives to be considered, I propose a "Human Population Ethic" be seriously integrated into the charters and declarations of the organizations in attendance here today.

A "Human Population Ethic" recognized as a responsibility and a necessity should acknowledge the following elective processes of achieving national and international living quality for all people, rich and poor, for the very survival of our species and the continuation of life support systems upon which we depend:

1. *Family planning service*—nationally financed and sponsored—designed to increase parental responsibility and to provide counseling with the purpose of decreasing unwanted births and child abuse, as well as to establish ideal family relations.
2. *Public medical clinics* for counseling and public display and distribution of contraceptives as well as in-care facilities for pregnancy termination upon elective choice of the pregnant female.
3. *Repeal of abortion laws* which are discriminatory against the poor and uninformed by placing pregnancy termination in the care of medicine and out of criminal code jurisdiction.
4. *Population dynamics in education* to allow the children of each nation their civic right to quality life information based on an understanding of the environment in which they live and to allow them to explore, by analytical reasoning, attitudes of the past regarding pronatalist policies and contemporary methods of health and family planning.

At the current rate of population growth the human species will double its numbers within 35 years. Can the United States and Mexico provide for demands of double the human population currently inhabiting these nations? Do we have and can we allocate double the resources currently converted to meet demand in just 35 years?

But, more important, is the destruction of life support systems worth the pleasure of knowing that we can support 7 billion people on this earth at half the current levels of affluency and twice as much effluency?

Advancement must now take on a new perspective—the theory of population stabilization within a closed living system— a "Humane Population Ethic."

ACKNOWLEDGMENTS

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LITERATURE CITED

Borgstrom, Georg.
1969. Too Many. Macmillan Co., London. 340 pp.

Environmental Action.
1971. "Clean air—dirty politics," Bulletin, Vol. 3, no. 11. Oct. 16. pp. 3-5.

Ehrlich, Paul & Anne Ehrlich.
1970. Population, Resources, Environment. Freeman & Co., San Francisco. 358 pp.

Hauser, Philip M.
1969. The American assembly: The population dilemma. Prentice-Hall, N.J. 206 pp.

Lilienthal, David E.
1966. "300,000,000 Americans would be wrong," New York Times Magazine. January 9. Reprinted by Planned Parenthood, N.Y. no. 545.

Mertz, Walter, M.D.
1971. "Possible causes of zinc deficiency," Clinical Applications of Zinc Metabolism. International Symposium. Case Western Reserve Univ. Medical School, Cleveland, O. October 29.

National Tuberculosis & Respiratory Disease Assoc.
1969. Air Pollution Primer. New York. pp. 60-86.

National Wildlife Federation.
1970-71 "Environmental Quality Index," National Wildlife Magazine, October-November.

"Nuclear threat inside America."
1970. Look Magazine. Vol. 34, no. 25. December 15. pp. 24-27.

Ordonez, Blanca Raquel.
1971. "Epidemiological aspects of air pollution," Air Pollution Abstract. APTIC 22426 March, 1970. U.S. Environmental Protection Agency Office. Vol. 2, no. 1. January. pg. 92.

Population Reference Bureau.
1964. "Mexico, the problem of people," PRB Bulletin. Vol. 20, no. 7. Washington, D.C. November. pp. 173-202.

———.
1971. "Future population of the United States," PRB. Vol. 27, no. 1. February. pp. 7-29.

———.
1971. "Man's population predicament," PRB. Vol. 27, no. 3. June. pp. 4-38.

———.
1971. "World Population Data Sheet," PRB.

Pories, M.D. Walter & William Strain, Ph.D.
1971. "Once upon a trace metal: the zinc story," Medical Opinion. Vol. 7, no. 5. May. p. 6.

Tamplin, Arthur R. & John Gofman.
1970. Population control through nuclear pollution. Nelson Hall Co., Chicago. 242 pp.

THE NEED FOR A NEW NORTH AMERICAN WILDLIFE POLICY[1]

DURWARD L. ALLEN

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Policy making, like budgeting for the future, frequently is done with little reference to the manner or means by which worthy ends are to be achieved. Probably we must accept this as a feature of the most disinterested kind of planning. Sometimes there is profit in setting standards and goals to which operations can aspire and against which accomplishments can be measured. It requires thinking things through.

Some such motives were in the minds of John B. Burnham and other leaders of the American Game Protective Association who discussed the need for policy making at the 15th National Game Conference in 1928. In his far-sighted paper Burnham spoke of issues that have a familiar ring today. He noted the increasing mobility of Americans, the flouting of laws by hunters not qualified to be called sportsmen, the paucity of funds—"We lag behind," he said, "in not putting into effect the things we know should be done."

The first resolution of the Association at that fifteenth conference asked that the chairman appoint a committee to draft a "national policy of wild life conservation and restoration, as a basis of coopertive work on the part of all interested organizations and individuals." The committee was appointed, with Aldo Leopold as chairman. He gave an interim report at the Sixteenth American Game Conference and the final report a year later, in 1930. This report has served Magna Carta purposes for 40 years. However, the world of man is changing more rapidly now than at any time in the past. I believe we might profitably reappraise our principles and guidelines in terms of issues immediately ahead. Here I discuss some problems, needs, and philosophies. Hopefully it may lead to another policy study and report.

A CONTINUUM OF GAME PROBLEMS

Deliberations of the original committee were concerned principally with service to the hunter, and the report itself was, as they said, ". . . a plan for stimulating the growing of wild game crops for recreational use." It was written by distinguished sportsmen, who were careful to identify and disapprove illegal activities and outdoor slobbery. They undoubtedly expected that through well-calculated educational programs there would be great improvements along these lines.

[1] Journal paper No. 4698 of the Purdue University Agricultural Experiment Station.

Experience of recent decades indicates that degrading behavior attends nearly every kind of mass activity, and it is a major issue wherever our out-of-doors is swamped by population growth.

On the other hand there has been a steady refinement of the public taste in favor of more sporting methods of hunting and fishing, as well exemplified by the increase in bow hunters. In the twenties, field archery was an embryonic pastime, and actual hunting with the ancient weapon was engaged in by a select few of esthetes who, often enough, made their own equipment. Last year a survey of the Wildlife Management Institute indicated that there are more than 800 thousand licensed bow hunters in 36 states.

Game regulations and management—including the critical province of state-federal cooperation—were a logical purview of the newly renamed American Game Association. An abundance of such issues were crying for attention. As president Daniel A. Poole, of the descendant organization, the Wildlife Management Institute (1971), said recently, there has been good progress in some areas with which the policy report was concerned: ". . . the development of college curricula in wildlife management, a switch in emphasis from artificial propagation and predator control to habitat improvement and natural propagation, development of a national wilderness system, and intensified federal-state cooperation in managing wildlife on public lands."

Leopold classified game into four categories: (1) species that were adapted to farmed habitats, (2) those that lived in forest and ranges, (3) wilderness game, and (4) those interstate and international travelers that we call migratory. This classification has management realism and is still useful. All types of game figured in early problems, and they still do.

In the 1930 report the committee advocated a vigorous program on agricultural lands that would recognize the rights of the landowner to trespass control, find ways to reward the farmer for managing game habitat, and preserve public access to private properties. Remarking on this in a paper discussing the game policy, committee member Seth Gordon (1930) said "sportsmen" were agreed on two points: They would have to pay for their sport, and the landowner must have a square deal. But he laid at rest the idea that great accomplishments would derive automatically from raising license fees.

It has been pointed out frequently that licensed hunters have, indeed, paid heavily in support of constructive outdoor programs, but the change in problems has largely been one of proportion and degree.

Today's agriculture is characterized by the big-business cultivation of crop monocultures on vast areas. These can simply be left out of consideration for wildlife production. On smaller, less intensively used, and more diversified farms there are better opportunities to manage a by-product like wildlife. Usually this is not our highest priced land, and there are problem sites to be handled with a view to their low use capability. There are things the rural resident can do to bring his surroundings to life in beauty and stability. We have made progress in learning the realities and limitations of habitat improvement.

But the truth is that for 40 years we have been waiting for someone to find a way to compensate landowners for producing wildlife for public use. It was a good idea, and if anyone comes up with new inspiration and a successful plan, I will be on his bandwagon in a hurry. But I see no real evidence that this is likely to happen on a large scale. As Leopold expressed it, wildlife is a "thin" crop. Frequently the per-acre yield and the dollar value are low. I hasten to recognize the benefits in big government programs that help reduce the intensity of land use for land conservation and economic purposes. The soil bank plan has pioneered the way for a still more valuable water bank system that can be another move toward mitigating the continuing drainage that has been so ruinous to great areas of wildlife habitat.

THE BROADER VIEW

Today, it is evident that game management is only part of the culture and custody of living things. But this was clear also to the early policy makers, for they recognized ". . . the protectionist or non-shooting nature-lover, who is on the increase, and whose rights and opinions must be taken into account." Forty years later the 1970 Survey of Fishing and Hunting shows that American citizens spent 847 million man-days in the field at bird-watching, nature walks, and wildlife photography. This was nearly 9 percent more than the total time spent at hunting and fishing.

Our modern outlook obviously covers the broad field of wildlife in all its forms. This means we are at the point where state programs should be supported, not only by the hunter and fisherman, but by general funds representing more fully the concern of all citizens for their living properties.

On second thought, perhaps those last words suggest a smug and homocentric attitude—actually it is one in which I do not wholly confide. For in truth, is man the keeper of all his fellow creatures? Does the primate with the big brain, who developed a culture and spread over the entire earth, now own the birds and beasts, the atmosphere and the ocean, the sun, moon, and stars? Are these our properties to cherish or destroy? Whatever privileges we claim, we must thereby own to responsibilities of the husbandman and landlord. If we see the earth only as the household and garden of our kind, then we the occupants and dependents are also the guardians. Should not a new wildlife policy be explicit in the charge we assume?

I suggest that we are at a time in our history when men must rise to a new level of sophistication in their attitudes toward the earth and the life it supports. How could we state a respectable concept and durable motive for managing and protecting living things? What are we after today and tomorrow?

Possibly we could state it this way:

1. We manage native fauna and flora as a part of our natural scene for many non-consumptive uses and esthetic satisfactions found by perceptive men in the orderly world of nature.

2. We protect and husband wildlife as a harvestable resource, most notably for hunting and fishing and certain carefully controlled commercial uses.

3. We harbor and conserve other forms of life out of a prudence that says we are not ready to foreclose options for the future and decide which forms of life may share this earth with us and which may not. In principle we recognize that non-human creatures should live even though we have acquired the means of destroying them.

RIGHTS AND JURISDICTIONS

In our social concerns, we profess a protective interest in the rights of minorities. But sometimes we seem to forget to defend the majority against attacks their provisions of individual freedom have made possible. In particular, our legislative process has a built-in mechanism that frequently permits a local group or individual to despoil public property and values. This has been evident in the abuse of our public lands, and wildlife is one of the public interests at stake.

If majorities of the present are poorly represented, what is to be said about majorities of the future? They, of course, are consistently outvoted. The public interest seems to be noboby's legitimate business, at least not for tax purposes. In resource affairs rights of the majority are a forgotten cause. We hear of the possibility of a new constitutional amendment that would provide guarantees against environmental degradation. I suspect this is something to be pursued, and it might even include a right to have some areas of the earth left alone to take care of themselves.

This confusion of rights is matched by difficulties in the field of state and federal jurisdictions. There is a good basic logic in our system, but it may well need some modification to permit more effective action on nationwide and international issues. We have encountered this recently in efforts to prohibit widespread poisoning of the environment and the use of aircraft for killing wild creatures The danger of wiping out remnant life forms such as the condor, black-footed ferret, eagles and falcons is a national, even international concern. More broadly I could mention the depletion of resources of the high seas and the jeopardy of the world's cats. Which leads to another question: Do all the people of the world have a stake in vanishing species? If so, is there a logic by which our Federal Government could assume certain responsibilities within our own borders under the treaty making powers of the President?

In state governments too we see frequently an unfortunate limitation of jurisdiction. For we have game and fish agencies with few, if any, custodial obligations for other animal life. As noted previously, we can no longer isolate game and fish problems: we are in the business of protecting and managing all living things. In 1930 it was almost true that the hunter was right by definition. Now he must bear the burden of proof that his uses and management are not damaging to other interests. In this relationship he gains support for many essential programs. There are common causes that will, or should, bring together some strange bedfellows.

MESECOLOGY

In general, we probably can say that what is happening to wetland and water habitats still fosters some of our greatest wildlife failures. From the Arctic to mid-America we see the proliferation of water ills in many forms. Drainage, filling, channeling, silting, pollution, and eutrophication in many combinations create ever-renewed battlefields for the defense of native conditions and living things.

An end to this is not in sight. In particular we witness the gains of a strange concept among those preoccupied with replumbing the natural water systems of the continent. In terms of ultimate effects they evidently aim to destroy our environmental diversity, standardize people and scenes, and manage resources and living space to produce every human being who can find standing room.

I refer to the idea that if God did not divide water supplies evenly among various regions, then it is up to man to do so. How far its proponents can go before provoking a revolution among the people who pay in taxes and the defacement of natural features remains to be seen. Against the background of centuries most of our water works will render transitory service to only a few generations; erosion and siltation still are geological processes. We are leaving people of the future a heritage of built-up flood-plains and mutilated scenery. Ultimate costs can not be calculated, and even the immediate price frequently is charged to the future. In the great plans did anyone ever hear about the half-life of a reservoir?

I give some emphasis to this because water problems are at the root of many trends adversely affecting our wildlife, both aquatic and terrestrial. It is evident that our opportunities and limitations in managing wildlife are intimately tied in with what is done with the surface of the earth, its soils, waters, and vegetation. It is true today and forevermore that we will not manage living things without managing environment. That is the big job in planning and operations, and natural processes will do the rest. One could say, perhaps, that the realization of wildlife benefits depends on how successfully we zone our living space for the kinds of uses that permit resources to be self-renewed.

The 1930 report mentioned the mobility of Americans, but I am sure that even the wise men who drafted it could not foresee the problems spawned in this field. Easy transportation has created a new dimension in the public use of wildlife, greatly multiplying the demands of urban dwellers on resources far removed from their local scene. Of peculiar interest is the so-called off-trail vehicle. Several years ago the cover of a mechanics magazine carried a spectacular illustration of a motor-driven monster. "Rugged new all-terrain vehicle!!" the ad proclaimed. "It breaks trail anywhere, knocks down brush and small trees as it goes!"

This personifies a feckless and unsophisticated attitude that is increasing among city-bound people. It regards everything beyond the back fence as a chaos of nature to be tamed and ordered through modern technology. Is there such a thing as a legitimate off-trail vehicle? In principle I think not, and we probably are in the process of making this limitation stick relative to snowmobiles, dune buggies, and any other terrestrial wonder that leaves tracks. In Michigan's northern state forests there are now some 700 miles of maintained trails open to snowmobilers. This is the way of the future, since it is evident that vehicles of every kind will continue to increase.

Perhaps it is natural always to regard the present as a unique dividing line between two alien eras—that of the past and that of the future. But the threshhold of the seventies might well be conceived as separating two phases of our modern cultural history. In the first phase we achieved enough medical technology to reduce greatly the checks on our own numbers. In terms of what a human living standard could be, and with the outlook that high living standards must be maintained into the future, the world has been vastly overpopulated. We indulged in open-ended exploitation of the resource base, and we simply threw aside the by-products and leftovers as though they had no value. In the frantic pursuit of what we call plenty we had little time to borrow the troubles of tomorrow. A major share of our economic expertise has been devoted to rationalizing and speeding from year to year, and from one election to another, the process of using up our earthly substance as though it had no end.

In this impetus of what we call progress, the stresses and problems of humanity are multiplying on an exponential scale. It has been calculated that our total technology is doubling in 15 years. There has been no time to engender the wholesome mores and traditions that would put resource use on a lasting basis. Philosophies are not developed in crash programs. Inevitably a set of moral imperatives must come if mankind is to survive in what we regard as respectability. Most people will be guided, not by scientific facts, but by what they consider to be right, without necessarily knowing why.

As long as "growth" in population and resource demands is the best working policy we can muster, we are still in the crude phase of our technological age. We are in a state of social savagery if we sit by and allow the whales of the ocean to be exterminated. We have not yet arrived on the modern scene as long as New York City can dump each week 1.5 million cubic feet of trash into the Atlantic off Ambrose Light.

The great need of these times is for the human population and its resource uses to be put on a relatively stable basis. The entire earth must be a renewable ecosystem if man is to have a future. Wildlife is one of those assets in which there is, literally, no limit to qualitative improvement.

If ever our educational institutions had a significant challenge, it is in cultivating in the minds of young people an awareness and respect for man's earth-origins and earth-dependence. This is the new departure in environmental education, and only small minorities on school faculties have any background for servicing it. For our scientific majority the specialist role is appropriate and endlessly valuable, but it is the generalist who must create a framework on which great revelations and small facts can be arranged in a orderly cosmography. I suggest that much of the great social unrest that pervades the world is founded in the idealogical vacuum through which many people see the earth and human destiny.

POLICY REALISM

I have emphasized that wildlife policy must be based on sound policies of land and water use. What we are doing now in these fields is largely to serve, at levels it will be impossible to maintain, the overdemands of a wildly expanding technology. Behind this is the massive advance of population—during 1972 there will be added to the earth's population 74 million more people, with all their needs and aspirations. In the long view our management of all resources must be based on a realistic population policy, and there is only one way to go—toward zero population growth and then a progressive reduction in human numbers.

This means a control of birth rates around the world, and it has hardly begun. In the United States we do not yet have a population policy. Like many other moves in the public interest, the formulation of such a policy is politically inexpedient. It is blocked by an atavistic allegiance to longstanding ways of thought, to an irresponsible consecration to economic growth (the easy way to profits), and the confusion of scientific specialists whose disciplines are adrift without benefit of an organizing concept. The immediate prospect is that we will not have a population policy until enough people become aroused to demand one effectively.

But we cannot wait for that. We must assume a calculated optimism because this is the only constructive course. In planning for what is right we can only assume that men will act wisely, that the next instar of human development can be continued indefinitely, that a refined culture will not be dependent on the using up of limited funds of earthly properties, that our mores of the future will require environmental enhancement as the only permissible change.

There are many uncertainties, but we do need another look at wildlife policy—and, beyond that, the next one in our future should come in less than 40 years.

REFERENCES

Burnham, John B.
1928. A national conservation policy. 15th Nat. Game Conf. Proc., 120-127.

Gordon, Seth.
1930. Giving the game policy the laboratory test. 17th Amer. Game Conf. Proc., 7-17.

Leopold, Aldo.
1929. Report of the committee on American wild life policy. 16th Amer. Game Conf. Proc., 196-210.
1930. The American game policy in a nutshell. 17th Amer. Game Conf. Proc., 281-283.
——— Report to the American Game Conference on an American game policy. 17th Amer. Game Conf. Trans., 284-309.

Wildlife Management Institute.
1971. The American Game Policy and its development. Reprint from Conference Proceedings.

DISCUSSION

DR. ANTHONY BUBENIK (Research Branch, Maple, Ontario): Dr. Allen, you said that there is a need for a new North American wildlife policy. My opinion is that it is a worldwide need. I came from Europe only 15 months ago. Despite the differences in hunting laws, and between wildlife management and tradition in Europe and North America, I was surprised that the basic idea in wildlife management, as far as it concerns the wildlife biologists, is nearly the same. In

Europe, for decades, the wildlife biologists were helping to maximize the hunters' harvest, which he is also doing here. Now a new generation of wildlife biologists is growing up in Europe who will be not only independent from the hunter but who will use the hunter as a conservationist. That means that they want the hunter only to optimize the harvest in such a way that the game population structure will be maintained in the optimal social status and optimum relationships to their environment.

DR. ROBERT K. DAVIS (National Audubon Society): I compliment Dr. Allen on a strong presentation and wish to throw out some comments which summarize my interpretation to Dr. Allen's conclusions. Most of us grew up with the notion that agronomists, entomologists, and agricultural economists could be left to define agricultural efficiency and that the wildlife managers could be content to work with whatever this definition left them in the way of management opportunities. We now know that this is tomfoolery and poppycock.

Agricultural efficiency must be defined broadly in terms of social values which include environmental concerns. We have also seen in the last 40 years the growth of many programs which subsidize habitat destruction or render habitat uninhabitable in often unanticipated ways. At the same time, there has been a change in social values more in favor of wild things and less favorable toward the products of technology.

My conclusions from this review are that the new American wildlife policy must be more than a wildlife policy narrowly defined. The policy statement that this working group produces must be concerned with agricultural policy, water resources policy, antipollution policy, cost-sharing policy in natural resources programs, highway policy and other issues which directly affect the future of wildlife habitat. This is not to say that we must solve all the world's problems but that we must identify the pressure points where we can get at the forces affecting wildlife habitat.

MRS. ESTHER DE GALLEY (Biological Society for the Defense of the Environment, Mexico, DF.): We have been accused in Latin America of an attitude of complacency. This was true some time ago when Latin American governments were expansionist-oriented, but it is no longer true. Latin American countries are fast developing an awareness of population pressures in relation to natural resources and in the very near future Mexico itself will be reversing its former policy. The means of birth control in Latin America have been abortion—illegal, unattractive, and unacceptable to the Catholic Church. We are now coming to realize that we need a contraceptive consultation service and governmental social and medical services on a nationwide scale.

Latin American countries will soon be inviting technological cooperation from other countries in administering their family-planning services. Latin America wishes to take advantage of the technological advances of the industrialized countries and to enjoy the benefits of these without endangering our planet in the process. We must cooperate in our common struggle for survival amidst a maze of ecological problems.

I personally favor cannibalism, because—as Mrs. Patricia Whiting pointed out—in reducing the population through cannibalism, Dr. Borlaug's full supply will automatically be reached.

PART II
TECHNICAL SESSIONS

TECHNICAL SESSION

Monday Afternoon—March 13

Chairman: Enrique Beltrán
Director, Instituto Méxicano de Recursos Naturales Renovables, México, D. F.

Discussion Leader: Caleb Glazener
Assistant Director, Welder Wildlife Foundation, Sinton, Texas

MEXICO'S NATURAL RESOURCES

MEXICAN FORESTRY

Eulogio de la Garza

Undersecretary of Forestry and Wildlife of Mexico, Mexico, D. F.

It is proper that, before analyzing the forestry situation in Mexico, we should examine certain data from the national census of 1970. The population in that year was 48.4 million inhabitants, among which 72 percent were under 30 years of age, thus corroborating that Mexico is a country of young people.

It also infers that the population in Mexico is eminently rural, because 42 percent live in communities of less than 2500 inhabitants, and 39 percent of the total population is working in primary labor, basically agriculture.

Within this outlook, undoubtedly, forests in Mexico represent one of the natural resources with great possibilities for diminishing unemployment and speeding up regional development.

Resources

There are 32 main types of forest vegetation. Among the most important, because of their economic value, are the high and medium tropical forests, pine forests, oak forests and fir forests.

Among the pine forests, 42 species and eight varieties have been classified. We know approximately 400 species from the oak forests, and in the tropical forests 300 tree species have been identified.

The national forest inventory, which is being conducted, yields preliminary figures as follows:

The wooded area of the country is nearly 40 million hectares;[1] 29 million hectares can be used, and out of these, 15 million are in conifers; three million are in Temperate Zone broad leaves, and 11 million hectares in tropical broad leaves.

The yearly cutting capacity of conifers, basically pine, is 21 million cubic meters round wood. The broad leaves' capacity, in general, is three million.

PRODUCTION

During the last 20 years, our forests have had restricted use, growing only from 4.5 million cubic meters in 1951, to 5.6 m.c.m., in 1970 (90 percent conifers and 10 percent broad leaves), which means that they only produce 25 percent of their actual capacity.

Distribution of wood production for 1969 was: sawn wood 54.3 percent; plywood 5.1; pulpwood 13.8; waste 26.8, according to the following table:

PRODUCTION 1969

Destination	Cubic meters round wood millions	Accumulated	Percentage
Sawn Wood	3.65	3.65	54.3
Plywood, particle board and hard board	0.34	3.99	5.1
Cellulose (kraft, newsprint)	0.93	4.92	13.8
Waste (branches, bark, etc.)	1.80	6.72	26.8
Total cut cubic meters round wood	6.72		100.0
Charcoal (broad leaves)	2.20		
	8.92		

In 1970 we had a production of 58,000 tons of resins.

FOREST INDUSTRY AND TRADE

Sawn Wood

The forest industry in Mexico during 1970 was made up of: 729 sawn wood installations producing 1.7 million cubic meters. By 1976 it is estimated that demand will be 3.3 million cubic meters.

In 1970 $140 million (Mex. Cy.) were imported in sawn products, and export reached $76 million (Mex. Cy.) in panels (Plywood, particle and hard board).

Twenty-two factories are producing 180,000 cubic meters. It is estimated that by 1976 demand will be for 600,000 cubic meters.

In 1970 imports were $26 million (Mex. Cy.), and exports were $3.5 million (Mex. Cy.).

[1] One hectare = 2.471 acres.

Cellulose

The country's production of cellulose and pulps is 473,000 tons with 68 percent coming from wood, 24 percent from sugar cane bagasse, and 8 percent from vegetal waste.

In 1970 imports of cellulose, wood pulps and paper waste amounted to 168,000 tons worth $280 million (Mexican Cy.).

Newsprint

Manufacture of newsprint is covered by a single plant with production of 40,000 tons, elaborating wood pulp and purchasing chemical pulps. In 1971, so as to complement consumption of newsprint, 241,000 tons were imported, this meaning a leak of currency amounting to $530-million (Mexican Cy.).

Packing Paper

Manufacture of boxes, sacs, bags and various wrapping materials, requires kraft and semikraft papers.

In 1970 kraft paper production was 120,000 tons, and semikraft 350,000 tons, thus covering the needs of the domestic market.

Importance of forest activity is evident as to the production value of forests in regard to raw materials which in 1970 reached $1,357 million (Mexican Cy.), and brought about an employment figure estimated as 57,000 positions of a permanent activity level.

Imports of forest products in 1970 attained a figure of $1,472 million (Mex. Cy.). The subject corresponding to cellulose, paper and its products, represented almost 90 percent of the total figure, and the rest mill-run lumber, veneers and others. From 1960 to 1970, imports of forest products were almost triplicated, representing 70 percent of the value of wood production. Exports mean only 5 percent of production, and eight percent of imports.

ADMINISTRATION

Forest administration is based in Article 27 of the General Constitution of Mexico; in the Law of Ministries, and in the Law of Forestry.

Article 27 of the Constitution points out that property of lands and waters within the limits of the national territory originally pertains to the Nation, which has had and has the right to bestow the dominion of same to individuals, thus constituting private property.

The Nation will have the right, at all times, to impose upon private property the temperance dictated by public interest, as well as to regulate the use of natural resources susceptible of appropriation in order to make a just distribution of public wealth, and therefore, take care of its conservation.

Direct dominion of natural resources in the continental platform corresponds to the Nation. In the aforesaid case, dominion of the Nation is inalienable and unprescriptable, and exploitation, use and profit of the aforementioned resources by individuals or constituted corporations established in accordance to Mexican Law, could not take place without concession bestowed by the Federal Executive, complying with the rules and conditions established by law.

The Law of State Ministries in Article 9 points out that there are multiple subjects corresponding to the Ministry of Agriculture and Livestock, among which outstand some as follows:

1. To plan, to promote and to advise forest production in all its faces.
2. Manage and administrate the National School of Agriculture, and the Colleges of Agriculture and Livestock; and to establish and manage Forestry Schools in the necessary locations.
3. To organize and promote forest investigations, establishing experimental stations, laboratories, reserves, hunting reserves, seed and plant nurseries.
4. To care for forest protection.
5. Promote reforestation and realize plans to reforest some territories directly.
6. To organize and manage national parks.
7. To bestow contracts, concessions and forest and hunting permits.
8. To promote industrialization of forest products.

We will mention Articles 1 and 9, of Forest Law:

Article 1. This Law has as an object to regulate conservation, restoration, promotion and use of forest vegetation, commerce and transportation of products originated from same, as well as national administration of Forest Service, and adequate development and integration of forest industry.

The mandates of this Law apply to all forest lands without consideration of ownership.

Article 9. Forest Administration belongs, in all faces, to the Secretary of Agriculture and Livestock, who will exercise authority through the Undersecretary of Forestry and Wildlife.

CONCESSIONS

In order to authorize an exploitation permit, as a basic requirement, a Forest Management Plan must be submitted.

Authorized volume cut depends upon the productive capacity of the forest, and it is regulated in accordance to the principle of sustained yield.

Three different types of authorization outstand: 1. Industrial Unities of forest operation generally standing for 25 years, and including considerable areas and volumes mostly above 100,000 cubic meters round wood per annum in conifers, and 10,000 cubic meters in precious tropical species, are established to supply with raw materials industries of national importance, requiring a Presidential Decree for their constitution. 2. Unities of Forestal operation of 10 years standing and varying volumes; and 3. Precarious permits with less than 10 years standing and varying volumes.

In 1970 the structure of exploitation permits in Mexico was as follows: Industrial unities 15; other unities 36; precarious permits 441; total authorizations 492.

SILVICULTURE

Mexico has a flora that is extraordinarily varied, complex, and subject to strong alterations.

It is an established fact that a forest will be cultivated and its conservation guaranteed, only so far as it represents an economic profit for the farmer, profit which will be a consequence of the possible demand of the tree as a commercial product.

The most important characteristics in coniferous forest in the country, the type of cutting, and form of regeneration are:

Diameter of dominating trees	30-60 cm.
National average volume	75 cubic meters round wood per hectare
National annual average volume increment	1.2 do. do.
Cutting volume	10 to 120 do. do.
Cutting types, percentage of annual concessioned volume:	
Thinnings	0.2
Shelterwood	1.0
Selection	98.8
Clearcutting	0.0
	100.0
Regeneration type, percentage of annual concessioned volume:	
Natural	100.0
Artificial	-------
	100.0

The average increase per hectare is actually below the potential. It is estimated that the ratio is from 1.5 to 3 times below the possible production per surface unity.

The origins are numerous: 1) By reason of unregulated cutting, burning, overexploitations, and improper silviculture treatment, the growth and development of species which hinder the establishment of pine and fir have been favored, so reducing the available area; the growing space "plundered" by oak, shrubs, grass lands, etc., is from 20 to 60 percent of the total area. 2) Extracting cuts sometimes do not favor the establishment of new seedlings, and because of bad tree population, deformed, etc., forest development lessens. 3) The lack of silviculture as translated in a bad composition, structure and density, obstructs the increase of the forest to its productive capacity.

The growth of rural population in the forest areas, the diminution of productivity of forest soils where agriculture and livestock growing is practiced, plus the lack of factories and technical assistance permanently granted in forest areas without concessions in the country (—60 percent), has brought as a consequence the practice of felling timber and burning in forest lands, especially in the tropics.

As far as plagues are concerned, it is estimated that in the last 10 years, a yearly surface of 26,000 hectares is affected by bark beetles and foliage destroyers.

INVENTORY, EDUCATION AND RESEARCH, RECREATION AND WILDLIFE

By the year of 1973, the first national inventory in our country, will be completed. Up to now we have information of 90 percent of the forest resources in the area.

Education

The National School of Agriculture, in Chapingo, is the only one offering a course in forestry and on a professional level.

In the medium level, we have the National School of Technical Guards, in Uruapan, and the Technological Institute of Durango, which offer a course of Forest Industries Technician.

On an auxiliary level, in 1972, the Secondary School of Agriculture, Livestock and Forestry, in the community El Largo (Madera, Chihuahua), will be established.

From 1972 on, the National Institute of Forest Research will take care of the training of laborers.

From 1972 on, the National Institute of Forest Research will be tied with the Forestry Unit at Chapingo.

The Undersecretary of Forestry and Wildlife will coordinate and direct the establishment of Training Centers at a laborer's level and courses at labor, medium professional and post-graduate levels, taking advantage of close coordinated conditions between the National School of Agriculture and the National Institute of Forest Research, coordination that can be extended to the industrial sector and to national and international organizations, bound to forestry interests.

Research

In 1971, 30 percent of federal investment was directed to forestry research activities.

We have the National Institute of Forest Research in Mexico City, and four Experimental Stations.

There are 37 research projects: 20 in silviculture and management; four in wood technology, and 13 in improvement of trees.

Recreation

The policy of establishing national parks was begun in Mexico as a tendency to preserve the conditions in certain areas of the country, through the avoidance of all economic activity.

The first national park was created in 1898. At the present time there are 50 parks.

The policy of national parks is being reviewed with the intention of increasing the number of visitors and the number of jobs; besides, studies are being made for pre-investment in six parks to develop conservation, and betterment of their public utility services and installations.

Wildlife

Within the concept of development and the integral utilization of the resources, goals have been fixed tending to a new conception of policy and administration of wildlife resources with the purpose of obtaining through the establishment of hatcheries in connection with hunting reserves, plus craftmanship activities in taxidermy and leather tanning, tourist industry development and promotion supported by them.

In the line of wildlife, also, studies are being made for modifications to the law and duty tariffs, with the purpose of directing this activity to the popular use in grand scale.

Logging

The supply of logs and split-wood is an item which allows more employment—25,000 persons, representing 44 percent of total occupation of forest production.

The process of supply means between 40 and 80 percent of the total cost of sawn wood, plywood, cellulose and paper.

Log costs and forest products prices are, in most cases, 20-70 percent above values in the world market.

Present high costs do not allow us to attain a better competitive position in the international market.

Most of the manpower employed in Mexico is predominantly part time, with a low educational level, dedicated mostly to manual labor without formal training in the use and maintenance of tools and equipment, nor in working methods, hygiene, safety and ergonomics.

The highest costs are transportation and administration; the skidding operation, because of our topography and low productivity, is the most important "bottleneck."

The intention of this administration is to encourage industrialization; the profitable use of forestry and a bigger share for the owners of wood lands, and is contemplating an increase in wages, higher stumpage values, competition of products and limited national market. As a consequence, it is expected that price and profit levels will not continue to be as attractive; therefore, in the future, there will be demanded better administration and organization, production costs not permitting improvisation, nor waste or inefficiency, making it imperative to educate and train all sectors involved, that is the corporations and the human element.

Facing this challenge, the Undersecretary of Forestry plays a basic role in order to give it the energy and spirit of innovation required, especially to increase the internal market, and conquer the foreign markets.

FOREST POLICY

In the last 20 years, forest production has practically been at a standstill. The actual value represents 25 percent of the potentiality of forest resources in the country, this being considered sufficient to supply present and immediate future needs of wood.

The present insufficient forestal production has forced imports amounting to $1,470 million (Mexican Cy.), strongly affecting the balance of trade.

How much and what is logical for the country to produce; where would it be produced; what financial requirements it needs; what investment does it take, and what is the participation of all sectors involved?

These are the main and the more pressing questions which we are getting ready to answer so as to develop the forest activity of the country.

The ideological concept of the country in regard to forestry matters, combines forest conservation with social welfare, for the men who live in, and make a living from the forests.

Making use of the availability of resources and the existence of domestic and foreign markets, our policy will endeavor:

1. To cover with our own resources the main part of our needs as foreseen for the future.
2. To obtain a maximum of profit, and generate permanent employment.
3. To integrate a technical forest service allowing a guarantee of forest cultivation.

The main objective is to create industries, because without them there are no jobs, highways, forest cultivation, etc. Industry is, perhaps, the most important factor for speeding the works of economic development.

To attain the above mentioned goals, it is necessary:

1. To promote the incorporation to production of new areas.
2. To increase the productivity of the actual forests. It is believed that by applying technical forestry, the allowable cut of conifers could augment by 50 percent.
3. To reduce costs in raw material to make profitable the exploitations (mainly to the cellulose industries to be set up in the future), in all locations of the country, and to be able to compensate the reduction in prices originated by bigger offers.
4. To establish forest corporations wholly integrated and permanent.
5. To create new forests and to restore those destroyed through self-paying programs of reforestation. It is estimated that the annual area of plantation required will be from 30 to 40,000 hectares to cover future deficiencies, and making the uses more profitable.
6. To make a better use of available woods and to promote new and larger uses.
7. To develop the natural resources of rural communities.

FORESTRY DEVELOPMENT NATIONAL PLAN. (F.D.N.P.)

During 1971 a program to enlarge a plan of forestry development and industrialization was initiated. The Undersecretary of Forestry has formally implemented in January 1972, studies for the elaboration of the F.D.N.P., which will determine a better means to satisfy the needs, will select the profitable uses with greater economic and social possibilities, and will determine the integration of present permits in the most beneficial units, including preinvestment studies in specific regions.

This plan must be finished this year, and we estimate that needs for wood products will be twofold in 1976, and that it will be threefold in 1990, as compared to the present.

One other fundamental objective of the plan is to make up regional projects so as to be able to define enlargements and needed integrations for the reduction of raw material costs, and the establishment of integrated industries, allowing better utilization of forests, road, power and water available.

The Undersecretary of Forestry and Wildlife has elaborated an analysis of forestry conditions and selected 13 regional projects of utmost importance.

Proformex.—It is located in the north of the State of Durango. Availability of raw material is 1.3 million cub. meters conifers, and an open volume of oak. Manufacture of cellulose for the production of liner and corrugated, plywood and sawn wood.
Estimated investment $2,100 million (Mex. Cy.).

Guerrero. It is located in the South Sierra Madre of the State of Guerrero. Availability of forests is 1.5 million cubic meters in conifers plus an open volume in oak. Manufacture of cellulose, newsprint, plywood, particle board, and sawn wood.
Estimated investment $1,200 million (Mex. Cy.).

Parral.—Located in the south of the State of Chihuahua. Availability 1.8 million (approx.) cub. meters conifers. Manufacture of cellulose as a complement to the existing factories of particle board, plywood panels and sawn wood.
Estimated investment $500 million (Mex. Cy.).

Huicot.—Located in the north of the State of Nayarit and the South of Durango. Possible availability 0.8 million cubic meters conifers and an open volume of oak. Manufacture of triplay and sawn wood.
Estimated investment $100 million (Mex. Cy.).

Michoacan.—Located in the vicinity of Morelia, Michoacan. Available volume is nearly 1.0 million cub. meters conifers. Manufacture cellulose, plywood and sawn wood.
Estimated investment $600 million (Mex. Cy.).

Istmo. Located in the Isthmus of Tehuantepec. Availability 0.4 million cubic meters conifers and 1.0 million cubic meters of low grade tropical timber. Manufacture of hard board for export, plywood and sawn wood.
Estimated investment $300 million (Mex. Cy.).

Chiapas.—It is located in the highlands of the state of Chiapas, with an availability of 1.0 million cubic meters conifers and an open volume of oak and low grade tropicals. Manufacture of cellulose, plywood and sawn wood.
Estimated investment $360 million (Mex. Cy.).

Lacandon. Located in Lacandonian Zone (tropical of the State of Chiapas). Availability 1.0 million cubic meters timber. Manufacture of cellulose, plywood, veneer and sawn wood.

Estimated investment $600 million (Mex. Cy.).

Atenquique.—Located in the south of the State of Jalisco will complement the existing plants of cellulose, kraft paper and resin drawing, with production of plywood and sawn wood, in order to obtain total utilization of cellulose material, and to diminish the cost of pulp wood.

The new investment is estimated at $40 million (Mex. Cy.).

Ensenada.—It is located in the northern part of the State of Baja California. Availability 100,000 cubic meters in pine. Manufacture: boards and sawn wood.

Estimated investment: $60 million Mex. Cy.

Protinbos.—It covers the entire State of Mexico, and has 0.5 million cubic meters and an open volume in oak. Manufacture of boards; will saw wood; will draw resin, and will develop related artisan industries.

Estimated investment: $80 million Mex. Cy.

Southeast.—It is located in the States of Yucatan, Campeche, plus the Territory of Quintana Roo. Its wood would come from exploitations corresponding to agricultural clear cutting in the region, and of import of round wood. Manufacture of plywood, particle boards, hard board, sawn wood and related industries. The plant is already erected, and in order to realize this project, it only requires coordination and organization of its supply sources.

Durango.—Located in the middle of the State of Durango. It counts with 0.7 million cubic meters of conifers coming from Communal Forest Corporations, and other forests. The industry is already established in the region, and to fulfill the project it is only required to coordinate and organize its supply sources.

The estimated amount for investment in the 13 projects, is about $5,940 million (Mexican Cy.).

These projects could be considered within the Forest Development Plan for the next five years.

Through this Plan present production will be duplicated, and due to the employment possibilities offered by forest activity, which is one of the highest in the national economy, a considerable number of new jobs could be secured, with the additional advantage that these could be acquired within the rural zones, where unemployment is, also, highest.

REORGANIZATION OF THE UNDERSECRETARIAT OF FORESTRY AND WILDLIFE

The institution of a promotion policy, and the establishment of the F.D.N.P., demand a public administration totally responsible of the use, protection and promotion of forests united with other government organizations concerned with this activity and which must reorient the works of utilization, supervision, reforestation, inventories, research, education and extension towards cultivation of forests, the productivity and development of industry.

Taking into account the socio-economic view as well as the magnitude, importance, and productive capacity of forests, our government has a well-defined attitude and is building up the necessary policy to attain through an ambitious program, the establishment of the way to a total utilization of forestry resources, integration of industries and the establishment of a national plan for forests cultivation, with a view that the farmer depending on this activity can evolve to the working-man level.

The silvicultural program, as a function, has the goal to guarantee the supply of raw material to industries, to maintain the vegetable cover; to rule hydrology in the basins, erosion control, and to preserve the beauty of landscape for recreation and development of wildlife supporting the tourist industry.

Forest policy tends to create new sources of employment in the rural zones, by profiting from the productive potentiality of forests and of insuring the market for the products of same, through the establishment of the guarantees elemental to any productive investment.

As a compensation for mistakes committed, we have inherited a very deep conviction of the people, over the great importance that forests have as yielders of raw material for a fores' industry offering promising horizons, as far as occupational perspectives in the rural zones, and ample conviction of the importance forests have as regulators and improvers of hydrology in the basins and in the environments.

DISCUSSION

PROFESSOR MAURO CÁRDENAS: What measure does the Forestry and Wildlife Office plan to take with respect to the direct intervention of private parties and public institutions in the unsuitable use being made of several national parks? For instance, the Secretary of National Defense is planning to install the new national military academy in the Desierto de los Leones Park, and the Nuclear Energy Commission has set up its installations in the Salazar National Park.

UNDERSECRETARY DE LA GARZA: Unfortunately, the decision was not mine to make, but was made by higher authorities. However, as far as my department is concerned, we will do everything possible to assure conservation of the national parks.

WILDLIFE PROTECTION AND SOME INTERNATIONAL COOPERATIVE ASPECTS

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INTRODUCTION

We are nearing the end of another millenium in the life of our planet, with an indeclinable hope of survival. Facing the dilemma "To be or not to be," Man, who consumes more food and more natural resources than all the other three million species of animals in the world put together, has begun to take a new and more careful look at his own fate. He is beginning to realize fully that the planet on which he lives has definite, limited dimensions, that there is no longer any new world to populate, and that there is perhaps no other planet on which he can live. We now realize that *"el síntoma más descollante respecto a nuestra condición humana de usuarios de los recursos de la tierra, es que la ciencia y la tecnología no nos liberan de nuestro suelo ancestral"* (Eichler, 1960:109). We are indissolubly tied to this small part of our universe, which is scarcely one part in a hundred million of the number of planets (Duchesne, 1969:33). We are becoming aware that, for Man's existence to continue, he must depend on the continued existence of many other species of plants and animals for food, and that these in turn depend on others, and these on soil, water, and solar energy. But food is not the only thing on which depends life, that miraculous consequence of a vast process of transformation and chemical selection (Duchesne, op. cit.)

Now we realize that Man has played a part in all this, as Dr. Harley J. van Cleve comments, "That like an anarchist who enjoys the protection and advantage of the laws, his actions reveal a disdain for precisely those codes that prevent his destruction."

"But while Man skates on thin ice by blundering shifting the ecological balance so as to cause population explosions, he also blindly tries to eliminate species he does not like, with consequences which are positively comic" (Taylor, 1970:81), or tragic.

PAST, PRESENT, AND FUTURE OF THE HUMAN POPULATION

During the late Mesozoic and Cenozoic Man's ancestors, due to their size relative to other mammals, were rather rare and inconspicuous species. But geologic events made profound changes in our planet; the great reptiles and then the giant mammals disappeared (Dumbar, 1961:508). Man made an almost abrupt appearance on the world scene. For this he needed less than a million years, which was the length of the Pleistocene (Howells, 1960:187).

Among the mammals he was steadily increasing in importance. Unable to compete in strength with his much stronger competitors, this creature, who in the course of evolution has become an isolated type, won out by his notably developed brain and, in consequence, his aptitude in making and using tools for definite purposes. Thus there emerged the modifier of his environment, whose population in the Stone Age is estimated at about a million. Likewise it is estimated that Neanderthal Man lived in a density of one person for each 2-5 square miles (4½ to 12 square kilometers). His numbers were adjusted to the density and distribution of game animals and of edible plants, as well as the risks of being eaten by other animals and of diseases. In a stable equilibrium, he replaced his numbers, and if chance favored an increase of the population he could hold it down by abortion, infanticide, or prolonged lactation. Nevertheless, the interglacial period witnessed a dramatic change: thanks to a series of technological advances, the human population began to grow steadily.

Even so, it was only in 1850 that the population of the world reached a billion. But only the next 80 years were required to add a second billion, in 1930. In 1960 a third billion was added, in only 30 years. The four billion will be completed in 1975 in a lapse of scarcely 15 years. But the pace quickens rapidly; we will have a fifth billion in 1985-6, a sixth in 1993-6, and a seventh in the year 2000 or just after. And this is no longer a population *explosion*, because in an explosion all the particles lose velocity as they pass from the center of the explosion to its periphery. In this case, to the contrary, the speed increases constantly (Taylor, 1970:14).

This being the case, we must reflect; if there are already alarming problems of congestion, pollution and an imbalance in Nature, what will the situation be like in the next 40 years?.

It is obvious that Man's existence depends on the existence of many other species of plants and animals.

From a biological point of view, the earth is ***already*** overpopulated and Man faces an ever-increasing poverty of natural resources.

It is, then, an inescapable duty to conserve those resources and to restrain our optimism. We possess a technology, but that technology is the product of Man, and if its present impact on the earth reaches the final consequences painted by the pessimists, technology will be Man's mausoleum. We cannot say whether bacteria or other microorganism will survive us. We are sure that the higher forms of life will disappear, as history shows.

EXTINCT ANIMALS

In 1700 there were 60 million bison, *Bison bison* on the prairies of what is now the United States and the northern part of the Mexican central high lands (Hall and Kelson, 1959:1024). The local Indians hunted them, but never to the point of reducing their numbers. Europeans came, and by 1900 scarcely a few dozen were left. The Europeans used rifles, then the most powerful arms. The natives only killed for urgent necessities; the Europeans killed for "sport"; nonetheless, as we can judge a century later, it was not the rifles that were guilty, but the "lack of respect for the rest of Nature"—they killed to kill, at times to use the skin, at others to use only the tongue as a choice morsel to satisfy absurd tastes.

Another case which history records and which we must not forget is the extinction of the passenger pigeon, the dramatic story of an animal which probably exceeded in number any other terrestrial vertebrate of which we have record in North America. The last survivor died in the Cincinnati Zoo in 1914. Earlier, the migrating flocks were one of the great wonders of Nature. The southward movements, which took the form of enormous congregations, were commonly 300 miles (480 Km) long by 1.6 Km wide. The great flocks could be heard for a distance of kilometers. Wilson, in Kentucky, calculated on a conservative basis that one flock contained over 2 billion 230 million birds, 2.23×10.9 birds (Bent, 1932:390).

In Michigan a million passenger pigeons were caught in a single year. On another occasion 7.4 million were killed at one time and place. At the present time, in Mexico and especially in the lower Rio Grande or Rio Bravo Valley, the same pressure is exerted on the white-winged dove, whose population exceeds 5 million and which migrates south, reaching Central America. If our attitude toward these birds remains the same as toward the passenger pigeon, may it not be, in the near future, another victim of the unbridled actions of present-day hunters?

Vinzenz Zinwiler, a Swiss ecologist, in his book *Extinct and Vanishing Species*, lists about 150 species which have disappeared in the past three centuries. The list goes from the auroch (1627) and the dodo in the 17th. Century to the Indian pink-headed duck in 1940. The reasons why animals disappear from earth are varied. The Tahitian paroquet disappeared because its habitat was changed by drainage; the New Zealand quail and many Hawaiian birds (see Warner, 1958) succumbed to introduced diseases; the so-called Tasmanian "wolf" was hunted because it was thought by ignorant persons to be a predator (while, as we all know, it was only a marsupial). The noctural kiwi was destroyed by the weasels brought in to "enrich" the fauna of New Zealand. Schomburgk's deer was persecuted for religious reasons in Siam (present Thailand).

It is now too late to do anything for these 150 extinct species. But we can do something for the 240 species currently threatened with extinction. In all the world there are species that, for one reason or another, are disappearing from the scene; and in Mexico we are greatly concerned that among these figures, in the first place, the giant imperial ivory-billed woodpecker, which for some time has appeared in the IUCN red book as an extinct species. The Forestry and Wildlife Subsecretariat sent a group of biologists in 1971 to investigate its status in the Sierra Madre Occidental of Chihuahua, and has reported that there are indications of its existence. [Incidentally, Allan Phillips (1971) informed us that he has never seen these birds, nor has he traveled in the mountains of Chihuahua; cf. Fisher *et al.* 1969:268]. But again we face the problem here of the necessity of proper protection, trying to maintain the habitat unchanged.

The California condor, *Gymnogyps californianus*, the only very large bird that survives in North America from ancestors that were widespread in the Pleistocene, also was considered to have disappeared from Mexico. It was said that the last individual seen was at La Encantada, in the Sierra San Pedro Mártir, Baja, California, in 1934 and 1935. In 1971, through the enthusiasm of Ed N. Harrison, president of the Western Foundation of Vertebrate Zoology, we were able to obtain indications of the presence of this magnificent vulture, which a member of the staff of the Forestry and Wildlife Subsecretariat, Sr. José Sámano Sánchez, had reported. This May another expedition sponsored by the Western Foundation of Vertebrate Zoology and the Mexican Wildlife Service, is exploring that part of Mexico more zealously, to make sure of its existence.

A quarter of a century ago, reports Lewis Wayne Walker (1965:27), Isla Rasa in the Gulf of California was protected by its isolation. Elegant and royal terns, *Thalasseus elegans* and *T. maximus,* and Heermann's gulls, *Larus heermanni,* nested there without danger, conferring on it an importance and uniqueness such that fishermen, in the neesting season, began gathering the eggs in quantities which jeopardized the existence of these species. Walker himself began an intensive campaign to awaken the interest of American and Mexican conservationists, culminating in the establishment of the island as a National Reserve and Bird Refuge, by decree of May 30, 1964. In this enterprise the National Audubon Society, the California Academy of Sciences, and the Arizona-Sonora Desert Museum have collaborated to the extent that it has been possible to station on the island, in the critical time of nesting, groups of biologists to study certain biological aspects and to stop the taking of eggs; as a result, the populations have now recovered and their existence for a long time in the future seems assured.

Among the mammals, the species most threatened with extinction are the tapir, *Tapirella bairdi* which tolerates neither the presence of man nor the destruction of the tropical forests; the spider monkey, *Atteles vellerosus*, whose distribution has been restricted steadily with the destruction of the tropical forests in which it is at home; and the howler monkey, *Allouata palliata*, for the same reason. *Atteles* faces extinction not only from habitat changes, but also due to persistent hunting because its meat is considered useful as a remedy in treating various diseases. In 1952, along the Interamerican railroad between the city of Veracruz and Tapachula, Chiapas, country people (both children and adults) could be seen offering young monkeys for sale at no more than 10 pesos each. Whoever bought these animals could not imagine that behind the simple buying and selling lay a tragedy: to obtain the young one they would kill the mother, which was often left lying; only very rarely was the meat eaten. Certain groups of Indians, like the Chamula, used the meat for food. At present the populations of both species are greatly reduced because their destruction continues, not only for the above mentioned reasons, but also because they are used, in southeastern Mexico, as bait by irresponsible hunters who try to obtain such valued game species, protected by law, as the jaguar and other magnificent representatives of the family Felidae. It has been shown that, to obtain a single specimen of jaguar, it is necessary to sacrifice at least 12 monkeys for each cat obtained. The red brocket, *Mazama sartorius,* so characteristic of the tropical forests of the southeast of the Republic, has also suffered the pressure of hunters and the effects of habitat destruction.

In the north of the country, the grizzly bear, *Ursus horribilis,* has practically disappeared. The Forestry and Wildlife Subsecretariat has tried to find this handsome mammal, even if in small numbers. There are indications that some individuals exist in the mountains of Chihuahua, even though it has been impossible to define their exact number. In any case, it will not be a population that assures the species existence, unless they are provided with all the environmental factors they now lack and they are protected from hunters who forget that these animals represent a heritage which we must preserve for the future. The pronghorn antelope, *Antilocapra americana,* (see Map, Fig. 1) has suffered the same ill fortune as the other animals mentioned above; its present numbers no longer insure its existence for many more years unless it receives the cooperation of all the

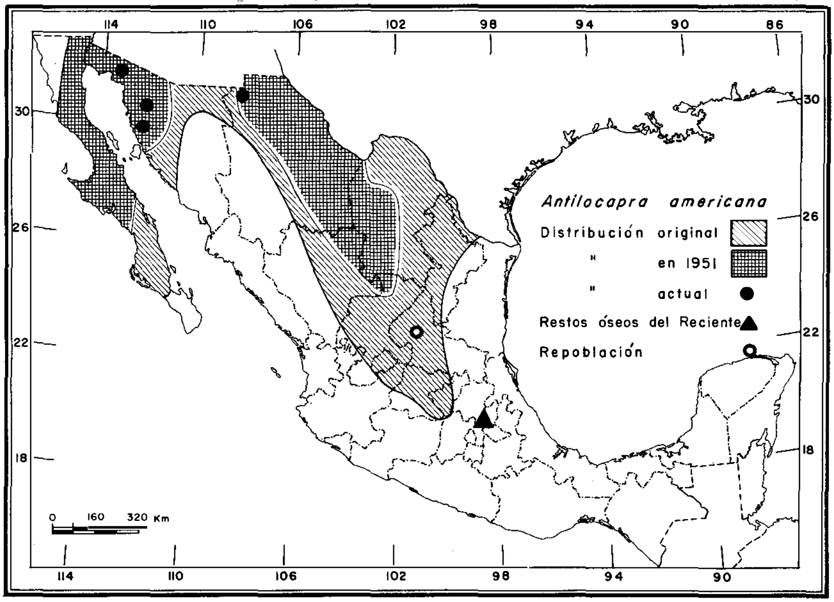

Figure 1.—Map showing the distribution of the Pronghorn Antelope, *Antilocapra americana*, in Mexico. Its present status, in the wild is very precarous. On February 15, 1972, the Forestry and Wildlife Subsecretariat, in cooperation with the Game and Fish Commission of New Mexico, U.S.A. transplanted 51 animals (37 females and 14 males) to a ranch 40 km north of Salinas, San Luis Potosí.

inhabitants of the country, especially those aware that the ***healthy*** wild community must have all of its members. The desert bighorn sheep, *Ovis canadensis*, the handsomest game animal that exists in Mexico, and which attracts the attention of hunters from all parts of the world, has now reached a vulnerable point, unless special reserves are established to protect it; in any case, in Baja California and in Sonora the rough mountains may be its most effective refuge, and the study of its biology and ecology demands diligence and efforts which we hope to display. The Forestry and Wildlife Subsecretariat, through the Direccion General de la Fauna Silvestre, includes in the development of its programs the establishment of biological reserves in critical areas to save wildlife species threatened with extinction.

On the other hand, special attention is given to the following aspects:

(a) Study of the populations of the more important species.
(b) Protection and increase of these populations.
(c) Adequate use of these, for recreation and social betterment.

To ecologists it is unnecessary to expound on the role the sportsman plays in the maintenance of the health of game populations, and it is our hope that hunters will collaborate with the efforts of the Direccion General de la Fauna Silvestre for the success of the program we have outlined.

Cooperative programs for the protection and perpetuation of the components of our fauna have already been established. The government of Mexico not only cares for the National Parks, as far as its resources permit, but it has also established sanctuaries and refuges for the protection of migratory water-birds in suitable places, and it is studying the present status of wolves and coyotes, which have been diminishing in numbers in an alarming manner, as may be seen in the maps, (Fig. 2 and 3). With the cooperation of all conservation organizations, we hope to be able to save these species, for wild animals belong not only to the countries they inhabit, but to all mankind; and though national governments must make the decisions, all of humanity should be interested in saving and protecting wild animals, for on this depends the survival of Man.

As George Lindsay (1970:10) expresses it, conservation is an international problem and wildlife an international resource. In Mexico there are obvious precedents for this sort of cooperation. It was as a result of an expedition of the California Academy of

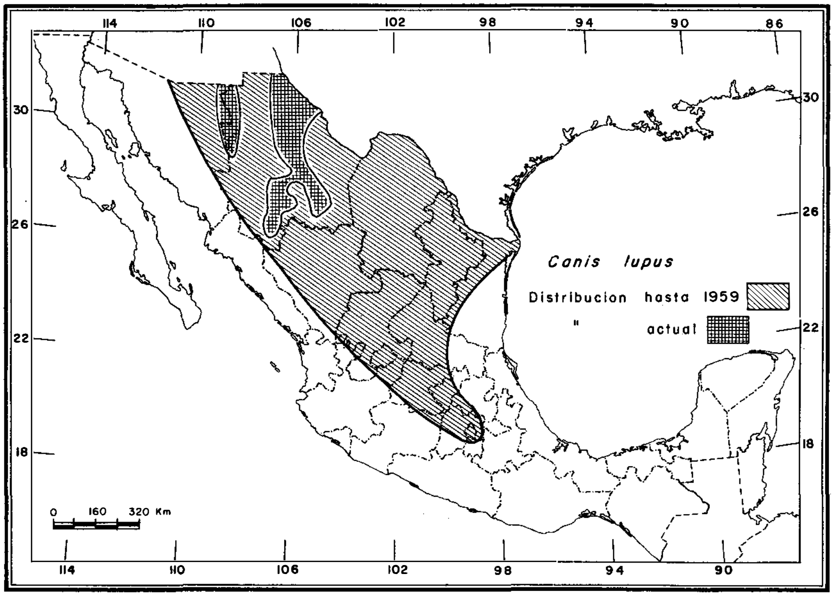

Figure 2.—Map showing the present status of wolves, *Canis lupus*, in Mexico, from personal observations of the author and the data of Hall and Kelson (1959).

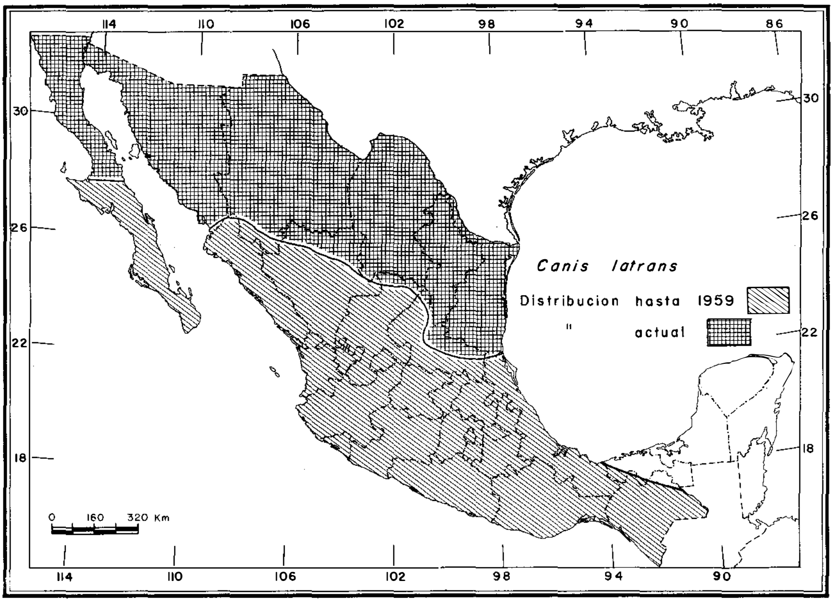

Figure 3.—Map showing the present distribution of the Coyote, *Canis latrans*, in Mexico, according to the author's observations and as given by Hall and Kelson (1959).

Sciences to Guadalupe Island that President Obregón declared it a reserve and the Guadalupe Island fur seal was saved from extinction.

With these ideas as our directive, we will participate wholeheartedly in conventions on the exportation, importation, and transit of species of wild animals and plants threatened with extinction.

SUMMARY

Many animal and plant species have disappeared from the earth completely, some of them by the direct action of Man, whether by profound change or destruction of their habitat or by irrational use. In México, some of the characteristic species have disappeared or are seriously menaced with extinction, because of intensive land use or persecution regardless of protective laws and regulations. We understand that the problem we face is more than national or regional: it is a world problem. Its solution demands a concerted international effort.

For a number of years, there has been cooperation with other countries of this hemisphere. México and the United States have cooperated to save other species, and since 1936 there has been a

treaty for the protection of migratory birds, mammals, and reptiles between Canada, the United States, and México.

In the past few days México has created a refuge in Laguna Ojo de Liebre, Baja California, to protect the gray whale during the birth of the young. The Subsecretaría of Forest Resources and Wildlife has also declared this place a refuge for migratory water-birds, by a decree signed by the President of the Republic.

To secure the protection of biotic resources México will participate enthusiastically with other New World countries in the making of agreements on the exportation, importation, and transportation of endangered species of wild animals and plants.

LITERATURE CITED

Bent, Arthur Cleveland.
1932. Life histories of North American gallinaceous birds. U.S. National Mus. Bull. 162 pp. i-Xi, I-490.

Duchesne, Jules.
1969. Meteorites and extraterrestrial life. Science Journal, 5(4):33-38. April.

Dunbar, Carl O.
1961. Geología Histórica. Traducción al Español de José Manuel López Rubio. Cía. Editorial Continental, S.A.

Eichler, Arturo.
1966. Conservación de los recursos naturales. Objetivos Económicos Sociales y Culturales, 2 tomos, 620 ilustraciones. Universidad de los Andes, Mérida, Venezuela.

Fisher, James, Noel Simon, and Jack Vincent.
1969. Wildlife in danger. A Studio Book. The Viking Press.

Hall E., Raymond & Keith R. Kelson.
1959. Mammals of North America, 2 Vol. pp. 1-1078 Illus. The Ronald Press Company.

Howells, William.
1960. Mankind in the making: The story of human evolution, pp. 1-381. Secker & Warburg. London.

Lindsay, George.
1970. Some natural values of Baja California. Pacific Discovery, 23(2): 1-10. March-April.

Mershon, W. B. (ed.).
1907. The passenger pigeon. Outing Publishing Company, New York.

Phillips, Allan.
1971. Personal Communication.

Taylor, Gordon Rattray.
1971. The doomsday book. pp. 1-320. Fawcett World Library. September.

Villa R., Bernardo.
1951. Jabalies y Berrendos. pp. 1-30 Illus. Dirección General Forestal y de Caza.

Warner, Richard E.
1968. The role of introduced diseases in the extinction of the endemic Hawaiian avifauna. Condor 70:101-120.

SOME INTERNATIONAL ASPECTS OF MEXICAN FISHERIES

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Man today wages a ceaseless struggle against hunger: his success depends upon his obtaining proteins to ensure an adequate diet for his integral and healthy growth. To achieve this goal is to contribute to the progress of nations, to their economic stability and to friendly cooperation in the exploitation of marine resources.

In the modern world there is an increasing demand for products of the sea as a source of proteins.

As countries develop, it becomes more difficult for them to obtain these products because the population is more attracted to employment on land. Highly industrialized countries even have to resort to recruiting foreigners for their fleets on the high seas. In this regard we can state with assurance that Mexico has some of the best fishermen in the world. In fact there are a large number of Mexicans in the crews of the tuna fleets of some countries.

In short, the world presents a field hungry for seafood and poor in human resources for fishing. Those countries with a high consumption of fish products have a high volume of imports. Proof of this are the changes in the last 25 years in international maritime law. To ensure rational utilization of fisheries, the countries of the world have adopted legal measures.

In the first United Nations Conference on Maritime Law, held in Geneva in 1958, a majority recognized the right to an exclusive fishing zone up to 12 nautical miles and in all the proposals presented in that conference there was agreement that a state can claim exclusive rights in that zone. In 1960, in the second conference on maritime law, also sponsored by the United Nations, this position was confirmed by 86 votes of the 88 participating states.

For Mexico the optimal utilization of marine resources is of vital importance as our President, Luis Echeverria, pointed out when he stated that the seas of Mexico are sources for the improvement of her citizens, for better nourishment, and for the creation of new centers of work.

In this administration, Mexico intends to double the amount of fish and shellfish caught and by 1975 have a production of 500,000 tons. The purposes of the National Fishery Program and the institutional

[1] In the absence of the author, this paper was presented by Sr. Rafael Vega Rivas, Director of Fishing Zones, Mexico.

improvements promoted by the executive branch are oriented toward the realization of this general goal.

We need this increase in our catches not only to augment domestic consumption and our exports but also to absorb labor, especially farm workers who live in coastal areas. An extensive program of activities to raise production along our coastline and diversify fishery activities is underway.

Mexico's coastline is 10,000 kms. long. Its continental shelf is 500,000 square kilometers and its coastal lagunas measure 1,500,000 hectares. Their waters have valuable species: shrimp, lobster, abalone, bass, red snapper, sawfish, totoaba, tuna, sardines and others. We have 50,000 registered fishermen but only 3,709 ships of 3 to 100 tons and 106 of more than 100 tons. However in 1970 the catch was 254,000 tons of fish and crustaceans with a value of 1,135,000,000 pesos. In 1971 the catch increased to 285,000 tons.

Shrimp fishing has been up to now the most important fishing activity of the country. In 1970 shrimp held the fifth place in national exports with a value of 790,000,000 pesos; in 1971 it was more than 1,000,000,000 pesos. Shrimp fishing has increased in the last 40 years from 20 tons caught in 1930 to 42,000 in 1970. This increase has led to the development of refrigeration, canning and fishing boat construction industries in the country. The Mexican technology used has made it possible for us to export ships and products of the sea even to such developed nations as Japan and the United States.

Our industry has risen from zero to 71 refrigeration plants with a capacity to handle more than twice the present production. That is why fishery investment is oriented toward the sea, to increase production and maximize the capacity installed for industrialization.

From 1952 to 1970, 1,747 shrimp vessels have been built in Mexico. Those of most recent design are equipped with refrigeration systems on board. They are fitted for diversified fishing so that they can catch scaly species when shrimp fishing is forbidden and when crustaceans are scarce.

To diversify fishing, the government, especially in the Pacific, promotes the intensification of catches of tuna, sardine and other species. In 1970, the tuna catch of 10 vessels was 10,443 tons with a value of 45,000 pesos.

Another aspect of the diversification in fishing done by first-class Mexican fishermen is the fishing of cod by two vessels of 650 tons in international waters of the banks of Newfoundland, South Greenland and Iceland. This effort of the private sector has made it possible for us to become self-sufficient in this species. Along with all of this, the enlargement and improvement of port installations has been planned also.

In general, the 1971 catch shows an increase of 12.9 percent in relation to the 1970 production. A scientific and technical basis is used to achieve this rise in production and diversification in the catch.

Mexico is trying to carry out the Mexico-United Nations oceanographic research program of FAO, whose main purpose is research on shrimp, tuna, sardine and anchovy—resources, the utilization of fauna accompanying shrimp, new species, the increase of commercial species, the study of estuarine waters, and training.

For this research, two modern vessels—the *Alejandro de Humboldt* of 450 tons and the *Antonio Alzate* of 120 tons—are used. These units began their explorations and studies in December, 1970. Students and fishwomen as well as technical experts of the program, have participated.

As a practical measure for fishery development, the government of President Luis Echeverria agreed to set up a state enterprise called "Productos Pesqueros Mexicanos." This complex coordinates the production and distribution of 22 industrial units in Mexico and two distributing units in San Diego, California. It has a fishing fleet, canning and refrigeration plants, refrigeration warehouses and distribution centers. Its installations represent 36 percent of the investment of Mexican capital to industrialize fishing and is responsible for 50 percent of the present fishing production.

The products of these plants enjoy great prestige in the domestic market and abroad. This company handles and distributes abalone, tuna, sardines, lobsters, canned, frozen and dried fish, frozen and canned shrimp, filets and slices of frozen fish.

To give support to those involved in fishery activities, new legislation is contemplated as a promotional tool to allow the operation of adequate mechanisms for expeditions management, to guarantee the rights of fishermen who contribute their personal effort and of those who bring their capital and experience to fishery development.

The political constitution of Mexico states that "the utilization of natural resources should serve for a fair distribution of public wealth and care for their conservation." The economically weakest groups have been the ones most favored by the government of the Revolution in the exploitation of these resources. Thus, the national program of President Luis Echeverria for the utilization of our fishery resources has social justice for Mexicans as its goal.

THE WWF PROJECT ON CROCODILES IN CHIAPAS

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As it is well known to all conservationists, the Crocodylia all over the world are in so dangerous a situation that it is difficult for them to survive ten or twenty more years, at least in the wild. If this is true for species of wide distribution, it is much worse for such species as *Crocodylus moreletti* that have always had a narrow range.

The Mexican Crocodylia are in no better situation and many are the causes for the present crisis, among which we can name the continuous drainage of marshy lands and the intrusion of human activities on the habitats. However, the main cause that is about to exterminate these reptiles is the commercial slaughter in order to get the skins. What is worse still, the harder it becomes to obtain the already rare skins, the higher the prices the hunter gets, and so he becomes more interested in the persecution and killing of the reptiles that bring him such good rewards.

As most countries, Mexico has laws intended for the protection of this valuable natural resource; however, I am sorry to tell, the results are frankly nil as it is impossible to enforce a law without a good and sincere vigilance.

As I am talking about the law, in this case the Mexican fishing law—although really it is difficult to understand why the Crocodylia are included in a fishing law—let me disagree in opinion with some officials who say such a law is correct. Let us see why: In the first place the act prohibits capture of crocodylians between January 1 and April 30. Instead it should be from February to late September as the courtship of *Crocodylus acutus* is in February and the female lays between March and April but watches the nest during two and a half months, although this species is least persistent on this matter than others. *Crocodylus moreletii* courts, mates, and lays only a little later, but some females lay eggs as late as July; however, the morelet's female watches the nest carefully and later the newly hatched young, so she is free from duty until October. On the other hand, the caiman, *Caiman selerops chiapasius,* courts in April or May and the female lays between July and August, the young hatch two and a half months later and are watched by the mother during fifteen to thirty days.

In the second place I say the Mexican fishing law is wrong because it specifies 1.50 meters as minimum length for capturing crocodilians and 0.60 meters for caimans. In other words, it protects only young specimens and permits the killing of the adults, which are the reproducers.

Possibly the affirmation that crocodilian and caiman females watch over their young will be doubted by many persons; even some modern authorities (Neill. 1971) doubt it. However the truth is that female caimans as well as female Morelet's crocodiles permit themselves to be killed over the nest rather than desert it at the approach of some foe, including man, who often takes advantage of this devotion to kill the guarding mother. The female of *Crocodylus acutus* also guards her nest although not so energetically. If she is too frightened she deserts it as soon as she senses the approach of man. This matter of nest protection is a decisive factor between success and failure. A deserted nest is almost certainly destroyed by predators. This has been proved by different investigators in other parts of the world and very carefully in Africa by A. Graham.

After watching the nest for the long time during incubation, which lasts between 75 and 90 days because of climatic irregularities each season, the mother more or less watches the young before they scatter about the neighborhood. The newly hatched crocodiles have a strong gregarious instinct that helps keep them together at a certain spot. During the first years the small crocodilians have numerous enemies, especially within the first months after hatching. In the state of Chiapas the young crocodilians are devoured by fishes; such predacious turtles as the snapping turtle *Chelydra serpentina*; some snakes like *Drimarchon corais* and *Constrictor constrictor*; such birds as herons, hawks, etc.; and finally several predatory mammals. When the mother, or in fact most adults, hear the distress call of the young, they come to the rescue and actually attack the offender.

However, the adults now and then devour smaller individuals, mainly if they are hungry. I have seen young individuals no more than two feet long trying to devour newly hatched babies.

It seems probable that females of several species help the young out of the nest. This too is doubted by some authorities based on observations of captive crocodilians in zoological parks located in temperate areas and probably living in artificially heated water. At liberty, it seems possible that females help the hatching of the young and certainly it is so in the caiman females or at least in *Caiman selerops chiapasius*. Some couples of this species remain paired for years, living in well-established territories guarding them against intruders of any sex. Both sexes of true couples watch the nest and in due time tear it to help the young get out, a task very interesting to witness.

It is sad to remember that nobody studied the crocodilians at the time when they were numerous. At present, observations are very difficult and many things probably never will be known because crocodilians are everywhere scarce and almost facing extinction. It is almost impossible to find populations of large groups, and the big individuals of maximum size are a thing of the past. At present most individuals are small and if the species have not become extinct it is only because they may reproduce while quite young and relatively small, or when they are about five years old.

In a work like this it is not possible to give many details on the biology of these interesting reptiles that are on the threshold of extinction, however, it is planned to publish the results of this study in the future.

In June, 1968, the project WWF-376 in cooperation with the Instituto Mexicano de Recursos Naturales Renovables and el Instituto de Historia Natural de Chiapas was approved for the study and experimental propagation of the *Crocodylus moreletii,* both in captivity and at controlled liberty. Later, in 1970, it was decided to incorporate in the study *Crocodylus acutus* and *Caiman selerops chiapasius*, that is, all species of crocodilians found in Chiapas.

The field work started in September, 1968, first investigating the real situation of *Crocodylus moreletii.* The exploratory works comprised the visit to most of the range of this species in Tabasco and Chiapas. With disagreeable surprise it was discovered that crocodile populations no longer existed. Some localities that fifteen years ago were teeming with crocodiles, at present had none and only after much difficulties and long walks was it possible to find a few widely dispersed small individuals, too scared to permit a practical approach even at night.

Before this alarming situation it was suggested the Instituto Mexicano de Recursos Naturales Renovables ask the Direccion de Pesca, (office that controls the exploitation of these reptiles) to prohibit all hunting of *Crocodylus moreletii* in Chiapas, where there still lived a few more individuals, widely dispersed among the numerous marshes and streams of the north part of the state. Unfortunately, the prohibition has not worked and the *lagarteros* or hunters continued killing the remaining crocodiles, mainly by taking them from the burrows in which they hide during the relatively dry season in such areas. Also they stretched large nets in deep waters, because the remaining individuals were too shy to permit hunting at night.

With those nets they annihilated the last small colony that lived in Lake Palestina, Juarez county in north Chiapas and where the author had hoped to conduct etiological studies. Fortunately in the year 1971 there was elected a new mayor for the Juarez county a learned physician, Dr. Aldo Guichard, who enforced energetically the prohibition and it is certain that at least during the three-year period that he will be in charge nobody will kill one crocodile within the area.

Due to the almost impossibility of finding wild population of the *Crocodylus moreletii* convenient for complete studies and as a part of the mentioned project, the author has been trying to capture young individuals found in practicable sites. At the same time, I have been taking as many notes as possible, although fragmentary, but any way so we know something of the habits and the tragic situation of this little-known species.

For all practical purposes the Morelet's crocodile is fast becoming extinct, probably because the skin is much more pliable than in other species and with dorsal scutes not so hard. Other crocodilian species, on the contrary, have bony scutes with high ridges, and, in general, the skin is thick. In fact, in most species the dorsal skin is discarded; therefore due to the good quality of his skin the Morelet's crocodile has been so badly persecuted and, if we add its reduced range, it is not strange that commercial interests have exterminated such valuable species.

Another point that contributed to the scantiness of this species is its habit of living in small shallow streams of slow-running waters or in shallow ponds and even in muddy little channels. All this made relatively easy the killing of most individuals, wiping out the population. On the other side we have *Crocodylus acutus* whose habitat is big rivers and deep lakes that make much more difficult the hunting of the reptiles, especially once they have been scared.

As it is well known, the Morelet's crocodile lives—or better said, used to live—on the Atlantic versant from southern Tamaulipas of Mexico to Honduras. This means that it lives in the same general area as *Crocodylus acutus,* but not in the same habitats. Both species are usually considered to be the same, even by the commercial hunters and they believe the Morelet's crocodile to be just individuals whose skins are soft and dark due to the medium in which they live and so they call it *lagarto negro.* However, they recognize the variety to be less aggressive.

Dr. A. Martin de Lucenay, around the years 1940-1941 made studies on the crocodiles in Veracruz and curiously enough he also did not recognize the species *moreletii* and named it as just degenerated individuals of *Crocodylus acutus* (A. Martin de Lucenay 1940). As I have said elsewhere in this paper, it is a pity that nobody made studies on this species when it was still abundant and also it is pitiful the projects for breeding crocodiles commercially did not materialize in the past, as it was planned as far back as 1940. If such had been the case we would not be facing the extinction of these valuable reptiles.

The Morelet's crocodile differs from the American not only in aspect but also in habits. As I have already said, Morelet's is the subjugated species and has taken refuge in dark shallow waters, sometimes just in muddy fields. Years ago, at some localities it was possible to find the American crocodile abundant in some rivers and only some few meters from the border, and in some muddy ponds, the Morelet's. This last species never entering the big river, even during severe droughts that dried the pond. In such cases it merely migrated to some nearby bigger pond or if that was not available sought refuge in muddy burrows to await the arrival of rains, all in spite of the presence of the nearby river, on the sandy borders of which the American crocodiles sunned themselves and dived at will in deep waters.

Crocodylus acutus nest on sandy beaches or bars, the female excavates a hole and lays the eggs, covering it with debris mixed with sand; the nest is almost level with the ground and only the tracks of the reptiles show the site. On the contrary *Crocodylus moreletii* builds a big heap of dry leaves and fresh vegetation and in the middle lays her eggs. The nest of this species is quite similar to the nest of the spectacled caiman.

Now, returning to the WWF 36 project, in several periods, from ten days to one month, during three years, it has been possible to capture 26 specimens up to four feet in length and which were destined for the experimental center of the Morelet's crocodile that is working in combination with the Zoo at Tuxtla Gutz., trying to reproduce the species in captivity. However during the field work we found a small lake of about five hectares and located in an almost ideal condition. It is natural habitat as years ago it sustained a large crocodile population. This lake was donated to the project by the owner, therefore it was decided to dedicate the main effort to the lake and breed the crocodiles under natural conditions, leaving a reduced number of specimens at the Zoo for controlled studies. This lake at present is surrounded by a wire net fence and also there has been planted a natural fence of *Pachira aquatica,* which when grown will replace the wire netting that soon rusts in that climate. This lake is located at Ranch Alegandria, Municipio de Juarez, on the north part of Chiapas.

In general the idea is to keep the small individuals at the experimental center in Tuxtla and once they grow large enough to care for themselves against the many dangers, they are liberated at the lake. Also we keep at such center eight specimens that are nearing the breeding size and once they lay eggs, which is expected will be in one or two years, we plan to liberate the hatched young at the mentioned lake.

All in all in three years of partial work we have accomplished the following:

Full prohibition against hunting Morelet's crocodile in Chiapas.

Full County protection for the same species within Juarez County in the State of Chiapas.

One lake of 150,000 square meters fully fenced and provided with a canoe and small bungalow.

Three big enclosures not available to the normal visitors at Tuxtla Zoo. These are for controlled breeding of some pairs of these reptiles.

26 captured specimens of such rare species as is the Morelet's crocodile. Among these there are several that already have grown almost to breeding size.

It has been gathering data for the writing of a monograph of the three species of Crocodylia that live in Mexico.

CONSERVATIONIST EDUCATION IN MEXICO

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For the sake of man's survival on the planet Earth and, what is more important, the improvement of his life, humanity must not only be wise enough to know how to do things but most also possess "knowledge of how to use knowledge" (Potter, 1970).

It seems that the main subject of conversation now, both at family reunions and in communication media, is the problem of contamination. Specifically, the well-known word "smog" is now used to designate the differential characteristic of our modern technological civilization.

In this regard, the bibliography that has been published in the last five years concerning pollution, the newspaper articles, the radio and television programs, and the so-called "spots" that are regularly given on radio, are making us so familiar with this problem that we hardly pay any attention to it.

There is a grave danger in mankind's tendency to attribute importance to very important facts only for a certain period of time, which, in spite of the magnitude of the matter, is often quite short.

I recall very well the day on which a rocket was launched from Cape Kennedy on its way to the moon. The television broadcast gathered perhaps a greater number of people than any other has ever done.

All of us—adults and children—were spellbound by the feat. Excitedly, we followed the landing of the American astronauts on our satellite. We were almost able to follow their subsequent tour personally, thanks to the extraordinary transmission from apparatuses developed by modern technology.

Well, despite its magnitude, are we still interested in that giant step by humanity, which held us in suspense for such a long time? It would be interesting to know how many people were concerned about the second moon trip. There were probably fewer concerned with the third one.

Presently, when a satellite is launched into space, it only takes up a few lines in the second or third section of the daily newspapers.

Therefore, to mention the "wolf" of pollution very frequently, without man's realizing what its real nature is, may cause that specter to devour us, or at least to do us such damage that it will be difficult for us to recover from its "attacks."

I think it would be redundant to center this present discussion on the effects which have so far been produced in our environment, since the literature on the subject, which is ever more abundant, and the examples cited from the public domain, such as the wide dispersion of DDT all over the planet, the detergent problem, the disasters of Donnora and London, etc., are now almost commonplace.

Thus, it would be unnecessary to reiterate something that is becoming so familiar through the wide publicity given it. What is not mentioned, however, in spite of the many campaigns that are undertaken to solve these problems, is the way in which the citizen or man in general can help solve them.

For this reason, and in order to be congruent in our discussion, we shall concentrate on a highly useful feature, which would help solve the problems of environmental deterioration. This is education, aimed at forming a "conservationist conscience," which will make it possible to visualize the very close relations existing among the natural resources and between them and man himself.

From February 9 to 13, 1968, Paris was host to an international meeting under the auspices of UNESCO, called "The Intergovernmental Conference of Experts on the Scientific Bases for the Rational Utilization and Conservation of the Resources of the Biosphere."

At this meeting, not only concepts relative to the structure of the biosphere and its deterioration were discussed, but also—and perhaps more important—those related to man's lack of sufficient mesological education, which is needed to detain this deterioration. We believe that one of the steps forward made at the meeting was the preoccupation they demonstrated with the unsuitability of traditional modes, which have been followed in school programs to teach the use of natural resources. These modes ought to be modified by planning based on an interdisciplinary integrated science.

There can be no doubt that such a science belongs to ecology, but perhaps more so to conservation. The latter is conceived of not only as the understanding of the interrelations between the biotic and abiotic beings that make up a biocenosis, but also of the measures and attitudes that man must acquire toward his environment.

The teaching of conservation at all levels of instruction in the world becomes relevant, once it has been recognized that present ecological and related studies are seriously deficient in not adequately comprising subjects concerning the environment, as was stated at the meeting in France.

Therefore, the need for a solid, well-integrated mesological (environmental) education becomes very important at all levels of learning, for the purpose of furnishing the student with a wide knowledge of man's role in nature, either in isolation or as part of humanity as a whole.

The inclusion of programs for mesological subjects, to facilitate the preparation of ecologists, and the need to organize post-graduate courses to train specialists with a complete view of the problems, structures, and possible solutions regarding our biosphere, were seen to be indispensable.

Perhaps the creation of a specialty—ecological engineering with the degree of Ecological Engineer—which would have practical value in the conservation of natural resources and the rational use of the earth, ought to be integrated as a prime necessity. Thus, man could understand the message which the so-called "spots" regularly broadcast on radio, as an extra-curricular education practice in some countries.

In our country—to give one example that I know well—one may readily hear on radio or see on television some messages which, with all good intentions, ask the citizen "to put trash where it belongs," or say "We're counting on you to fight pollution." Nevertheless, I am not yet able to determine how most of the people who hear or see them can understand the importance for our environment of placing their garbage in a suitable container. Nor can I tell how the common, everyday citizen may help combat pollution.

As long as it is not explained to people that a certain attitude on their part influences the scheme of life, surely they will not change their behavior. They may feel their eyes bothered by the smoke that floats over the centers of large cities, or when they go to the country, they may notice that there are more gullies and few woods for amusement and recreation. Maybe they fail to make a clear association of the relationships existing in this tragedy, however, and perhaps even less do they connect them with the damage that such effects can cause in their children or grandchildren.

Goudswaard (1967) very rightly says: "What's the use of creating national parks or fighting for good legislation to protect rare species of animals, when the basic idea of preserving nature has not been fixed in the human mind?"

Hence, to fix this basic idea, education is needed on the conservation of nature. This requires more than knowledge of the isolated characteristics of natural resources, even though such knowledge may be very deep. It also implies a knowledge of "their reciprocal relationship with the environment, as well as the formulation of a suitable policy for handling them, based on this knowledge" (Beltran, 1966).

In this regard, we are now going to present and evaluate the teaching of nature conservation in our country, with reference to a worldwide framework.

Laptev (1967), from the University of Tomsk in the Soviet Union, was one of the first in his country to establish, about 1949, a course for the protection of nature. It was then called "Protection of Nature and Transformation of Fauna," but the title was shortened in 1961 to "Protection of Nature." It attempted to promote a more rational attitude in man toward nature, by means of spreading knowledge among the general public through the preparation of well-trained graduates for this purpose.

Shaposhnikov (1967), speaking of the principles and ways of teaching conservation in the Soviet Union, believes that two means could be used: a general part and a special one. Regarding the focus and development of both parts, nature has been considered as a biological complex, which includes the historical process, national and international legislation, and the relationship between conservation and academic institutions, both private and public.

Concerning conservationist education at American institutions and universities, Simms (1967) thinks that the teaching of this interdisciplinary science will serve two well-defined purposes in his country, that of training professionals and that of general education.

In Czechoslovakia, following a conference organized by a state institution for the conservation of nature and a training course for academic personnel, given at the Brno School of Pedagogy, conservation courses were set up at the university level. There, the approach is somewhat similar to the Soviet one.

The conservationist group that gives these classes follows two lines of approach. First, they imbue the future teachers, who are in a position to influence human groups, with the importance of a proper human attitude toward nature. The second line of approach is directed toward the technical group, whose activity can influence the landscape, as well as the realm of nature itself. This group includes engineers and other technicians: the very ones who, having little knowledge of biology and only a relative interest in ecology, frequently cause damage to the entire natural resources of a region in the course of their activities.

Before the creation of the Nature Conservancy in Great Britain in 1949, no institution in that country offered classes on conservation.

Years later, an incipient conscience was awakening to environmental deterioration, and a Department was created at the University of Edinburgh for research and education on conservation.

Presently, the graduates of a good number of British universities are warmly received in postgraduate research, forest commissions, African national parks, the teaching profession, official planning or consulting offices, and so forth.

In our country, the idea of approaching natural resource problems from a panoramic point of view—all together, as a harmonious whole—is nothing recent. In 1939, Beltran suggested a suitable policy for the handling of natural resources in Mexico. Now, many years after this greatest of all Mexican conservationists proposed it, his policy has proven its goodness and usefulness as the most advisable way to solve those problems of environmental deterioration which he foresaw at that time.

It was Beltran himself who, five years before proposing that policy, gave a start in Mexico to the teaching of Nature Conservation, by establishing it at the National School of Agriculture in the sixth year of the forestry course. This was the first promotion of such a specialty: the chair of cynegetic zoology and hydrobiology. For this purpose, he not only had to make a program but a text, as well.

Later, Prof. Beltran continued exercising his conservationist influence. Thanks to him, the "Conferences on Hunting and Fishing" were set up in the same area of the same school, this time in the seventh year, with clear ecological preparation applied to Mexican resources.

Nonetheless, we believe that Prof. Beltran's conservationist ideal became reality in 1945, when for the first time in our country—and surely the first time in the world—a course of studies was created with a definite focus on conservationist education. It was called "Conservation of Natural Resources," and began at what is today the Escuela Normal Superior.

He had to be tenacious and overcome resistance which at times was considerable, as in the decade of the 40's whoever talked about the destruction of resources and their consequent "conservation" was thought to be a pessimist. Moreover, many people with solid academic training failed to understand the range of the world or its goals. In spite of this, he created a new course, this time at the National School of Biological Sciences, which depended on the National Polytechnic Institute. This one was called "Mexico's Biotic Resources."

At the time of this writing, there exist conservation courses—the children of those created by Prof. Beltran—at institutions other than those mentioned above, such as the Faculty of Science and of Philosophy and Letters at the National Autonomous University of Mexico and some schools and colleges of Mexico's state universities.

Although Halffter (1967) enumerates a regular series of courses with clear ecological patterns, which can be studied at university and polytechnic schools, it is actually true that neither are they as sufficient as might be desired nor do they have a real conservationist focus, due to their lack of coordination.

Finally, I shall reiterate something that I once stated (Gonzalez, 1967): Mexico is a pioneer in the teaching of conservation, since this practice began in 1939 at a school of higher learning, was continued at a school for teachers and of polytechnics, and is carried on more recently at our universities. Despite all this, however, Mexico's development in this regard has not been in keeping with the antiquity of its conservation course.

We must fight so that the ideal of conservation taught at schools on all levels be broadened not only with respect to the number of courses but also with respect to quality and focus.

Clearly, we need not only technicians but also conservationists and ecologists, who will coordinate and give advice on our government's activities, in order to become more familiar with our natural resources and, thus, to be able to use them adequately and administer them rationally.

Our country demands that its educational authorities take into account the need for more and better conservationists in the professorships of our schools, so that they may instill in Mexicans the necessary "conservationist conscience," which will make them understand why they must "put trash in its place" and the importance of their help in the "fight against pollution."

REFERENCES

Beltran, Enrique.
1966. El carácter interdisciplinario de la conservación. Edic. IMRNR. México.

Gonzalez C., Ambrosio.
1967. Educación superior. *in* Mesas Redondas sobre educación y propaganda en la conservación. Edic. IMRNR. México.

Halffter, Gonzalo.
1967. Comentario. *in* Mesas Redondas sobre educación y propaganda en la Conservación Edic. IMRNR. México.

Laptev, R.
1967. Teaching conservation of nature course at V. V. Kuibyshev Omsk State University. IUCN Publication New Series, Supplementary Paper No. 9.

Potter, S.
1970. Bioethic. MacMillan. New York.

Shaposhnikov, L. K.
1967. Principles and forms of teaching the nature conservation course at high educational establishments. IUCN Publication New Series, Supplementary Paper No. 9.

Simms, D. H.
1967. Conservation education in university and other institutions of higher learning in the U.S.A. IUCN Publication New Series, Supplementary Paper No. 9.

DISCUSSION

MR. O. S. FIGUEROA (Biologist): Mexico must begin preparing ecologists and conservationists in order to prevent what has been happening in many countries, and in ours in particular, from continuing. I refer to the fact that lawyers, economists, and even public accountants have been turned almost overnight into distinguished conservationists, which is an exceedingly dangerous practice.

FROM THE FLOOR: Pressure must certainly be brought on the authorities to create conservation studies programs at both intermediate and superior levels of education, but it must be biologists themselves who point out the need for increased conservation training in such schools.

TRENDS ON ENVIRONMENTAL CONTROL IN MEXICO

HUMBERTO ROMERO-ALVAREZ

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The strong current of interest and of genuine concern that is moving the whole world to discover practical and efficient formulae to preserve, control and improve environmental conditions has been intensely reflected in Mexico. This movement has produced a series of actions that, at the present time, are in the process of evolution.

We are going to consider the problems that may affect living organisms from their contact with air, water and soil, whose physical, chemical, and biological conditions have been unfavorably altered; the tactics adopted in Mexico for their solution and the measures already taken or to be adopted.

Considering that these problems have many aspects, we will analyze only those of major significance from the technical, administrative, and social points of view, although recognizing at the same time that, in Mexico, as a consequence of its social, economic and climatic conditions, other problems, such as those of sanitary food handling and noxious fauna, assume tremendous importance.

TECHNICAL ASPECTS

Until the last few years, the scientific knowledge and the technology of environmental sanitation in Mexico, were limited in their application to very small groups, mainly within governmental agencies, such as those producing goods and services related to public health activities. Physicians and engineers, trained in sanitary sciences in foreign universities—mainly in the United States—made efforts, at times systematic, and at times isolated or sporadic, to improve the environment.

Only during the last decade did a combination of circumstances result in rendering these actions more definite and in giving them a more ample projection.

With regard to air pollution, a study group, created by the Ministry of Public Health and Welfare, undertook important investigations concerning qualitative and quantitative characteristics of atmospheric pollutants in the Valley of Mexico. Several sampling stations were established, and their continuing work has been extended to other cities in the country. The Mexican research efforts were subsequently integrated on a hemispheric level with those stimulated and conducted by the Panamerican Health Organization.

Additionally, the Division of Environmental Hygiene (formerly Industrial Hygiene) has accomplished important research on local problems and water contamination. Outstanding among these is one of water pollution by arsenic compounds; another is that of the toxic effects of insecticides and pesticides used in agriculture and in public health campaigns.

On the other hand, the National University of Mexico (U.N.A.M.) through its Geophysics Institute, has been carrying out studies to determine which are the principal atmospheric contaminants in Mexico City and their magnitude of incidence. More recently (1970) the National Academy of Medicine, jointly with other official and private institutions, planned a field investigation to determine and quantify the effects on human health of some contaminants in the Mexico City metropolitan area. This scientific investigation, currently underway, undoubtedly constitutes the first and only serious effort to date, to evaluate the epidemiological problem of atmospheric pollution in the most important urban and industrial center of the country.

With regard to water sanitation, Mexico has had broad experience in solving sanitary engineering problems resulting from the need of supplying potable water and sewerage services to various communities, and of extending them continuously to localities in the country whose growth, particularly in urban areas, has been truly explosive. In this field, the transfer of technology has been efficiently achieved;

current engineering practices and technical procedures have been mastered and have been well adapted to actual Mexican conditions, with continuing evidence toward perfection.

Water pollution is a problem which has been growing in Mexico and is due primarily to the demographic, industrial, and agricultural growth of the country. The technical basis for its control necessarily demands a previous exact knowledge of the problem, its localization, its magnitude and other characteristics, as well as the establishment of an adequate methodology for its study.

With this objective there was carried out during 1969 and 1970 the first formal study of a major watershed, that of the Lerma River, This pilot-type study produced a wealth of information which, when duly evaluated, should establish guidelines for allowing the establishment of technical specifications, in accordance with the needs and possibilities in the country, and for accomplishing similar investigations in other watersheds and refining adequate control measures.

The investigations of the status of pollution of the Lerma River, employing modern technical resources, were carried out through the initiative of the Community Water Supply and Sewerage Branch of the Ministry of Hydraulic Resources, in joint action with the Engineering Institute of the National University of Mexico. No information is available concerning any similar efforts carried out during any earlier period, with the exception of the preliminary study of pollution of the Papaloapan River, accomplished in 1952 by technicians of the Ministry of Hydraulic Resources.

Regarding the reuse of municipal sewage and other effluents as a water saving measure, and as an indirect pollution control method, there should be mentioned the projects developed and currently under operation in the cities of Mexico, Monterrey and Saltillo.

It is evident that the progress achieved in environmental improvement and control is due chiefly to the ever increasing availability of national technical personnel. The National University of Mexico has played an important role in the professional preparation of such personnel, having initiated postgraduate courses in Sanitary Engineering, in 1951. Subsequent support by the Federal Government and the Panamerican Health Organization has greatly stimulated these activities, initiating successfully complementary research efforts.

The Universities of Nuevo Leon and of Chihuahua, the National Polytechnical Institute and the Technological Institute of Monterrey, are also carrying out programs for the formation of sanitary engineers.

Special mention should also be made of the School of Public Health for the training, since the 1920s, of physicians, engineers, sociologists, nurses, as well as specialists in environmental sanitation.

ADMINISTRATIVE ASPECTS

During the past year great progress has been made in Mexico toward providing greater effectiveness to environmental control efforts through provision of a sound organizational structure. The outstanding accomplishments have been the review of legal tools, including the issuance of new laws as well as the administrative reorganization, to create adequate agencies to carry out the control programs, promoting and watch-dogging the correct compliance with the laws.

Of prime importance is the Federal Law for Prevention and Control of Environmental Pollution, in effect since March, 1971, and applicable to the entire country. This law designates the Executive Departments responsible for its application, the activities to be carried out, the methodology of corrective measures, the prohibitions concerning those atmospheric, water and soil contaminants which might be prejudicial to the well-being of the natural flora, the wildlife and, in general, to public or private resources. The law specifies the requisites for the proper use of water and land and the sanctions to be imposed on violators for any misuse of these resources.

On September 17, 1971, six months after the law was put into effect, there were issued the Rules and Regulations for Prevention and Control of Atmospheric Pollution Caused by Emission of Smoke and Dusts; study and formulation of complementary regulations are underway.

In another field of the environment, the New Federal Water Law, in effect since January 26, 1972, emphasizes the protection, improvement and conservation of water sources, the prevention and control of water pollution, and water utilization methods for domestic, industrial, agricultural and livestock purposes, and in the development of aquatic, wildlife and plant species. Also covered are methods for proper exploitation of residual waters to avoid adverse alterations of ecological systems and especially of the receiving waters.

In its participation, the Ministry of Public Health and Welfare and the General Public Health Council have already finished a new draft of the Sanitary Code, which is said to cover complementary aspects of control of the environment.

All of these legal means have been giving place to specific actions of an administrative nature, outstanding among which was the creation on January 30, 1972, of the Under-Secretariat for Environmental

Improvement within the Ministry of Health and Welfare. This new Federal Government body, still under organization, will deal with, in addition to inherent functions of planning, promotion, supervision, etc., the means of reconciling the various interests of the country. While recognizing the need for stimulating the country's economic development, maximum efforts will be made toward avoiding or controlling any measure which may result in deterioration of the environment, thus attempting to minimize any adverse effects on public health or on the wildlife and plants of the country.

This Under-Secretariat will absorb the duties previously assigned to the National Council of Science and Technology, in the realm of research applied to the struggle against environmental contamination.

Since 1947, Mexico has had, for the control and proper use of water, a Ministry dedicated exclusively to land reclamation and to the administration of water resources. However, with the ever-increasing need to insure the sound use, and to oversee the conservation and quality improvement of the national waters, the Ministry of Hydraulic Resources, in accordance with the new laws, has created a Directorate specifically dedicated to this task. This new body replaces and amplifies the areas of responsibility of the Office for Prevention and Control of Water Pollution, formed in 1969.

Within their respective spheres of action, other official agencies are also working to improve environmental conditions. This is the case of the Ministry of Industry and Commerce in which was created the Under-Secretariat of Fisheries to oversee the activities for the protection and exploitation of these resources. The Ministry of Agriculture and Livestock is similarly responsible for land improvement and for preservation of wildlife and plantlife. This agency has well-advanced plans for establishment of a laboratory for quality control of insecticides. Additionally the proposed laboratory will establish standards covering insecticides application, with the objective of reducing damage to the ecological systems and to public health.

The broad range of activities being developed by the newly created agencies and by those already established necessarily require a close effective coordination as well as a comprehensive public relations approach. For this purpose there is a Central Program Coordinating Committee for Environmental Improvement, which acts dynamically under the chairmanship of the Minister of Public Health and Welfare. Working and evaluating meetings are carried out periodically in strategic points throughout the country.

SOCIAL ASPECTS

As it is recognized, the control of the environment is a collective function which demands the united efforts of the entire community. Without a prior community awareness and without the community's conscious acceptance of the control plans it is not possible to embark successfully on a program as complex as the one in which we are now engaged.

In this regard, Mexico has obviously been favored by the intense propaganda—originiating in countries of great economic and technologic development—concerning environmental contamination and the urgent need for adoption of measures to avoid continued deterioration. In effect, it may be said that there already exists a clear consciousness of this need, at certain cultural levels and in certain geographic areas, where obvious problems are already being faced.

Contributing to the development of this collective consciousness is the circumstance that Mexico is a country with an urgent need to improve the living conditions of the majority of its people. For this reason, the country must zealously attend to the renewal and preservation of the quality of those resources. These circumstances make the Mexicans more sensitive to certain aspects of the pollution problem. Probably water is the element which, due to regional scarcity and conflicts over its uses, most frequently presents situations in which the interest and concern of the public are most often and most emphatically revealed and in which the community demand is most obvious. Many examples might be cited. There exists local pollution in some portions of the Lerma, Papaloapan and Coatzacoalcos Rivers and in the coastal waters at the mouth of the Yaqui River, which render these waters toxic for fishes. The serious concern of the Federal Government to protect the waters of Acapulco Bay is very evident. And perhaps best known, because it represents an unjust, painful situation, is the saline pollution of the waters which are received internationally, by the Irrigation District and the City of Mexicali, resulting in that "grave ecological attack" which we should all gladly like to see resolved.

The great urban concentrations of the country, such as the Valley of Mexico, located at high altitudes, create a critical need for careful exploitation and recycling of water. The coincidence of urban concentrations and the most important industrial zones, produces in turn, a problem of atmospheric pollution which becomes more acute every day. The latter problem is probably not well appreciated by the general public but has received major attention on the part of government officials.

As a result of the global attention to which we have referred, and because of the vital dependence felt by the Mexicans for a sound exploitation of their natural resources, it is encouraging to note that there already exists, in the process of formation, a popular consciousness of the problem of environmental deterioration, as a subproduct of progress, and of the demand that everyone must help to achieve a solution as an act of genuine national solidarity.

In this sense the reactions to the Government's efforts may already be noted. Every day the press, the radio and the television make frequent references to the struggle to maintain a healthy environment. Previously nearly unknown terms such as "ecology," "contamination," and "pollutants" are more and more evident in public use. Organized groups in commerce and industry, scientific societies, educational institutions, service clubs, all, without exception, include the "topic of the day" in their work programs.

In international circles Mexico receives a continuous flow of information and, in turn, is communicating its experiences in the certainty that through this spirit of friendly cooperation, the formulae for mutual life will be found, harmonious among human beings themselves and between human beings and Nature, to insure the future well-being of mankind.

In summary, it is believed that the situation existing in Mexico in both technical and administrative aspects, as well as the attitude of official and private sectors, lend themselves to the development of formal activities for control and improvement of the environment and such activity, judging from efforts made to date, offers a promise of successful results.

The legal instruments, which already exist, complemented by regulations in dynamic and realistic terms compatible with the economic and social situation in the country, make feasible the future prevention and control of all forms of deterioration of the environment. There is developing a collective consciousness in the sense that the programs of environmental improvement require the participation of the entire community. The activities now being conducted in coordinate fashion are oriented toward a knowledge of the true magnitude of the problems and their effects, not only in the area of health, but in other aspects of the people's economic and social activity. These activities demonstrate an awareness that Mexico needs, for her welfare and progress, the maximum but equitable and just exploitation of her natural resources.

DISCUSSION

DR. GEORGE HALAZON: I wonder if it would be useful for the countries of Latin America in evaluating economic aid programs going to those countries, to make it a requirement prior to getting that help, that the nation should help itself in the methods of birth control as part of their national policy.

DR. ENRIQUE BELTRÁN: I will try to answer that question, although I consider it is a delicate matter, since it involves the sovereignty of each nation. I don't see how one country or group of countries may impose their views on other nations; or what right the rich countries have to regulate other countries' problems. I think it is not only necessary, but urgent for all countries to control population growth, which is the most serious menace for the future of mankind. I have sustained this opinion in several lectures and papers. But to decide and implement such policies are rights that belong to every nation involved. In Latin America it will be necessary to overcome the obstinate opposition of the Catholic Church. If the problem of population is not solved, it will be impossible to solve other problems. This to me, is the most important problem of all.

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TECHNICAL SESSION

Monday Afternoon—March 13

Chairman: EDWARD L. TOWLE
President, Caribbean Conservation Association, St. Thomas, U. S. Virgin Islands

Discussion Leader: RICHARD H. STROUD
Executive Vice President, Sport Fishing Institute, Washington, D. C.

COASTAL AND MARINE RESOURCES

ENVIRONMENTAL MANAGEMENT OF THE COASTAL ZONE

WILLIAM S. BELLER
U. S. Environmental Protection Agency, Washington, D. C.

Countless communities are allowing their quality of life to slip by, almost unnoticed. Many let it happen out of lethargy, others out of ignorance, but most for economic reasons and in pursuit of short-term gains. A little more noxious gas in the atmosphere is said to be of small account compared to the willingness of an industry to move into the neighborhood and give jobs. By similar reasoning, a little more pollution in the water can be tolerated. Or the land can easily mitigate the effects of the pesticides. What adds to the problem is that the communities are sometimes right.

We seek to conserve our natural environment not only for aesthetic and recreational reasons, or even because many of us find it a good scientific field station, but also because it is integral to our lives. Parts of the environment such as our air and water, many organisms in the soil such as nitrogen-fixing bacteria, if changed beyond a point whose values we would like to know, could put a new species of animals on the endangered list, namely us.

To bring this fact home, and to show that giving money now to prevent unnecessary environmental damage is far cheaper than trying to regenerate an environment, I recently asked a member of a legislative body: "How much would your constitutents pay to recover a healthful atmosphere, once it were lost?" He answered: "Not very much. They would rather put their money into designing and producing a comfortable gas mask." Although this viewpoint is a commentary on our times, I do not believe that most legislators think so cynically about their constituents.

It would indeed be disappointing to see the enormous ability of man to adapt to his environment taking him down such a route, instead of letting him try the alternatives. One such alternative for the coastal zone, which together with ocean islands are perhaps the areas that suffer most from abuse of their natural resources, is through a program of environmental management geared to the quality of life desired by the citizens.

MEANING OF TERMS

We define the adjective "environmental" as denoting, in part, the quality of the air, water and land at a given time and place. This definition suggests that the environment has values that we can determine, such as weight of particulates in the air, biological-oxygen-demand of the water, and acidity or alkalinity of the earth. What is important is that we can put these aspects into numerical form, which helps show us how much our natural environment is changing.

We should now expand the definition to embrace the quality of man's entire ecosystem, including the economic and cultural aspects. Although these last factors are as important as any that one can bring up, we can get away from going into a full discussion of them by noting that a good quality of the natural environment, in nearly every instance, enhances all of the other aspects of the human environment.

In this regard, somebody might argue that powerplant engineers are not too worried about the quality of water they bring in from streams to use as a coolant, nor are processing industries too concerned about the quality of the water into which they discharge their effluents. Alas, in many instances this is true; but society is beginning to worry about the quality of their water, and industry is beginning to feel the displeasure of the citizens. A direct result is the forming in many parts of the world of environmental protection agencies. These help make and enforce regulations and strictures to keep industry, municipalities, and others from changing without limit the natural environment.

Another result is what may be classed as a citizen's revolt: the growing activity of part of the public stemming from their belief that theirs is not simply a privilege but a basic right to have a healthful natural environment. We have such a revolt in Bowie, Maryland, which is striving to ban the use of non-returnable bottles; in a group of citizens who through court action (1971a) caused the U.S. Atomic Energy Commission to consider seriously the environmental effects of nuclear powerplant siting; and in other groups of citizens invoking the "trust doctrine" to get their governments to act in their favor on natural resource and environmental problems (Beller, 1971).

These examples show only the nose of the camel under the tent, but they do show that industry, too, has more to gain than lose by helping maintain a good quality of the natural environment. Indeed, some companies have already realized this fact, and are seeking to build reputations on it.

The adjective "environmental," then, denotes the quality of man's entire ecosystem, but lays much of its stress on the condition of his air, water and land. Consequently, we shall concentrate here on the natural environment.

Some of the developing nations may feel that they have time enough to worry about their environment; what is important now is to use what is at hand to bring jobs and food and shelter to their people. We can agree with this set of priorities, but also believe that a land can go ahead with them without auctioning off the quality of its environment. Lands do mature, and we recall the lament of the octogenarian: "If I'd 'a known I was going to live so long, I'd 'a taken better care of myself."

Turning now to defining management, we see this as peculiarly a human function, wherein we direct today's activities and make plans for tomorrow so that our prospects will be better than they are today. The most fortunate managers are those who still have alternatives, such as choosing the ways to get the best use out of a still healthful environment.

The coastal zone is the area where the sea and land meet, and where the fingers of the sea poke into the land. It is also where the effects of these meetings are strongly felt. Thus, the coastal zone includes the land, waters, and lands beneath the waters near the shoreline.

We see no upper bound to the value of the coastal zone: it gives us an avenue for our commerce; a nursery ground or habitat for most of our fish and some of our wildlife; a unique recreational area; a sink for our wastes; a storehouse of oil and other minerals; land for choice real-estate developments and luxury hotels; sites for industrial developments; and a useful moat for defense.

For legislative purposes, the coastal zone is often defined arbitrarily and with the preciseness of Procrustes. A legendary Greek thief, he forced travelers to fit into his bed by cutting off the limbs of those too long, and stretching the limbs of those too short. (A few historians claim that the vagabond had two beds, a very short and a very long one.) Some States in the United States define the coastal zone as running seaward to the outer edge of the Territorial Sea, and landward to a seacoast highway or a vegetation line, or other boundaries set by the government officials. The Territorial Sea comprises state waters and reaches seaward three nautical miles for most U.S. coastal states.

The concept of managing a coastal zone is a new idea. This area is neither a political entity nor an environmental one, such as a river basin. It was a striking thought to give special attention to a ribbon of land and water on the basis of its fragility and ecological value. Yet the (U.S.) Marine Council in its report for 1968 did pose the dilemma of how to develop the zone without destroying it (1968). Then in early 1969, the President's Marine Commission recommended that the U.S. Government help coastal states develop plans for managing the coastal zone(1969). A spate of bills were introduced into the U.S. Congress to accomplish the Commission's recommendation, including several umbrella bills for land-use management.

We come now to our basic premise: in the environmental management of the coastal zone, we try to anticipate the pressures on the quality of the air, water and land which result from acts of nature; or from acts of man as part of nature. We seek to work with these pressures in a way that will bring the greatest good to society.

WHAT ARE THE PRESSURES?

The coastal zone is the target of recreationists, conservationists, preservationists, industrialists, educators, builders, defense strategists, shippers, tourists, politicians and government regulators. To this mix, each year we add more millions of people needing heat, electricity, water, jobs and other comforts of life that depend substantially on coastal resources. It is no wonder that a voluminous study (1970) of estuarine areas in the United States shows, despite geographic differences, increasingly strong but almost identical pressures on many of these areas. Here is a sampling:

—Expanding population, rising incomes, and the desire to own a waterfront property are adding to the mounting pressure to fill parts of Tampa Bay. About 60 percent of all the marshland that existed around the Bay and about 25 percent of the mud flats have already been filled or diked off.

—Filling and diking in Charleston Harbor for agriculture, residential, and industrial sites are continuously eroding the valuable marshlands. It is estimated that almost a third of them have been lost.

—For some coastal communities on Galveston Bay, filling in of wet or marshy areas is inevitable to provide recreational facilities to help satisfy the rising demands from urbanized areas.

—Public access to the water is poor on San Francisco Bay and is limited to a few shoreline parks and marinas.

—Public access to the waters of Puget Sound is poor. The majority of frontage on the Sound is privately owned.

—Tampa Bay is a receptacle for wastes from domestic, industrial and agricultural sources throughout its tributary area. In the waters immediately adjacent to Tampa, public bathing and commercial shellfishing are prohibited due to extensive pollution.

—Waste discharges from 29 industrial sources and 8 municipal sewage treatment plants have degraded a 50-mile reach of the Delaware River rendering it uninhabitable for fish life throughout a major portion of the year.

—Deposition of dredging spoil constitutes a continuing threat to the natural environment of Penobscot Bay, Maine.

Upstream pollutants affecting downstream water quality; no benign sites on which to put dredging spoil; rapid filling of marshlands; poor public access to public waters—in most of these problems it is not the technical but the jurisdictional, administrative, and political considerations that loom largest. These are necessarily influenced by economic factors:

Should a company go out of business and deprive its employees of work and the community of taxes if the company can show it cannot afford to buy the equipment it needs to treat its wastes to meet government standards? To ensure itself against a shortage of power, should an area let a utility discharge heated water into an important estuary, even though the effluent will diminish some of the marine life there, and some of the aesthetic and recreational values? For the sake of tourism, should an area permit some of its beaches to be closeted by hotels?

Because nature seldom defers to political boundaries, the problems of coastal-zone management often involve simultaneously all lands that border a common water basin. In this connection, we can think of problems such as those raised by the disposal of toxic wastes at sea, industry's search for concessions, the *Torrey Canyon* disaster, water shortages, need for electrical power, ocean dumping, and fishing rights.

Some of these lands might find that their own difficult coastal problems have easier joint solutions. For example, nuclear power-plants might be built and shared by coastal nations that otherwise might not have enough money or demand for such a powerplant, thereby lowering the unit cost of electricity. Where fresh water is also needed, desalting units might be added to the nuclear plant. A side benefit could be that only one of the nations would have to give up any of its coastline for the enterprise. The nations might be able to avoid even this effect by putting the units on the seabed or an outlying island.

By working together, these lands might also standardize on the environmental concessions they give industry, in this way allowing companies the benefits of a good quality environment without forcing them to play one nation off against another.

Lands linked by estuaries could help one another increase fish catches by suitably protecting and nuturing spawning areas and juvenile fish. Cronin (1967) stresses the possibility of profitably manipulating rivers, bays, marshes and other coastal areas to help productive growth. He cites the value of nutrients in sewage and detergents, if properly used. He also suggests that thermal effluents might be helpful in accelerating the spawning of all species of organisms and in photosynthetic production. A caution Cronin makes is that while some of these proposals are supported by field evidence, others will need to be rigorously investigated before they are accepted and used.

PHILOSOPHY OF ENVIRONMENTAL MANAGEMENT

A coastal community, as every other unit of government, usually wants to achieve as much material good for its citizens as possible, and in the most economical way. Because the downstream effects of a community's actions are not immediately apparent to its citizens, and if noted, might be costly to change, these effects are often disregarded. Enlightened self-interest of such communities, though, would show that benefits do surely come from a regional or ecosystem-basin approach to environmental management. Failing to see this, or not being able to see it for political reasons, must put the burden on the involved nation itself to set environmental guidelines or criteria for its lesser political units to follow.

Self-interest also suggests that citizens of coastal areas plan and enact coastal-zone programs as soon as possible. This is fairly easy to do for developing nations, where costs of coastal land are usually low, many commitments not made, and constraints and allowances easier to install than in established areas. The job is much more difficult to do in the established coastal areas, where intensive or single-purpose uses may already have stunted further growth and enjoyment of these areas.

In the United States, some of the states, such as Massachusetts (1963), Delaware (1971b), and Washington (1971c), have anticipated the Federal Government in passing coastal-zone legislation. Their Acts range from Delaware's absolute prohibition on new heavy industry's settling in the coastal zone, to that of Washington, where the state is calling for an inventory of resources preparatory to the making of a master plan.

In a remarkably clear and forecful paper, Caldwell (1970) gives us some information about environmental management, although his main emphasis is on land use. He makes a case for the ecosystem approach to land use, which looks to conserving the health of the natural ecosystem as the new basis for public policy. Caldwell says that compromises will have to be made when the requirements of natural ecosystems conflict with those of systems made by man. In these instances, man may have to yield by revising his concepts of what constitutes private and public land. Caldwell bases his proposal on the fact that we are drawing upon our natural resources with increasing rapacity; unless something is done to call a halt, and that will ensure the ecosystem integrity of our planet, then soon we will not have a planet to worry about.

The Marine Commission in its report to the President (1969), while concerned with what was happening to the natural ecosystems in the United States, thought that other factors should be considered as well. As noted earlier, the Commission pinned its hopes on the State Governments, which would derive coastal-zone management plans based on the physical, biological and economic characteristics of the state coasts and estuaries.

Taking their lead from the Marine Commission, U.S. Congressional committees, too, are seeking to let the states draw up their own plans in managing their coastal zones. Typically, one bill directs that full consideration be given to "ecological, cultural, historic, and aesthetic values as well as to needs for economic development" (Hollings, 1971).

We can perhaps use the ideas of Caldwell, the Commission, and Congressional committees toward solving the problems of coastal-zone management. Such an approach would have as its goal the achieving of a desired and realistic quality of life for coastal communities and their nations. The quality of life would necessarily correspond to some balanced condition of the human ecosystem. The human ecosystem we define as including man and his works. We suggest that environmental management of the coastal zone, in fact of any area, should seek to achieve an ecosystem balance that corresponds to the quality of life that society wants, and is willing to pay for.

This ambition allows us to pose coastal-zone problems, delineate the needed research, and make decisions. How many beaches should a community have? How important do its citizens consider swimming; how far would they be willing to travel to reach a beach; how much room do they want on it? What restrictions are they willing to put on industry, and themselves, to achieve the water quality needed for swimming? How earnestly are they willing to enforce their water-quality laws? These are a few of the questions that must be asked and answered if a coastal-zone program tailored to the desires of a people is to be drawn. The premise on which this technique rests is that a society sets a certain environmental quality of life as its goal, and then is willing to arrange its affairs to reach and maintain it.

A small ocean island, with the cooperation of its people, would be fairly easy to program for the described type of environmental management. Islands behave like pure coastal zones because there is scarcely a major decision made on them that is not affected by the nearness of the sea. It indeed would be instructive to use an island as a working model and show the benefits that could be derived from a complete program of environmental planning and operation. As a result of such a model island project, not only other ocean islands but also coastal areas on the mainland might see their problems and some of the solutions clearer than they do now (Beller, 1971).

The alternative to seeking an appropriately balanced environment, that of allowing random development of the coastal zone, besides wasting resources, can cause resentment by the community and its ultimate deterioration. Such a reaction to a failing environment is not restricted to the coastal zone but can be seen in many core city communities as well.

St. Thomas, U.S. Virgin Islands, illustrates what can happen when a community suddenly realizes that most of its beaches are not available. Until late last year, this island had only two public beaches that were easily accessible to its residents and had a reach of sand—Lindbergh Bay, which is close to Charlotte Amalie; and Magens Bay, which can be reached from town only by a tortuous drive on narrow roads. The remaining beach areas on the island were either in private hands, blocked by a sea wall, or fronting on polluted water. Not unexpectedly, on weekends the public beaches were crowded and noisy.

Finally frustrated at the loss of what they felt was their heritage, citizens of the island petitioned their legislature to open to the public all of the hotel-controlled beaches there. The legislature, in the face of highly dramatic public hearings held by the responsible subcommittee, passed an Open Beaches Bill, which became law.

The people of these islands were fortunate that public and private interests coincided to conserve some of their beaches. For every one of these happy instances, there are countless others where a community does not know it is selling a precious piece of its environment and quality of life until it is irretrievable.

A NATIONAL STRATEGY

Let me briefly sketch a way to translate into a government program a community's desire for a given environmental quality of life. We assume that through public hearings or other democratic means, the community and its government have decided what the best uses of their shoreline should be. Most of the coast would undoubtedly have coincident uses: recreation, real-estate development and aesthetics; industry and aquaculture: fisheries, boating and waste disposal; water supply and research and education.

The uses of the coast would dictate the needed quality of the waters. To reach or maintain this water quality, the government would have to study the wastes put into the waters by the various contaminating sources: municipal, industrial, mining, agricultural, commercial, recreational and natural. If the prescribed uses of the coast are endangered by the contaminants, then the government would have to look at the various ways to correct the problems, and pass and enforce appropriate regulations. In general, and finally, the government would have to take a hard look at the resources it has available to deal with the problems, that is, the human and financial resources, before it embarks on its action program.

What has just been said is close to the way we are looking at water-quality problems in the United States. It is not necessarily the way other nations should look at their own environmental problems. These must be solved in the matrix of a nation's own geography, economics and cultural heritage.

On the basis of the local use of the coastal zone, we can derive a national strategy. The government could specify national effluent standards, which would prevent the migration of industry from one area to another in search of more permissive environmental standards. The government could state a policy of non-degradation of its waters, which would be the determinant in the siting of new or changed effluent sources on the shoreline. It could adopt a long-range policy calling for maximum reuse of treated water in agriculture and industry, and possibly for recharge of ground water and recycling of municipal wastes. Where the ground table has been significantly lowered, as in some arid areas, these last methods could be essential.

If a nation earnestly wishes to improve its environment, then it must also have the trained people able to effect this: the engineers, scientists and environmentally knowledgeable sociologists, economists and lawyers. Here is where the local colleges and universities can make a handsome contribution in terms of training their people; and the government would find it well within its interests to encourage such training. Foreign consultants are good, but they are only the initial cup of water that primes the pump, which must then draw upon its own water table for sustenance.

SUMMARY

The importance of the problems of the coastal zone stems from its large value and fragility relative to inland areas. The current emphasis on these problems comes from industrial nations seeing the value of their coastal areas diminishing because of ill-considered uses and from prudent developing nations seeking to avoid such misuses.

In this paper we have gone full circle. We started by defining environmental management of the coastal zone, and noting that the quality of the environment can in large part be measured by the quality of its air, water and land. We tried to show some of the competing and often conflicting pressures in the coastal zone, and we briefly noted the reaction to these of several of the states in the United States.

We suggested that the role of the environmental manager is to devise his plans so that the coastal pressures contribute to an ecosystem stability that will permit a people to have the quality of life they want and are willing to pay for. Finally, we noted that by monitoring and regulating specific environmental parameters, we could help ensure reaching and holding that ecosystem stability.

LITERATURE CITED

Anonymous

1963. An act relative to removal, filling and dredging of areas bordering on coastal waters. Mass. general laws. chapt. 130, sec't. 27A.

1968. Marine science affairs. National Council on Marine Resources and Engineering Development. 2nd report on marine affairs from the Pres. to Congress. U.S. Gov't. Print. Off. 228 pp.

1969. Our nation and the sea. Commission on Marine Science, Engineering and Resources. Rep't. to Pres. and Congress. U.S. Gov't. Print. Off. 305 pp.

1970. National estuary report. U.S. Dept. of the Interior Fish and Wildlife Serv. Seven vols. Conflicts and problems in specific estuaries, vol. 5, append. G, 94 pp.

1971a. Calvert Cliffs' Coordinating Committee, Inc. v. United States A.E. Com'n., 449 F.2d 1109 (D.C. Cir. 1971).

1971b. Coastal zone zoning act. Amend. to itle 7 of Del. Code, Enact. of Gen. Assembly, Dover, Del.

1971c. Shoreline management act of 1971. Dept. of Ecology, State of Washington, Olympia, Wash.

Beller, W. S.
1971. Ocean islands—rosetta stones for coastal cities. Marine Technology Society Preprints, 7th Annual Conf. pp. 473-482.
Caldwell, L. K.
1970. The ecosystem as a criterion for public land policy. Natural resources journal, 10, (2) pp. 203-221. Univ. of New Mexico School of Law.
Cronin, L. E.
1967. The role of man in estuarine processes. Proceed. Conf. on Estuaries. Am. Assoc. Adv. Sc. pp. 667-689.
Hollings, E. F.
1971. National coastal and estuarine zone management act of 1971. S. 582, committee print no. 2, revis. Aug. 6, 1971, 92d Congress, 1st Sess., Wash., D.C.

USE OF DEAD REEF SHELL AND ITS RELATION TO ESTUARINE CONSERVATION

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INTRODUCTION AND BACKGROUND INFORMATION

Two of the three genera of living oysters have their centers of abundance in shallow waters. These are typified by the European flat oyster, *Ostrea edulis,* and the Virginia oyster, *Crassostrea virginica.* The third genus, *Pycnodonte,* lives in waters sometimes up to a mile (1609 meters) deep.

The European oyster does not form massive shells or massive reefs as the Virginia oyster does and these differences are characteristics of generic distinction (Gunter, 1950). The reef-building proclivity of this American oyster depends essentially upon the ability of the individuals to live on top of each other while all grow and survive for a few years, even though the lower ones are finally covered over and smothered or are slowly pushed down into the mud and buried. This type of growth leads to thick deposits of shell that comprise some of the largest aggregations of organic material on earth, rivaling some of the coral reefs in extent and mass. The Point au Fer reef off the mouth of the Atchafalaya River in Louisiana was thirty miles (48.3 kilometers) long and many feet deep. Most of it is buried now due to natural geological processes of sedimentation, which have been accelerated by growth of the Atchafalaya River over the past hundred years caused by the levees of the white man (Gunter, 1952) along the Mississippi River.

The Virginia oyster is estuarine and is not found in the open ocean except in rare cases. Off the Crystal River of Florida, which has no estuary, there are live oyster reefs (Dawson 1955) in the open Gulf. The same thing is true of the Gulf off of the western portion of Atchafalaya Bay, Louisiana, where the heavy fresh-water outflow maintains inshore Gulf waters in an estuarine condition (personal communication, Dr. J. G. Mackin).

Nevertheless, old oyster shells have been found by the writer and others on the northern shelf of the Gulf of Mexico and the Atlantic (see Gunter, 1969). Presumably these grew in old estuaries farther out on the shelf before the last rise in sea level. The age of the genus *Crassostrea* and its species are unknown, but it certainly existed before the present system of the bays and estuaries of the Earth formed, and was ready to take advantage of the present and possibly expanded estuarine area when it arose.

The last glacial period, the Wisconsin or Würm, began to melt 11,000 to 12,000 years ago, according to the geologists, and the sea level rose to a few feet below the present level by about 6800 to 5700 B.C. There is some disagreement about this time and it seems to be growing shorter in recent accounts, but it is of little importance to our interests here. Since then there has been a slower rise.

According to Rainwater (1964) and Ryan (1967), the estuaries which formed all along the Gulf coast following the relative standstill of the rising waters were approximately forty feet (12.2 metres) deep. Now most bays have been over half filled with silt and most of them are now 10 to 12 feet (3.3-3.9 metres) deep, with a few approaching 20 feet (6.6 metres). Others are filled and the rivers flow into the open ocean. The life of the bays remaining would seem to range from two to six thousand years, granting the continuance of present geological processes. In short, the bays are filling in except for certain areas of the Louisiana coast, which have been robbed of sediment by levees along the Mississippi River. In these areas the bays are deepening and the land is cutting away (Gunter, 1952; Eleuterius, 1971). Along most of the nothern Gulf Coast the sea level is still rising about 0.1 of an inch (2.5 mm.) per year.

After the great melting of the ice the rivers ran into the bays and estuaries at approximately the same rate as today. The bays were larger and deeper than today and proper salinities for oysters existed near the river mouths. Presumably, the remainder of the bays were highly saline and not fitted for oysters because of increased enemies, diseases and parasites in high salinity waters, (see Gunter, 1955).

In this connection Ryan (1967) gives a very interesting figure which essentially is a side view of all the buried and live oyster beds from upper Mobile Bay to the lowermost ones, closest to the Gulf. It was also reproduced by Gunter (1969) in connection with a previous discussion of this question. The beds are not necessarily connected as shown in the figure for this is a side view of all beds, some of the west, east or middle parts of the bay. As the bay filled up the depth of the oyster beds became less towards the mouth of the bay and instead of being around 38 feet (11.6 metres) in the upper bay, their lower part or base is at 12 feet (3.7 metres) in the lower bay. Furthermore, the only shells now at the surface of the bottom above the mud, where live oysters can grow, are within fifteen nautical miles (16.68 kilometres) of the lower bay.

There are no known discontinuous dead shell reefs extending from the greater depths to the surface, but some have been known to extend from 28 feet (8.5 metres) to 8 feet (2.4 meters), a thickness of 20 feet (6.1 metres). This is shown in Gunter (1969, Figure 2).

This buried shell is 99.9 percent calcium carbonate and it is valuable for several reasons. It was once used entirely for road material, but is now most valuable to industry. This material is dredged, washed, loaded on barges, delivered to shore and sold. It is an excellent raw material for chemical processes.

REEF SHELL, MUDSHELL AND CONSERVATION

Much of the history of the use of dead reef oyster shell has been lost, but we know that this material was used in the making of lime by the pioneers. It was also used as road material for the filling of chuck holes, etc. Some of the large shell-dredging companies had their beginnings in operations which began with planks laid at low tide to the dead reefs that projected above the surface a few yards offshore. These crude little tracks were crossed by men shoving wheelbarrows and gathering their loads with shovels.

The Louisiana Wildlife and Fisheries Commission (1968) has given the history of reef shell leasing in that state, which began in 1913. Other miscellaneous points concerning the Gulf coast were mentioned by Gunter (1969).

Oyster reefs are composed of thick deposits of dead shell, some of them a few to several meters deep. They generally have a ridge or hogback with live oysters growing along the flanks. The hogback or central portion of a large old reef is made up of finely divided shell which moves with the wind and the waves and is even thrown up in ridges which project to the surface or even above it at moderate tides. This material is quite free of mud and it needs no washing when it is gathered. It is also free of sessile organisms. Quite probably this barrenness is due to the fact that this shell moves and is ground about by the wind and waves and any delicate larvae which would set in such a situation would soon be destroyed.

There certainly seems to be no physical or chemical characteristics of this shell from the central reef which cause it to be barren. The writer discovered (Gunter, 1938) that mudshell makes a fine cultch and it is now used for that purpose by the States of Florida, Mississippi and Louisiana and possibly by private oyster growers. On the other hand, reefs at the surface may show no attached organisms, but the screen pile from a cut made through the reef right nearby will show setting of oysters. This probably comes about because the particles of shell in the screen pile are relatively immobilized by the surrounding mud, while the upper shells on the natural reef are subjected to movement.

Nevertheless, in the minds of the public and many non-biologists, these old dead shell reefs are veritible gardens of Eden, similar to a tropical coral reef and absolutely athrob with life. An example of this erroneous conception was advanced by Eckhardt (1968) as follows: "They are like a miniature mountain range under water. Their sluices and ridges provide a nursery ground for myriads of marine organisms. This minute marine life, in turn, provides food for the next cycle of life in the bay, the shrimp and the smaller fishes. The shrimp and the small fishes then provide food for the large fish, the game species such as the channel bass and the spotted sea trout. . . ."

Unfortunately, this is incorrect and a mudbank or even a sandbank would be much more attractive and much more productive of life. There is no infauna on the old shell reefs and there are no sessile organisms. In fact, there is nothing to attract small shrimp and small fishes because the only food for them present is the plankton in the water, which is everywhere. Larger animals are attracted to an old shell reef because it is a physical object. An old boat, a wreck, a rock jetty or any other physical object will serve just as well or better as an attractant to fishes because such objects do permit the growth of sessile organisms. A dead shell bank is virtually barren.

The hundreds or possibly even thousands of towhead reefs ranging from a yard to a couple of small boat lengths in extent, which dot Galveston Bay from the former Redfish Reef area south at least to Texas City, to my personal knowledge, are infinitely more productive of life than old barren shell reefs, such as the Hannah's Reef.

Yet such misleading ideas as Eckhardt's are picked up by conservation-minded and well-meaning public and absorbed *in toto,* becoming a part of the thinking of the group which opposes mudshell dredging in the bays, the one industry which probably has a beneficial effect ecologically and economically.

Similar innuendo is the statement given by news writer Carter (1970) in *Science* as follows: "Shelldredgers have removed most of the shell from the bay, often taking exposed shell as well as shell underlying a heavy layer of silt. Shell is valuable in highway construction and for other uses (as in the manufacture of cement), and from it fortunes have been made. The U.S. Army Corps of Engineers has moved finally to protect major reefs that are still left and state authorities have tightened their own formerly inadequate regulations for protection of reefs. Little shelldredging is now being done, but until recently, the dredges were taking millions of cubic yards of shell from the bay each year. Not only were shell reefs destroyed but in some cases the dredging and washing of shell caused the silting up of parts of reefs bearing live oysters," (p. 1103). He continues on page 1105 with the following statement, "Had Galveston Bay been thought of as a system of interrelated parts and functions, the state surely would not, for example, have allowed shelldredging, in 1963, to begin dredging within 300 feet of live oyster reefs (the previous limit having been 1500 feet) when no significant study of the situation caused by dredging has been made."

The facts are that a few scrubby oysters on the flanks of a shell reef are worth nothing compared to the thousands of dollars of buried shell beneath them. The total volume of the live oysters involved can easily be replaced in the same area or nearby with the shell being dug up and seeding it. In the generally muddy waters of the bays, it makes no difference, but these planted reefs can be in the area of a circle, a ring or a square, or even a four-leaf clover if desired. In Mississippi we use a conventional rectangle because it is easy to follow in planting.

Lastly, the permission for dredging within three hundred feet of reefs in Galveston Bay was a management problem and a wise decision. It resulted in the destruction of nothing. But such is the inclination to criticize with no basis in fact that such remarks which inflame the public are made. They cause difficulties for well-meaning administrators, lead to unnecessary punitive actions which harm the economy, and conserve nothing.

Reef shell or dead reef shell is called mudshell on much of the Gulf coast because of the fact that the deposits being worked are nearly always buried under an overburden of sediment. Thus in the process of working the shell the dredges, which are large cutter hydraulic dredges, generally sweep the overlying mud away. Nowadays this mud is redeposited in the cut behind the dredge. The layers of shell are cut through by the cutter ahead and the shell is sucked up on to the dredge where it is washed in a stream of water and thrown onto a barge with a stream of muddy water being thrown to the side.

Mudshell operations are carried on chiefly in the Florida west coast, Alabama, Louisiana and Texas areas. Some shell dredging is done in Virginia, and there are potentials in North and South Carolina and Georgia.

After operating for many years with no apparent harm to the environment, the dead reef or mudshell industry has come under very strong attack from the protectionists, conservationists or what have you. Vast meetings and hearings concerning dredging permits are held with people coming from long distances to voice opinions which vary from careful statements of experienced professionals to others that are illiterate, weird, and astounding in their degree of impossibility and lack of understanding. These latter opinions are voiced quite often with an arrogant, intransigient, holier-than-thou attitude which makes the well-meaning biologist despair of the democratic process.

SOME REASONS WHY MUDSHELL DREDGING DOES NOT HARM THE ENVIRONMENT

The mudshell industry began in the State of Louisiana in 1913, and it has increased greatly there since that time. Today over 10,000,000 cubic yards are removed from the bays every year and the State of Louisiana gets over a million dollars in excise taxes from this source alone. At the same time last year it produced over 1.3 billion pounds of marine products, of which 10,000,000 pounds were oyster meats. In all three categories, the fisheries, oyster, and mudshell production, it leads all of the states in the United States.

Along these same lines the writer showed in 1969 that the production of mudshell in Alabama, Louisiana, and Texas was positively correlated with the fishery production. There was a lugubrious error in these calculations and, instead of mudshell production, the State of Alabama figures were for yards of dirt removed from channels by the Corps of Engineers. However, when the proper figures on mudshell production were supplied by Mr. Eddie May of the Seafood Division of the Alabama Department of Conservation, the correlation was still positive and "significant." However, nobody is advancing the argument that this is a real correlation between shell and fishery production, or that fisheries actually relate closely to mudshell dredging and vice versa, and the figures are not reproduced here. Rather we look upon the apparent correlation as the result of an increase in coastal activity which comes along with increase in population, better technology, etc. It is indicative, however, of the fact that the mudshell industry has not harmed the fishing industry to any detectable extent.

It is a well-known fact that nutrient salts and various organic nutrients are buried with sediments deposited in the bays. It is also recognized that most of this material is irretrievably lost unless the sediments are stirred up again. This leads to many divergent ideas including some possible benefits from hurricanes and other heavy storms. Similarly, shrimp trawlers, oyster dredges and other artificial means of stirring the bottom release nutrients from the sediments. In this regard, we might mention that a study made of a large channel dredge in the upper Chesapeake Bay, which is yet unpublished, indicated that the dredge liberated as much nutrients from the sediment as came in an equal length of time from the sewage of a city of 10,000 population. This beneficial effect of sediment stirring by mudshell dredges was first advanced by Ingle (1952).

In past years this factor was more important than it is now because today some biologists are of the opinion that hyperfertility of the bays of settled coasts with large human populations is taking place because of sewage pollution. That may well be true, in which case the effect of nutrients released from the sediment is no longer beneficial except in bays far from human habitation.

In former times the screen pile and wash water of dredging operations were essentially the cuttings from the bottom, minus the shell. These were cast aside and there remained the dredge cut. This was cut from the bottom a little wider than the dredge itself and sometimes eight to fifteen feet deeper than the natural bottom. During hard cold spells fishes were known to retreat into these areas probably because the water was a few degrees warmer than that of upper levels. At best, however, this is a very minor benefit because the dredge cuts do not persist and, furthermore, the dredge cuttings are now placed back in the cut so as to diminish the size of the hole.

Mudshell dredging is of benefit where it removes old reefs that impede water flow. A classic example concerns the Redfish Reef complex that used to extend from Edwards' Point (now called Eagle Point) eastward to Smith's Point across Galveston Bay. It acted as a partial dam and during low tidal stages its effect was complete. During that time cattle could ford from one side of the bay to the other, a distance of six miles (9.7 kilometers). In those days the whole upper bay was known as the Trinity and no oysters grew north of Redfish Reef, and all oysters on the upper side of the reef were small and stunted. This was because the combined effect of the Trinity River and the Redfish Reef kept the upper bay as a large low-salinity lake with no living oysters and with only low-salinity fauna. This general situation was noted as early as 1892 (Rathbun 1895).

The outstanding oyster biologist Galtsoff (1931) observed all these facts and recommended that passes be cut through the reef by the state or that it be cut up by the mudshell dredges. This was a shrewd appraisal based on biological knowledge. The mudshell operators did cut it up to the vast benefit of the whole upper bay. The Vingt-et-un Islands flourished as a spoonbill rookery and the Redfish Reef area flourished as an oyster producer. Over 100,000,000 cubic yards of shells have been taken from the old reef, and since that time this area has produced more oysters than the remainder of the State of Texas. This was doubtless due to the proper mixing of low salinity, nutrient-laden water with higher salinity water, which led to the optimum estuarine conditions. Even so Eckhardt (1968) mourned the passing of this old reef, but fortunately Galtsoff's ideas had prevailed long before and the state is wealthier and better off biologically because of the mudshell operations.

Hannah's Reef at the mouth of East Bay is a similar but not so extreme situation as Redfish Reef was and does not block that bay as completely as Redfish blocked Trinity Bay. Nevertheless, it greatly impedes the flow of salt water into East Bay and its removal would benefit the whole area. It would cause a much greater flow of salt water into East Bay than any passes through Bolivar Peninsula that could be dug. The shell would benefit industry and part of it could be used as cultch for oyster beds in the vicinity. The hogback ridges of shifting shell are barren, non-fertile and non-producing. Any attraction they have for fishes is purely as a physical mass, which can be obtained just as well by other means. If the Save Our Bay local organization would get behind such a move it would benefit Galveston Bay.

OBJECTIONS PUBLICLY RAISED TO MUDSHELL OPERATIONS

Letters to the editor are common means of objection by literate citizens, and these express both views. In Mississippi various fishermen, both sports and commercial, express their opinions. Members of the State Legislature generally do not come out in print, but verbally express themselves at local meetings. The general populace is against dredging and the legislators who show up at these public meetings follow this view. The Marine Conservation Commission and the biologists generally take the other view and try to fend off the criticisms by a few facts. Generally large public meetings are held before the Corps of Engineers which now has to grant permits which take into consideration "environmental impact."

In Alabama, one of the local coastal newspapers, *The Mobile Register*, has conducted an opinion poll. A recent poll on whether or not the mudshell industry should be abolished in Alabama showed an 85 percent vote for the industry, which the paper stated to be the highest majority ever given in its poll of public questions.

The Louisiana operations are generally in the marshes and so far away from public view that they cause little trouble. The greatest difficulty seems to be over the clam-shell barges in Lake Pontchartrain that occasionally knock out the Pontchartrain Causeway, which is sometimes known as the longest bridge in the world.

In Texas the industry is very much on the defensive and has even been accused of harming the last winter refuge of the whooping crane (see Laycock 1968), although there is no evidence for this charge and all facts seem to be against it. Some of the charges commonly made against the mudshell industry are given below.

1. Sediment will wash up on the beaches and ruin them.

This cannot happen unless the dredge outfall is put on the beach. Furthermore, the experience in the State of Mississippi which has artificially maintained the beaches shows that the fine sediments of mud quickly drain away and largely pure sand remains.

2. The salinity of the water will be changed.

This is impossible and untrue and is scarcely worth refuting.

3. Big holes will remain in the bay for a long time and they will fill up with soft ooze.

Mudshell dredging is a type of strip mining under the bottom of the bay. It differs in that it is in a sedimenting area and any holes fill up very shortly, and in a few years they are gone. Furthermore, since the dredge cuttings are now put back behind the dredges the dredge cuts are not nearly so large and they quickly fill in. These areas are easily marked also and easily avoided by commercial fishermen. They are also an extremely small fraction of the bay bottoms. In contrast the sub-areal scars on land remaining from strip mining to get limestone rock, which is also pure calcium carbonate, will last for many thousands and even a few million years.

4. The old stinking mud when stirred up can be smelled five miles away.

Anaerobic processes go on in the muddy sediments except for a few millimeters near the surface and hydrogen sulphide is generated. It is quickly oxidized upon reaching the air and although a dredge can be smelled downwind for a few yards, to say that the smell extends five and one-half miles is preposterous.

5. When sediments are stirred up they get the whole bottom of the bay to working and moving about and this causes live reefs to be destroyed.

This is also preposterous. What is happening is that the bays are generally filling in with sediment, and Ryan (1967) estimated that in Mobile Bay there was a deposit equal to four tons (1.9 metric tons) deposit per acre per year.

6. The stirred up mud will be placed on live oyster reefs and will destroy them.

As is noted above dredge cuttings are now placed within the dredge cut. Furthermore, a plowing process is coming into use and the overburden of mud is no longer disturbed. The sediment from the dredge outfall settles within 300 yards except for a small dustlike component which drifts away in the water. In fact, studies made in Texas have shown that 95 percent of the sediment settles within the first hundred feet and 99 percent of it settles within the first 399 feet. Furthermore, the plume from an operating dredge cannot be seen after the wind gets up to about 15 miles per hour in a shallow bay.

The Corps of Engineers found in Bon Secour Bay, Alabama, that transport of spoil material from channel dredging was limited to 1200 feet (368 meters) and that dredging compared to the weather factor was insignificant in sediment movement. In Chesapeake Bay a monitoring study of ship channel dredging showed that turbidity was generally within the range of natural variation (Cronin, 1970).

Various biologists, for instance Cabrera (1971), have shown that oysters do best at turbidities of 200 to 500 parts per million, which is quite common in the bays and estuaries. The highest turbidities in rushing mountain streams are about 5000 parts per million, but there is no telling what the water turbidity was in such hurricanes as Camille, which struck the Mississippi coast on 17-18 August, 1969. The power of this storm uncovered old boats and barges that had been sunk approximately a hundred years ago and washed some of them ashore. The bottom topography was changed and some oyster beds were rolled away and some were covered with mud. Otherwise there is no known permanent damage to the bottom and there was no known mortality of fishes. In fact, the fishing following Camille was reported to be "fantastic," as is generally reported following all hurricanes. The terrible sedimentation seems to cause no damage to the bays. In this respect it may be noted that the objectors to mudshell dredging generally do not raise questions about large channel dredgings which remove a great deal more material and throw it up in spoilbanks that extend for miles. The contrast is amazing.

SUMMARY AND CONCLUSIONS

A great deal of opposition among the general populace of coastal areas has developed to digging dead reef shell buried under the mud in spite of the fact that the operations vary from innocuous to beneficial, and in some instances, highly beneficial over and above the wealth gathered from the ground. Instances are given above and recommendations are made for the removal of another reef which would benefit Galveston Bay.

Aside from objections which are preposterous, such as the statements that dredging will change the salinity of the water and pollute the bay by stirring up the bacteria on the bottom, the anti-dredgers seem to object mostly to the stirring up of the sediment or mud. They fail to realize that this material is not filth, but contains nutrient salts which enhance plankton growth when thrown back into the water. Additionally, these people simply do not realize that the sedimentation movement caused by the shell dredge is minuscule when compared to the sediment movement caused by weather, water currents, and natural geological processes which are going on all the time. These people should be taught carefully and patiently and, for the time being for the general welfare of everyone involved, they should be ignored.

LITERATURE CITED

Cabrera, J. J.
1971. Survival of the oyster *Crassostrea virginica* (Grnelin) in the laboratory under the effects of oil drilling fluids spilled in the Laguna de Tamiahua, Mexico. Gulf Research Reports, 3(2):197-213.

Corps of Engineers.
1968. Surveillance program. Sedimentation effects of hydraulic dredging, Bon Secour Bay Section, Gulf Intracoastal Waterway, July-December 1967. U.S. Army Corps of Engineers. Mobile, Alabama, pp. i + 14

Cronin, L. E.
1970. Summary, conclusions and recommendations. Gross physical and biological effects of overboard spoil disposal in upper Chesapeake Bay. Contribution No. 397, Natural Resources Institute, University of Maryland, 66 pp.

Dawson, C. E.
1955. A study of the oyster biology and hydrography at Crystal River, Florida. Publications of the Institute of Marine Science, IV(1): 279-302.

Eckhardt, B.
1968. Death of Galveston Bay. Transactions Thirty-third North American Wildlife and Natural Resources Conferences, pp. 79-90.

Eleuterius, L. N.
1971. Recent changes in the Louisiana marsh near Vermilion Bay. Gulf Research Reports, 3(2):259.

Galtsoff, P. S.
1931. Survey of oyster bottoms in Texas. Investigational Report No. 6. Bureau of Fisheries. pp. 1-30. U.S. Government Printing Office, Washington.

Gunter, G.
1938. A new oyster cultch for the Texas coast. Proceedings of the Texas Academy of Science, 21:14.

————.
1950. The generic status of living oysters and the scientific name of the common American species. American Midland Naturalist 43(2): 438-449.

————.
1952. Historical changes in the Mississippi River and the adjacent marine environment. Publications of the Institute of Marine Science (Univ. Texas) 2(2):119-139.
1955. Mortality of oysters and abundance of certain associates as related to salinity. Ecology 36(4):601-605.

————.
1969. Reef shell or mudshell dredging in coastal bays and its effects upon the environment. Transactions of the Thirty-fourth North American Wildlife and Natural Resources Conference. 51-74.

Ingle, R. M.
1952. Studies on the effect of dredging operations upon fish and shellfish. Tech. Ser. No. 5, Florida Board of Conservation, Tallahassee.

Laycock, G.
1968. Deep in the mud of Texas. Audubon 70(6):98-118.

Louisiana Wild Life and Fisheries Commission.
1968. The history and regulation of the shell dredging industry in Louisiana. 32 pages (Processed).

Mackin, J. G.
1961. Canal dredging and silting in Louisiana bays. Publications of the Institute of Marine Science (Univ. Texas) 7:260-314.

Rainwater, E. H.
1964. Late Pleistocene and Recent history of Mississippi Sound between Beauvoir and Ship Island. Mississippi Geological, Economic and Topographic Survey, Bulletin 102:32-61.

Rathbun, R.
1895. Report on the inquiry respecting food-fishes and the fishing grounds, Rept. U.S. Commission of Fisheries 19:23-26.

Ryan, J. J.
1967. Preliminary report of the sedimentological study of Mobile Bay for Alabama Department of Conservation. Ms., 5 pp. Presented at the 18th Annual Meeting of the Gulf States Marine Fisheries Commission at Montgomery, Alabama, 20 October 1967.

DISCUSSION

MR. RON JONES (Texas Parks and Wildlife Department): Do I understand you to say that we should ignore all effects of shell dredging?

MR. GUNTER: I am not an administrator, but I do not feel that mud dredging is harmful, and I believe it is beneficial. It has brought a great deal of money into the country, and into Texas in particular. I think you have more oysters now than before dredging started. North of Galveston there is a reef between Eagle Point and Smith Point that, as far back as 50 years, should have been removed so that the waters in Trinity Bay could mix with the waters below. Some 100,000,000 yards have been removed, and there has been better oyster production as a result. Another example is the reef in East Bay. The fishermen want to use the reef as a platform—the only attraction is physical. Dredging it would not be harmful to the fishing.

D. R. BLANKINSHIP (National Audubon Society): How about removing metals from the bottom? Does shell dredging affect bottom conditions? What about the problems of turbidity? Is salinity not affected by dredging? Are there changes in the flow patterns.

MR. GUNTER: There should be no concern for removing metal objects which may have been buried for hundreds of years. Dredging cannot affect salinity; it hardly affects flow patterns; and bottom conditions are not changed.

* * *

ANADROMOUS FISH MANAGEMENT IN THE COLUMBIA RIVER SYSTEM: AN ECONOMIC APPRAISAL[1]

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In a span of less than 35 years, large-scale investment in hydroelectric development of the mainstem and tributaries of the Columbia River—the prime power stream of the United States—has transformed this former swiftly flowing stream system into a vast series of impoundments. By any consideration, water development in this river is massive and extensive ($3.2 billion alone in projects constructed, under construction, and planned by the U.S. Army Corps of Engineers).

River flow has been extensively regulated by storage, hydroelectric peaking, and water withdrawal for irrigation, industrial, and domestic purposes. The river water velocity has been greatly reduced while the surface acreage of the original river has tripled. Regulation is still proceeding at unreduced tempo and will continue to do so for at least another 15 years.

The development of the water resources of this river system and the ensuing modification of the aquatic environment make this one of the most important "social engineering" experiments in modern times. When viewed as such, an appraisal of the effects of technology upon the environment and of attempts made to eliminate its adverse and unintended effects on the anadromous fish resource provides a useful post-audit.

In the Columbia River system, one of the important resource problems is the maintenance of the Pacific salmon fishery in the face of encroachment on, and alteration to its fresh-water habitat. Important lessons for environmental management stem from and revolve around this issue. The salmonoid resource returning to its spawning grounds is a sensitive environmental indicator, highly useful for detecting the impacts of economic growth on its aquatic habitat.

The most immediate lessons have particular application to the many coastal streams in California, Oregon, Washington, British Columbia, Alaska and the Pacific Asian mainland, to all those streams which constitute the spawning and rearing habitat of the many

[1] Issues and findings discussed in this paper merit a more exhaustive treatment and elaboration which would, however, exceed publication guidelines. This paper, therefore, can only treat in a summary fashion some of the findings which have been developed more fully in Bollman, Frank Herbert, "River Basin Development and the Management of Anadromous Fisheries; An Economic Analysis of the Columbia River Experience." Unpublished Ph.D. dissertation, Department of Agricultural Economics, University of California, Berkeley, 1971.

species and races of the Pacific Salmonidae. However, the lessons also have transfer value for those programs of regional development in Mexico, South America, Asia and Africa where the rivers do not support anadromous fish runs but which are productive of other species. In attaining their principal objective—the massive transforming of river basins to stimulate "economic growth"—valuable fish resources can be depleted unnecessarily and irreversibly by water-development projects.

The decline of anadromous fish in the Columbia River and in other streams throughout the world epitomizes the widespread, although sometimes imperceptible phenomenon wherein ecological equilibrium is disturbed by "social engineering," which tends to discount or not fully account for long-term environmental and other social costs.

Although its Pacific salmon stocks have been seriously depleted and numerous races rendered extinct, in the aggregate the Columbia River fishery still contributes about 25 percent of the Pacific Northwest salmon catch, supports a large and growing sport fishery, and is a source of food and livelihood to Indian tribes fishing the upper river and tributaries.

While the program of water development in this river system is massive, the program of mitigation of anadromous fish loss is possibly unique in its magnitude and sophistication. The Federal Government, in cooperation with the States of Washington, Oregon, and Idaho, has developed a program of mitigation which entails large investments in fish-passage facilities and hatcheries for supplementing yield lost as a result of major dam construction on the main stem of the river and principal tributaries. Cumulative capital outlays up to 1969 by public agencies and private companies for the construction of fish protection and supplemental facilities exceeded $239 million. Annual operation and maintenance costs of these facilities in 1969 amounted to $5.5 million—$1.4 million for fishways, $3.9 million for hatcheries and $0.17 million for screens. In addition, $1.5 million was expended on biological research and investigation to improve the habitat. Up to 1969, $62 million had been spent on operating and maintaining these facilities, while an additional $21.5 million had been spent on research. Impending water-resource developments and those in various stages of completion will intensify the competition for the use of the Columbia's waters. Environmental changes have occurred already to the detriment of fish life and reproduction. The resolution of some of these chronic problems means a continuance of the extensive program of research and the manipulation of water releases to effect suitable temperature and flow conditions for fish life.

SCOPE OF THE STUDY AND SOME RESERVATIONS

What is at stake in the retention of this fishery is well worth consideration. Annually, the returns to commercial fishermen since 1964 have exceeded $7 million, while sportsmen annually have spent some 400,000 days angling for Columbia River salmon and steelhead. More importantly, the value of the anadromous fishery is appreciating, especially the sport fishery, and this has to be accounted for in estimating the long-run future stream of benefits from this renewable resource. Decisions to diminish or no longer retain a program of mitigation should be made in the knowledge of the likely magnitude of future social benefits which might be forfeited. Whether the mitigation program for the anadromous fishery which has evolved in the Columbia River system could be demonstrated to be a socially wise investment, therefore, becomes an intriguing puzzle which prompts a comparison of the benefits and the costs entailed in preventing the elimination of these runs—a quick and inevitable result if passage were not provided to upstream areas.

However, in assessing the relevancy of the findings presented in this paper, it must be emphasized that mitigation is but one management practice for maintaining anadromous fish yields in the river. And any assessment of the performance of the mitigation program, as such, is beset with the difficult task of disentangling the separate effects of not only major federal dam construction, but of "overfishing," pollution, over-appropriation of water• in small tributary streams, the inefficient screening of water diversions, and other effects upon the waters of river system and estuary brought about by economic development. The present status of the anadromous fish resource therefore must not be attributed entirely to construction of large main-stem dams. Many other depleting influences had been (some still are) at work on the fish resource prior to the federal program of construction commenced in the mid 1930's.

In the management of an andromous fishery, as in any fishery, institutions have an important role to play. Tenure and ownership of this fishery are important for allocating the fishery to various user groups and in programming its conservation. The latter function includes the protection afforded by a program of mitigation; management (regulation of catch) practices should compliment mitigation measures, the overall objective being the maintenance of an "optimum level" of spawning stocks and the aquatic conditions for replacement in the river, since these are the principal determinants of long-run productivity, especially above Bonneville Dam. In 1972, to control the factors responsible for the deterioration of the aquatic habitat is proving to be far more difficult and tenuous than to limit the size and composition of the catch.

Mindful then of the complexity of the task, the purpose of the present paper is to report on some of the findings of a comprehensive study to estimate the present and likely future benefits and costs of retaining this resource by those specific programs which attempt to "make whole" the segments of the fishery threatened with elimination by river development projects. A review period, 1939 to 1969, is selected since it is over this time span that large-scale federal dam construction has taken place.

Two accounting tasks are basic to the study: the first is the computation of the annual commercial and sport catch attributable to Columbia River-produced salmon and steelhead. Since salmon have a wide distribution on the open seas, the identification and measurement of Columbia River fish in the various Pacific Coast fisheries are major tasks, made possible only by the recent availability of data from large-scale sampling surveys. The catch for subsistence and commerce at the Indian fishery located upstream has also to be included and the value of the total harvest computed and imputed.

A second accounting task is also basic to the study. The annual capital outlays for three different types of anadromous fish protection and propagation facilities, viz., fish passage facilities, screens, and hatcheries in the river system are estimated for the review period—1939 to 1969. The annual costs of operation and maintenance of these facilities and the costs of biological research and investigation to maintain the fishery have also been estimated for each federal and state agency and public and private power company involved in water development. This phase of the analysis might be considered as worth doing in its own right. For the first time possibly, and for a fairly long period, some 30 years, 1939-1969, there is a reasonably accurate accounting of the annual costs to retain one valuable biological resource—anadromous fish in the Columbia River.

An assessment of the performance of the mitigation programs is obtained by comparing levels of fish productivity now prevailing upstream and downstream with those prevailing in the late 1930's and the early 1940's. Trends in yields for the different species are assessed, and the counts over selected dams are measured over time. The shifts that have occurred between the river and ocean catch are also recorded. To better judge what might be the final outcome of the mitigation program, likely future conditions of the aquatic habitat are assessed, and a forecast is made of what is likely to occur in the future to both benefits and costs of this program. The analysis is then carried to its logical conclusion. The stream of benefits overtime is contrasted with the stream of costs incurred to maintain the fishery in the river. An arbitrary cut off date 1989 is selected—50 years after the first main-stem federal dam—Bonneville, was completed.

THE STATUS OF THE ANADROMOUS FISHERY: COMMERCIAL CATCH

The identification of the various races of fish produced in the Columbia River system and taken in the commercial catch is extremely difficult and increases in complexity as the fish leave the parent rivers and migrate offshore in the open ocean. In the open sea, identification is rendered more difficult as salmon from many different river systems are intermingled. While knowledge of the distribution of salmon on the high seas is possibly adequate, identification of salmon by area of origin is far from complete and costly to obtain.[2]

A picture is now emerging of the significant contributions which Columbia River salmon are making to the commercial and sport catch of the various fisheries extending from Alaska to California from the results of coastwide detection of fish which have been fin marked prior to release as fingerlings. Percentage contributions have been applied to each fishery to obtain annual estimates for the harvest of salmon and steelhead over the 30-year review period, 1939 to 1969.

During this period the commercial catch of all anadromous species (except sturgeon) attributable to the Columbia River, has been as high as 39,400,000 pounds in 1942 and as low as 11,900,000 pounds in 1960.

Salmon production, as recorded in recent harvests, is approximately two-thirds of that recorded in the late 1930's and early 1940's at the start of the large-scale damming of the river. Whereas in the early years, chinook made up about 75 percent of the total catch and consistently exceeded 20 million pounds, in recent years, the annual chinook catch has not exceeded 12 million pounds and now constitutes a little more than half the total catch. The decline in both the troll and gill-net catch of chinook is most marked after 1956, and there has been no evidence of a recovery.

However, troll coho catch has more than doubled while the gill net catch of coho has remained at the same level. The over-all total catch of coho salmon has shown a steady increase since 1960. The coho catch then constituted less than one-tenth of the total salmon-steelhead commercial catch. In recent years the coho harvest has consistently exceeded one-third of the total catch.

There appears to be a definite reversal in the downward trend in coho production detectable prior to 1961; whether the recent high

[2] Five species of Pacific Salmon of the genus *Oncorhynchus* spawn in the Columbia River system; these together with steelhead trout, *Salmo gairdnerii*, are the principal anadromous species.

levels of catch, from 6 to 11 million pounds, will be sustained over time, cannot be gauged. Coho salmon populations (as shown by catch records) are subject to long cycles, within which there can be sudden and large changes. The hatchery program, initiated as a mitigation measure, is doubtless one factor improving productivity, but the exact role played by hatcheries must await the results of continuing experiments in marking, recovery, and evaluation.

The other salmon and steelhead commercial catches have declined to approximately one-fourth of the catches in the early 1950's. The catch of chum salmon is now negligible—3,000 pounds in 1968, as compared with 4,000,000 and 5,000,000 pounds in 1941 and 1942. Sockeye salmon production fluctuates wildly with current low yields matching those recorded in former years. Commercial steelhead production in the last four years to 1968 amounted to 20 percent of the average level for the years 1939-1943.

In summary, since the early 1940's there has been a steady (and serious) decline in over-all salmon and steelhead production which continues the trend discernible since the early 1900's.

SPORT CATCH

The Columbia River makes a substantial contribution to ocean and river salmon sport fishing in Oregon and Washington, with Idaho basically dependent on the Columbia River runs. The coho salmon sport fishery off the California coast also draws on Columbia River fish.

The Columbia River contributed, in 1968, 4,300,000 pounds of chinook and 2,248,000 pounds of coho and 2,046,000 pounds of steelhead to the West Coast ocean and river sport fishery. Angling effort had grown from 170,000 angler days in 1958 to about 445,000 angler days in 1968, while success increased at 2 percent annually. A straight line trend projects 900,000 trips would be taken and 1,650,000 fish landed by 1985. The degree of competition between commercial and sport fisheries is growing in intensity, and ultimately will require "apportionment" of total catch between the two uses.

A SUMMARY ASSESSMENT OF PERFORMANCE TO 1969

Shifts have occurred in species composing the catch in the period of intensive dam construction in the river system. The productivity of those species or races of species, especially spring and fall chinook, which spawn above Bonneville Dam, have declined greatly, although spawning escapements (as measured by counts over Bonneville Dam—the first main-stem dam) have been maintained.

The areas affected by river basin development have generally been areas of chinook production; 70 percent of the fall run of chinook is produced in areas above Bonneville Dam.

The loss of production from tributaries and streams upstream from Bonneville Dam over the period of 30 years—1939 to 1968—is approximately 10.1 million pounds, which is offset in part by an increase of 4.6 million pounds in the coho catch, production of which comes largely from the lower river.[3] On balance, the overall loss from the Columbia River system is approximately 5.5 million pounds. While the mitigation program has not succeeded in maintaining former productivity in the river upstream from Bonneville Dam, it has offset, in some measure, the productive capacity lost upstream by increasing the output of coho salmon downstream from the dam.

Closures or shortened fishing seasons on salmon and steelhead have permitted the dam count to remain at relatively high and stable levels because there are fewer removals below the dam, but annual total populations are reduced from former years. "Escapements" have rarely exceeded 200,000 fish. Fall chinook runs now entering the river average only one-third of a million fish. Strict regulation of the fishery below the dam maintains reasonably stable counts between 100,000 and 150,000. This run—the chief component of the chinook catch—is important in the total mitigation program and maintained by intensive artificial propagation.

Upriver-bound salmon (those passing over Bonneville Dam) are presently suffering the effects of a degraded aquatic environment; interdam losses have been high in recent years, so that the Bonneville count does not reflect the number of fish which ultimately spawn in the upper reaches.

The present hatchery program under the Columbia River Fishery Development Program has increased coho production considerably. However, maintenance of water-quality standards for fish life and reproduction in the lower Columbia and estuarial areas, in terms of flows and temperature regimes is vital for the continued success of the hatchery program in offsetting the loss of natural production from spawning areas removed by river development. The future of anadromous fish in Idaho waters is basically dependent upon improving water quality conditions in the lower Columbia River. Further, the rehabilitation of natural production from the Willamette Basin (already initiated) is ultimately governed by the successful retention of adequate water quality in the estuary of the Columbia.

In summary, the policy of mitigation to "make whole" the fish

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[3] Professor Milo Bell estimates the loss of production upstream from Bonneville Dam as high as 15,000,000 pounds. Possibly this assessment is for a longer time span. See David C. Flaherty, "Washington and Its Water," *Quest*, Vol. 7, No. 1 (Pullman: College of Engineering, Washington State University, 1969), p. 15.

resource has been only partially successful in the areas upstream from Bonneville Dam. Smaller numbers of fish now originate from these areas. Escapements to these areas have not been achieved, although the count at Bonneville Dam of "gross escapements" has been maintained. The salmon fishery is now more dependent on fish produced in the streams and in hatcheries between the mouth of the river and Bonneville Dam.

The objective of the mitigation program to supplement fish production in the lower river areas to replace production lost in the upper river basin has been moderately successful—coho salmon, in part, has supplemented chinook lost in this attempted regional replacement of fish stocks.

AN ASSESSMENT OF FUTURE CONDITIONS FOR MAINTAINING THE FISHERY

Retention of water quality in the passage routes and the natal environment is critical to maintaining the resource; regeneration is dependent on access to hatcheries and small natural spawning areas remaining in the river system.

Future conditions for the maintenance of a major fishery might be assessed by analyzing the likely impact of those forces operative in the past and still in operation and forces which are more recently emergent.

In the first category are those major alterations to aquatic habitat brought about by dams already constructed and those likely as a result of the construction of new dams. The loss of natural spawning areas and the role of dams as barriers to fish migration, both up-stream and downstream, remain the two important forces affecting and likely to reduce production still further, especially, the construction of additional dams planned for the Snake River basin.

Water flow and temperature regimes are undergoing change as a result of present dam developments; new predator competition and disease relationships are being established that greatly affect the survival of migratory fish. Countering these changes is proving to be as difficult a task as providing for the safe and economical passage of migrating fish over dams.

Five impending water developments will accentuate the problems that presently affect both the natural and artificial production of salmonids; they are, the development of industrial sites on the lower river and in the estuary proper; the establishment of large-scale nuclear power plants, using the river's water for cooling; completion of the Canadian dams and the releases of water from Canadian storage in the upper Columbia; the addition of two dams to existing dams on the Lower Snake River and, should it come to fruition, the withdrawal of water out of the Columbia Basin for transfer to southwestern United States. As a result, unforeseen changes in environmental conditions upstream may so complicate the task of maintaining the resource that large additional sums will be required to overcome ensuing difficulties. While the cause of deterioration in a specific aquatic habitat may be identified fairly promptly, devising corrective measures to ameliorate deleterious conditions seems to require long gestation periods. There is a backlog of chronic and pernicious problems known for many years but for which solutions, if to hand at all, are only in the pilot test stage; a gatewell-sluice system of bypassing fish around turbines is a promising accomplishment in the test stage; developing means of guiding young salmon safely down past dams in their seaward migration remains largely unresolved; efficient methods for collecting fingerlings migrating to the sea from headwater areas have yet to be pioneered.

Nitrogen supersaturation, as a result of spilling at certain times at main-stem dams, and thermal pollution from thermoelectric power plants are two relatively recent environmental complications; their effects on juvenile fish already have been measured.[4] This in itself is an improvement in the state of knowledge (largely attributable to newly acquired research capacity) in comparison with that prevailing prior to 1961. But again, totally effective corrective measures have to be devised to offset these deleterious effects. On balance, it appears that problems awaiting solution and the likely compounded changes in temperature and dissolved gas regimes in the river will mean a higher level of federal spending on research than that funded throughout the 1960's, viz., $1.5 million annually.

Nevertheless, despite the projected effects of impending developments, there are some features of the program of river development and that of mitigation which were not present in the period under review—1938 to 1969—and which may offer tentative grounds for cautious optimism.

The period of large-scale dam construction is drawing to a close. Fish runs, although greatly reduced, have been maintained in both the Snake and upper Columbia River system. Fish passage facilities have been successful in permitting spawning fish to ascend the river over the series of dams already erected. The return of the runs re-established in Idaho streams demonstrates salmon stocks are

[4] The summary report, "Nitrogen Supersaturation in the Columbia and Snake Rivers" concludes that "the anadromous fish of the Columbia Basin, a major regional and national resource, could be reduced to 10 percent of its present size within three years," if the present "toxic concentrations of dissolved nitrogen persist from most upstream dams to the mouth of the Columbia River." Environmental Protection Agency, Reg. X, Seattle, Wash.

resilient; and, although greatly reduced, as shown by the count at successive dams, a portion of the run has ascended the river over the long series of dams and survived the changed water conditions. Even if, in the pioneering stages of managing the changes in aquatic environment, large segments of the fishery resource are lost, this need not result in permanent elimination of the runs in the upper Columbia and Snake River systems. Restoration is an option should deleterious water conditions and poor fish passage be remedied. The rehabilitation program in Idaho streams importantly demonstrates the ability of fisheries management there to translocate runs and re-establish them either by artificial or natural means.

Throughout most of the period under review, the runs originating in Idaho streams have not been supplemented by artificial propagation. Recently acquired increased hatchery capacity in Idaho is a new and positive element in the mitigation program for upper river stocks. When and if these problems of nitrogen supersaturation and high-temperature blocks in the river's waters are solved, the increase in artificial propagation capacity in Idaho could provide a means of significantly increasing upper river run sizes.

The introduction of fall chinook and transplants of coho into the formerly inaccessible Willamette watershed, which contains large areas of natural spawning grounds to be rehabilitated, appears quite successful.

Willamette River runs do not ascend any of the large run-of-the river dams and hence, are subject only to the estuarial conditions and those in the relatively short passage of the main Columbia. Retention of reasonable water-quality standards in the estuary and in the Willamette River itself (where strict water quality standards are now enforced) is reasonable assurance that these runs will continue to increase. Should the upper Columbia River and the Snake River runs not be maintained, these lower river runs would constitute a large measure of replacement. Supplemental hatchery production might be expected to be largely successful in the retention of a run size expected, upon stabilization, to be in excess of 280,000 fish.

Also stricter measures are now operative to ensure minimum standards of water quality. The enactment of the revised Fish and Wildlife Coordination Act places storage and release of water for fish conservation purposes at water projects on a basis comparable in all respects to power, irrigation, and other uses. This Act also provides authority for the establishment of enhancement to the fishery as a project purpose at proposed Corps of Engineer projects.

In contrast to the previous water development policy, the legitimatizing of enhancement as a project purpose appears to apply to projects not now recommended or authorized. The new emerging policy might be interpreted to encompass a review of existing conditions for fish production in watersheds where resource use in the past excluded the use of water for fish.

And finally, some of the influences which were depleting of the fish stocks are no longer operative in the river system. The screening of diversions is now almost complete, and any new diversion will be promptly screened. All major blocks, both natural and artificial, have been removed to allow runs access to spawning grounds. And unlike the situation in the late 1930's there is now an awareness and appreciation of fisheries problems by the public, and active cooperation from other resource development and management agencies is forthcoming in conserving the salmon resource.

COMPARISON OF BENEFITS AND COSTS

The decision to continue mitigation of fish loss involves a forecast of what will occur in the future with respect to both benefits and costs.

To ascertain likely costs, it was decided to adjust operation and maintenance costs for fish mitigation facilities by a 2 percent annual increase with all new planned investment accounted for in amount and projected year of construction. The best estimates presently available for projects planned by federal and state agencies and private companies were used to compile these costs. Research costs, however, were adjusted by 4 percent annually.

Estimates for the planned capital investment in fish passage facilities for federal and state agencies' and private companies' projects in the next 20 years, 1970-1989 inclusive, is $54,028,000. This is planned as additional to the $181,854,000 invested in fish facilities up to 1969. Annual operation and maintenance costs for those facilities existing in 1969 will have increased from $1,406,300 to $3,178,400, while the cost of operation of fish facilities at projects to be constructed in the period 1970-1989 would be $1,048,000 by 1989.

Up to 1969, investment in hatcheries to mitigate the effects of river development on fish totalled $55,028,000; annual operation and maintenance costs amounted to $3,917,000. In the 20 years to 1989, new hatcheries planned to offset the effects of additional dams were estimated to require a capital outlay of $41,467,000. At the end of this period, 1989, annual operation and maintenance would be approximately $7,591,000. The actual annual costs of operating new hatcheries planned for construction in the period 1970-1989 would amount to $1,657,000 by 1989.

Research costs in 1969 amounted to $1,512,261. By 1990, annual research costs estimated to increase annually at 4 percent would have increased to $3,265,000 (in current dollars).

Estimation of future benefits from the fishery involves a consideration of likely levels of physical production. A level of 29,500,000 pounds (the average of the combined sport and commercial catch for 1965, 1966 and 1967) was selected as feasible. The continuing rehabilitation of the Willamette watershed is envisaged as offsetting the possible loss of upper river runs as a result of not resolving the existing passage and water-quality problems. The retention of upper river runs with the resolution of these problems would simply increase the level of benefits which are based on this conservative estimate of future production.

An apportionment of the total catch is made with increasing quantities going to the sport fishery, with future sport catch projected as a continuation of the linear trend of actual catch from 1956 to 1968.

Benefits are computed on the basis of values that are established in the marketplace for the commercial fishery and the estimated gross expenditures for the sport fishery projected on the basis of trends in the past under the constraint that the level of production remains constant.

The comparison of benefits and costs over the approximate 60-year span—1939 to the year 2000—is possibly best illustrated by matching benefits with costs for three distinct periods: (a) 1939 to 1956, (b) 1957 to 1967, and (c) 1968 to 2000.

For each year in the period 1939 to 1956, the annual net economic value of the commercial fishery alone exceeded the annual costs of mitigation. This was the period prior to large expenditures for mitigation measures; the full impact of dam construction on fish production was still to come. The sport fishery was sizable and continued to expand during this period. The net benefits from the sport fishery would contribute to increase the excess of net benefits over costs during this period.

The next period which might be examined is that from 1957 to 1967. Two independent estimates in 1962 and 1965 estimate that the respective annual combined net economic benefits from the two fisheries exceed the annual costs incurred for mitigation.

In 1967, a third estimate of the value of the sport fishery alone, viz., $25,970,000, is more than double the costs of mitigation for the year—$12,470,000. Nevertheless, while it might be taken that net benefits exceed costs up to 1967, the excess of benefits over costs continued to decline during this period as the costs of mitigation rose steeply from $5,352,000 in 1957 to $12,470,000 in 1967. This was a period of intensive dam construction and one in which the costs of mitigation entailed in fish passage facilities at dams and supplemental production facilities and research were correspondingly high.

The third and last period which might be considered is the period 1968 to 2000 for which gross benefits and, consequently, net benefits have been projected for a sport fishery which is assumed to continue its growth at the same linear rate recorded for the 12 years, 1956 to 1968. With fixed supply, the increase in sport catch is accommodated by a corresponding reduction in the commercial catch.

Two distinct periods are discernible in this span of some 30 years into the future.

For the first 20 years—1968 to 1987 inclusive—costs outweigh benefits; however, from 1988 onward, the situation is reversed. Benefits exceed costs and the gap grows increasingly wider so that by the year 2000, net benefits exceed costs by $6,000,000 annually. The accumulated excess benefits for the 13 years—1988 to 2000—totaling $40,534,000, greatly exceed the accumulated losses (the excess of costs over benefits) for the earlier period—1968 to 1987—which amounted to $32,426,000. And benefits continue to increase, outpacing costs as time elapses.

As a renewable resource of appreciating value, the program of maintaining the salmon-steelhead fishery in the Columbia River has resulted in a net contribution to social welfare, and on the basis of the assumptions and projections included in this analysis, will continue to increasingly add to net social welfare after about 1990.

The disposition of benefit and costs over the total period under review illustrates a fundamental principle that irreversibilities should be avoided where economically and technically feasible. The excess of costs over benefits in the period 1968 to 1987 might be considered insurance premiums paid by society to avoid maximum social losses—the loss of the fishery. Indeed, to retain a renewable appreciating resource for perpetuity by such payments for a relatively short period of time is only a sensible investment by society.

DISCUSSION

DISCUSSION LEADER RICHARD STROUD: What is the net value in dollars assigned to sport fishing?

DR. BOLLMAN: We'll furnish a written resume on this question.

MR. GERALD Z. WOLLAM (Medford, Oregon): Is it not true that no chinook salmon go up the river above St. Joseph's Dam? The fish hatchery has not been used because no salmon reach it. There is no production in the Columbia River above Pasco. What is the future of th Columbia River? I understand there are nine nuclear power houses considered for this river. Will not the proposed nuclear power plants effectively eliminate this river as a salmon-producing stream? The water temperature is approaching the lethal limit for fingerlings. There is supersaturation of nitrogen, and the effect on chinook is that they do not spawn successfully. There is no movement of water on the Snake River, which is badly polluted. The fish cannot find their way. It is very likely that the upper river runs will be lost. Will the supersaturation of nitrogen be modified.?

DR. BOLLMAN: I do not know the current conditions in the river with respect to nitrogen supersaturation (See footnote 4). I understand that there have been some alterations in the original plans to locate nuclear power stations on the river. You can expect to receive a written answer to your question when the current status and conditions have been ascertained. Answers to some of these questions in the unpublished Ph.D. dissertation cited in Footnote 1 of my paper.

DISTRIBUTION AND MANAGEMENT OF CARIBBEAN SEA TURTLES[1]

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People, especially turtle hunters, have recognized for a long time that sea turtle populations were declining in the Caribbean region. Descriptions of the abundance of turtles, especially the green turtle, *Chelonia mydas*, during the settlement of the West Indies seem almost unbelievable today. Unfortunately, a complex of related factors associated with population growth and economic development in the Caribbean and the burgeoning market for exported turtle products are accelerating the decline year by year. Coordinated action is needed soon if these valuable resources are not to be destroyed. Available distributional data with salient aspects of conservation work in important areas are compiled to give an overview in hopes of stimulating more active regional interest. Five species of sea turtles are known to live in the Caribbean, *Lepidochelys olivacea*, the olive ridley; *Dermochelys coriacea*, the leatherback; *Caretta caretta*, the loggerhead; *Eretmochelys imbricata*, the hawksbill; and *Chelonia mydas*, the green turtle, and these are treated in approximate order of increasing economic importance.

Sea turtles of the genus *Lepidochelys* are not common or widespread in the Caribbean, Kemp's ridley, *L. kempi*, is primarily an inhabitant of the Gulf of Mexico (there is a record from Isla Mujeres [Smith & Taylor, 1950]) and consequently it is not treated here. Isolated records of individual adult olive ridleys, *L. olivacea*, are known from Gibara, Oriente Province, Cuba (Aguayo, 1953) and off San Juan, Puerto Rico (Caldwell & Erdman, 1969). Small numbers

[1] Contribution No. 105, Virgin Islands Ecological Research Station, Caribbean Research Institute, College of the Virgin Islands, St. Thomas.

of olive ridleys are caught regularly in the extreme southeastern corner of the Caribbean Sea. In eastern Venezuela this species is known from Isla la Tortuga, Islas Píritu, and the region of Cumaná (Flores, 1969). A few nest each year on Trinidad (Bacon, 1971). The animals from Venezuela and Trinidad are the eastern fringe of the olive ridley population which feeds on the fertile continental shelf of northeastern South America and nests at various sites in the Guianas, but primarily in a major aggregation at Eilanti, Surinam (Pritchard, in press). Based on the ratio of tagged to untagged turtles, Pritchard (1969b) concluded that 1,500 females nest at Eilanti. This and other ridley nesting beaches are included in a nature reserve established in 1969. The turtles are totally protected and egg collection is restricted in order to establish a sustained yield of protein (Schulz, 1971).

The leatherback, *Dermochelys coriacea,* is known to nest occasionally on island and continental beaches throughout the Caribbean, but significant numbers consistently nest in only a few localities. Pritchard (1971) summarizes all available data on the biology and distribution of the leatherback. He estimates that roughly 15,000 leatherbacks (out of an estimated world total of 24,000 to 49,000 breeding females) nest in the largest known aggregation near the mouth of the Organabo River in eastern French Guiana. Some turtles (200 to 400) from this aggregation nest across the border in Surinam. Aggregations occur in the Caribbean at Matina Beach, Costa Rica (at least one thousand nesting turtles), Trinidad (estimated 500 turtles from Bacon, 1971), and on Venezuela/Guyana border (Pritchard, 1971), with small numbers nesting regularly in Colombia east of Santa Marta (Kaufmann, 1971) and near Acandí on the Gulf of Urabá (Medem, 1962).

Away from the area of the nesting beaches leatherbacks are rarely seen at sea in the tropics, so there is no developed fishery for them in the Caribbean region. Where leatherbacks (and other sea turtles) nest frequently the meat typically is not highly regarded, and the main threat at the species worldwide is excessive egg collecting. Thorough-going illegal collecting is a serious long-term drain on the Matina Beach aggregation (Carr, 1969). In the Lesser Antilles the odd leatherback caught in a turtle net or while nesting encounters less discrimination and is usually killed for food and oil. In the Virgin Islands "trunk oil" rendered from the cartilaginous body armor of the leatherback is considered a potent medicine for respiratory infections and other ailments and consequently sells for phenomenal prices. Bacon (1970) estimates that 20 to 30 percent of the leatherbacks nesting each year at Matura Bay, the main nesting beach in Trinidad, are illegally killed by local villagers.

Green turtle hunters on Shell Beach, Guyana, kill nesting leatherbacks because they consider them to be "useless" but numbers there are small compared to Surinam and French Guiana. In Surinam the leatherback is fully protected and enforcement is effective. In French Guiana, though restrictive legislation exists, the large aggregation is protected primarily by its isolation (Pritchard, 1971). In Mexico Caribbean nesting is limited, but the leatherback is totally protected.

The meat of the loggerhead is considered less desirable than that of other species but its importance for both local food and export has increased as the abundance of greens and hawksbills has declined. The primary nesting areas of the loggerhead are in the southeastern United States. However, significant nesting occurs in the Caribbean in Quintana Roo, Mexico, the cays south of Cuba, and Columbia east of Santa Marta. Individuals and small groups of loggerheads nest throughout the Caribbean but the distribution is not uniform. Only one nesting loggerhead had been observed in fifteen years of surveillance at Tortuguero (Carr, 1969). Very few are caught offshore from the Guianas and only one is known to have nested there despite considerable nesting there by all other species (Pritchard, 1969a; Schulz, 1971).

Loggerheads occur commonly off northern Trinidad and may rarely nest there (Bacon, 1971). Very few are caught in the central and southern Lesser Antilles, but they are reported to be more common from some of the northern Leeward Islands to Puerto Rico. In Puerto Rico about two hundred a year are caught, but they are not known to nest (Rebel, in press). Loggerheads nest on the mainland and offshore islands of Venezuela (Flores, 1969) but are not common in Venezuelan waters (Medem, MS, 1965). Kaufmann (1971) estimates that four to six hundred loggerheads per year nest on 60 kilometers of beach east of Santa Marta. Because of overhunting the green and hawksbill rarely nest here. Beginning in 1970 an important 7.5 kilometer section of this beach was protected by government guards, but elsewhere all nesting females and eggs encountered are taken for local use. Except for the few Caribbean localities where protective legislation is enforced, loggerhead or any other sea turtle eggs are collected at every opportunity for food and sale.

Mexico and Cuba appear to commercially exploit the loggerhead on a large scale than other Caribbean nations. Both countries seek to protect turtle eggs and have provisions for the incubation of shelled eggs removed from slaughtered females. Some component of the catch is obviously breeding turtles (despite protection of nesting females and a closed season for nesting in Mexico). In Cuba the fishing season for loggerhead and other species corresponds to their nesting season so it appears that primarily breeding adults are exploited (Cardona & de la Rúa, 1971). They describe collection centers where turtles are held before slaughter and give methods for collecting and incubating eggs in enclosures. They recommend that hatchlings be held and fed for two months prior to release.

The loggerhead is the most abundant turtle in the Caribbean waters of Mexico, but it is less desirable than the green (Fuentes, 1967). Seasonal camps for the protection of nesting female loggerheads and greens and incubating eggs are established on Isla Mujeres. Some small-scale captive culture and release of juveniles is done. Turtles taken around Mexico's Caribbean islands are processed in plants in Yucatán and 50 percent of the loggerhead meat is exported frozen to the United States (Rebel, in press). Very little scientific work has been done on Caribbean loggerhead populations, and more tagging is needed to outline the range of populations from various breeding sites.

Though once abundant in the Caribbean, and still widespread, hawksbill stocks are declining severely under intensive hunting, primarily for its decorative shell. Hawksbills are usually coral reef dwellers and diffuse nesting on beaches near their feeding grounds appears to be a common pattern for this species in the Caribbean. Party because of this we know very little about this species despite its economic importance worldwide. Carr *et al.* (1966) discuss seasonal changes in abundance and some tag returns from Tortuguero hawksbills and concludes there is evidence for long-distance migration and nesting aggregation at some localities. A beach on Chiriquí Point, Panama, was once considered the major western Caribbean nesting site for hawksbills (Carr, 1955), but exploitation has been intensive for many years and its current status is unknown. The San Blas Islands, Panama, which once supported large numbers of hawksbills, are badly depleted. Columbian hawksbill hunters are moving to Panamanian waters because of decreased catches (Medem, ms. 1962). Similar word-of-mouth tales of decline come from throughout the Caribbean, and in the Lesser Antilles and offshore islands of Venezuela hawksbills are usually captured incidental to other fisheries; small quantities of shell are used in local industries or exported (Roze, 1956; Rebel, in press).

In two western Caribbean areas some concentrations persist. Hawksbills are seasonally abundant on Columbia's offshore atolls and banks and up to one hundred per day are taken with large dipnets over the reefs (Ben-Tuvia & Ríos, 1971). Nesting turtles are also turned and eggs collected by turtle hunters who stay on the cays during the season. This fishery, based primarily on the high export price for shell, is completely unregulated (Ríos, pers. comm.). Turtlers from San Andres, Providencia, Jamaica, and the Cayman Islands have been visiting these atolls, especially Roncador, for hawksbill for well over one hundred years (Parsons, 1956).

A survey of the important hawksbill populations in cays off the east coast of Nicaragua in July, 1971, showed that approximately 5 percent of the eggs laid went uncollected and 50 to 60 percent of the nesting females were killed (Nietschmann, MS, 1971). Because of the high price for shell augmented by the eggs, meat, and calipee, they are subjected to phenomenal fishing pressure in this uncontrolled fishery. Nietschmann recommended a complete ban on hawksbill fishing and sale of hawksbill products from these waters for three years to avoid the imminent demise of the resource. Unfortunately, the Nicaraguan government is not likely to respond to this suggestion.

The natural distribution of green turtles partly controlled early pattern of settlement in the Caribbean, and the species is still an important food resource and item of commerce. Parsons (1962) describes the long history of overexploitation and consequent local extirpation in this region and elsewhere. Like the other common species of sea turtles, isolated nesting and probably small aggregations occur at numerous localities throughout the Caribbean. Only two major nesting aggregations remain, one at Tortuguero, Costa Rica, and the other at Aves Island west of the Lesser Antilles arc. Returns from turtles tagged at Tortuguero since 1955 show that they come in numbers from feeding grounds all over the western Caribbean, notably the Miskito Cays, the coast of Panama, and the Guajira Penninsula of Columbia. A few have come from surprisingly distant points such as Florida; Campeche and Isla Mujeres, Mexico; and Isla Coche in eastern Venezuela (Carr, 1967). The work of Carr and his students has generated awareness of the critical importance of Tortuguero to the continued availability of green turtles in the western Caribbean, and Costa Rica has taken increasing steps to protect the aggregation. An important section of the beach is included in the plans for Tortuguero National Park.

Recognizing the continuing decline in the resource because of overhunting, fisheries personnel from Costa Rica, Nicaragua, and Panama met late in 1969 and agreed to prohibit the commercial exploitation of the green turtle and its eggs for three years and to gather information that would lead to a rational exploitation policy. They invited other countries to join them in the ban. The agreement was promptly ratified by the governments of Costa Rica and Panama, but not by Nicaragua, and exploitation of green turtles in the Miskito Cays has continued (Carr, 1971).

Early in 1969 a turtle freezing plant with an exclusive license for the east coast of Nicaragua was under construction in Puerto Cabezas supported by a loan from INFONAC under the A.I.D. program. The operator planned to butcher 30 turtles per day weighing over 150 pounds each, supplied by Nicaraguan fishermen. The meat, calipee, and hawksbill shell were to be exported. This ill-conceived project seems likely to have contributed to the collapse of the Tripartite agreement. To favor its own developing fishery, Nicaragua officially banned Cayman turtlers from the shelf waters where they have hunted, but boat-loads of turtles from the area are still arriving in Grand Cayman.

At Tortuguero harpooning of turtles during the nesting season is currently legal at distances greater than 5 kilometers offshore and the product of this fishery goes primarily to two turtle export freezing plants. During the 1970 season increased land and sea patrols considerably reduced the incursions of the harpoon boats close to shore and the activities of poachers on the 24-mile long beach (Carr, 1971). Unless cooperative efforts to manage the population both on the nesting grounds and the feeding grounds are renewed, the long-term survival propsects are dim.

Long ago turtlers recognized Aves Island as the major remaining site of green turtle aggregation in the eastern Caribbean, and they have hunted there consistently for at least a hundred years (Parsons, 1962). The island is an extremely isolated, waterless, sandy cay 220 kilometers west of Dominica in the Lesser Antilles. Venezuela was the victor in an arbitrated international dispute over the island and its guano accumulations in the late nineteenth century. Aves is uninhabited and 500 kilometers from the Venezuelan mainland, so that turtle poachers and bird egg collectors from many of the Lesser Antillean islands occupy it freely. The extremely small size (4 hectares) of the island makes it convenient to collect every nesting turtle that comes ashore until the capacity of the hunters' vessel is reached. The number of turtles each night during the peak of the season has declined considerably over the last ten years under this intense exploitation, but the high price ($75 U.S.) for a turtle makes the rough trip worthwhile for even a small boat.

There are no long distance recoveries from the tagging program which was begun last year at Aves (Rainey, MS, 1971), but the aggregation is presumably drawn from Lesser Antillean feeding grounds. Except in a few outlying areas, green turtles are no longer common in the islands and they are taken only occasionally, generally in the nesting season. Survival prospects of the Aves aggregation are improved as a result of recent field work and a brief meeting there last year on the problems of protecting the island. Returning Venezuelans petitioned their government to declare Aves and surrounding waters a faunal preserve. Protection and study of the population from a small, periodically resupplied station on the island seems feasible. The opportunity to tag and examine the entire nesting population could provide data which is difficult to obtain elsewhere.

Significant numbers of green turtles nest in the Guianas, notably Surinam. Tag returns from Surinam turtles show that they are being caught in numbers along the northeast coast of Brazil, principally in the State of Ceará (Pritchard, in press). Tab returns from green turtles nesting on Ascension Island overlap with the Surinam returns off Brazil leading to the suggestion that separate breeding populations may reside in the same area (Carr, 1971). Multiple tag returns have led to concern about the heavy exploitation of the Surinam population on the Brazilian coast. In Surinam the killing of sea turtles is effectively prohibited and the taking of eggs is carefully restricted, but it is difficult to justify these conservation measures without accompanying controls in Brazil (Schultz, 1971).

There is also an important green turtle breeding ground and fishery in the coral islands and along the mainland coast of Quintana Roo, Mexico. Until the development of the Pacific ridley fishery, the green turtle in the Caribbean was the primary Mexican sea turtle fishery (Márquez, Ms, 1968). The earlier discussion on the loggerhead fishery in the area is all equally applicable to the green except that most of the processed catch is exported to the United States. Carr suggested that this nesting ground is the source of west Florida's population of immature green turtles (Parsons, 1962). Some tagging of nesting females was done in this region in the past (Solís, 1966), but it would appear from a recent summary of Mexican sea turtle conservation work (Andreu, 1971) that the program has stopped.

A few of the Caribbean countries harboring significant sea turtle concentrations have a reasonable idea of the magnitude of the resource and have control of the exploitation, e.g., Surinam, Costa Rica, and Mexico. But even these countries have no control and little information on exploitation at the other end of the turtles' migratory pathways. The more typical Caribbean pattern seems to be a decentralized fishery with little regulation which is generally not enforced, and very limited data on stocks or exploitation. Fisheries personnel are generally already overcommitted and important fishing areas may be nearly inaccessible. Especially in the coastal areas where sea turtle stocks are already reduced to economically inconsequential levels, the prospects for effective management with diffuse marketing are poor.

Restoration of depleted stocks would require reduction or temporary cessation of turtle hunting and is not likely to be a popular program. Hungry people and those in remote areas will continue to take turtles and eggs as they have for generations.

These coastal populations are growing rapidly and require more protein to sustain them. Improved transportation accompanying development in Caribbean nations has provided greater access to inland markets, especially for perishable turtle products. Modern fishing equipment, especially the outboard motor, has markedly increased the range and effectiveness of turtle hunters. (Before the availability of outboards the wasteful, wholesale slaughter of several species nesting on Shell Beach, Guyana, did not occur.) Tourism has created large new markets paying disproportionately high prices for the novelty of eating sea turtle or taking home a lacquered juvenile hawksbill. Tourist facilities, scenic coastal highways, and burgeoning coastal villages displace turtles from nesting beaches. People and governments regard these growth trends and their correlates (e.g. an active money economy) as largely beneficial, so they are likely to continue.

In addition to the growth of internal markets, the export market for sea turtle products has grown and immense markets for new products have been developed through mass marketing campaigns in wealthy nations. The consumption of additional turtle products (e.g. meat and soup) has grown considerably, especially in Europe, through the efforts of German turtle processors.

Two other mass markets for luxury turtle products have recently been developed on a large scale in the United States, one for turtle oil in cosmetics and the other for sea turtle leather. As most crocodilians were driven to the brink of extinction by hide-hunting and the trade in them was increasingly restricted, an alternative source of reptile leather for luxury shoes, handbags, etc. was developed from the small area of soft skin on the underside of the neck and axilla of sea turtles. The export trade in hides was a primary reason for the phenomenally rapid growth of the olive ridley fishery on Mexico's Pacific coast. Large quantities of hides were shipped to the United States and Japan. In recognition of the radical decline in the catch, Mexico recently closed the fishery completely for one year. This was undoubtedly a difficult step, but warranted under the circumstances. The drain from illegal exploitation is still heavy. Like calipee, the dried plastral cartilage used in making soup, and hawksbill shell, properly cured hides are a low-bulk, high-value product amenable to illegal exploitation.

The most feasible if seemingly drastic approach to reducing over-harvesting of sea turtles is to modify the international market. This is especially relevant in the case of the hawksbill, which is vanishing around the world because of hunting for shell. By placing the hawksbill on the Endangered Species List, any bulk trade in shell into the United States has been eliminated, although it is likely that tourists still bring in fabricated articles illegally. It is necessary to apply whatever leverage is available through international organizations to spread the ban to other countries importing shell, e.g., England, Holland, and Japan. The demise of the shell trade would not assure the survival of reduced populations because hunting for food for local markets would persist, but the respite might provide time for the development of regional controls.

In general, a continuing export of sea turtle products from the Caribbean means trading the piecemeal destruction of a potential protein resource for hungry coastal populations for a small gain in foreign exchange. The fecundity of sea turtles is low compared to other marine organisms and they will require careful management (all out of proportion to their contribution to the balance of payments) in the areas where they are accessible, to to restore depleted stocks to optimum levels.

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LITERATURE CITED

Aguayo, C. G.
1953. La tortuga bastarda (*Lepidochelys olivacea kempi*) en Cuba. Mem. Soc. Cubana de Hist. Nat. 21:211-219.

Andreu, G. C.
1971. National and regional reports: Mexico. *In* Proc. 2nd Working Meeting of Marine Turtle Specialists. IUCN Publ. New Ser. Supp. Pap. No. 31:41-44.

Bacon, P. R.
1970. Studies on the leatherback turtle, *Dermocheyls coriacea* in Trinidad, West Indies. Biol. Cons. 2(3):213-217.

———.
1971. Sea turtles in Trinidad and Tobago. *In* Proc. 2nd Working Meeting of Marine Turtle Specialists. IUCN Publ. New Ser. Supp. Pap. No. 31:79-83

Ben-Tuvia, A. and C. E. Ríos.
1970. Report on a R/V Choco cruise to Providencia Island and adjacent banks of Quitasueno and Serrana near the Caribbean islands of Columbia. Proyecto para el Desarrollo de la Pesca Maritima en Columbia. Comunicaciones 1(2):9-45.

Caldwell, D. K. and D. S. Erdmann.
1969. Pacific ridley sea turtle, *Lepidochelys olivacea*, in Puerto Rico. Bull. So. Calif. Acad. Sci. 68(2):112.

Cardona, R. and R. de la Rua.
1971. Protejamos nuestras tortugas. Centro de Investigaciones Pesqueras. Habana Contr. No. 33, 29 pp.

Carr, A. F., Jr.
1955. The windward road. Alfred Knopf. New York, 258 pp.

———.

1967. So excellente a fishe. The Natural History Press. Garden City, New York, 248 pp.

———————.
1969. Sea turtle resources of the Caribbean and Gulf of Mexico. IUCN Bull. 2(10):74-83.

———————.
1971. Research and conservation problems in Costa Rica. *In* Proc. 2nd Working Meeting of Marine Turtle Specialists, IUCN Publ. New Ser. Supp. Pap. No. 31:29-33.

——————— and D. Goodman.
1970. Ecologic implications of size and growth in *Chelonia*. Copeia (4): 783-786.

———————, H. Hirth and L. Ogren.
1966. The ecology and migrations of sea turtles, 6: the hawksbill turtle in the Caribbean Sea. Amer. Mus. Nat. Hist. Novitates No. 2248, 29 pp.

Flores, C.
1969. Notas sobre reptiles acuaticos de Venezuela y su importancia economica. Lagena (1969) No. 21 & 22:1-20.

Fuentes C., D.
1967. Perspectivas del cultivo de tortugas marinas en el Caribe Mexicano. Boletin del Programa Nacional de Marcado de Tortugas Marinas. 1(10):9 pp.

Kaufman, R.
1971. Report on the status of sea turtles in Columbia. *In* Proc. 2nd Working Meeting of Marine Turtle Specialists. IUCN Publ. New Ser. Supp. Pap. No. 31:75-78.

Márquez M., R.
1968. Las tortugas marinas de Mexico. MS.

Medem, F.
1965. Informe sobre la imgracion, reproduccion y comportamiento de la tortuga marina "Gogo" o "Caguamo" (*Caretta c. caretta*). Corporacion Autonoma Regional de los Valles del Magdalena y del Sinu. 12 pp. MS.

———————.
1962. Estudia sobre tortugas marinas. Informe sobre la comision realizada en la costa Atlantica. Corporacion Autonoma Regional de los Valles del Magdalena y del Sinu. 12 pp. MS.

Nietschmann, B.
1971. The exploitation of hawksbill turtles, east coast of Nicaragua: results and recommendations from a preliminary study. 10 pp. MS.

Parsons, J. J.
1956. San Andres and Providencia. U. Cal. Pub. Geog. 12(1):84 pp.

———————.
1962. The green turtle and man. Univ. of Florida Press. Gainesville. 126 pp.

Pritchard, P. C. H.
1969. Sea turtles of the Guianas. Bull. Fla. State Mus. Biol. Sci. 13(2): 85:140.

———————.
1969. The survival status of ridley sea-turtles in American waters. Biol. Cons. 2(1):13-17.

———————.
1971. The leatherneck or leathery turtle, *Dermocheyls coriacea*. IUCN Monogr. No. 1. 39 pp.

———————.
In press. Recoveries from sea turtles tagged in the Guianas.

Rainey, W. E.
1971. Reconnaissance of the green turtle (*Chelonia mydas mydas*) nesting aggregation at Aves Island, Lesser Antilles. MS.

Rebel, Thomas P.
In Press. Sea turtles and the Sea turtle industry of the West Indies. University of Miami Press.

Roze, J. A.
1955. Las tortugas marinas de Venezuela. Revista Pecuaria (240):9-11.

Schulz, J. P.
1971. Situation report on marine turtles nesting in Surinam. *In* Proc. 2nd Working Meeting of Marine Turtle Specialists. IUCN Pub. New Ser. Supp. Pap. No. 31:68-74.

Smith, H. M. and E. H. Taylor.
1950. An annotated checklist and key to the reptiles of Mexico, exclusive of snakes. Bull. U.S. Nat. Mus. No. 199. 253 pp.

Solis R., M.
1966. Marcado de tortugas marinas en el Caribe Mexicano. Boletin del Programa Nacional de Marcado de Tortugas Marinas. 1(3):3 pp.
Witham, R.
1970. Breeding of a pair of pen-reared green turtles. Quart. Jour. Fla. Acad. Sci. 33(4):288-290.

DISCUSSION

DR. CRAIG KOENSLER (UN—Mexico): There is now an organization, CICAR, composed of countries from the north as far as the U.S. to the south as far as Brazil, trying to disseminate knowledge about sea turtles, their exploitation and protection.

DR. CLARENCE COTTAM (Texas): Is there any program for the artificial propagation of turtles?

MR. RAINEY: There are a number of efforts. The one on the largest scale is on Grand Cayman Island on green turtles. They now have 40,000 and are considering slaughter. In three years, the turtles weigh 100 lbs.

RESOURCE MANAGEMENT PROGRAMS FOR OCEANIC ISLANDS

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The remote and varied oceanic islands of the world are currently experiencing an insidious metamorphosis into densely populated, urbanized, homogeneous tourism-oriented communities with seriously degraded environments. While the stresses and pressures of unrestrained development and modern technology are partly at fault, a serious methodological crisis is increasingly apparent in the matter of resource planning, allocation, and management for island systems.

This paper considers three problem areas that have a bearing on programs of resource management in oceanic islands. The first, relates to the peculiar characteristics of islands that argue for special management approaches. The second, deals with implications of long-term growth within a finite island system; while the third, is addressed to the more immediate problems of market failure. Taken together, these problems present management with a formidable challenge.

A simple construct with six constituents that are judged to be of key importance in a program for oceanic islands is developed. It is suggested that a favorable long-term solution to island resource problems will depend, in part, on how successfully the key constituents are incorporated into management programs for island systems.[1]

[1] A model, based on the Virgin Islands case, will be the subject of a subsequent paper.

CHARACTERISTICS OF ISLANDS THAT ARGUE FOR SPECIAL MANAGEMENT

Within the context of coastal and marine resources, oceanic islands are seen to embody certain characteristics common to continental coastal and sub-littoral zones. For this reason the coastal zone management concept is of considerable interest to island resource planners and environmental specialists. The existence of several important features that are not held in common, however, argue for special resource management approaches when dealing with islands: (a) islands are discrete and finite in extent, with a fixed endowment of resources; and (b) they are ecologically fragile and concomitantly vulnerable to the destructive effects of modern-day development technology.

Finite in Extent

A basic feature of oceanic islands is the existence of a limited and fixed endowment of resources: land, fresh water, forests, and fauna. This underlying condition of scarcity applies equally to resources of the uplands, the coastal "plain," and the littoral and sub-littoral zones.

Land scarcity impresses one with the need for guidelines and criteria in allocating the land resource to various competing uses, while at the same time, maintaining its environmental integrity. This latter qualification is especially pertinent to oceanic islands, which characteristically have limited waste assimilative capacity. Their watersheds generally disembogue directly into the sea. Little land is available as an environmental "sink" for waste disposal; few internal plains offering local base levels (or lakes) exist, which on continents, serve to trap pollutants. All wastes tend to gravitate rapidly to the land/sea interface of the coastal zone.

Other resources are also in short supply. Fresh water is scarce, particularly on the smaller volcanic islands where rugged relief combines with the torrential nature of the seasonal rainfall to produce a high run-off rate that limits storage and recharge of underground water reserves. The case of the flat coral islands is more serious, for they lack even an initial supply of fresh water. Given the absence of orographically induced rainfall, the construction of catchment basins to augment water supply is of marginal value.

Scarcity of marine resources of major commercial importance is a fact of life for many islands, dispelling the myth that most oceanic islands are set in a sea of unlimited bounty. A partial explanation for the somewhat modest fisheries resources of islands compared with those of the continental shelf lies in the difference in productivity of nutrients in the two areas. Coextensive with the inshore reef system of oceanic islands is a narrow zone of modest primary productivity resulting from the nutrient input of sporadic island runoff. As we move offshore, the level of productivity decreases markedly.[2]

Regarding the management of continental resources, there is mounting pressure to single out the coastal zone as an area of critical concern that deserves special management legislation (U.S. Senate, 1971). Notwithstanding reasons that could be advanced for emphasizing the coastal zones of islands,[3] this paper chooses to examine resource management within the broader and more encompassing framework of the "island system."[4]

In the context of the continental coastal state that has much of its territory located away from the sea, where population and resource conflicts are concentrated, it is appropriate to deal with the coastal zone as a special entity separate from general land-use planning.[5] When dealing with islands, however, it is more to the purpose to go beyond the notion of a single zone of scarcity, and recognize the presence of islandwide scarcity.[6] We think that the island system planning approach is justified for all islands that exhibit high man: land ratios, regardless of their size.

Fragility of the Ocean Island Environment

Islands are ecologically fragile and consequently vulnerable to the destructive effects of modern-day development technology. Evidence of this abounds throughout the Caribbean region. This aspect, coupled with the aforementioned resource limits, call for special management approaches.

One reason for island vulnerability derives from the fact that the historical element of remoteness and isolation, serving to inhibit development is becoming inoperative. The revolution in transport and communications has spelled the end to this inhibitory factor. The Virgin Islands, for example, is now serviced by jet, sea planes, hydrofoils, cruise ships (not requiring docks), passenger ferries STOL aircraft, yachts, and television.

[2] W. N. Brownell & W. E. Rainey. *Research & Development of Deep Water Commercial and Sport Fisheries Around the Virgin Islands Plateau;* VIERS No. 3, Caribbean Research Institute; St. Thomas, U.S.V.I., August, 1971, p. 4.

[3] Two good reasons are: first, the coastal zone represents an important, although narrow, nutrient enrichment area of the marine environment; and second, it represents a higher proportion of the total island domain than is the case with continents (i.e. relative to continents, islands have a higher ratio of linear coastal exposure to the area of hinterland remote from the sea).

[4] The "island system" as defined here, includes both the island landmass and its contiguous littoral and sub-littoral zones.

[5] This is the position taken by advocates of the Coastal Zone Management Bill S. 582, in lieu of the National Land Use Policy Bill S. 992.

[6] Common standards for defining the coastal zone, use as the limit of landward extent, the ridgeline of mountains that make up the watershed, or in some cases the most inland boundaries of the counties that stretch along the coast. Reference to either of these standards would place the entire island of St. Thomas within the coastal zone.

The barrier of isolation has further been transgressed by exogenous factors occurring far beyond the shores of the island itself as in the case of offshore oil spills, [7] ocean dumping of chemical wastes and habitat destruction of migratory species, all of which have affected tropical islands in recent years.

The presence of contaminants on the high seas surrounding island systems reinforces the conclusion reached by the BOR Report, *Islands of America*, that islands hold a special position with respect to "impact of uncontrolled and unplanned technological encounters."[8]

The second reason for island vulnerability arises from the fact that the traditional development barrier of resource scarcity—or its complete absence—is no longer of crucial import. Technology has overcome many of the constraints on development posed by physical resource deficiencies. The power of technology to surmount resource deficiencies is well-illustrated by the example of St. Thomas, U.S. Virgin Islands. Because of poor agricultural resources, most foodstuffs are imported; fresh-water scarcity necessitates that it be brought in by tanker and vast quantities manufactured in costly desalination plants; owing to the dearth of construction aggregate, sand is both imported and dredged from inshore areas; and finally, given a short supply of the land resource itself, more land is created by dredge and fill operations along the coast.

A third factor that pertains to island vulnerability can be attributed to the development phenomenon itself, which may occur with little or no forewarning. The stimulus underlying a development thrust is often capricious, unpredictable and exogenous. With no anticipatory planning, an island's vulnerability is exacerbated. For example, the essential stimuli to the growth of the Virgin Islands was the foreclosure of Cuba as a tourist mecca by Castro's revolution, and the availability of a $200.00 duty-free purchase allowance for Americans returning to the U.S. mainland. What planner could have predicted the effects of these actions upon the Virgin Islands in 1960?

The fourth element of island vulnerability arises out of the close geographic proximity of ecosystems which are both (a) diverse and (b) interdependent.

Diversity simply reflects the presence of heterogeneous conditions and habitats. Life forms that flourish in oceanic island habitats tend to be environmentally specific. The occurrence of coral reef

[7] In the second week of December, 1971, a tanker in international waters travelling between St. Croix and St. Thomas cleaned out its tanks of heavy oil, which eventually washed up on the north coast of St. Croix, Buck Island National Reef, and the shore in the Christiansted area. See the *Daily News* editorial "Deliberate Pollution" of December 16, 1971. An almost identical situation occurred in mid-February with similar results to the coastline of St. Croix and Buck Island. See the *Daily News* of February 19, 1971.

[8] Bureau of Outdoor Recreation, Department of the Interior; *Islands of America*; Washington, D.C., 1970, p. 38.

formations that fringe an island illustrates this well. In one locale, coral appears to flourish, while in another seemingly identical area, it barely holds its own or is absent altogether.[9]

Interdependency is the first principle of the life web. This interdependency exists both within an ecosystem (as in the example of coral, with its algae and other floral and faunal associates) and between ecosystems.

In the latter case, an island's vulnerability is accentuated by the close geographic proximity of the various subaerial and subaqueous ecosystems, such that an impact in one ecosystem will be rapidly transmitted to another. If any of the environmentally specific parameters governing coral reef growth are seriously transgressed, then one may expect death of the reef.[10]

The maintenance of water circulation is the *sine qua non* of coral reef growth, as the coralline algae that cements together the reef fragments requires a continual supply of oxygen.[11] This is demonstrated by the vigorous growth that occurs at the surf zone where both nutrients and oxygen are found in abundance.

The fact of interdependency in island ecosystems means that care and knowledge should be exercised in making land-use decisions that affect the environmental status quo.

Land clearing for construction or other purposes that takes place in an upland ecosystem can adversely affect an offshore reef through siltation which acts to smother it or by blocking sunlight vital to photosynthesis. In a similar vein, offshore construction or dredge and fill operations that may occur far distant from a coral reef ecosystem can interfere with a pattern of water circulation on which its growth depends.

The degradation of zones of primary productivity around oceanic islands, owing to man's malpractices, provides yet another instance of the web of interdependency. The dredging of shallow embayments can destroy the intertidal water mass exchange (a characteristic of shallow areas) which in turn lowers the productivity of the area.

Farther afield, upland deforestation, cultivation, and erosion impoverish the littoral and inner sublittoral zones by transforming the pre-existing permanent streams into intermittent ones of low nutrient

[9] The precarious growth localities for coral are on (a) leeward coastlines, due to the salinity variations (evaporation from a semi-enclosed lagoon or the influx of fresh water off the land); and (b) on the landward side of reefs due to sedimentation in sheltered water and the lack of wave action which reduces nutrient and oxygen levels in the water. (F. G. Walton Smith. *Atlantic Reef Corals,* University of Miami Press, Coral Gables, Florida, 1971, page 5.)

[10] Conditions for optimal reef growth are temperatures within 73 to 77°F., water salinity around 35 parts per thousand, the presence of ample sunlight, and the unimpeded flow of water movement in the form of waves and currents to bring food and oxygen to the coral and its algae associate (Walton Smith, pp. 4-5).

[11] A. E. Dammann, *et al.* Study of the Fisheries Potential of the Virgin Islands; VIERS No. 1, Caribbean Research Institute, St. Thomas, U.S.V.I., August, 1969, p. 21.

carrying capacity. Such has been the experience of St. Thomas.[12]

The final element of "vulnerability" refers more narrowly to the biological resources of an island, and not to the island itself. The question is: how tolerant are the life forms to environmental change? Have life forms on islands evolved within constraints set by a more stable, less extreme environment than that of continents?

If we have in mind the coastal fisheries resources of the Caribbean, the answer is that an island's marine biological resources *are* less tolerant to changes in the physical regime, and consequently more vulnerable, than marine resources of the continental margins.[13]

In sum, islands are seen to be extremely vulnerable to development stresses and outside influence. The section that follows considers the adverse effects generated within the island system by some of these influences, and discusses the challenges they pose for management.

MANAGING ISLAND GROWTH—PROBLEMS & CHALLENGES

When looking at growth problems, it is useful to recognize two dimensions to the development process. On one level the problems are those that accompany the growth phenomenon whenever and wherever it takes place, irrespective of the operative economic system; on the other level, the problems are those that result from failures of allocation that commonly occur within the framework of a free enterprise system.

The point of recognizing these dimensions is to suggest that current management programs initiated at the local or regional level may be powerless to resist the gross effects of the worldwide development activity per se; while in the localized arena of market failure they *can* effectively counteract the consequences and process of misallocation.

Long-term Growth

Of the various aspects of long-term development that affect islands, we will limit ourselves to an examination of the stresses and strains manifest in an island whose population threatens to outstrip its resource base.

The desirability of stemming the tide of material growth is predicated on the view that an endless increase in population and/or material goods will eventually lead to the improverishment or destruction of the very qualities of the oceanic island that attracted residents to its shores in the first place. In short, an island can be thought of as having an optimum growth level—beyond which

[12] Dammann, *et al.*, p. 6.
[13] Dammann, *et al.*, p. 24.

its inhabitants will experience diminishing returns and a declining quality of life.[14] Where this vague point of diminishing returns is to be found on a development continuum is now impossible to say. It remains in the realm of subjective opinion. A social consensus would be the only way of defining such an elusive "point." The task of management would then be to stay within the prescribed bounds. Staying within bounds is ultimately contingent on stabilizing the population at a predetermined level. Keeping growth under control would also be well served by recasting the capitalist growth ethic into an equilibrium, no-growth mold.[15]

For an island to resist both population and material growth, a radical departure in social, economic, and political thinking is demanded. Given the magnitude of the effort that will be required to neutralize or even regulate present development trends, it is expected to cause painful reprecussions. This eventuality, however, should not deter us from considering unlimited "growth" as a potential hazard to resource management programs.

Ocean Islands as Closed Systems

Reference to a closed-system model gives us a better perspective of what is involved in resource management of islands. The traditional free enterprise economy is, in the words of the economist Kenneth Boulding, a "through-put" economy which has as its emphasis the production and consumption of goods (Boulding, 1966). In this economy with which we are familiar, there is a one-way flow of the materials stream from initial extraction, to production of goods, to their consumption, and finally to their being discarded as junk. Such an arrangament works satisfactorily in a world of ample resources and available space to dispose of the wastes; but it is inappropriate in an island "world" of fixed limits.

Within the context of a bounded earth, Boulding argues the relevance of an alternative economy that is "closed"—"spaceship Earth"—where resources trace a circular stream from input, to output, and back to input. There are four revealing notions that we can identify in this closed economy idea, that bear repeating in the context of managing oceanic islands.

First, being "closed" it follows that there are a fixed number of components in the system. The addition of components from the outside (imported) will necessarily displace those already there. In

[14] It can also be considered to have a *maximum* growth level which reflects the absolute physical limit to the number of inhabitants that the resource base can sustain.

[15] N.b. The three preconditions for curing society's consumer "neurosis" would be the preexistence of an equitable income distribution; the attainment of a sufficiently high per capita income level to obviate the craving for more and more goods; and perhaps a fundamental change in the value ethic of materialism itself.

the real world terms of St. Thomas, Virgin Islands, to pick an example, one is simply saying that the action of bringing 15,000 vehicles (the number of operating vehicles for 1971) into an island of 32 square miles will generate reprecussions or impacts. Introductions in a closed system do not occur in a vacuum.

Second, given the circular flow of resources that exists, material goods are not "consumed" by the user in a traditional sense of "annihilation" (Ayers & Kneese, 1969); goods are only altered by the user, then discharged as waste or recycled for further use.

In keeping with the example of the 15,000 vehicles on St. Thomas, the problem that confronts island management is to know what to do with the 15,000 derelicts destined to blanket the countryside as the vehicles are retired from use over the next decade. Where does one put them? Knowing what to do with the 75,000 tires (which are not biodegradable) that are discarded every three years is a big enough problem alone!

The third notion that derives from the closed economy idea is that the initial endowment of stock natural resources is fixed. If stock resources are squandered, they are then effectively—at least within the measure of our lifetime—lost. Conservation is mandatory where depletion of stock resources through overexploitation or mismanagement is irreversible.

Finally, as Boulding points out, the goals of a closed economy are quite different than traditional goals of maximizing production/consumption. Success of the closed economy is judged by how well the "nature, extent, quality, and complexity of the total capital stock" are maintained.

In the long term, this last notion is probably the key to the success of any management program designed for oceanic islands. The chief operative principle must be the maintenance of the total capital stock. The earlier argument, calling for a fixed ceiling on population and material growth within the island estate, is predicated on the validity of this stock maintenance principle.

The chief planner of the San Francisco Bay Conservation and Development Commission (B.C.D.C.) would echo this viewpoint. Referring to the direction of future planning efforts, Jack Schoop states that one's long-term objective is "to change the values and redress the legal, economic, and property system that is still dedicated primarily to taming, overcoming—indeed, obliterating—the natural environment." Final success or failure is conditioned on a change in values ". . . of those substantial interests whose natural inclination is to put private rights above public rights and to put immediate growth ahead of the long-term implications of growth."[16]

The changing ethic relating to the use of the nation's resources may soon be officially recognized at the federal level of government in the guise of the new U.S. Water Resources Council "Standards."[17] The "Standards" document explicitly recognizes the desirability of diverting a portion of the nation's resources from production of more conventional market-oriented goods and services to the task of accomplishing environmental objectives.[18] Emergence of these new values is an encouraging development for island management as they contribute directly to the "principle of maintaining the total capital stock," discussed earlier.

Market Failure

President Nixon in his recent environmental message to Congress states that "the temptation to cast technology in the role of ecological villain must be resisted—for to do so is to deprive ourselves of a vital tool available for enhancing environmental quality."[19]

At this point in time, technology can hardly be viewed in the role of prospective ecological savior, or even as an enhancer of environmental quality as he would suggest, for on balance, more battles are being lost than won. It is more appropriate for us to view technology as being potentially neutral. We can then focus our attention on the broader picture of market failure,[20] within which technology has been permitted to exercise a "villainous" role.

The market failures of greatest importance in St. Thomas lie in the areas of spillovers in the form of water pollution, scenic degradation, and solid waste disposal; and in the underprovision of goods such as recreation that requires large initial investments, with little potential for profit until maximum capacity is reached. A third area of concern for St. Thomas lies in the fact that many private allocation decisions made in the coastal zone lead to results that are inconsistent with the

[16] His words carry weight, coming as they do from the planning headquarters of this celebrated and successful Commission that has been widely emulated in proposals for regional resource management. (*v* Jack E. Schoop. "The San Francisco Bay Experience," in *Coastal Zone Resource Management*, eds. J. C. Hite & J. M. Stepp; Praeger, N.Y., 1971, pp. 3-19.)

[17] The "Standards," which is designed to replace the obsolete Senate Document 97, provides the basis for federal participation in all water and related land resources programs. If approved by the President, its implementation will have far-reaching consequences. (U.S. Water Resources Council. "Proposed Principles and Standards For Planning Water and Related Land Resources," *The Federal Register*, Vol. 36, No. 245, Part 2, December 21, 1971.)

[18] "As incomes and living levels increase, society appears less willing to accept environmental deterioration in exchange for additional goods and services in the market place." Water Resources Council, pp. 24151-52.

[19] The Executive. "President's 1972 Environmental Message to Congress," Office of the White House Press Secretary, February 8, 1972, p. 7.

[20] For a lucid analysis of both causes and implications of market failure on resource allocation, interested readers are referred to: M.I.T. *Economic Factors in the Development of a Coastal Zone*. Cambridge, Mass.; September, 1970, pp. 20-33.

public interest, but no effective procedural mechanism exists to check this trend at the present time.

When focusing on the environmental components of market failure (spillovers and underprovision of non-material goods), it is clear that the problems are both multifarious and difficult to describe with precision because of the different value systems that people hold. Reference to the "environmental quality objectives" of the proposed planning standards of the U.S. Water Resources Council, presents us with a useful framework for examining environmental values of an island that are frequently affected adversely through market failure.

Note, that the adverse effects of market failure (chiefly spillovers) are the obverse of the Water Resources Council list of beneficial effects. As an aid to exposition, these adverse effects (negative impacts) are separated into four categories. We will deal with them in turn, for they illustrate the non-monetary values that island management must consider in allocating and planning resources to mitigate the undesirable effects of market failure.

Adverse effects of the first category are those which "imperil, degrade, or destroy . . . beaches and shores . . . estuaries . . . and other areas of natural beauty."[21] To elaborate, the concern here is with the impacts that adversely affect "public aesthetic values and recreational enjoyment" in addition to the quality of "scenic shorelines." Estuaries are viewed—beyond their economic value—as valuable for their intrinsic worth as aesthetic attractions and "as marine ecosystems of special worth."

Some of the most important market failure problems of St. Thomas fall into this category. The rampant growth of the island has placed enormous demands on the scarce coastal zone resources as sites for industrial, residential, hotel, and condominium development. A by-product of this growth has been the aesthetic degradation of the natural shoreline scenery through poorly designed or misplaced structures improperly installed.[22]

The second category of adverse effects identified in the environmental quality account are those resulting from the "alteration or degradation of especially valuable . . . . . biological, and geological resources and selected ecological systems." Speaking of biological resources, an adverse effect of particular concern to those in environ-

[21] Water Resources Council, p. 24160.

[22] Another feature of this urbanization of the coastal zone by private interests has been reduced public access to the beaches, which are a major public recreation resource. The heated controversy, presently un-resolved, that surrounds the topic of free access to all beaches in the Virgin Islands is indicative of the high value that the public places on these aesthetic and recreation resources. Act No. 3063, recently enacted, is a sell-out of the public interest to the hotel and real estate interests. The Act is an anemic policy statement regarding the rights of the public to use and enjoy the shorelines of the Virgin Islands. It fails, however, to guarantee, promote, or otherwise legislate access through private holdings to the beaches.

mental education is the recognition that the foreclosure of opportunity to observe and study biological resources—terrestrial and aquatic—will lead to diminished understanding and appreciation of the natural world as the habitat of man.[23]

Ecological systems are given a particularly explicit treatment in the environmental account which is based on attributes going far beyond the immediate economic utility of ecological systems as a resource base for man's material needs. These attributes are in the realm of science and aesthetics.[24] Adverse effects are those in which a reduction or loss of opportunity of these attributes occurs, as a result of an implemented development plan. An example close to home of an "especially valuable" biological resource/ecological system that would be accorded high (nonmonetary) valuation in the Water Resources Council Standards, are the bioluminescent bays of Puerto Rico and Vieques Island. These bays are delicate fragile systems, rarely found in the world and, therefore, of international significance (National Park Service, 1968).

The third category of adverse effects are spillovers that act to degrade selected quality aspects of water, land, and air. No elaboration of these types of pollution need be pursued, as we are all familiar with them.

The final category of adverse effects results from the loss of freedom of choice to future resource users by actions that magnify or cause irreversible or irretrievable effects. This point is of consequence to islands that are scarcely endowed and ecologically fragile. It stresses that plans made in a world of uncertainty should assume a cautious approach in environmental affairs and avoid irreversible commitments of resources to future uses.[25]

Several striking examples of foreclosure of future resource opportunities occur in the U. S. Virgin Islands: on the island of St. Thomas, 90 percent of the beaches are effectively controlled by hotel and condominium developments; on St. Croix, the establishment of the Hess and Harvey industrial complex at Krause Lagoon has obliterated the most biolologically productive spot in the Virgin Islands and threatens to induce further environmental decay of the entire southwestern coast.

In reconsidering the immediate problems incurred by development. the central point to be stressed is that specific problems that one can identify as a by-product of the contemporary development process—

[23] Water Resources Council, pp. 24161-62.
[24] Water Resources Council, p. 24161.
[25] Water Resources Council, p. 24152.

air pollution emissions, untreated sewage effluent sources, disappearance of recreational land, disfigurement of landscapes, floral and faunal habitat destruction and the overharvesting of coastal fish and sand resources—all owe their origin to fundamental imperfections of the market mechanism. Thus, a program of management should avoid a piecemeal problem-by-problem approach and instead address itself to the more encompassing task of resolving market failure. The B.C.D.C. experience demonstrates that such a task can be achieved successfully by a regional authority.

Islands, however, require more than market failure remedies. If we are ever to preside over an island's destiny, then we must enlarge our management view beyond piecemeal ad hoc allocation and market failure problems and accept the challenge of uncontrolled growth, spurred by forces presently beyond our control. The final section of the paper discusses some elements or "constituents" that are judged to be of key importance in furthering this aim.

KEY CONSTITUENTS OF A MANAGEMENT PROGRAM FOR ISLANDS

In our view, there are six key constituents that merit inclusion in management programs devised for oceanic islands. The first three elements pertain to the stewardship of limited resources within a fragile insular framework that is vulnerable to outside influence. The next two elements are addressed to the response of management to market failure; while the final element (included as a postscript) is advanced in the spirit of an operative tenet.

1. *Conservation*

Acceptance of a conservation ethic is indispensable to the principle of maintaining the total capital stock. Both terrestrial and marine island resources are fixed in extent. Some of these islandwide scarcities can be circumvented through importation (fresh water), while others constrain more rigidly (amount of available land). In either case there is a management imperative to conserve, and preferably, enhance, the original endowment. The fact of island vulnerability provides additional grounds for employment of a conservation ethic.

2. *Interdependency*

Recognition of the interdependencies that link the closely-knit subaerial and subaqueous ecosystems is basic to the relevance of an artificially conceived management plan that must come to terms with the complex physical and biological interactions of the island regime.

3. *Growth Limits*

The realization that there are limits to growth, must be a feature of any long-range management program for islands. Ancillary to this notion of a growth ceiling is the notion of an optimum growth level, that will occur somewhere along the development continuum in advance of the growth limit. An adjunct to ascertaining the maximum population that an island can support should be the establishment of standards that reflect this optimum population/development level.[26]

4. *Resource Allocation*

Islands require that special attention be paid to circumventing market failure in the allocation process. Islands are especially vulnerable to the adverse effects of technological spillovers; underprovision of non-material goods, and the overexploitation of fish resources and other common property resources.

The use of multi-objective criteria, of which the Water Resources Council's standards are an example, insures that environmental values not represented in private market allocation will be accorded equal value in the arbitration procedure. Comparisons made between alternative projects that favor on the one hand, the economic efficiency account, and on the other, the environmental account, can assist in delineating difficult development/conservation dichotomies.

The criterion of "inherent dependency" is useful in determining "who" gets "what" and "where."[27] Land uses that operate independently of the inherent resource base are more likely to affect the environment adversely than those uses which are subordinate to it. The dependency of a user on a given resource will at least offer an incentive to maintain the environmental status quo and, in some cases, improve it.

5. *Management Structure*

There is need for a centralized management structure when dealing with island resources. Such a structure built around the concept of an island system will bring under one domain all the actions and interactions of resource use. In this way, specific localized activities can be viewed in terms of their over-all impact (beneficial and adverse) on the island system. This, in economic terms, is what is meant by "internalizing the externalities."

[26] Governor Evans of the U.S. Virgin Islands has called for limits to growth of the V.I. population, noting that without limits "we will develop the neuroses present in the big cities." (*Daily News,* March 8, 1972.) Conversely, however, he is also fighting for a larger, new jetport to handle 747's.

[27] This criterion is accorded a high place in the Comprehensive Ocean Area Plan (COAP) of California. (Proceedings of the 12th Meeting of the California Advisory Commission on Marine & Coastal Resources (CMC) Sacramento, California; September, 1971, pp. 31-40.)

In concert with the centralization of territorial jurisdiction, We would advocate a parallel centralization of administrative function, particularly with regard to islandwide planning, conservation, and environmental protection. One must avoid the dilution of authority that occurs by spreading environmental management across jealously competitive different departments, which is the situation currently in the Virgin Islands.

Market failure should be treated at the outset as an expected element of the free enterprise system, and not as an aberration to be treated piecemeal after the fact. Too often market failure problems are neglected until environmental deterioration reaches an advanced stage, and remedial action is costly, if not impossible.

6. *A Postscript*: *The Wisdom of Restraint*

A tenet that should underlie all island-management decisions is that of restraint. Management in a world of uncertainty involves risks about future outcomes. The danger of making a wrong allocation decision in the environment sphere lies in the irreversibility of the bad decision. Most environmental resources, once committed, cannot be reclaimed for other alternative uses. It is a sensible insurance policy to guard against the foreclosure of future options. This vital concept—which constitutes an admission that decision makers are fallible—was previously mentioned in the discussion of the environmental account of the W. R. C. "Standards." The COAP guidelines[28] and the recommendations of the President's Panel on Oilspills, also recognize its importance.

In the latter instance, the Panel advocates use of an "escrow resource policy." It bears repeating in the context of the island situation. They point out that potential offshore resources are ill-served by dichotomizing resource allocations into "develop" or "preserve" categories. Instead, they recognize a class of escrow resources in which resources can be placed for fixed periods of time, in lieu of being exploited or placed permanently off limits.[29]

Rather than limit this policy to the realm of offshore resources, we suggest it be incorporated into management programs of island systems. It offers clear advantages (by reason of its selectivity when putting a hold on a particular resource) in comparison with the use of a blanket "moratorium" on development which has been instituted in the coastal zones of some states.

* * *

The future viability and environmental quality of all islands and

[28] CMC. "Reports on the 9th & 10th Meetings"; May, 1971, pp. 26-27.
[29] Executive Offices of the President. "Offshore Mineral Resources"; 2nd Report of the President's Panel on Oilspills, Washington, D.C., 1969, p. 7.

especially tropical island ecosystems will depend on how successfully these key constitutents are incorporated into insular resource management programs.

LITERATURE CITED

Ayres, R. and A. Kneese.
1969. Production, consumption, and externalities, American Economic Review, June.

Boulding, K. E.
1966. "The Economics of the Coming Spaceship Earth," Environmental Quality in a Growing Economy, ed. H. Jarrett. Johns Hopkins Press, Baltimore, Maryland.

Brody, R. W., W. N. Brownell, and E. L. Towle.
1971. Aspects of marine pollution in the Antilles. Reprint of FAO Tech., Conf. on Marine Pollution and Its Effects on Living Resources and Fishing. FAO Report No. 9, Rome. p. 120.

Brownell, W. N. and W. E. Rainey.
1971. Research and development of deep water commercial and sport fisheries around the V.I. Plateau, VIERS, No. 3, Caribbean Research Institute, August.

Bureau of Outdoor Recreation, Department of Interior.
1970. Islands of America, G.P.O., Washington, D.C.

California Advisory Commission on Marine & Coastal Resources.
1971. Reports on the 9th and 10th Meetings, Sacramento, California, May.

———.
1971. Proceedings of the 12th Meeting, September.

Daily News.
1971. (Charlotte Amalie, St. Thomas, U.S. V.I.); Editorial, "Deliberate Pollution," Dec. 16.

———.
1972. Origin of Buck Island Oil Pollution Unknown, Feb. 19.

———.
1972. "Governor calls for limits to growth of V.I. population," March 8.

Dammann, A. E. et al.
1969. Study of the fisheries potential of the Virgin Islands, VIERS No. 1, Caribbean Research Institute, St. Thomas, U.S. V.I., Aug.

The Executive.
1972. President's 1972 Environmental Message to Congress. Office of the White House Press Secretary, Feb. 8.

Executive Office of the President.
1969. Offshore mineral resources, 2nd Report of the President's Panel on Oilspills, Washington, D.C.

Grigg, David.
1970. Some effects of dredging on water quality and coral reef ecology. Caribbean Cons. Association Environmental Newsletter 1(2): Oct. pp. 22-28.

I.U.C.N.
1971. Regional Symposium on Conservation of Nature—Reefs and Lagoons. Noumea, New Caledonia, Aerg.

M.I.T.
1970. Economic factors in the development of a coastal zone, Cambridge, Mass., Sept.

National Park Service, U.S. Dept. of Interior.
1968. The bioluminescent bays of Puerto Rico: A plan for their preservation and use, Washington, D.C.

Schoop, Jack E.
1971. The San Francisco Bay experience, Coastal Zone Management, eds. J. C. Hite and J. M. Stepp; Praeger, N.Y.

Smith, F. G. Walton.
1971. Atlantic reef corals, Univ. Miami Press; Coral Gables, Florida.

U.S. Senate, Subcommittee on Oceans & Atmosphere.
1971. "Coastal Zone Management Hearings"; Serial No. 92-15, Washington, D.C.

U.S. Water Resources Council.
1971. Proposed Principles and Standards for Planning Water and Related Land Resources, The Federal Register, Vol. 36, No. 245, Part 2, Dec. 21.

TECHNICAL SESSION

Tuesday Morning—March 14

Chairman: E. L. Cheatum
Director, Georgia Institute of Natural Resources, Athens

Discussion Leader: Charles H. Callison
Executive Vice President, National Audubon Society, New York City

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PRESERVATION: PERIL OR PANACEA?

A COMMITMENT IN DEFENSE OF NATURAL SYSTEMS

Margaret Owings
Big Sur, California

Although my paper focuses on California, its intent is to use California primarily as an indication of what I consider serious errors in Wildlife operations across the country.

I speak as a layman, one person out of the vast growing assemblage of conservation-minded citizens. I am one of those citizens who place high value on wildlife in its natural state in a propitious environment, and do not care to kill it.

I am oriented toward the preservation of wildlife rather than toward its exploitation for commercial gain, sport-killing for recreation, and the ingrown theory that wildlife is useless unless used. I am concerned about the gratification of our greed.

I am, perhaps, the proverbial "little old lady in tennis shoes," although the cliché is often inappropriately employed. Also, I am a woman who ensnares rattlesnakes alive and moves them from the point of land on which we live to an isolated region several miles away. I kill them only when their location is markedly hazardous to our family and they cannot be extracted without risk. One might say that this is a form of "management."

I carry a distrust for management programs which frequently impress me as systems to subjugate and subdue. Some might consider them practical solutions, mathematical equations that balance life against life, a controlled world without blemish. I favor the necessary studies to carry out research on shifting situations in wildlife populations and habitat, if the study itself does not damage the studied. I am aware that the biological imbalance already brought about by man can sometimes be rectified by some management—including the management of man himself. Invariably, out of wildlife studies come management proposals for manipulation from the complex to the simple. Is this a step forward or backward?

My introduction to wildlife management took place along the border of the Los Padres National Forest, California, in high ridge country laced only by fire-road. It was the early fifties when I was hiking along an animal trail with my dog. A government vehicle appeared and braked to a stop to warn me that I had better pick up my dog since traps and cyanide guns had just been set out. Quite naturally, I asked the man what they were after. The answer was "predators" because they had just introduced a dozen wild turkeys into the area and wanted to clear the region of their natural enemies.

I didn't need an education in science to recognize that protection of exotic game targets for the sportsmen through extermination of predators upon which the natural system depended was wrong. From that moment on, I took a new look. I paid attention to government agencies and their bureaus and the pressures that directed their activities.

Administrators of the natural resources, I found, usually claim that their decisions are in the public interest. This public interest, however, is subject to opinions based on self-interest and reflects dominant groups. A major criterion for determining public interest is often not related to quality perspective or long-view consequences but, instead, is based on numbers of people, sums of money, and associated commercial enterprises.

In the administration, the resource managers themselves, I found, tended to operate away from the field, caught up in administrative work with prime focus on management of people in their regulation and use of a resource. Biologists present their specialized studies but it is the administration which interprets them in relation to their established policies. Wardens in the field, who recognize the values of wildlife inter-relationships, are given no prerogatives to make management decisions and those at the top of the pyramid, appear to wear blinders when it comes to diversity.

Who are the dominant groups that direct the administration of wildlife in California? Since few in the Department of Fish and

Game are charged with maintaining wildlife for the enjoyment of citizens who do not care to kill, the dominant groups to receive attention are the Associated Sportsmen and the California Wildlife Federation—the hunting public. Though the public owns the game, the Department of Fish and Game, supported mainly by funds which accrue from hunting and fishing licenses, duck stamps, wetlands stamps and the Pittman-Robertson tax, serves primarily to enhance this game for some 763,284 hunters and 2,323,847 fishermen whose fees pay the bills (Figures for 1970).

Thus, approximately three-million, out of some twenty-million citizens in the state, direct the wildlife program, sending their lobbies into the legislative sessions and penetrating in depth the administration of the Department. But a counter-balance to this California self-service pressure-group has sprung out of a growing revolution of public attitude and a sudden astonished awareness that the law reads: "Wildlife is the property of the people—the sovereignty of which they have vested in the State to conserve and manage for the benefit of all the people."

What has brought about this change in public attitude? The recognition of a deteriorating environment and the growing comprehension of the word "ecology"? Or, the impact of the long view—our planet in space, "small and blue and beautiful in the eternal silence in which it floats"? Or, is there a growing intimate sense of loss as the news media and television present endangered species with quality photography illustrating animals in action in the systems in which they live?

Whatever the stimulus, a fresh concept is taking hold that wildlife is there, that it is part of us, that we are part of it, that all life is an extension of ourselves. And out of it, a new form of recreation is evolving that takes nothing away—observing wildlife with binoculars and recording it with lens, describing it in writing and participating as individuals in the act of appreciation and the effort of preservation.

In California, these people have grown increasingly uneasy and impatient with the administration of the State Fish and Game and with its handling of certain of the state's distinguished mammals. These people are organizing and have taken their concerns to their legislators and have found a responsive body at the Capitol to introduce restrictive legislation for the protection of wildlife. In addition, these people have defeated special-interest bills favorable to Department programs.

In the spring of 1970, the foremost issue pertaining to a special-interest group became, in simple terms, a matter of values—balanced one against the other.

Where do you place your value, the public was asked, on a small gourmet industry, the red abalone, or on a rare marine mammal, the southern sea otter?

California Senate Bill 442, pressured by the abalone industry and approved by the Department of Fish and Game, was introduced to "solve" the sea otter and commercial abalone controversy. Although the population count of the "fully protected southern sea otter, ***Enhydra lutris nereis***" (Fish and Game Code Section 4700), was 1014, this Bill provided that sea otters could be "taken outside the California Sea Otter Refuge," providing there had been a public hearing before the Fish and Game Commission.

The public was quick to discover that the word "take" could imply "kill" and that one-third of the total southern sea otter population was outside the Refuge as the bill was introduced. Although the 100-mile Refuge, established by legislative act soon after the otters were rediscovered in 1938, was to protect otters, not to limit their movements, the reading of the bill suggested otherwise.

Placed in the category as competitors for the red abalone, the otter was blamed for the decline of an industry which was suffering, in great part, from its own overharvest. In addition, the abalone resource was declining along the entire California coast, much of which was far from the otter's range. Although the otter is skilled in extracting abalones from underwater rocks, he does so with time, effort and many dives. He also eats some 26 other items of food which he procures more easily.

As the facts unfolded, the bill became an educational process for the public. Their admiration for the otter's charm and tool-using capacities commences to reach deeper into understanding his complex role in the marine ecology. Since otters are the chief harvesters of the sea urchin, the absence of otters in southern California waters had permitted the urchins to multiply unhindered. Since the sea urchins destroy kelp, they affect the vast community of marine life dependent upon it, including the abalone. Thus, the public learned about the subtle life relationships that link marine organisms to one another and to their surroundings.

Amended at the last minute to remove the word "take" and substitute "catch, capture or pursue," the bill moved into public hearing where it was backed by the sportsmen's lobby and the California Wildlife Federation. "Speaking for more than 800,000 people, whom we represent in California," they said, "this is a very good piece of legislation."

But the informed and serious conservation groups placed their values with the otters, bombarded their legislators and defeated the bill. Dr. Robert T. Orr, Associate Director, California Academy of Sciences, summed up the issue in essence, when he testified at the hearing.

"We are living in an age when our nation is becoming very conservation-minded—trying to undo the great damage that man has done to his environment. Senate Bill 442 is so far out of tune with this concept that it might well have been conceived in the 19th century. It proposes to curb sea otters which are barely past the danger point. And why? So that a small group of market hunters, commercializing on something that belongs to all of us, can continue their exploitation to produce a gourmet item."

After the defeat of this ill-advised bill, it appeared to many of us that the Department continued a devaluation of the southern sea otter when it refused to recommend to its Commission the placing of this animal on the state's "Rare and Endangered List." With its population dangerously low, this sub-species of the more populous northern sea otter, *Enhydra lutris*,[1] is subject to residues of mercury, cadmium, copper and zinc in the marine life on which it feeds as well as pollution from pesticides, toxic wastes and raw sewage. Continual harassment by commercial abalone divers (approximately 50 deaths in 2 years) as well as propeller lacerations from increasing boat activities (27 deaths attributed), added to he unceasing threat of oil spills from tanker traffic, would indicate small assurance of safety for this unique marine mammal.

Was the Department's negative recommendation influenced not by these facts but by the fact that their own hands could be tied in carrying out a management program if the otters were placed on the "Rare and Endangered List."?

Government stewardship to guard a diversity of wildlife for the benefit of all the people has foundered too often and too long. Without a game label, the wildlife is tossed into the "varmint category" easy target for the man with the gun. Fish and Game admit that they know nothing of the nongame distribution. "Little has been done for nongame either in research or management."[2]

Yet these animals such as the bobcat and coyote, etc. increase the efficiency of life as a part of the ecosystem. Whether it be prey or predator, man moves in with carnage. A recent aerial broadcasting of grain soaked in 1080 poison in Fresno and San Luis Obispo counties

[1] Dr. Aryan Roest—"Systematic study of the sea otter, *Enhydra lutris*." October 23, 1971, Biosonor Conf., Menlo Park, Calif.

[2] Howard Leach, "California's Endangered Wildlife, 1971." Joint Conference, Calif.-Nevada Sect. Wildlife Society.

in California brought this justification from the Agricultural Commissioner. "It is no longer feasible," he wrote, "to control ground squirrels with coyotes and rattlesnakes."

I have made reference to hunting which is approved by law as a recognized form of recreation. Men purchase arms from the munitions industry and equipment from the sporting goods market; they buy licenses and stamps from the government and go out in trucks at prescribed dates according to regulations and shoot game they do not need for food. There are exceptions, of course, when game may serve an indispensable food requirement, but these are rare. Hunting augments the economy, which is a factor in its political power and, according to Ed Zern, outdoor writer for *Field & Stream,* it answers a "psychic need."[3]

What is this psychic need? Is it to perform man's dominion over life? To fell a great tree? To dam a wild river? To cut down a strong free animal in action? I call it an uneven contest, this use of steel and fire and neither tradition nor its legality make it benign.

Mr. Zern claims that non-hunters refuse to accept death as an essential part of life. Yet, how can man refuse or accept death unless he himself is prey? What predator stalks the hunter's trail in North America? In Africa, man can experience the role of being prey to others when he walks through the bush and forest along the Mara River in Kenya, taking a chance, observing, sensing the uneven varied, staccato pulse of wildlife. Without a rifle one is totally part of this process of life. Using caution, one is exhilarated and stimulated through an intuitive sense braced for consequences, but without a safeguard guarantee. Give one the guarantee and vitality stagnates. A keener experience I have never known.

But I am not here to moralize about hunting. Many sportsmen carry their own code of ethics and carefully follow the law as it is defined. There are others, however, with gun-racks in their pick-ups who only need a moving target. Within sight of our house in Big Sur, the great blue heron lay on its side on the shore; the doe giving birth to a fawn stumbled and fell under our redwoods; the white Stellar sea lion, a beach master lording it over his harem, was struck by an explosion at the peak of his power. We watched it happen. The trucks move on. They are what Ian McHarg would call "vandals of our storehouse."

Although Howard Leach, California Wildlife Management Supervisor said, "we realize how unknowledgeable we are concerning the status of California's nongame animals, particularily those in short supply," the California mountain lion, moved from nongame category

[3] Ed Zern—"I am a Hunter," Audubon Magazine, Jan. 1972.

into big-game status, caused the Department, without preliminary studies, to commence sale of an unrestricted number of one dollar permits to hunt lions any season, day or night, either sex, young or old, use of dogs and no game limit to the hunter. A sanctimonious measure was added against traps and poison.

At this time, when the world is closing in on wildlife from all sides, the Department, without any study to substantiate it, made a flat statement. "The lion's population," they said, "is stable."

"To base management policy on guesswork," wrote George Schaller to the Natural Resources Committee, May 21, 1971, "is a sad state of affairs in a state with as large a Game Department staff as in California."

With the cougar's wild habitat increasingly accessible to skilled hunters and trained dogs, discrete lion populations could be eliminated. Before the year was over, the State had sold 4746 lion permits to prospective hunters. "As long as we keep on killing them, there must be lions left,"[4] was the only possible theory under which this game program could be operating.

In the early months of the 1971 program, Assembly Bill 660 was introduced to stop the sport-killing of lions and provide for the take and capture of lions causing depredation. The public, perceiving an acceleration of the decline of this beautiful animal, was challenged into vigorous activity.

How can a lion population be stable, they asked, when hunting itself is not stable? The California Fish & Wildlife Plan in 1964, stated that "There are probably no more than 100 individuals who make an effort to hunt lions." Yet, suddenly in 1971, 4,746 hunters were to enter the field seeking a big game trophy.

Over 50 conservation organizations banded together with a "preservation platform" that covered the state with its message. In alarm, chairman of the State Fish and Game Commission called it "tunnel vision." As the conservationists carried the bill through the Assembly, the California Wildlife Federation wrote their members, "once again the anti-hunting people are threatening our sport."

13,003 lions had been killed in the state between 1907 and 1971. The peak decade of this kill, recorded by bounty payments, was from 1927 to 1936 with 2,708 lions taken. The last recorded bounty decade ending in 1963, showed 1292 lions taken, or a 53 percent drop in kill. In the five highest kill counties in the state, Humboldt accounted for 492 lions in its peak decade between 1907-1916 and dropped to 34 lions in the last recorded decade, a 93 percent decline; Trinity county

[4] Bil Gilbert—"A Close Look at Wildlife," American Environment Series, *Life Mag.*

recorded 265 lions in its peak period between 1937-1946 and dropped to 13 lions in the last bounty period, a 95 percent drop; Shasta county declined 75 percent, Mendocino county declined 57 percent and Monterey 34 percent.

Dr. A. Starker Leopold testified before the Senate Committee expressing a hope that the time would come when the final satisfaction of a lion hunt would end with treeing the lion with dogs, not shooting it. However, he indicated that the lion would be better off under Fish and Game with supervised hunting than with no jurisdiction under legislative action. Pointing out that virtually nothing is done in California to help an animal flourish, unless it comes under the jurisdiction of the Department, he pressed for a much needed study and agreed that a four-year moratorium on hunting during the study years would make it a liveable bill. We amended the bill to follow these proposals.

In the meantime, the Fish and Game Commission, on guard, passed new cautious regulations for the coming season on lions, permitting only 50 lions to be shot during a limited season with certain areas closed to hunting.

But the conservation-minded citizens had been challenged. They were not assured—and in a massive manner, they pressed the amended bill through the legislature, defying the California Wildlife Federation, they reached the Governor's desk, procured his signature and made it into law.

As Dr. Leopold remarked, "if the Department cannot accept the change of public attitude toward wildlife and respond to these pressures, everything will consequently go the legislative route."

Mr. Leach echoed this opinion when he concluded a Department paper with this warning. "We better get wired into the environment issue of the day or someone else will take our place."

Yes, someone else will take your place and will bring to a halt the lop-sided program dealing primarily with game animals—failing outright to strengthen or protect wildlife as a whole.

The American Game Policy, 1928-30, aimed at stimulating the growing of wild game crops for recreational use, can no longer stand alone any more than a living body split down the center can operate without the other half. With the biota losing its structure and wildlife populations shrinking, the federal and state agencies must be reminded for the final time that the public, not the sportsmen, own the game and nongame animals.

This public voice, as yet an unharnessed strength, will prevail—and newly established wildlife agencies, oriented in training for a guardianship role, will replace the present bureaus, financed by funds from general taxation as well as a share of the sportsmen's fees and a preservation license purchased by citizens across the nation.

Out of the 37th North American Wildlife Conference, this single imperative change must evolve. It calls for a decisive move into new directions of wildlife husbandry by both state and federal agencies.

DISCUSSION

MR. GOODE P. DAVIS (Arizona): I would like to comment briefly on the mountain lion. It seems to me that the idea of a moratorium on mountain lion hunting makes sense, although this idea has not been adopted in any western state outside of California. Less than a decade ago, the lion was a varmint with a price on his head, hunted relentlessly throughout the West. Today it is a big-game animal in most of the states of the West, but practically nothing from the viewpoint of hard qualitative management data is known about the lion in most of this region. Therefore it seems to me that elementary common sense would dictate a policy of caution.

Unfortunately the western states have put the cart before the horse and, although a number of studies have been initiated, the lion is being hunted—the seasons and bags are liberal. I personally feel that this is an unfortunate policy, although it probably cannot be reversed at this time, and considering the political climate in a number of states, such as Arizona, this is probably the best that can be expected at this time. In closing I would like to comment on one example, briefly about my home state of Arizona. I feel that the Arizona Game & Fish Department should be commended for having initiated a long-range behavorial and ecological study of the lion. But, in a sense, they are tiptoeing through the lilies as the ranchers, the livestock interest in general, still hold the whip hand in Arizona to a great extent than they do in any other state where the lion is big game. Nevertheless, I feel, again using Arizona as an example, that her present 12 months hunting season on the lion is too long and that it is reprehensible to allow the shooting of spotted kittens and females accompanied by kittens.

MR. JOHN DANIEL CALLAHAN (Salem, Oregon, member of the Oregon State Game Commission.): If we accept this tune, I believe the biggest problem that wildilfe has is the loss of quality in environment, and I believe it has been mentioned that the world is closing in on wildlife on all sides. Do you feel that with the biggest problem being loss of quality in the environment, that wildlife would be better off without the support of the hunting public, or do you feel that really the hunting public and the non-users have interests in common, and that the problem is really one of wise management?

MRS. OWINGS: I am very much aware that the hunting public has been helpful in many ways to the wildlife but primarily for game, and my interest in my talk today was primarily that non-game—which is a vast amount of animals in the State of California that has no attention given to it—is indiscriminately handled and given no consideration.

MR. CALLAHAN: Thank you. May I make one comment? You might be interested to know that in Oregon we sent a bill through the legislature under which the Game Commission is to manage non-game species, and it was generally supported by the hunting public.

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PRESERVING QUALITY ON SPACESHIP EARTH

GARRETT HARDIN

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To discover profound truths about man and his relations with the world around him, we are well advised to follow two simple rules:

Rule 1. Take a simple idea

Rule 2. Take it seriously

Let's begin with this simple idea: *Earth is a Spaceship*. We should have known this 2,000 years ago, but no one said it explicitly until our generation, and we still have not taken it sufficiently seriously. When we take it seriously—when we admit that escape from spaceship Earth is only for a very few people, and that mankind as a *species* is inescapably bound to spaceship Earth—then all human problems are seen in a new light.

But it is hard to think of a body so large as the Earth—about 13 million meters in diameter—as a spaceship, so let us look at our mundane problems with the aid of a much smaller model, something more obviously a spaceship. Let's take an object about the size of the artificial spaceships we have sent to the moon, which are closer to 13 meters in width. Thirteen meters or 13 million meters—what's the difference? Not much; and the burden of proof must always fall on him who says there is a significant difference.

So let's look at a small spaceship and ask some simple and profound questions. After we discover the answers for a small spaceship we can see if a large spaceship is any different.

(1) *Can a spaceship hold an infinite number of people?*

A 13-meter spaceship quite obviously cannot. How many can it hold? That depends on the state of technology, on the duration of the trip; and on how much discomfort the passengers will tolerate. The number of passengers on a 13-meter ship seems to be about four. How many passengers a 13 million meter ship can carry is still a matter of dispute, but it is not many more than the present number of 3½ billion; and it may be far less if the passengers are to enjoy a high standard of living. Only a finite number of people can ride on any spaceship.

(2) *Is the maximum number the optimum number?*

We can, if we wish, say that maximum is synonymous with optimum. Lemmings, if they could think about the matter, might say so; so also might sheep and bacteria. But such an answer is not worthy of men who have created civilization, for civilization can be maintained only if the size of the human population is considerably less than the theoretical maximum.

Suppose that energy is the factor that limits the number of passengers on a spaceship. Pursuing a normally active life four passengers on a 13-meter spaceship would require some $4 \times 3{,}000 = 12{,}000$ kilocalories of food energy per day. But with that daily income of food calories it would be possible to have more than four passengers. If the spacemen would just stop moving around, if they would all lie down and remain motionless they might be able to get by with as few as 1,600 kilocalories per day. At that level of food intake there could be seven passengers. A daily ration of 1,600 kilocalories merely maintains life. With less than that a man wastes away and gradually dies. With just that, he merely remains alive, and nothing more. He cannot move around; he can do no work, enjoy no sports, play no music, do no dancing—in fact, he cannot do any of the things that set him off as a man. If he is willing to live a merely vegetablelike existence he can get by on 1,600 kilocalories, and the spaceship can support nearly twice as many people. But who would regard that as an ideal existence? Who would call that an optimum number? By any reasonable standards the maximum is not the optimum.

The analysis can be carried farther. In a wealthy (and often wasteful) country like the United States the daily use of energy far exceeds 3,000 kilocalories per capita. The average U.S. citizen at the present time uses about 150,000 kilocalories a day, all but 3,000 of them being expended for non-food uses—making clothes, furniture, buildings, running the machines, manufacturing and employing computers, automobiles, television, airplanes—all these other energy-consuming activities. Perhaps they are not all necessary. Perhaps people would be better off living a somewhat less extravagant life. Nevertheless, it is clear that what we regard as civilization requires a daily expenditure of energy that far exceeds the mere 3,000 that suffices for vigorous physical activity alone. The excess over 3,000 may not be a simple measure of the level of civilization, but it certainly is a measure of the *possibility* of civilization. Cut down on this excess too much and the possibility of the good life disappears.

A few other points should be made. Do you like to have meat with your meals? If you do, the population of the spaceship must be smaller. Animals convert the calories of green plants into animal calories, but with only about ten percent efficiency. If you would like about one-ninth of your food to be meat, this 333 kilocalories of animal energy would require a preliminary production of 3,333 kilocalories of plant energy. Add that to the other 2,667 kilocalories of plant energy taken in as plant material, and you find that each person depends upon a primary production of food energy of 6,000 kilocalories a day. On a meat-and-vegetable diet like that it would take 24,000 kilocalories per day to support four people. A meat-free diet of the same caloric content would support eight people—twice as many. But would that be something to be proud of—supporting more people, less pleasurably, less comfortably? Is the maximum an optimum? What transcendental principle tells us that the maximum number living the most miserable possible life is the best number?

Suppose someone wants to bring a canary on board a spaceship? Or a cat, or a dog, or any other pet? Clearly the demands of each and every nonhuman animal make inroads on the supply of food for human beings. More pets, fewer people. Is this bad? If you say, "yes," why do you say, "yes"? Is the maximum number of people desirable, if that means—as it does—depriving ourselves of the companionship of all other forms of life? Remember, our trip is going to last a long time; already man's trip on spaceship Earth has lasted something like a million years. "Variety is the spice of life"—part of the quality of life. And every thing we do to increase the variety of life on board our spaceship reduces the number of human beings that can live on it. Many of us prefer a rich life to the maximum population. Let's admit it.

(3) *Is it safe to do what comes naturally as far as population is concerned on board a spaceship?*

Obviously not. If there are no restrictions on human breeding, the population will pass successively through the following stages: a presumptive early stage in which there is actually underpopulation, which would be followed successively by a stage of optimum population, a stage of maximum population, then one of increasing misery, concluding ultimately with the death of the species. Now that man has gotten rid of all of his big animal predators, and is making rapid progress in getting rid of the small predators we call disease germs as well, there is nothing "natural" to prevent the human species from following this sequence to its tragic end.

(4) *What is the normal rate of population growth in a spaceship?*

The flat answer: *zero.* Over the long term, births must equal deaths. For most of man's existence on earth, births *have* equalled deaths. For the first million years of man's existence, the rate of population growth was about .001 percent per year—a rate so low that it took about 70,000 years for the population to double. At that rate it is doubtful that anyone could perceive any change in population size. But, as you know, for the past 300 years the rate of population growth has accelerated fantastically. Worldwide, the yearly increase is now about 2 percent per year, which means that the world population is doubling every 35 years.

Mexico is increasing even faster—its population is doubling every 21 years.

Plainly, there are serious problems on board this old spaceship of ours.

(5) *Can there always be freedom to breed on board a spaceship?*

The answer is simple: *No.* Suppose you went on board a 13-meter spaceship with three other people; and suppose two of them were a married couple.

Capacity of the ship: four.

Loading of the ship: four.

All is well.

But suppose the married couple, half-way on the way to Saturn, calmly announced that they intended to have a child. Such behavior would obviously be unacceptable, since the well-being and survival of all would be threatened by the increase.

On a crowded spaceship the production of children is everybody's business.

(6) *On a spaceship, is the act of breeding, judged by itself, either good or bad?*

The answer: *Neither.* If the spaceship contains less than its capacity load, producing more children may not harm the community, and may even help. But once the population has reached the optimum point, any further increase diminishes the well-being of all. Thus is illustrated a fundamental principle of situational ethics: *the morality of an act is a function of the state of the system at the time the act is performed.* The morality of an act cannot be judged by itself, in a vacuum.

(7) *Can we solve the difficult political and educational problems of restraining reproduction on a spaceship?*

To this we can only answer grimly: *We had better.*

(8) *Can the community of a spaceship tolerate different standards of the good life?*

Ours is an age that praises tolerance; few have the temerity to speak out against it in public. Yet even tolerance must have limits—as it does in matters of population. If some people on board a spaceship are willing to settle for lower standards of living, such people will tend to displace those with higher standards. Unless restricted, low standards drive out high standards. Total vegetarians, under free competition, will displace those who like meat in their diet. Such amenities as community parks will disappear when people say that parkland is needed to grow food to produce more babies. "Are redwood trees more important than people?" It is hard to answer such a loaded question without appearing to be hard-hearted. But we must insist that redwood trees—and many other amenities—are needed *for* people.

(9) *"Why should we do anything for posterity: what has posterity done for us?"*

This is an old question, and one not easily answered. Either we cut down thousand-year-old trees to make houses for ourselves, leaving no great forests for our descendants; or we—the present generation—forgo using this heritage in order that our children and our grandchildren—in order that *everybody's* grandchildren—may enjoy them. Only if we find the intellectual reasons and the moral courage to act as trustees of the natural wealth, we have inherited will we leave anything for our grandchildren. We must have the courage to say *No* to those who would diminish the quality of life that more people can live. If we do not have this courage we betray the implicit terms of our trusteeship.

10) *In what way is Spaceship Earth different from a 13-meter spaceship?*

In this way: that on the larger spaceship we must learn to tolerate unfairness. Let me illustrate this shocking point. Suppose the passengers who got on the smaller spaceship took with them the original of Leonardo da Vinci's *Mona Lisa* for their enjoyment. With only four people on board, all the passengers have an *equal* chance to look at and enjoy the painting, to the best of their individual abilities. On a small spaceship everyone has a fair chance.

But ours is a large spaceship, with $3\frac{1}{2}$ billion people on it—and there is only one *Mona Lisa*. We can all look at reproductions of it, but not all of us can enjoy the original. "But that isn't fair!" some proclaim. Indeed it isn't. But is there any other option?

The great outdoorsman Robert Marshall (1937) a generation ago suggested an alternative. To share the *Mona Lisa* fairly among all the inhabitants of spaceship Earth we *could* cut it up into little squares and give each person his fair share—which turns out to be a piece one five-hundredth of a square millimeter in size. I think most of us will agree that this kind of "fairness" is unacceptable. Better to be unfair and let a few people enjoy the *Mona Lisa* than to be fair and prevent anyone from doing so.

Note this important fact: Because there are many amenities that cannot be subdivided without destroying them it follows that the larger the population on our spaceship the greater the amount of unfairness we have to put up with, if we are to preserve the non-divisible amenities intact. If we don't like this kind of unfairness we must work to diminish the size of the population on board our spacecraft. To do this it is *not* necessary to kill any of the passengers; we need only see to it that the birth rate is less than the death rate—which, at present, is not the case anywhere on our 13 million meter spaceship. Unfortunately.

(11) *How can the passengers on a spaceship accept special privilege and unfairness?*

Plainly they must. *We* must. The *Mona Lisa*, and all original works of art, cannot be subdivided. Neither (for the most part) can many of the beauties of nature: lonely beaches, wild animals in their natural habitat, wilderness areas, etc. Since not everyone can enjoy such limited goods, how shall we allocate the privilege of enjoying them? Different students have proposed different answers. Different nations will adopt different policies. All we can give by way of a general treatment is a listing of a variety of possible answers.

Special privilege can be systematized on any of the following bases:

(A) *Nobility*. In the past, hereditary nobility had rights of access to the limited luxuries of the world that the common man did not have. This tradition is increasingly unpopular.

(B) *Money*. The price for using limited goods can be set high, perhaps at a public auction. Then those with the most money can enjoy them, those without can not. Put in other terms: economic nobility can get the tickets, instead of hereditary nobility.

(C) *Lottery*. The right to shoot a rare (but not too rare) animal; or enjoy an isolated beach; or pack back into a wilderness, can be distributed by chance, that is by some sort of lottery. If the gods decide, it is fair—so man has reasoned for millenia.

(D) *Age* can be the determining factor. Most societies give extra privileges to the aged. (Or is it that the aged *take* these privileges?) This is not an altogether desirable way to discriminate. One of the results, for example, is a vast horde of the elderly becoming world-travelers at a time when the state of their health prevents their reaping full enjoyment from their travels. The young, who are rich in vigor and poor in money, find it more difficult to travel. Should we not reverse this allocation of privilege? Though I am one of the elderly, I think so.

(E) *Self-selection* by passing a difficult test. To be properly enjoyed, the wilderness area should be enterable only by someone in the best of health. The visitor should enter on his own two feet, not in a motor-car. Making the walk long and difficult will hold the number of people entering a wilderness to a low enough number that all who enter can enjoy it (Hardin, 1970).

(F) *Community selection.* To the extent that the controlling members of a community can overcome their natural envy (Schoeck, 1969), it may be possible to assign rare and nondivisible goods to a few persons who are regarded as something of a natural resource themselves. Early in his career as a composer, Jean Sibelius was given a fat pension by the government of Finland, a pension which made it possible for him to save for his own enjoyment a near-wilderness area. Speaking for myself, I find this sort of action much more appealing than special privilege for hereditary nobility. He whose grandfather was a great man is not necessarily a great man himself. "Life peerages" in Great Britain make much better sense than do hereditary peerages.

(G) ***History.*** Whether we like it or not, "nature" has distributed the natural resources of the world very unfairly among the various nations. The Congo has more cobalt than most parts of the world; Russia and China have more tungsten; and Mexico has more silver. You may say that this is "unfair"; but that's the way it is. A nation that wants something it does not have must trade for it something that it does. ***But no nation can have a surplus of anything if it has too many people.*** To bargain with the rest of the world, to make up for the deficiencies that "nature" has handed it, a nation must keep its population sufficiently below the carrying capacity of its land so that it has something to bargain with.

Excess population is no longer an element of national strength; it is a cause of national weakness.

What I am about to say in closing I could not say at a meeting of diplomats. But a scientific convention is no place for empty words of flattery and obfuscating diplomacy: It is a place for the truth, spoken in a spirit of helpfulness. Let me speak frankly in that spirit.

The area of population is notoriously one in which most particular predictions fail. But though predictions are not very reliable, "counter-predictions" can be. Nathan Keyfitz, one of our best demographers, has made such a counter prediction (Keyfitz, 1971):

Mexico cannot continue with its present rate of increase for as

> long as the lifetimes of children now born. For if it did, the population would double four times, that is multiply by sixteen, so that there would be eight hundred million people in Mexico. Since this is virtually impossible, the argument shows that opposition to birth control cannot be a matter of principle (except for those willing to advocate higher death rates), but that differences of opinion can arise only on whether birth control is to be applied a little sooner or a little later.

Or, one might add, whether birth control is to be achieved by one method or by another. But birth control—and more importantly, population control (Hardin, 1971)—must be achieved very soon if this lovely country is not to be utterly ruined in your lifetime.

Very soon? Sooner than that: *It should have begun yesterday.* But the past cannot be remade—you will just have to do the best you can from this point on. I will not urge upon you that you do this for the sake of the rest of the world, for the sake of the other groups of passengers on spaceship Earth. You would rightly regard it as effrontery if I, a member of a nation that has shown little restraint in grabbing the lion's share of the earth's resources, were to urge restraint upon the members of another nation which has not been nearly as acquisitive. On the contrary, I urge that you control your population not for the sake of other nations but for your own sake. Faced with the competition of other nations you have to protect yourself.

How can you do that? By warfare? No more. The coming of atomic warfare has forever ruled out warfare as a rational method of acquiring what you might regard as your share of the world's resources. Warfare is out, so you must do the best you can, living where you do, and making use of what "nature" has given you. Nature has not been "fair" in the allocation of her riches, so how do you get that which you have not? How do you lay your hands on cobalt, on tungsten, on iron-ore, on petroleum—or on any other mineral that you feel you have not enough of? The only way you can do it is by trading whatever you have a surplus of. The word "surplus" means "more than needed," and is directly proportional to the extent that the existing population—which generates "needs"—falls short of the maximum possible population.

The more people, the less surplus.
The less surplus, the more "unfair" your supply of needed things.
The less the supply, the weaker the nation.

People may be said to be a natural resource, too—but not just "raw" people: finished people, trained people. If you train your people in science and technology, and in other skills that may be equally important, the cleverness of your people can furnish you with products that can be traded with other countries. But the ability to train the coming generation can be overwhelmed by a generation that comes on too fast; and an ambitious, but untrained and underemployed, rising generation can threaten the stability of a nation.

A high birth rate interferes with proper education.

Poor education produces unemployment.

Unemployment produces social instability.

As a member of the often rather foolish country to your north, I do not feel that I have any particular words of wisdom to tell you that spring from the example we have set. We, too, had a chance to learn from the mistakes of others; and we failed. The history of the ruin of the Mediterranean basin by the European civilization which developed long before America was discovered (Marsh, 1864) is a history from which we in the north should have learned. We did not. We were deaf to the warnings of a far-sighted few. So we have little to offer by way of an instructive example—except an example of what *not* to do. A counter-example.

As one who wishes well for all mankind, for all of the inhabitants of spaceship Earth, I hope that you can learn from our mistakes—from the mistakes of all the nations that have preceded you in the developmental process—so that you can do better than your predecessors did. If you escape making our mistakes you may ultimately be far stronger than we. If so, you will benefit. In fact, the entire world will benefit. Your intelligent trusteeship of the corner of the world's goods that is yours to take care of can benefit the community of all of us who live on this finite, and really rather tiny, spaceship Earth.

BIBLIOGRAPHY

Hardin, Garrett.
1970. We must earn again for ourselves what we have inherited. *In* Wilderness, the edge of knowledge, Maxine E. McCloskey, ed. San Francisco, Sierra Club.
———.
1971. Education in an overpopulated world. Science Teacher, **38** (4):20-23.
Keyfitz, Nathan.
1971. Models, Demography, **8**:571-581.
Marsh, George Perkins.
1864. Man and nature. (reprinted 1965), Cambridge, Mass., Harvard University Press.
Marshall, Robert.
1937. The universe of the wilderness is vanishing. (Reprinted 1971) Living Wilderness, **35** (114):8-14.
Schoeck, Helmut.
1969. Envy: A theory of social behavior. New York: Harcourt, Brace & World.

DISCUSSION

DR. E. L. CHEATUM, (Chairman): Dr. Hardin was talking about preservation, preservation of some quality in human existence. Does someone wish to direct a comment to Dr. Hardin?

MR. WILLIAM BELLER (U.S. Environmental Protection Agency): Concerning the paper and particularly the analogy, I am somewhat fearful of the extrapolations from something very small to something very big. I fear that we may derive from conditions on the smaller spacecraft when applied to Earth things we don't want to. For example, might we not need that child for insurance in the event that someone dies? On a spacecraft we cannot countenance diversity; the need is for regimentation. Gross survival is what is needed on a small space-craft, and not quality of life. Illness would be a crime. The elderly would be the most disposable, and I have a personal fear of that. Culture would take up too much room and consequently so would open spaces and wildlife. So we have to use the analogy with a great deal of caution.

DR. CRAIG KENSLER (FAO, UN, Mexico): Rather than a question, I would just like to comment. As a relatively young person working in the United Nations, my particular job is to go into a country and try to do the most in developing resources from the ocean. Many of us have heard that the ocean is a gigantic food source. My comment is that this is not really the case, with exploitation rates as they have been, with pollution as it is now going on, and with the worst problem of all, population growth. Many times when I am working in these areas I find myself saying "What you are trying to do is perhaps good, but by the time you do it, the population will have increased so much that any new food source you could obtain from the ocean is wiped out."

I think that the population problem is so important that we should no longer think of the ocean as a gigantic basin that will produce so much food that populations can increase two or threefold. This is definitely not the case. Food can only be produced perhaps for another 20 years through increases from the ocean. After that it will become more or less stable. A number of years ago in New Zealand I heard a Maori woman say to me something that was interesting, and I will end on this note: "No child should be born into this world without hope." You had a wonderful, wonderful, paper.

NATURAL AREAS AS NECESSARY COMPONENTS OF MAN'S TOTAL ENVIRONMENT

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Our theme is that natural environment is an essential part of man's total environment. Preservation of a substantial portion of the biosphere in a natural state, while not a panacea for all the ills of mankind, is, nevertheless, a necessity if we base the carrying capacity of the earth on the quality of human life. First, we define "natural environment" as that part of our environment which is essentially self-supporting, in that a minimum of human management is required for maintenance. In terms of function, "natural environment" is that part of man's life support system that operates without energetic or

[1] In the absence of the authors, this paper was read by Dr. E. L. Cheatum, session chairman.

economic input from the power flows directly controlled by man. "Natural environment" is a more restricted category than "open space," a term widely used by planners to mean any part of the landscape, whether natural or man-made, that is free of building structures. In this context "natural environment" includes ecological systems ranging from little-used wildernesses to moderately used forests, grasslands, rivers, estuaries, and oceans, which produce useful products and recycle wastes on a continuous basis, but *without appreciable economic cost to man.* These self-maintaining ecological systems run on sun energy, including the energy of rain, wind or water flow that are derived from sun power. In contrast, what we choose to call "developed environment" includes ecosystems that are structured and maintained by large auxiliary power flows from fossil or other concentrated fuels that supplement or replace the natural energy flow of the sun. A city, of course, is the ultimate developed ecosystem, but golf courses, suburban developments, agricultural fields and channelized rivers are also developed ecosystems since they require a diversion of energy from man-controlled power flows to maintain them in the developed state even though natural elements (water, trees, grass, bacteria) may have important roles in such systems. Developed systems generate economic wealth but *the economic cost of maintenance increases as a power function of the intensity of development.* For example, it is well known that the cost of maintenance (C) of a network of services increases roughly as the square of the number of units (N) in the network, as shown in the following equation:

$$C = \frac{N\ (N\text{-}1)}{2} \quad \text{or approximately } C = \frac{N^2}{2}$$

Thus, if a city doubles from 10 to 20 million units the cost goes up 4 times. Furthermore, the stress on supporting natural life support systems increases markedly, again as some kind of multiplier, as the size and power demand of developed systems increases. *Because the multiplying maintenance costs are too often not anticipated and the useful work of nature totally undervaluated, developed systems have an inherent tendency to grow beyond optimum size, and at the expense of natural systems.*

In some parts of the world aesthetic and recreational values (and associated economic dividends) have been sufficient to justify preservation of large natural areas in parks and refuges. In some countries preservation of greenbelts and other natural areas have been a cultural or religious tradition. However, in the future neither aesthetic values nor ethnic traditions will be adequate basis for preservation of natural environment because rapid technological and population growth produces a strong drive to convert natural environment into developed environment. General public awareness that natural environment is important is, by itself, not enough. So powerful is the positive feedback within the urban system, and the economic "forcing function" from outside that there has to be equally strong negative feedback control built into economic and political systems to prevent over-development. To suggest that cities and other highly developed ecosystems have an inherent tendency to grow beyond the optimum (*i.e.* to "overdevelop") is not to embrace an anti-human, anti-urban or anti-development philosophy. Because cities and other developed environments are so valuable to man they must be protected from exploitation just as is necessary for any valuable resource. Specifically, cities need the protection of an adequate life support system, many elements of which natural environment provides free of charge. Without natural recycling and other work of nature, the cost of maintaining quality life in cities would be prohibitive. Later in this paper we will show by actual calculation that the per capita cost of treating human wastes, which are only one small part of the pollution disorder generated by cities, would be more than doubled if there were no natural environment available and able to carry out the work of tertiary treatment of these wastes.

A first step towards redressing the inbalance in valuation of natural versus developed environment would be to determine the real value of "natural environment" in comparable monetary terms as are used to determine the worth of developed environments. The example of the previous paragraph suggests one approach, and we will have more to say about this later in the paper. However—and this is our most important theme—*the true value of a man's total environment is determined by the diversity interaction between the "developed" and the "natural" environment and not only by the worth of each as a separate component*. Yet, at the present time society does not evaluate in any effective manner total environment, but bases human values on the monetary worth of separate components, largely the highly developed ones. If power-hungry developed systems spread in an unrestricted and unplanned manner at the expense of the natural environment, then a point is soon reached where the latter is unable to perform its "free" life support functions. Then, not only does the quality of the remaining natural self-supporting environment decline, but, more important, the quality of the highly developed environment also deteriorates as the costs of pollution and other disorder abatement rises percipitously in non-linear, multiplying fashion. *Accordingly, there has to be some optimal proportion between the* *natural and developed environments* (since 100 percent of either would be unthinkable). Once a rational ratio for a given region is determined there has to be an agreed upon "environmental-use plan" (= "land-use plan" as this term is generally understood by planners and conservationists), with sufficient legal and political sanction to counteract the overdevelopment syndrome. We aim to show that it should now be feasible to model environmental decision-making so as to predict the total consequences of varying the proportion of developed to natural environment (1:1; 2:1 and so on) and thereby find an optimum range in terms of quality of the total environment. After we have presented a very simplified and theoretical working model for such ecosystem management, we will then discuss more pragmatic approaches which we hope planners will find useful until such time as realism can be built into total models.

THE ECOSYSTEM MANAGEMENT MODEL

Figure 1 pictures the essential elements, energy flows and human values that must be considered in modeling environmental-use options designed to maintain an optimum balance between natural and developed ecosystems in counties, watersheds, states, regions or other

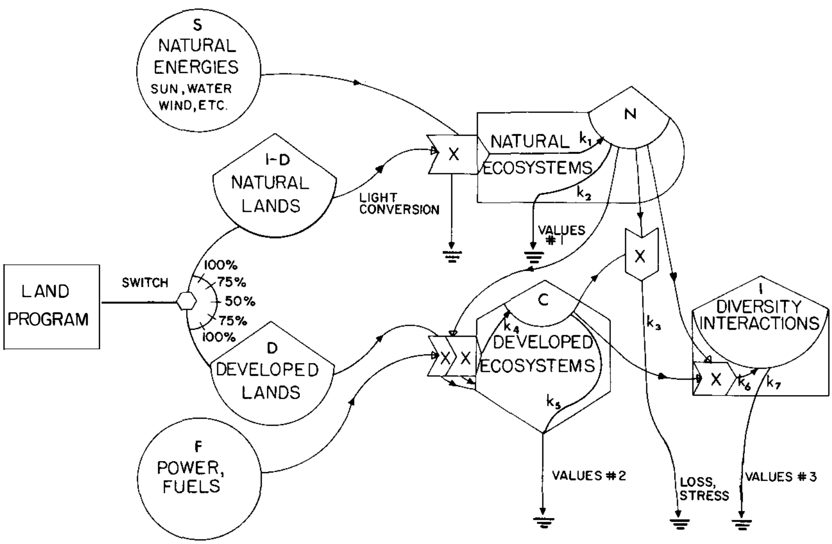

Figure 1.—A Model for Land Management in which the Proportion of Natural and Developed Lands can be Varied in Order to Determine the Optimum Balance in Terms of Value of the Total Environment (sum of values 1, 2, and 3). See Text for Explanation of Symbols.

relatively large areas of the biosphere. The symbols used in this model are part of an "energy language" devised by H. T. Odum and described in detail elsewhere (H. T. Odum, 1967, 1968, 1971). Circles represent energy sources while the tank-shaped, round bottom modules represent stored or potential energy or resources. Natural ecosystems are depicted as bullet-shaped, autotrophic modules, that are self-nourishing and developed ecosystems as hexagonal, heterotrophic or consumer modules that require an energy input for nourishment. Both natural and developed ecosystems have storage capacities important for maintaining function during period of reduced energy inflow. Downward-directed arrows into heat sinks (like electrical "ground" symbols but only one-way flow) show where energy is lost during conversion from one form to another as required by the second law of thermodynamics. Modules containing a large "X" stand for a multiplicative function during work transfer or exchange as discussed in the preceding section of this paper. Especially important is the energy drain and reduction in storage capacity that developed systems impose on natural systems, as shown by the "stress" arrow in Figure 1. Note that except for original energy sources and land resources all modules have at least one input, or source of energy, and at least two outputs, one representing a heat loss or energy drain and the other is passed on as an input to another unit in the system. Seen graphically in this manner, the interrelationships and interdependence of components as working parts of the whole can be clarified. Finally, the model identifies the three environmental values as previously mentioned, namely: (1) the value of natural ecosystems as such, (2) the value of developed ecosystems as such, and (3) the value of man's total environment as determined by "diversity interactions" between 1 and 2.

If all of the inputs and outputs of components in the ecosystem model can be quantitated in common-denominator energy units (which can be converted to monetary units as will be discussed in the next section) different options in land-use planning can be simulated with analog or digital computers. The switching module in Figure 1 shows how a land-use program could theoretically vary the percentage of land that is developed in order to predict interactions, and to determine an optimum proportion between developed and undeveloped land in terms of the quality of the total environment (Value No. 3, Figure 1). To be realistic the oversimplified model of Figure 1 would have to be expanded to include separate modules for different types of both developed and natural systems since energy requirements and outputs vary widely within each of these two general classes of ecosystems. For example, as already noted a high-density city has a much greater power requirement, and, therefore, exerts a much greater stress on its surrounding environment, than does a low-density suburban development.

Since the metabolism of a modern city with its automobiles, industries and high electric power consumption is about 100 times greater than the metabolism of most natural ecosystems (4000 as compared to 40 kcal/M^2/day) it is easy to see why high-powered systems tend to be destructive of lower-powered systems in contact with them. Even the simplest models clearly demonstrate that high-powered systems, such as cities, require an abundant life support from nature. If large areas of natural environment are not preserved to provide the needed input from nature then the quality of life in the city declines and the city can no longer compete economically with other cities that have an abundant life support input. Frequently, it is not energy itself that becomes the limiting factor, but some basic natural resource required to maintain the high rate of energy flow. In south Florida water seems now to that limiting input. Continued urban or industrial growth in many areas will depend on developing special water sources such as by desalination, or pumping water from underground or distant sources. If such special sources are developed the city's energy cost rises until it can no longer compete with cities that do not have to pay this extra cost. It is a sad situation when cities grow beyond their means and can no longer pay for their own maintenance. They borrow money or demand federal grants in order to grow ever larger and more demanding of their life support system when they ought to be diverting more of their energy to maintaining the quality and efficiency of the environment already developed, and to reducing the stress on vital life-supporting natural environment. Preliminary simulation of the south Florida situation indicates that a 1:1 ratio of natural to developed environment would provide a basis for an optimum environmental-use program. Until this kind of systems analysis procedure can be refined and become a basis for political action, it would be prudent for planners everywhere to strive to preserve 50 percent of the total environment as natural environment.

CALCULATING THE MONETARY VALUE OF NATURAL ENVIRONMENT

As indicated in the preceding section, it will be a long time before total ecosystem management will be accepted as an economic and political reality. In the meantime, we have to justify and manage on the basis of separate values (Values No. 1 and 2 in Figure 1). A stronger economic basis for justifying the preservation of natural environment is obtained if we calculate the work of nature in terms of dollars or other currency units. Since money and energy flow in opposite directions, which is to say that money outputs is exchanged for energy input, H. T. Odum (1971) has suggested that the ratio of Gross National Product (GNP) to National Power Consumption can be used to convert calories to dollars. For the United States this works out to be approximately 10,000 kilocalories equals one dollar. Using this conversion Lugo *et al.* (1971) calculated the work done by a tree with a 50 M^2 crown as being worth \$128 per year, and \$12,800 over a 100-year life span of the tree. The useful work done by an acre of forest, then, would be \$10,360 per year and \$1.04 million over a 100-year period. This value may be regarded as somewhat inflated by egocentric man, since he might not consider all work done by a forest useful to man. However, we believe it comes closer to the real value than conventional economic cost-accounting which values a forest only in terms of yield of wood or other consumer products and ignores its life support value.

Another approach to economic justification for preservation of natural environment involves evaluating the work of nature in treatment and recycling of wastes. Again, conventional accounting rarely includes placing a dollar value on such useful work. This can be done by calculating how much it would cost cities to completely treat wastes by artificial means if there were no natural environment available to do at least part of the work. Experiments at Pennsylvania State University have shown that land areas covered by natural or semi-natural vegetation can be effective natural tertiary treatment areas for municipal wastes that have gone through secondary treatment (see Parizek, 1967; Sopper, 1968). While these studies suggest that 2 inches a week of waste water can be added without stress, we would suggest that about half of this, or 4 feet per year, would **be a** more judicious rate in terms of avoiding mineral buildup in the land filter. An acre of land could then absorb about 1.3 million gallons of treated waste water per year, which is about the amount of waste water produced by 35 city people (100 gallons per day per person or 36,500 gallons per year). If this waste were subjected to artificial tertiary treatment the cost would be 30¢ per 1000 gallons or about \$400 for the 1.3 million gallons. Thus, an acre of natural environment could be worth at least \$400/year for this one useful function alone. Most of all, if all wastes had to be carried through tertiary treatment in artificial systems because there was not enough natural environment to do this work free, then the taxpayer's bill for waste treatment would be doubled since tertiary treatment costs about twice as much as secondary treatment.

THE PER CAPITA APPROACH

In a recent study E. P. Odum (1970) attempted to determine the total environmental requirements for an individual as a basis for estimating the optimum population density for man. In this study, the State of Georgia was used as an input-output model for estimating the per capita acreage requirements on the assumption that this state is large enough and typical enough to be a sort of "microcosm" for the nation and the world. The basic question asked was: How many acres of environment does each person require to maintain a reasonably high standard of living on a continuing, self-contained equilibrium basis—in the sense that imports and exports of food, other energy and resources would be balanced? In other words, what does it take to support a quality human being in an area that can not count on being an ecological and economic "parasite" on some distant region. As it turned out, Georgia is a good microcosm for the United States because its human density, growth rate, food production, and the distribution of its human and domestic animal populations are all close to the mean situation for the whole nation.

The per capita area required for food was estimated by taking the diet recommended by the President's Council on Physical Fitness and determining how much crop, orchard and grazing land is required to supply the annual requirement for each item. If we would be satisfied with a diet based on intensive grain and soy bean culture perhaps as little as one-third of an acre could keep a person fed and reasonably well nourished, but the kind of diet Americans enjoy (including orange juice, bacon and eggs for breakfast and steaks for dinner) requires a great deal of land to produce, at least 1.5 acres per person. The impact of domestic animals on man's total environment is often overlooked in land-use planning. In Georgia, for example, domestic animals (cattle, pigs, chickens, etc.) consume primary production (food produced by plants) equivalent to that consumed by 21 million persons (compared to 4.8 million persons now living in the state). And this does not include pets, which for the nation as a whole consume enough food to feed five million people. While the impact of domestic animals on the environment is not nearly so great as that of an equivalent human biomass the stress they place on the natural environment is considerable, and must be accounted for. We could, of course, do away with domestic animals, but this would mean giving up meat in the diet (and associated options) and dehumanizing man himself to the level of a domestic animal.

TABLE 1. MINIMUM PER CAPITA ACREAGE REQUIREMENTS FOR A QUALITY ENVIRONMENT

Food-producing land	1.5 acres
Fiber-producing land	1.0 acres
Natural use areas	2.0 acres
Urban-Industrial Systems	0.5 acres
TOTAL	5.0 acres

In a similar manner, the per capita acreage needed for fibers (paper, lumber, cotton, etc.), watersheds, tertiary treatment of wastes, recreation, parks, highways, urban and industrial living space were estimated. For some uses good data are available in statistical yearbooks, but for other needs (for example, outdoor recreation) we had to depend on recommendations of professional planners who deal with the particular human need. Our preliminary attempt to sum up total environmental needs in terms of the *minimum space required* is shown in Table 1.

It should be emphasized that this estimate of 5 acres (2 hectares) per person applies to a self-sustaining region with good soils, a temperate climate and abundant rainfall; requirements would be larger in areas with a less favorable climate. Since Georgians now enjoy 10 acres per person, we conclude that optimum population density (again on a self-sustaining basis at an American level of affluence) is no more than double the present population.

In this model (Table 1) about 2/5 of the total requirement is designated as natural environment. When we consider that food and fiber-producing lands contain considerable natural elements which contribute to life support and recycling, this estimate comes close to the 50 percent figure previously suggested as a working hypothesis for planners.

APPENDIX

To illustrate how the model of Figure 1 could be used, hypothetical data based on reasonable expectations for energy flows and exchange coefficients were fed into an analog computer and the output plotted as a performance curve, as shown in Figure 2. The "sum of values" on the Y-axis is the sum of the three values shown in Figure 1, and is plotted as a percentage of the maximum sum. In this highly generalized run the optimum plateau covers a broad range between one-third and two-thirds developed lands. Anything more than 60 percent developed (or anything less than 40 percent natural) environment resulted in a precipitous decline of the value of the total environment. It should be emphasized that the optimum mix between developed and natural environment could vary considerably from region to region depending on the intensity of development, the kind and

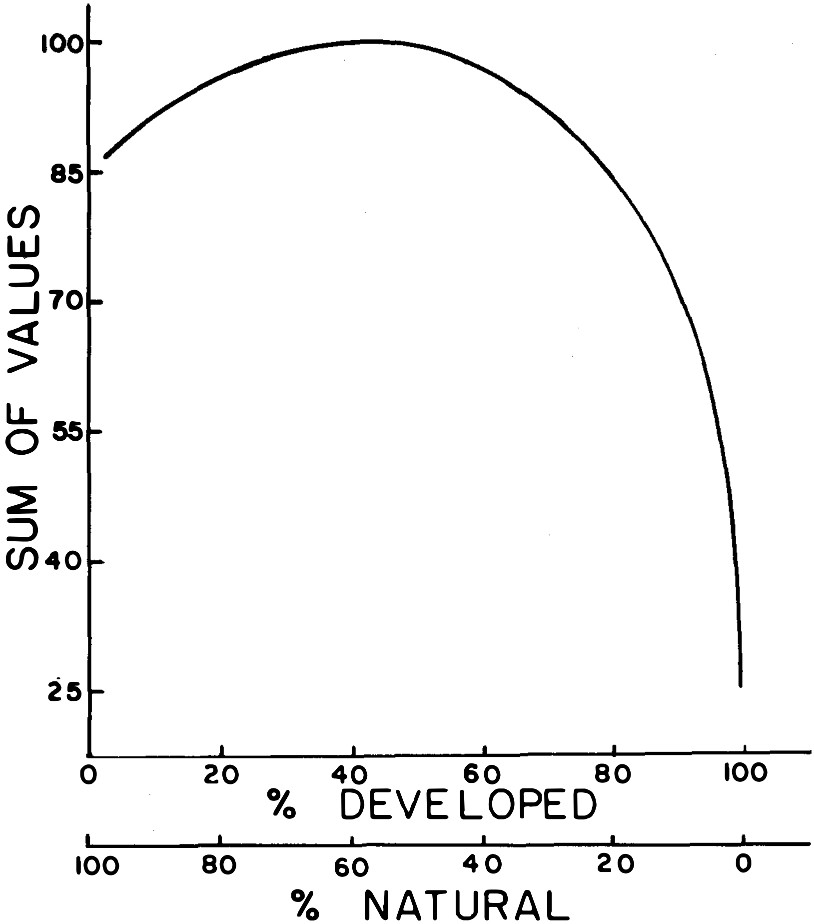

Figure 2.—Performance curve generated from the model of Figure 1 using hypothetical data based on reasonable values for energy flow in highly developed and natural environments. The "sum of values" is the sum of the three values shown in Figure 1 plotted as a percent of maximum. W. Smith, H. McKellar, and C. Littlejohn, of the University of Florida, obtained the diagram using analog computer using light settings of percentage of developed land.

amount of poisonous wastes produced, the capacity (productivity) of the natural environment, the density and behavior of the human population, and so on. However, performance curves of the type shown in Figure 2, appear to be characterized by rapid declines once one goes beyond the optimum plateau. If this is a true generalization it may explain why it is difficult to recognize overdevelopment before it is too late.

During the coming year it is hoped that data from actual situations can be used to further test and refine the procedure. Particularly desired are data on actual economic budgets, power flows and land use patterns in large metropolitan districts, or other regions or sections that have a functional unity. First attention will certainly be given to areas where research and planning inventories can provide accurate values, and where public opinion and government organization are sufficiently strong to promote serious planning aimed at preventing overdevelopment.

In addition to showing energy relationships, the energy diagram is a way of writing differential equations, and the differential equations are an intermediate step in putting the model on analog or digital computer. The translation of the Fig. 1 model is given as three linked equations below in which the natural energies are designated S; fossil fuels, F; the developed lands, D; the natural lands, (1-D); the natural ecosystems, N; the developed ecosystems and cities, C; and the interactions of diversity of man and nature, I; k's are the coefficients for each pathway which may be evaluated from data. Where the pathway has little drain action on its source, it is indicated by a small triangle and its outflow action omitted in the equations.

$$\dot{N} = k_1 \, S(1\text{-}D) - k_2N - k_3CN$$

$$\dot{C} = k_4 \, DFN - k_5CN$$

$$\dot{I} = k_6 \, CN - k_7I$$

Value rates (V) are the sum of the energies of replacement and maintenance and, thus, are the sum of three rates of energy flow.

$$V = k_2N + k_5C + k_7I$$

The graph in Fig. 2 is the steady state sum of value flows found with one set of coefficients (k's) in the set of equations on an AD-30 analog computer.

LITERATURE CITED

Lugo, Ariel E., Snedaker, S. C., Bayley, Suzanne and Odum, H. T.
1971. Models for Planning and Research for the South Florida Environmental Study. Final Report Contract 14-10-9-900-363 between National Park Service and Center for Aquatic Sciences, University of Florida, Gainesville.

Odum, Eugene P.
1970. Optimum population and environment: A Georgian microcosm. Current History, 58:355-359.

Odum, Howard T.
1967. Biological circuits and marine systems of Texas. In: Pollution and Marine Ecology (Olson and Burgess, eds.). John Wiley and Sons, New York. pp. 99-151.

———.
1968. Work circuits and systems stress. In: Symposium on Primary Productivity and Mineral Cycling in Natural Ecosystems (Young, ed.). Univ. Maine Press, Orono. pp. 81-138.

———.
1971. Environment, power and society. John Wiley and Sons, New York. 331 pp.
Parizek, R. R., Kardos, L. T., Sopper, W. E., Meyers, E. A., Davis, D. E., Farrell, M. A., and Nesbit, J. D.
1967. Waste water renervation and conservation. Penn. State Univ. Studies, University Park, Penn. 71 pages.
Sopper, William E.
1968. Waste water renervation for reuse. In: Water Research. Pergaman Press, New York, Vol. 2, pp. 471-480.

DISCUSSION

MR. WILLIAM BELLER (U. S. Environmental Protection Agency): Again I would like to caution against overuse of an analogy. The statement was made here that an acre of land would cost $400 for use in tertiary treatment but was worth $12,500 in terms of the energy that the trees contribute. Fine. But suppose you have an acre of land in the middle of a city and a developer comes up and says, "I'll give you that money; give me the acre of land." I am afraid you have yourself in a box and you must have higher values. So please don't establish a low value, because they may come and buy it from you.

DISCUSSION LEADER CALLISON: Thank you for that word of caution. Mr. Chairman, is there time for another comment?

DR. ROBERT WEEDEN (University of Alaska): Those of us who would like to preserve tundras and deserts would also like to supplement this system of monetary and energy interchange values. Clearly these are based on a biological productivity. Tundras and deserts are lower in biological productivity, and through this system alone, then, would have lower monetary values. I think that Dr. Hardin and many of us here can think of ways in which you can supplement this system, as proposed by Dr. Odum, with other types of value systems.

DR. EARL J. BELL (University of Washington): I have some experience in doing ecological modeling in the San Juan Islands area in the State of Washington, and I would like to urge you to more general caution. Now Dr. Odum's statement that analogue or visual stimulation can be carried out is a fantastic overstatement of the problem. Every one of those connections in that diagram requires some kind of functional determination of how that connection works. This requires an inordinate amount of basic research, number one, and every single one of those connections must be specifically introduced into the computer in some sort of mathematical function. Therefore, the tendency here is, I think, to raise hopes a little too much. I have read Dr. Odum's book and I would like to caution that this is not going to be any kind of panacea. Every single ecosystem that gets modeled is going to be the result of thousands and thousands of man hours of work. Thank you.

DR. CHEATUM: Both Odums, Gene and Tom, recognize this. And this one of the reasons I think Gene said that it will be a long time before we can really effectively fill in the little boxes in this model. It will take a tremendous amount of work. and it is going to cost a lot, but in the meantime we may be able to work more efficiently with new concepts, with at least what we have.

MANAGING MARINE ENVIRONMENTS

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INTRODUCTION

The world oceans are exploited today almost wholly by hunting and gathering. Except where individual nations have laid claim to the sea bottom or to fishing rights within territorial waters or where treaty limits are established, the pelagic ocean waters are commons; they belong to everyone and everyone has as much right of entry and exploitation as anyone else. This is even encodified in international law as the doctrine of *res communis,* or community ownership. Community ownership and exploitation, as Garrett Hardin has so elegantly shown (Hardin, 1968), inevitably leads to overexploitation, to reduced yields, and to decline in the health of ecosystems.

Because of severe competition for resources on the ocean commons, a broad trend toward international management of marine resources has appeared in the last few decades, and it has, in some cases, resulted in a marked recovery of limited parts of the marine biota, sometimes from the very brink of total destruction. The northern fur seal, *Callorhinus ursinus,* like so many of its fellow pinniped species, was severely depleted because of uncontrolled hunting. The major nations concerned with the species (USA, Japan, Canada, and the USSR) signed a treaty in 1909 to reinstate a healthy population. The USSR continued to manage its portion of the seals, which bred on the Commander Islands; the USA agreed to manage the populations breeding on the Pribilof Islands; all four nations share in the hunt. Under such *limited national entry* into the fishery, and a management treaty, the total Bering Sea population has returned to between one and two million animals. Similar treaties and agreements exist for other species or groups, for instance oceanic tuna, Pacific salmon and the northern Pacific halibut. These treaties have had various degrees of success. The world whale fishery has nearly foundered under the relatively ineffective International Whaling Commission. Unfortunately, the management of whales was primarily directed towards the health of the fishery rather than of the whale populations themselves. This led to the overexploitation of blue and humpback whales, particularly in recent times (the right, bowhead, and gray whales had already been depleted before the IWC came into existence). To the

IWC's credit, all of these species are now protected. Hunting now centers on the fin, sei, and sperm whales.

Now, finally, the whaling nations are showing signs, under great pressure, of cooperating to produce a fishery in which these species are no longer rapidly declining toward extinction; some are stable, some recovering slowly, some still precariously close to local exterpation. Whaling has, perhaps, become *a sustainable yield* fishery; it is very far from being a *maximum* or *optimum yield fishery* which is more nearly the case with the northern fur seal.

A new involvement for the seas is the rapidly evolving technology of mariculture, or sea farming. With it come a galaxy of management problems, for in sea-pond mariculture (as opposed to open-water mariculture) as in any human management of food production, the natural systems of the sea become subordinate to those designed and controlled by humans. It is perhaps fortunate that the rise of mariculture comes just at the moment in history when we also are witnessing the rise of awareness that *ecosystem management* is a universal need on land. We contend that it is also a universal need in the sea. In fact, both from the standpoint of human material welfare and the preservation of aesthetic values, ecosystem management is the only way the two, often contending requirements, can be brought together. In its deepest sense, the ultimate aesthetic value of nature is a healthy and natural ecosystem. It is also true that manipulation of the marine environment for mariculture is immensely more complex than farming the land. In fact, it is the conclusion of most people in the field that a healthy ecosystem is the most important requirement for open-water mariculture.

PROBLEMS OF MARINE ECOSYSTEM MANAGEMENT

Probably at this time, when the genesis of our thinking about ecosystem management is not very old, we know only grossly the sorts of problems and opportunities we face. Real sophistication will come when such management becomes a reality, and when men are forced to grapple with it in actual practice. It seems true that the maximum or optimum-sustainable-yield method of dealing with single species is an unspoken way of managing within the unseen and unknown constraints of an ecosystem. The rationale is: if the basic population of a marine organism is allowed to survive, while only a surplus is taken, there is rather little likelihood of creating a serious population perturbation within the total environment. Yet, in practice natural populations prove to be capricious things. They often fluctuate in incomprehensible ways that sometimes seem unrelated to the carefully programmed catch dictated by man's best attempts at estimating natural populations and their dynamics. We learn, to our consternation, that natural populations are themselves equilibria, and that their levels often respond to forces we scarcely understand or fail to comprehend altogether. Nature, we learn, is far more complicated than management on a species level; population dynamics studies directed at single harvested species tell us little about the ecosystem of which these species are a part. The northern fur seal is, again, a case in point. At the time of its first protection, populations were about a fourth of a million. By 1930, under treaty protection, the population had leveled at about a million and a third. By 1950 or so, populations had reached about two million on the Pribilof Islands alone (reports of 4-5 million seem to have been erroneous). There were signs, at that time, that disease and mortality were increasing and reproductive rate decreasing.

The treaty stipulates that the fur seal be managed by maximum sustainable yield (MSY) and the population was thus reduced. Today it stands at 1.3-1.5 million. But the point is that the recruitment rate today is not that of 1930 when the population was at about the same level. Why? The answer is not to be found in the mathematics of population dynamics. Rather, it may be an ecosystem problem. Likely causes are pesticide and other pollution problems or man's competition with seals for food through the development of the Bering Sea ground and midwater fisheries.

We submit that until we begin to monitor the ecosystem within which the seals live, their true management will not be complete.

Any rational person must realize that in a multination world many of whose members are resource deficient, exploitation of the ocean will occur. The question is not "Will the ocean be exploited?" but "How will the ocean be exploited?" In addition, a question of values enters at the beginning of any attempt to exploit marine resources. It is composed of two parts, the first of which involves social decision or "need" and the second of which involves the biological and managerial questions we face here. First, it must be asked: "Why should a resource be exploited?", and that is the social question. It is not our concern in this paper to define for society why it should need to kill fur seals or any other animal. The need may be real, as with food supplies, or it may be frivolous, as with millinery or women's fur coats, or it may concern economics or native rights. Our concern, however, is with a strategy of exploitation which leaves basic resources in good shape, and which protects the aesthetic values that serve to make our world more livable. We choose not to engage the question of motivation.

Is managing the ocean like managing the land? It is not, and the differences between the two endeavors are crucial. The major difference is that while rather little life exists in the atmosphere, the hydrosphere contains the major variety and mass of life on this planet. Instead of there being a skim of life as we find on land, usually less than a few meters thick, in the sea life occupies the whole water column, in addition to forming a skim on the sea bottom. This is true whether there is light or not, and most of the sea is utterly black, except for occasional flashes of biological light.

While the winds of the atmosphere sweep around the earth, they carry rather little with them; dust, aerosols, a few insects and spiders and some birds, all of which utilize the atmosphere only for transport. The air is not an ecosystem; there is no nutrient recycling there. Even populations of airborne microorganisms are attenuated in the atmosphere by rain. The sea is the opposite. It's a bouillabaise of animals and plants, of uncountable microscopic organisms, of nutrients, of degradation products of life, of inorganic contributions from land, from chemical precipitation, and of dust from the atmosphere. Its "winds," which are the ocean currents, move at all levels from the surface to the deepest sea where water generally creeps northward from the Antarctic Convergence. With them move nutrients and life. With them move clouds of reproductive products, and of larvae, so that no part of the sea is ever free of the replenishing supply of life suited to it, save those places where man has so altered the conditions of life that occupancy is not possible.

Another vital difference is what is called "*the downstream effect.*" Broadly, this effect is that while primary productivity may occur at a given locus in the sea, currents may move the resultant organisms so that secondary and tertiary production may occur elsewhere. One cannot look at the sea as one does a forest and expect the nutrients of the soil or of a nearby stream to determine the standing crop of the occupant forest, and then to find this converted by local consumers to other trophic levels. Mobility of whole fractions of the ecosystem can be very great in the sea, and often are. There are, of course, exceptions to this where the comparison between the dynamics of land and sea may be closer. A good example is eel grass or turtle grass beds which derive nutrients from the benthos rather than the water column.

Because many of the important creatures of the sea, in resource terms, are primarily creatures of the hydrosphere—tunas, fur seals, whales, and so forth, it is not surprising to find them moving vast distances in this fluid medium. They are not restricted by terrain, or by rivers, or by intervening deserts. Waterways are open, depending upon the behavioral and/or physiological capabilities of the animal to move hemispherically. Even rather local movements, such as those we find in animals like sea otters or porpoises, can confound our thinking when we base them upon land-derived models.

The human view of the sea is, in general, the top of it. Because of this, it is all too easy for us to consider the sea to be homogeneous. We have already mentioned the currents that sweep like rivers across and through it, but there are many other factors which give the sea texture in the same way we find habitats on land varying markedly from place to place. Some examples are eddies, upwelling areas, thermoclines, and areas of run-off from land. Of course, for the manager it is crucial to understand these local variations and how they affect the resource to be managed. The nearshore environment is inextricably linked to the adjacent land. Both are part of the same interacting systems, especially where the sea meets the land across broad shelves that lie not too far beneath the surface. Here, almost imperceptibly the land grades into estuaries and marshes, and thence into the sea. Products from land, influenced by man or not, contribute to the sea. Sand, silt, pesticides, effluent wastes, fresh water, and nutrients are some of the things that pass from land to sea. Indeed, the marine ecosystems often depend upon nutrients of terrestrial origin. In return, the sea modifies the climate of the land, provides fog and rain and unbroken access of sea winds to the shore, and is a "store-house" of the sun's heat. In truth, the sea and the land are one, and to manage the sea and the land separately is to invite incomplete understanding and ineffective management. "Coastal zone management," a popular phrase these days, lies close to reality, providing it is prosecuted from this holistic viewpoint.

It is no longer useful to consider waters farther offshore as simply water. The sea bottom affects life in the water column above it in ways we are only now seeing for the first time. Masses of organisms that provide crucial food for surface creatures move vertically in what is called the *deep scattering layer* (a reference to the ability of such clouds of organisms to reflect and scatter the sound of fathometers and sonar sets) and are concentrated in relation to submarine sea mounts, which sometimes lie very far below the surface. Recent evidence from marine mammal distribution shows some species to be feeding in relation to terrain lying deeply submerged beneath them (Evans, in press).

Volcanism may contribute chemicals, such as mercury, to local areas of the sea and produce products inacceptable to man, but away from the crustally active areas the same species of food fish may be perfectly usable. The Continental Slope, where the continental land mass slopes into the abyss, is a highway for some large creatures, such as some of the great whales. Some, like the sperm whale, find their food there in greater abundance than elsewhere. The submarine canyons that cleave this slope in many places around the perimeter of the oceans affect us, too. Sand migrating along the edge of the sea in longshore currents may drop into them, slide seaward and be lost to deep water. Likewise, effluents from man's activities on land may be poured into such canyons and produce no noticeable surface effect, though the eventual problems such practices may create for the sea as a whole remain to be assessed.

We may draw from these examples the simple fact that sea management, no less than land management implies the need for knowledge of the terrain to be managed.

PROSPECTS FOR INTERNATIONALISM AND REGIONAL MANAGEMENT

The strategy of using the sea as a commons, with equal entry opportunity for anyone, is capable of defeating any attempt at ecological management. Instead, such successful management as has been carried out in the sea has involved two very different concepts. The first is *limited entry,* and the second is the associated idea of the *most concerned countries.* In a nutshell these ideas state that exploitation be on the basis of management schemes involving only one or a few countries who are most directly concerned with the resource in question. Under such circumstances, it is possible to work out treaties and agreements based upon population health; it may even be possible to encompass ecosystem health, in which basic ecology is primary.

The northern Pacific fur seal fishery is, once again, an example of a successful arrangement of this sort. At this time, this agreement is *species oriented* rather than *ecosystem oriented,* and hence, as we pointed out earlier, it is only a partial approach to total management of the resource. Ecosystem orientation in management involves a further concept, that of the *most sensitive organism.* Inevitably, we direct most of our attention to those resources valuable to us directly; we manage grasslands for cattle production, ponds for bass, estuaries for oysters, the ocean for tuna and whales, and so forth. Yet, on an ecosystem basis, this is not sufficient, for it does not consider the complexities of food webs, recycling, and trophoenergetics which are the core characteristics of ecosystems. The delicate balance of plankton composition, of benthic species composition, are the correct targets for management. Present thinking states that ecosystem health can best be gauged by the maintenance of its most sensitive major components. The mere identification of those components in the sea has barely begun. The alteration of our concepts to their management—to that of ecosystem health—requires a sophistication not widely attained.

Limited entry does not necessarily imply exclusion of possible user countries beyond the management group. But the banding together of a forceful group of users who can devise management plans and, through international channels, can require non-members to conform to sensible exploitation measures, may insure ecosystem health. We recognize the inherent difficulties that limited entry may produce in some cases, but careful planning at the international level can avoid many such cases and allow for the adjudication of others. By separation of the question of quotas for a harvest from the problems of basic management of the entire resource, regional ecosystem management may well be achieved.

TWO MODELS FOR MARINE REGIONAL MANAGEMENT

We feel that wherever possible marine management should be *regional,* and should be ecosystem oriented, involving both land and sea. We feel that such regional management should be established on a limited entry basis, with the most concerned countries involved in carrying out the charge of maintaining the ecological health of the region. Such regions should have as much ecological reality or discreteness as possible. We recognize that in the last analysis all parts of the world affect all others and no regional system can be completely natural. But it can be functional. Such regions can, at their simplest, be enclosed seas, or at their most complex, ocean compartments such as current systems, and gyres.

As an example of such regional management plan let us suggest that the Bering Sea be developed into a "managed sea." This body of water is a very special region of the world oceans. It is one of the richest marine areas on earth with a primary productivity of about 4 gm. C/m^3/day in summer. This very high productivity compares favorably with other rich oceans; as the upwelling waters on Africa's southwest coast (about 4.0), the Arabian Sea (6.4) and the richest of all seas, the Peruvian upwelling (11.2). The cycles of Bering Sea productivity are not clear. They depend both upon a late-winter sub-ice diatom bloom and a late-summer bloom in the water column. Nevertheless, the shallow-water Bering Sea, and the adjacent Chukchi Sea north of the Bering Straits, support possibly a million tons of marine mammals, possibly 100,000,000 sea birds, large quantities of commercially valuable fish, and an unmeasured quantity of benthic invertebrates. At the present time, these resources are under-utilized by man.

The Bering Sea is young and shallow. It dates from about the end of the Pleistocene and is mostly less than 100 m deep over its

5,000,000/km^2 of epicontinental area. Further, it is relatively unpolluted, but looming on the horizon are both intensive exploitation of renewable resources plus oil, mineral, and gas exploitation which could be serious threats to its productivity. This region is the richest large sea left in the Northern Hemisphere for which there is yet time to plan effectively *before* multiple use develops.

The Bering Sea lies between only two countries: the USSR and the United States. While it is open narrowly to the north and the Arctic Ocean, the vast majority of its nutrients come from its sides, on the Alaskan mainland and the Siberian mainland, where numerous streams and rivers pour rich silts into it. To the south, a flux of water moves between the islands of the Aleutian archipelago to the systems of the North Pacific. It is within the powers of the two countries concerned to form an agreement that would consider the energy budget of this sea, the impact of man upon its biota, the inputs of pollutants from its borderlands, the seasonal flux of both inorganic materials and living things, and the optimum ways in which its riches might be harvested for man's needs. Even though not bordering the Bering Sea, Japan and Korea gain important resources from it and might well be asked to take part in such an ecological agreement. In this way it could become a true "managed sea."

There are other seas that could be managed as units. The Gulf of California, lying wholly within the borders of Mexico, comes to mind. This very rich sliver of sea should be protected as an ecosystem from possible overexploitation, from pesticides and other pollutants that could easily affect its rich life, and from other challenges to its integrity as an ecosystem. The Persian Gulf, the Red Sea, and the Gulf of Mexico are other possible examples. The Baltic and Mediterranean countries are already seeking ways in which regional management might be possible.

We have pointed out that many of the sea's resource organisms are migratory. What of them, when regional management is being considered? What can be done with such creatures as the gray whale, which summers in rich northern seas but gives birth to its young in the warm lagoons of Mexico? The case is not unlike that of the northern fur seal which is harvested on its northern breeding islands, the Pribilof's and the Commander Islands, yet migrates far south into Californian and Japanese waters. The simplest solution would seem for each such important resource to be considered separately by limited entry treaty, as is the case with the fur seal, and for the signatories of such a treaty to include nations along the range of the species concerned. In the case of the gray whale the situation is clear-cut. The animal summers in USSR and American waters, migrates adjacent to or through Canadian and American waters and winters in Mexico. To protect it and its integrity as part of the ecosystems involved in its path, its breeding, feeding and migration grounds all need consideration. At present, it seems relatively secure on its feeding grounds, since it is presently protected by international law which prohibits its capture. However, concern exists about its breeding range which is peculiarly subject to human intervention.

The shallow lagoons in which it gives birth and nurtures its young are prime areas for human impact, and indeed, such impact has been increasing. The major nursery lagoon, Laguna Ojo de Liebre, or Scammon's Lagoon, of Baja California, Mexico, is now being used extensively for salt production with associated barge and ship traffic. We hope that the very recent designation of this lagoon as a Mexican national reserve will lay the groundwork for Mexican contribution to international resource management.

Recognition of the gray whale's ecological needs would be greatly advanced if a multination agreement could be devised on its behalf. Mexico, we feel, will reap long-term financial benefit from making national parks of the most important nursery lagoons in addition to Laguna Ojo Liebre. Surely, in time, the spectacle of 11,000 whales coming to have their young in these calm inshore waters can provide economic benefits equal to or greater than those provided to Mexico by foreign financiers, who seek only the convenience of a sea entry for their salt barges.

CONCLUSION

The totality of ecological needs for a region or a species need to be considered in devising its management. For those who would tell us that such complicated and difficult agreements need not be forged since the best thing to do is avoid human impact altogether, we have two replies. First, we reiterate that the seas and their resources will be used, including gray whales and seals, and that such impact can only be expected to increase. Successful protection of species and regions must always rest upon the best possible information, and we need more than we have. Second, if we abdicate by calling a unilateral moratorium on exploitation we are unlikely to be followed by any of the resource-hungry nations of the world. We will only succeed in weakening our position in the management debate. It also makes no ecological sense to say: "Leave them alone and everything will be alright." Such "protectionist" philosophy neither recognizes international realities nor ecosystem ecology.

A second alternative is to continue our present ways, to enlarge upon treaty arrangements for various aspects of the environment, one by one. Thus we have separate conventions at present, for the sea floor, territorial waters, the high seas, and for fisheries, which divide the seas in an unnatural manner (cf. Ray, 1970). We also have separate treaties for fishes, invertebrates, and mammals and other treaties for oil discharge and for various military and commercial uses. We now know, as ecologists, that these separate parts do not form a comprehensive whole.

Obvious signs exist that man's intervention in natural systems is having deleterious and semi-permanent effects. Whether we like it or not, man has already intervened with the sea's productivity to the extent that there is no alternative to management on a scale we scarce imagined a decade ago. "As much as 25 percent of the DDT produced to date may have been transferred to the sea" (National Academy of Sciences, 1971). Already deleterious effects are known for plankton, invertebrates, and vertebrates. The fate of the other 75 percent is not clearly known. Almost certainly, some or most of it will find its way into the marine environment—the "ultimate sink." The results are frightening to contemplate. Hood (1971) states: "No longer is man an insignificant influence on the sea . . . a poisoned ocean is untenable for man's existence on the earth."

Therefore, management and exploitation are not possible in older ways. Neither is sanctuary, the creation of parks, nor protection or conservation of species.

A new alternative is regional management on an international level. This does not imply the disposal of old treaty arrangements, but it does mean bringing them together under a broader cooperation. It does mean the dropping of some historic "national" priorities—a world community acting to conserve, maintain, and reap the benefit from a world ocean. How this may be achieved is too complex a topic for consideration here. The Conservation Foundation *Newsletter*, November, 1971, contains a digest of late thinking and development on the subject.

As our ecological awareness grows as a people, our understanding about the precious nature of ecological balance also grows. We begin to learn that one man's affront to nature affects us all to some degree. This knowledge leads directly to the concept that ecological sins are universal sins. One man's rape of the land or pollution of the atmosphere cannot be considered *in vacuo*. We all need that air and that land to live. This problem is even more immediate when one considers sea management. Because most organisms in the sea spend their lives in the hydrosphere, either as eggs, larvae, or adults, disturbance of the circumambient water is automatically a serious affront to the life of the sea in general. Because the seas flow, such disruption is apt to spread long distances.

One may draw from these ecological considerations the conclusion that the basic determinants of management strategy must lie with those who attempt to understand marine ecosystems.

We are learning to feel the pulse of the natural systems of the Earth, the dominant one of which is that of the world's oceans. Our survival may depend upon our handling of this ultimate problem.

LITERATURE CITED

Conservation Foundation.
1971. Newsletter 11-71. Washington, D.C. 20036.
Evans, W. E.
In press
Hardin, Garrett.
National Academy of Sciences
1971. Chlorinated hydrocarbons in the marine environment. Washington, D.C.
1968. The tragedy of the commons. Science, 162 (3859): 1243-1248.
Hood, Donald W., Editor.
1971. The impingement of man on the oceans. Wiley-Interscience, New York.
Ray, G. Carleton.
1970. Ecology, law, and the "Marine Revolution." Biological Conservation, 3 (1): 7-17.

PANEL DISCUSSION

DAVID BROWER (San Francisco, Friends of the Earth): I am grateful for the series of papers this session has offered us this morning. I think they are challenging and they alone make this conference worthwhile.

Dr. Hardin, I would hope that in your spaceship analogy in the miniature you might add a paragraph about the support system for that 13-meter ship to show that on such ships they have always been able to get a package of food and other supplies from the big storehouse, before they took off on a little one. The importance of the big 13,000,000-meter spaceship—a feature that relates your talk to Mrs. Owings'—is the wildlife component that we need along with it. It is a totally interrelated web of life that covers this earth, and there is no one here clever enough to know which forms of living things we can afford to do without. I am grateful to see the movement from the concept of "game" to the concept of "wildlife." We need to move now to organizations that are concerned with the preservation of non-human life as the best of the entity that we need on our spaceship.

For scale, I always like the one that I heard Jacques Yves Cousteau tell architects about in Palm Springs, Calif., when he said that if you consider the earth the size of an egg, all the water and all the oceans on that earth would amount to but one drop on that egg's shell. When he said that, I didn't believe him—I remembered the globe that seems to have about 70 percent of its surface blue. But I went home and did the arithmetic—the blue is a few thousand feet deep, the earth is 4,000 miles deep and a drop of water is about 1/6 of an inch across. I did more arithmetic to find out that the atmosphere if you reduce it to the density of water—a droplet is 1/32 of an inch across, and the soil upon which all living things depend, is a speck barely visible to the human eye.

So that speck, the droplet and the drops are all that make this earth, this spaceship, different from the moon. And we have been using the droplets and the drop and the speck as if they were just infinite things for our waste, for our disorganization, for the system that used to work very well. When you compress the time of the earth's age to the six days of creation, life began for us Tuesday noon, agriculture 1½ seconds before midnight on Saturday, the Industrial Revolution and its attack on a working system, but a fortieth of a second before midnight. Unless we get that perspective clearly in mind, that our cleverness hasn't been running long enough to be counted upon, then we are going to miss the right solutions.

I am grateful for the computer simulations of Mr. Odum and Professors

Forester and Meadows, and Prof. Watts. These will help us think more consecutively than we know how to think, but the one thing we must realize is that we have one of the best computers of all attached to each one of us, one that has been training for 3 billion years, and has enormous capabilities. The one hope we have is that all of us use that capability. We can make a difference. Thank you.

MR. JOHN ANDERSON (National Audubon Society): Since I'm a hunter, it may be difficult for Mrs. Owings to believe that I share her concern for the preservation of natural systems, that I admire and appreciate her efforts and would like nothing better than to assist her in her endeavors. I think she is on the right track. If she distrusts my motives, I don't think that's her fault nor is it mine. I think it comes from the fact that a hunter can't possibly explain how he can love a beautiful wild creature and also love to kill it under certain very special circumstances. I can't even define what a hunter is, only what he is not. He is not an ordinary person carrying a gun in hopes to get a shot at something and he is definitely not a slob hunter—I use the term for lack of anything better—the slob hunter is another gun toter who is the worst enemy of the real hunter, far worse than a strict preservationist.

Real hunters, such as Aldo Leopold and John James Audubon, were extraordinary men with an undying love of nature. I think it is unrealistic to expect Mrs. Owings to recognize or distinguish between these three classes of gun-toting humans, and yet I don't see how a hunter like myself can expect to preserve my way of life, without the help of Mrs. Owings, so I would like to ask her if she has any suggestions on how we might break what I see as a very serious communications barrier.

MRS. OWINGS: Let me thank you for your remarks, and I am sure we can get together for an understanding. I think that the whole future of wildlife depends on this understanding that we have and what we work out together intelligently.

DR. CRAIG KENSLER (UN Fishery & Research Development Program, Mexico): Looking over the talks this morning, something continually comes through my mind, and this is not a question, it is again a statement. Looking at such phrases in the first talk as "natural systems"; in the second talk, "preserving earth or preserving earth's quality"; in the third talk, "natural areas and life support systems"; and in the last talk, managing not only the "marine environment" but the occupants, what kept going through my mind was a title of a talk that will be given some time. It has been touched on here, and it's almost a takeoff on the last talk we heard and this is that almost before we can manage any of these systems, must we not also look at manging land's occupants, meaning humans? And a point you have just made—will we come to an understanding? Hopefully we will, and yet don't we all harbor our thoughts, our questions, our fears?

I work for an organization that should bring this together, the United Nations. However, in my little sphere of marine resources I know that the UN can do no more than all the countries within the UN wish to do and wish to contribute, and as long as we have fights among countries I think we are going to have fights over methods of managing resources, be they resources of coastal lands, coastal waters, or resources of the high seas. For example, the conflict that I see with regard to managing marine resources is not a conflict of the high seas because 5 percent of the ocean, the area along the continental shelf, is the rich area. This is the food-producing area of the ocean, this 5 percent, and this 5 percent also happens to be the areas under very heavy exploitation. For example, Campeche Bank in the Gulf of Mexico is a gigantic shrimp producer shared by Cuba, the U.S. and Mexico. How about the area around Japan? Japan has now fished herself out, so she has fleets in all oceans of the world. The same with the Soviet Union, the same with various countries of the eastern bloc, and so these countries are now fishing the coastal areas, and unless we can work out either with the United Nations or other international groups a common understanding and a concern that unless these areas are fully utilized, but rationally utilized, unless we can forget about the fights we have—why can we not talk with Cuba to get a rational fishing regime for the Gulf of Mexico's stocks of shrimp? This is my fear—that perhaps we will not have this understanding and by the time we do, it may be too late.

DISCUSSION LEADER CALLISON: Thank you very much. Before I take another comment from the floor I would like to ask Dr. Norris if he wishes to respond to that thoughtful statement.

DR. NORRIS: I really can do no more than agree with you. These problems of bringing nations together are extremely difficult, as anyone knows. The approach I was trying to put forward was based on two things: first of all to bring our law and our negotiations into an ecosystem framework in which we are looking at the sea in ecosystem terms. For example, what sense does it make under present law to consider some of the creatures that live on the sea bottom as minerals, which means king crabs are minerals, for example? I say the law needs to be recast in ecosystem terms, pragmatically, to avoid as many wrangles between nations as possible. I talked about the limited entry design. There are moves in this direction around the world. The nations that surround the Mediterranean Sea and the Baltic Sea are beginning to stand together in regional treaties to try and improve the situation in those areas. This is very hopeful. It needs to be spread elsewhere, it seems to me.

I don't think that we should ignore the majority of the ocean even though at the moment our utilization of it is minimal. We have a tuna fishery and a few others on the high seas. I think what we may well turn to what is perhaps the greatest protein resource of the sea which is not utilized at all by man at the moment, except in a secondary way, and that is the great migration of the deep scattering layer in which a mass of organisms over the entire world with the exception of the poles, moves from the deep sea to the surface every day and back. This is an enormous bio-mass which we have scarcely looked at, so we mustn't forget the 95 percent completely in favor of the 5 percent.

MR. WILLIAM BELLER: The criticism was made but I completely disagree with the conclusions as a practical matter. I regret that I do disagree with you. I said in my speech that low standards did give place to high standards given free competition. For example, the U.S. is certainly by world standards a wealthy country even though we do have some miserably poor people in our country. But by world standards we are very very wealthy. There are about 75 million more people on the earth every day. Of these, 50 million are born in conditions of really great poverty. We in the U.S. could invite all 50 million into our country each year. This would be a very Christian, a very fine thing to do, but within four years' time the immigrants we had invited in would equal the population of the country; in other words, in four years time we would have doubled our population. We, the U.S., would be worse off, and the people in the other countries would be no better off, because the next year they would produce another 50 million extremely needy people. I think it is completely unrealistic to say we must first solve the problem of justice, before we solve the problem of survival. I regret this, but I think we have to solve the problem of survival, which means the continuation for a while of injustice while we survive, because this is the first order of things, and the only thing that we in a wealthy country like ours can offer other people is not our wealth, which great as it is, is far from sufficient to take care of the world's population, so long as it continues to increase at any rate whatever, particularly not at 2 percent per year. The only thing we can offer the rest of the world is whatever aid we are capable of giving by way of helping them control their own population for their sake, as well as for ours. As they become wealthier by controlling their population, then the problem of justice will solve itself as a byproduct of the solutions of the problem of population.

DR. GERARDO BIDOWSKY (Union Nacional para la Conservación de la Naturaleza [National Union for the Conservation of Nature] Switzerland): As many others present in this room, I feel closely identified with the ideals expressed in the paper on Spaceship Earth. Particularly on the matter of population and resources, it is not enough for us to understand the basic principles which have been laid down this morning and with which I feel myself and many others in this room totally identified with. The real problem, I feel, is how to transmit this message. I reported in the Preparatory Meeting of the Stockholm Conference of the United

Nations that there will be a formal declaration. This formal declaration unfortunately mentions that the problem is excess population in other countries, where the real problem of development is the lack of population and therefore there is a tremendous understanding gap. I was wishing to make this point in more detail in Spanish—that we concentrate muh more our efforts in transmitting some of the information on the Spaceship Earth on the values of the natural system particularly to those countries who want to develop, who have the right to develop, but who want to do so with the best quality of life, and this demands adaptation of these methods to the different cultures throughout the world. Thank you.

DISCUSSION LEADER CALLISON: Thank you very much. The managers of the conference inform me that it is time to bring this session to a close as there is another one scheduled at 1 o'clock.

TECHNICAL SESSION

Tuesday Morning—March 14

Chairman: M. A. Marston
Regional Director, U.S. Bureau of Sport Fisheries and Wildlife, Denver, Colorado

Discussion Leader: Eugene Bossenmaier
Wildlife Planner, Department of Mines and Natural Resources, Winnipeg, Manitoba, Canada

RESOURCE PLANNING: NEW NEEDS AND VIEWS

AN INTEGRATED APPROACH TO RESOURCE PLANNING[1]

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Introduction

For many decades the free-enterprise democratic governments at both the federal and state or provincial level of the North American continent have had available to them adequate quantities of the means of production, namely land, labor and capital. Land in this discussion includes water. During this same period society has been changing relatively slowly, thus permitting decision makers the luxury of a fairly good batting average with the "intuitive approach" to decision-making. More recently the rules of the game have changed.

Land

Many thinkers are expressing concern that our forecast of population increases and their resultant needs for land will far exceed the available supply. This concern seems justified as land is the ultimate resource upon which man normally lives and pursues his various ends. It is immobile and cannot be manufactured. Once desecrated it

[1]The major source for this paper is the report "A Planning, Budgeting and Control System for the Ontario Department of Lands and Forests" co-authored with my colleague Bob Carman. His contribution is gratefully acknowledged.

is difficult to replace. As the degree to which demand for goods and services provided from land areas exceeds the supply, conflicts between competing uses are intensified. Conflicts occur whenever there is a deficit in the supply of land to be used for various purposes in terms of either its inherent productive potential or location relative to demand.

CAPITAL

Because of changing social values many governments have taken steps to improve social welfare and educational programs, the future costs of which, were incorrectly forecast. (The break-down of the intuitive approach to decision making). We have made social commitments that we cannot really afford. But politically we cannot rescind them either. Thus money also is in short supply, particularly for other programs suh as natural resource production, and the provision of outdoor recreation opportunities.

LABOR

As a means of stretching scarce dollars, staff complements have been frozen or at least severely restricted. In some cases, money may be available but complement is not. Thus available skilled labor cannot be used.

Therefore, from the standpoint of future programs in the natural resource field, substantial quantities of suitable land, skilled labor, and capital as inputs to production are, and will be, in short supply for some time to come.

CHANGE

In addition to scarce resources, society has been subjected to an accelerated rate of change. Drucker (1968) states we are moving into a world economy with the growth industries based on knowledge rather than manufacturing. Toffler (1970) refers to this era as "super industrialism." He translates Francis Bacon's notion that "knowledge is power" into contemporary terms by stating that "Knowledge is change." Therefore, the accelerated knowledge acquisition and rapid analysis capability, due to computers, are feeding the engine of technology thus accelerating change beyond our control.

Brzezinski (1970) claims "the exponential rate of change as manifested by the growth of population and proliferating technological conversion of natural resources, is unbalancing the world's physical and psycho-social ecosystems and threatening global disaster." He goes on to state that, if we are to survive, we must recognize that both the present and immediate future are pre-ordained by existing commitments. We must leap-frog the immediate future to an un-prescribed future and stake out for ourselves some options where we can hope to regain mastery over an uncontrolled present.

Because of the scarcity of land, labor and capital we have been forced to turn to planning as a means of ensuring the most effective use of these scarce resources. *Long-range* planning is the type being proposed as the means of coping with a rate of change that in this post industrial society appears to be accelerating out of control.

WHAT IS PLANNING?

Since we have chosen planning as one means of becoming more effective managers, we had better define it.

What is so magical about planning that it will solve the problems just outlined?

Planning is one process of directing change. It is achieved by analysing and selecting ends to be pursued by an individual, a society, or an agency of that society. The process also includes analysing and selecting means of achieving selected ends. Basic components of planning are therefore the analysis of alternative ends and means as well as the selection of those most appropriate. The selected ends and means are usually set down in a document referred to as a plan. An approved plan is a commitment to the action necessary to implement the means chosen for achieving the selected end.

Although this definition applies to most types of planning the *long-range policy variety* is our main concern in this paper.

WHAT ARE ITS IMPLICATIONS?

This type of planning emphasizes in-depth analysis of alternatives. Alternative ends are the various natural resource programs that governments may choose to achieve for the benefit of people. Alternative means are the various management techniques or activities that may be applied to implement each program. Ideally, the selection of the appropriate end and means should be based on a benefit-cost analysis. This adds to the complexity of planning.

The ends pursued in natural resource management, such as providing outdoor recreation opportunities and renewable natural resource production, span broad spectrums of social and economic benefits.

The social benefits which must concern natural resource planners include psychological and physiological well-being provided by leisure-time pursuits, employment opportunities for those who prefer to live in non-urban environments, and most important, a suitable habitat for man and other animals.

The economic benefits which must be measured include jobs, per capita income, export dollars earned, contributions to the Net National, State or Provincial Product and taxation revenues generated.

In total these benefits represent many of the important values held by North American residents. They are complex because so many of them cannot be measured in dollars; the social values are abstract and intangible and can be compared with economic values only by subjective analysis through the time-consuming political process.

Planning-time horizons raise another serious problem for the planner. Forest stands take a relatively long time to mature, which creates difficulties in future predictions. As well as problems in estimating yields and future market prices for goods, there is the problem of forcasting the competing demands for scarce resource inputs in order to achieve outdoor recreation and commercial production outputs. Even in fish and wildlife management, where life spans are in the medium time range, the overriding effect of uncontrolled habitat factors, such as climate, makes probability estimates a hazardous undertaking.

Traditionally, inputs of land, labor and capital in measuring costs have been expressed in dollars. For natural resource planning, labor and capital can be handled in this traditional manner, but land requires a different approach. No pricing mechanism has been developed yet for the large areas of federal and provincial or state lands owned by the public. Since these resources are used for a wide variety of government programs, a method of allocation using criteria developed outside the marketplace must be used. This process is complicated further by the fact that land varies greatly in its ability to produce goods and services—its location is fixed and its total extent is finite.

Although we evaluate land capability as if a particular unit of land had a fixed potential for the production of goods and services, we realize that there is a whole range of possible outputs which will result from a corresponding range in possible complementary inputs of labor and capital. Considering all the different uses for land and all the "pieces of land" there are available, a nightmare of investment alternatives can be postulated. Add to this the complexity of multiple use wherein two or more uses can be combined in a wide variety of compatible arrangements on a single piece of land and you have an array of alternatives that is mind-boggling, to say the least.

In summary, planning must accommodate a complexity of factors including diverse social and economic benefits which cannot be readily compared, long-time horizons whih create imponderable forecasting probabilities, a lack of a pricing mechanism for both social benefits and land held in the public domain, and an infinite array of individual and combined investment possibilities. In addition it must cope with rapidly accelerating technological change.

Is it any wonder that the smart administrator has retreated to the "seat of the pants" or "intuitive approach" to decision-making. Only fools and planners rush in where others fear to tread.

SOME ALTERNATIVE APPROACHES

Since these problems of change and scarce resources demand that we adopt a conscious and deliberate approach to resource management, how can we devise a planning system which will meet the complexities just described? The Planning-Programming-Budgeting System (PPBS) being implemented by many segments of government to rationalize the allocation of scarce resources, is a starting point. It offers a framework which establishes people-oriented ends as the first step and follows through with an analysis of alternative means (courses of action) to meet these ends. Unfortunately PPBS concentrates on investments of labor and capital. A complementary system has to be integrated with PPBS to accommodate the analysis of land inputs. The Ecological Basis of Land Use Planning, as proposed by Angus Hills, provides a philosophical background for evaluating the land component.

The trick is to devise a planning system which will incorporate the best of PPBS with the best of the Ecological Approach.

PLANNING PRINCIPLES

It is my hypothesis that an integrated planning system that is to meet the challenges just outlined, must have for its foundation, sound planning principles. The term "principle" has many meanings but the ones most clearly related to my intent include code, rule, ethic or law. These meanings indicate my strong belief that if you ignore established principles in planning, you will fail.

The following principles were derived from an analysis of the basic requirements of a plan and planning process and the overriding need for integration between resource planners with different thought processes and biases.

1. Goals or ends must first be stated.
2. There must be a commitment to integrated planning by all agencies concerned with the ends sought.
3. Dialogue must be maintained with the public throughout the planning process.
4. Environmental quality standards must be selected for specific eco-systems.

5. The administrative organization chosen must facilitate the planning, its co-ordination and implementation.

APPLICATION OF THE PRINCIPLES

Time does not permit me to discuss the above principles in detail. They are adequately covered in existing planning literature should you wish to investigate further.

What I would like to discuss now is how we have applied these principles in our planning in the Ontario Department of Lands and Forests.

Principle 1—"That goals or ends should first be stated."

We define a goal as a value or end to be sought in relation to the needs and wants of people. A more specific end is called an objective. An objective is defined by (Cressman, 1970) as a specific statement concerning *what* is to be achieved. Objectives, therefore, should be quantifiable and capable of attainment, and should have a performance measure associated with them.

In 1968 the Ontario Government decided that the "intuitive approach" to decision-making was inadequate for today's conditions and selected instead the Planning, Programming and Budgeting System as pioneered by Dr. Roman Krzyczkowski, and tested by the United States Department of Defense. Implicit in this approach to decision-making is the establishment of people-oriented ends as the first step.

In 1969-70 we hired Operations Research Incorporated to work with our people and analyze current and potential goals, objectives and program structures for the Department. Our Tentative goal is:

"To provide from Crown land and water and to encourage on private land and water a continuing combination of resource development, outdoor recreation and quality environment most consistent with the social and economic well being of the people of Ontario."

These tentative objectives are in use today:

1. *Land Management*

   To provide co-ordinated land and water resource management within the framework of a governmentwide quality environment goal through planned land-use allocation and control, environmental protection and inter-agency co-operation so that optimum social and economic benefits accrue to the people of Ontario both now and in the future.

2. *Outdoor Recreation*

   To provide opportunities for (a) a wide variety of outdoor recreational experiences accessible to and for the continuing benefit of all the people and (b) an optimum continuing contribution to the economy of Ontario and its regions from the tourist industry.

3. *Resource Development*

To provide an optimum continuing contribution to the economy of Ontario and its regions from the industries utilizing renewable natural resources.

This goals-and-objective statement has the approval of our Minister and is being considered by the Cabinet Committee on Policies and Priorities.

We are presently trying to quantify the selected objectives and select performance measures for each.

We have made a good beginning towards applying this principle.

Principle 2—"That there must be a commitment to integrated planning by all agencies concerned with the ends sought."

Some of the terms used to describe the type of planning we are interested in are: comprehensive—meaning to include all parts; simultaneous—meaning at the same time; co-ordinated—meaning the bringing of the parts into proper relationship, and long-range—meaning to some future time horizon.

The term "integrated planning" has been adopted to convey the above meanings.

In looking for a way of planning that included all relevant components, that considered all these components at the same time, and that brought the parts into proper relationship, we have adopted the team approach. We feel this is the best way to bring together various disciplines and professional biases and ensure constant and adequate communication during the planning process.

District, regional and head office planning teams are common in the Department. So are policy and special project teams or task forces. The Provincial Government as a whole supports this principle and makes good use of the team or committee approach to interdepartmental planning and problem solving. The Committee on Government Productivity, a major government committee concerned with more efficient government, recommended in its Report #1 a wider use of task forces and teams for special projects.

We have been fairly successful in applying this principle, particularly at the field level.

Principle 3—"That dialogue with the public should be maintained throughout the planning process."

The key item in any planning process is a continual and successful dialogue between the planner (technocrat) and the planee (people affected by the plan).

I agree with Friedman (1960) who says "plans don't necessarily fail because of their material content, but because the planner has failed to establish lines of communication with the people for whom he is planning." The people for whom the planning is being done have a moral right to express their values and wishes to the planners.

We make extensive use of *special advisory groups, public hearings,* continuous dialogue with *other Departments, special user groups* and *local citizens.*

To formalize the inputs of local citizens and special user groups we have developed permanent District Advisory Committees whose sole function is to advise the District Forester concerning the land-use policy for his area. Membership is made up of all the significant user groups for the District as well as the appropriate Provincial Members of Parliament.

These District Advisory Committees ensure local input into the planning process.

So far this approach to public dialogue has been quite rewarding and I feel we have successfully adopted this principle.

Principle 4—"That environmental quality standards must be selected for specific eco-systems."

The environment is a system. It is the system in which man lives and pursues his various ends. The environment, as a system, is made up of many inter-related physiographic, biotic and human activity-oriented features. It can be subdivided into many subsystems, sometimes referred to as ecosystems. Planning is the chosen means of directing future change in these subsystems.

The subsystems or ecosystems that we consider to be significant from the standpoint of natural resource production and the provision of outdoor recreation opportunities are called "strategic zones." These are human ecosystems based on patterns of natural and human activity features that provide a certain potential for management, different from that of its neighbor.

Selected environmental-quality standards are an appropriate portion of the goal and objectives established for each zone. Water quality, aesthetic logging standards and the proposed degree of development are but a few of the environmental constraints defined for each zone. Within these constraints the production of goods and services proceeds.

We have made fairly significant progress in applying this principle and have established a section in our Environmental Protection Branch primarily concerned with environmental quality considerations.

We intend to faithfully apply this principle.

Principle 5—"That the administrative organization chosen must facilitate the planning, its co-ordination and implementation."

The end product of our planning is the Multi-Year Plan which displays alternative program levels for analysis and approval by Cabinet. It must be updated annually.

To do this there must be established within the organization, specific planning muscle for this purpose. The District and Regional Planner positions provide a nucleus of planning at the two field levels. Careful nurturing and development of these will ensure continuous planning in the field organization.

At Head Office, Policy Planning Advisory Groups for each program will ensure a continuous planning input into the preparation of the Multi-Year Plan.

Co-ordination of the various program inputs is assured by the use of various planning teams, policy review committees and ultimate analysis by the Management Committee.

SUMMARY

I have suggested that land, labor and capital are or will be scarce resources. I also suggested that society is being subjected to rates of technological change never before experienced. I suggested too that *long-range planning* is one remedy to this our "post industrial dilemma." To be successful, however, the planning system adopted must be founded on the planning principles just discussed.

A continuous monitoring of the planning system is also essential to ensure continued adherence to these principles.

LITERATURE CITED

Brzenzinski, Z.
1970. Between two ages. New York Viking Press.
Cressman, E. M.
1970. North Georgian Bay recreational reserve—a land use planning approach—a thesis University of Guelph, Ontario.
Drucker, P.
1968. The age of discontinuity. Harper and Row.
Friedman, J.
1960. Notes on societal action. Journal American Institute of Planners 35(5).
Toffler, A.
1970. Future shock. Random House Inc., New York.

DISCUSSION

MR. WILLIAM BELLER (Environmental Protection Agency, Washington, D.C.): Concerning what was said by the speaker as regards regulations for the environmental quality: First they are established, and next their uses are derived. Doesn't this mean they are working backwards? It might be better to prescribe the uses first and then establish what type of environmental quality is necessary. This could go from conservation to industrial use, and later we can define the quality of the environment. Once this is done we can proceed to the total program and to regulate what we want to do with the environment and assure its continuity.

MR. ANDERSON: I consider your point to be very well taken. I am not so naive that I have not realized that we must make some trade-offs; we must first examine the environment and then see what type of production is possible within these constraints. In the past there was a different viewpoint and now it is refreshing to see it from a new angle. We have to consider all things in one plan.

I think you will agree that it is a little refreshing that somebody, at least, is trying to look at the environment from a thoughtful perspective. It is but one of the natural features that I considered in the whole planning process. I also realize that perhaps the decision-maker, if he has a conscience at all, if he is well aware of the trade-off he is making, will be a little more cautious than he has been in the past.

CHAIRMAN MARSTON: If there are no more questions from the audience I would like to ask Mr. Anderson a question. Actually it sounds like Utopia in Ontario, and I suspect that it isn't running all that smoothly because you are attempting to do something that is, as you say, all-comprehensive and integrated. But certainly somewhere along the line you must face a deer hunter or a fisherman, who obviously believes there are deficiencies, and I am wondering when the integrated approach to resources planning comes face to face with this problem, and who decides whether or not the long-range demands of the deer hunter will be met.

MR. ANDERSON: If we look upon the needs and wants of people, if you will, as an open-ended bag which is continually getting larger and larger, and upon the existing resources of land, labor, and capital as a closed bag which is fixed, how do we meet needs and wants of people that are everincreasing in relation to the fixed bag of resources? Obviously one of the needs and wants of the people is an opportunity for hunting; somebody has to provide it so that even if the values of people change, and this becomes a need they no longer want, you are off the hook.

On the other hand, there are only so many resources to go around that can be made available to satisfy the needs and wants, and of course then you'll have a problem. As I say, I hope that I haven't given you the impression that everything is ideal in Ontario. It is not. One of the basic concepts we have to consider is the present use of resources, and we must be reasonable. You have to consider changing as little as reasonably possible present use, or you are really not looking at things realistically. If I overemphasize and get you people all upset by saying that we must look at the environment first, I apologize, but I still think that it is about time that somebody reversed the former viewpoint and begin examining environment first.

SPEAKER (unidentified): In your paper you recommended a dialogue with the public throughout the planning process, through advisory groups and public hearings. Do you find that these approaches give you all the qualitative and quantitative information that you need to set oriented goals for your people, or do you find it necessary to supplement them with some studies of public demands?

MR. ANDERSON: There are more planning principles aside from the one I gave, but time didn't permit me to discuss them all. One of the other ones is, of course, an adequate planning process and continuous data collection throughout the planning process. The only data that you get from the public, of course, are free expressions of their needs and wants. In the past the planner has gone away to a corner, done his planning using his own values, and when he presented his plans to the people concerned their reaction has been, "What the hell, this is not reflecting my values." And so it's been back to the drawing board. It takes a little longer, mind you, to listen to the public and try to see what their needs and wants are, but the time spent is well worth it, because in the long run you have a document that the politicians or decision-makers are prepared to make a commitment towards achieving. Just let me set you biologists straight on one thing. You've got to listen to the public. Let's not have so much management for resources' sake, but more management for people-oriented ends.

MR. RON JONES (Texas): I sympathize with many of the problems you have stated, which we also have in planning. I have been working on a state-wide plan for outdoor recreation in my state for a couple of years, and we have produced two previous plans that I had a little to do with, so I can agree with you thoroughly that without involving the local decision-makers and people, the plan is a failure. There is one point where I think I'm a little bit lost in your steps, and that is the first step of the scientific method, or definition and statement of the problem. I think we have to know what the problem is that we are trying to solve prior to setting our objectives and our goals, because these problems must have some priority ranking or else we'll have a never-ending need for monetary resources and we will never solve all the problems that we are faced with. So certainly we must define our problems and then we must set some priority among those problems, and this goes back to determining the demand from the public.

We have just finished a survey in Texas where we interviewed some 15,000 persons in their households, a cross-section—and this is no easy task—to determine the needs of the people. I just want to say, in closing, that I think we need to stick in some place here a definition of the problem before we got very far into the planning process and find ourselves chasing ourselves in terms of not enough monetary resources to meet our needs. Thank you.

MR. ANDERSON: I think really our biggest problem is that, having lost sight of our objectives, we immediately redoubled our effort. Our basic problem is analyzing the needs and wants of people and providing for them. How can we provide for them if we don't know what they are? This is, in my opinion, the greatest problem—we don't really know what the needs and wants of people are. For example, let me state that there are about 120 programs in the Ontario Government. Somebody has to put these in order of priority. At the present time, education is top dog—it's receiving approximately 31 percent of the provincial revenue; 31 percent of every dollar taken in by Ontario goes to education. Now where do you suppose deer hunting falls in that order of priority? Probably right at the bottom of the list, for all I know. But again the problem has been that this commitment has been made to education as the top-dog program without really forecasting the future costs implicit in such a program, and at the present time I think we are really scrambling to keep up with those commitments.

Naturally, somebody has to put these programs in order of priority from education right on down to resource management, and if the people *want* resource management or deer hunting, as the case may be, then it should be placed somewhere on that priority list. If they don't want it, then it doesn't matter what you fellows say—it won't be there.

THE BROAD PLANNING CONTEXT OF NATURAL RESOURCES PLANNING

ROBERT H. MARDEN
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I propose to set forth some views on the very considerable task of state planning for natural resource development within the larger framework of comprehensive state planning. Of obvious importance is the related topic of the major impact that federal or national policies, programs and actions have upon such state or provincial natural resources planning.

We have all been made vividly aware in the past few years how interdependent we are—as passengers on Spaceship Earth, as citizens of our national societies, as citizens of a single state or province, as consumers of resources, as members of one or several interest groups. Yet the fact that we are interdependent does not necessarily mean that we agree with each other on what should be done in particular circumstances.

On the international scale, the folly of war generally, the unchecked and massive public investment in the essentially non-productive function of creating and maintaining complex weapons systems, and the apparently irrepressible urge of nations or parts of nations to resort to civil or international war shows how far we have to go to become truly civilized. Within a nation, or within a state, we argue over how we should use the natural resources which we still have and over how much public funding should go for one public purpose—natural resource development, for instance—as opposed to allocations for other pressing public needs or demands. This type of conflict *could* be basically rational, but often it is conducted in very irrational terms. The current conflict between snowmobile enthusiasts and those who would like some peace and quiet out in the snowscape—such as many skiers and many conservationists—may well become as intense as the war between the cattlemen and the sheepmen in our western states.

At the state level and in conjunction with many federal agencies, we are beginning to devise ways of viewing all the over-all needs of the state, of its communities and of its citizens, and linking these requirements to the total resources—federal, state, local, and private—which are available to meet these needs. The general term for this activity is "comprehensive state planning." Within that concept, we must rely heavily upon the public agencies in particular fields—health services, transportation, housing, natural resources—to develop their over-all *functional* state plans for consolidation into a single, more or less balanced "package." Commonly this "package" is expressed in the state budget for the next fiscal period—one or two years, depending upon the state.

"Comprehensive state planning" is a nice phrase which rolls very easily off my tongue; but it is a great deal harder to accomplish. In its essence, the concept of comprehensive state planning includes:

First: *Defining where we are now* (in a particular field, or generally); how we got there, and what constraints we inherit from past actions or inaction.

Second: *Deciding where we want to go* in the immediate future, and increasingly, over a longer time period that for some functions is in decades. (Commonly, the outer time-frame is the year 2000 just now, but at some time we must break through into the 21st century.) This is the definition of *goals* for our unit of government.

Third: *Deciding how to get where we want to go*—that is, the technical means of accomplishing our goals.

Fourth: *Defining how much needs to be done* in given time periods—a year, five years, a decade—to get where we want to go—the particular *objectives*.

Fifth: *Allocating our scarce fiscal and human resources* in order to get those things done—the definition of *programs*.

I'm sure it is obvious that this deceptively simple listing of the components of comprehensive state planning involves massive problems of new concepts, management, organization and the basis of resource allocations for state governments.

One approach to the methods by which this may be accomplished is suggested in Mr. Anderson's paper and I would concur with many of his remarks.

However, the experience of numerous states—as well as that of the Federal Government—suggests that there are some real conceptual and practical problems in applying "PPB"—Planning, Programming, Budgeting—as it was originally proposed. It may be that the Province of Ontario *has* overcome these problems, in which case we will all be in their debt. However, based on our 1969 survey of the state of the PPB art, Massachusetts devised an alternative approach which we call the Program Management System (PMS). The primary distinction between PMS and PPB is to concentrate first on a tight analysis of the *individual programs* which our agencies currently operate. This analysis gives us a firm factual foundation on which to build. A further advantage of our PMS approach is that it is consistent with—and directly translatable into—our automated financial information system and our existing budget system. This eliminates the need for two budgets and avoids conflict with our state legislature over changing their familiar line-item budget system.

It is necessary to pay some attention to definition of goals and sub-goals at the same time, and work to link them to the detailed program definitions. At this time, PMS is *not* being applied across the board in Massachusetts.

Despite this difference in approach from that of Mr. Anderson, I absolutely agree with his five key principles. I would emphasize strongly that any governmental body considering any variant of this approach *must* realize that it is time-consuming and requires some types of staff not commonly found in state or local government. We concluded, after considerable testing, that there is no easy shortcut around the intensive central staff input in their work with the program managers.[1]

Apart from the concerns of state governments as such, there is the massive impact of federal action on state governments. This total impact arises from many diverse pressures or influences—some intentional and some accidental. In the natural resources field, increasingly there are major federal programs such as that for water pollution control—which it appears will be very substantially expanded through pending amendments to the Water Pollution Control Act of 1965.

These amendments provide very substantial sums for requirements planning, involving the state governments very directly with substate regional planning agencies. Following this planning phase will be a very large expansion of construction funds over current levels. The statewide planning of outdoor resources has been very significantly accelerated through the BOR of the U.S. Department of the Interior. It appears that some form of federal stimulus is in prospect—if indeed not a federal requirement—for statewide land-use planning. Of course, the direct federal involvement in large-scale water resource development has been of tremendous importance in many parts of the United States. Finally, there is the very extensive federal ownership of land within many of our states—whether large in total, or important in particular parts of the state.

Perhaps the most significant impact of these federal programs related to resource development is the requirement for state matching contributions towards such programs. One problem is that most federal programs are established to fit a particular need which is nationwide—but which may not be of such importance in a given

[1]*PMS, a Program-based Management System for Budgeting, Managing and Controlling State Expenditures, Volume I: PMS Described;* 1971; The Commonwealth of Massachusetts, Executive Office for Administration and Finance.

state. Yet if the state's environmental priorities are not covered by a federal-aid program, often it is difficult to secure the 100 percent state funds required—as compared with those environmental programs for which the Federal Government provides one-half or two-thirds of the cost. Consequently, the federal aid programs in the natural resources field may well "skew" the states resources development effort away from what its real priorities are.

The same problem exists on a very much larger scale when we look at the *total* range of federal-aid programs which are utilized in a particular state. There are well over 1000 such programs—although few (if any) states utilize all of them because they are directed in some cases at regional problems; for instance, the fire ant is not a problem in Massachusetts.

There is a "skewing" effect of potential federal grants in all fields of aid according to their varying requirements for state matching funds. Aside from 100 percent federally-funded programs—which only compete in terms of administrative and managerial time—the prime impact upon most states over more than a decade has been the federal highway program with its 90 percent federal dollars. While some states are beginning to reconsider whether they want to be entirely covered with concrete, the tremendous scale of the highway programs has made even the 10 percent state funding requirement a heavy drain upon state resources. Federal-aid programs for welfare and health services have increased very substantially as well in the last decade.

It is my contention that the leaders in the natural resources field will find it in their own interest to become very much involved in three areas of general public policy.

The first need is to support the establishment of more rational state planning systems that really get at the question of allocating state resources according to real state needs and priorities, rather than the highest federal-aid program bidder. I believe that such an approach would have directed more resources into the natural resources field at an earlier date than actually has occurred due to the belated public concern about pollution and related problems.

The second suggested concern is to support those proposals for federal block grants to the states—"revenue sharing"—whether they are for all purposes of state and local government, or for particular broad functional areas of such governments. To the extent that such funds are free of "matching" requirements, they will tend to reduce the pressures for state and local governments to "skew" their resources to federally-matched programs.

A third suggested concern is to support those who are pressing for a very serious look at "re-defining national priorities" as the popular phraseology has it. If the many critical needs of our domestic society are to be met and if natural resources development and maintenance are to be expanded, it is very much simpler to have a "bigger pie" to divide up. We need a bigger pie for *domestic* purposes, and that must mean cutting down on the proportion of our wealth devoted to military and space expenditures—painful though that may be for some localities who are hooked on the seductive drug of military and space industry. While you might feel that it is too heroic to urge cutting back on space or military expenditures, certainly it should be feasible to oppose whole new programs of very dubious merit—of which the B-1 bomber seems to be a case in point with an estimated price tag over the next several years of $30 billion or possibly much more.

In summary, therefore, I would urge that leaders in natural resources development in every level of organization and government must pay increasing attention to the total context within which you plan to carry out your primary concern. There will be serious clashes of opinion over what should be done, how much of it should be done, and the resources to be devoted to which activities at any given time. You will not win every time; you will not always be right. But the planning for natural resources development must—and increasingly will—take place within a broader context than has been true in the past. I believe that it is in your own interest that you pay increasing attention to the shaping of that context.

* * *

DISCUSSION

SPEAKER (Unifidentified): Within a nation or within a state or a province we argue over houses, of course, and considering the range of programs it's difficult enough to do it within the resources field; we have to weigh apples and oranges and pears and mangos when we are trying to talk about housing, about transportation, etc. And we cannot view these as single items; we have to view them in their related context and we have to realize that there will be trade-offs. We have, for instance, to encourage economic development in order to provide a better fiscal base for resources management. This may mean that some of the areas that might desirably be kept free of any settlement at all, or at least any dense settlement, may have to be devoted to industrial use or power transmission lines or whatever.

BILL MENDELL (Michigan): You have defined everything on comprehensive state planning. To me a state line is an artificial boundary. It seems to me it would make more sense if there were some kind of regional planning defined on the resource base itself, let's say a drainage basin or a mountain range, or something like that.

DR. MARDEN: That was a very good point, and I'm happy to say that we in Massachusetts in New England are taking the lead in that kind of activity; we have one of the so-called Title-Five Commissions like Appalachia. This one involves a total area covering all the six New England States, and it's called the

New England Regional Commission. It has a very strong concern with environmental matters. We are conducting a pilot total assessment of need and input of resources of the natural river basin which is located both in Massachusetts and New Hampshire and falls into the Merrimac. We are contemplating another interestate river program of that sort and we also deal through the New England River Basins Commission with the total range of river basin concerns in New England. They have just proposed, for instance, a total Connecticut River watershed planning activity. Furthermore, the proposed amendments of the Water Pollution Control Act of 1965 will give a tremendous boost to basin planning as well as to planning of substate areas for land use and their related settlement pattern. I'm happy to say Massachusetts is making a pilot program covering the budget and requirements for that act.

Such action is going to provide a tremendous boost to state land-use planning, very bluntly defined but centered, of course, on the particular needs of the Environmental Protection Agency. Now, we intend linking that with transportation planning, with settlement planning, with new communities and housing planning, in an attempt to get at some of the questions which concern all of us about what should we be doing, and what we want our state to be like, in 10, 20 or 30 years from now, and what we do about it now.

MR. WILLIAM BELLER (Environmental Protection Agency): I want to speak on a very important question that was brought up, which is priority. It was brought up in the last two talks, and we have spoken about involving the public and asking them what they need and want. I think that is essential. But there is another side to this coin that has not been looked at much, and that is to ask the public what they are willing to pay for. Are they willing to pay for another beach?

You know, on the election ballots we say that we'll have bonds for education, bonds for sewers. Do we ever have bonds for more fishing, for more open spaces? So, when we ask people questions, I suspect, we can't say: "Do you want another beach?" Of course the answer is yes, but are you willing to have another beach at a 10-cent increase in your real estate tax? So what I'm suggesting is this, and I'd like to pose it as a question: Can't we establish priorities and marry what the people need and desire to what they are willing to pay for, and put this into our inquiries as well as what would you like Santa Claus to give you?

DR. MARDEN: That's a good example. It's the type of problem a governor or a President would deal with, when there is a finite amount of resources and almost literally an infinite demand in infinite subjects. We are beginning to do this in Massachusetts, and I suppose that is to some degree an indication of the inadequacy of past efforts, but now we've got our state budget up to two billion dollars, and we have not looked at it across the board in terms of relative priority, but in terms of non-priority or particular enthusiasms of the moment. So now in Massachusetts we have 400 million dollars bonded for natural resource activities—that's from the BOR and I think we are one of the leaders in that.

But the question is a very real one. If my memory serves me, the total water pollution control needs in Massachusetts have been roughly estimated at one and a half billion dollars in the next five years. Now, we certainly aren't going to have that amount of money either from the Federal Government or from Federal Government aid handouts. We are not going to be able to do all those things that are desirable, and the same thing will apply in almost every functional field. We need 600 million dollars to get a fast railroad network from New York to Boston, which we need because if we do, we can avoid building 1½ billion dollar new jet-port somewhere—I don't know where, because nobody wants to have it in his backyard. But the point is if we can do one we can avoid the other. However, we don't even get the 600 million for the railroad.

This is the kind of thing which State governments either singly or jointly in a regional area and in conjunction with the Federal Government, are going to havet o approach on a much more realistic and tough basis. We're just going to have to realize that there aren't enough resources at hand. If we cut out the space and the military budgets entirely, we still could not do it. So we are going to have to strike a balance. There's going to have to be some trade-off and it's going to be difficult, but such changes are unavoidable.

DISCUSSION LEADER BOSSENMAIER: I would like to ask Dr. Marden a question and to make a comment. There are some differences between Canada and the U.S. in the fish and wildlife management programs. In Canada the provinces must go to the General Treasury and make their case while in the U.S. there are earmarked funds from central agencies and fishing fees that give some money to the program. From what you said, I believe you think this is too narrow an approach. Do you think that wildlife interests would fare better if, instead of earmarked funds, they made a case for funds from the General Treasury?

DR. MARDEN: My impression is that as our budgets are very rapidly expanding. There would be more dollars which could be available for these purposes if they were not earmarked. I don't know the exact amount of earmarked fish and wildlife license fees in Massachusetts, but I suspect it is quite small as compared with the real needs. The costs are escalating faster, I think, than the production of pheasants that are released in the areas where the hunters want to shoot them. I think they would do better and it would be very much simpler in allocating resources on a rational basis. It is then up to your interest groups to make very sure that their voices are well heard in deciding where those priorities go, but I haven't noticed any great reticience on the part of the fish and game folk.

MR. RON YOUNG (Director of Planning, Texas Parks and Wildlife Dept.): I'm not trying to be trouble maker but some of these things bother me. One is we mention river basin planning. We are presently doing a pilot environment study with the eight counties surrounding the Houston-Galveston area. We are running into a severe data problem. We have the SCS collecting data on a river basin basis, we have counties who have collected data on a county basis, we have a coastal management study going on where they have arbitrarily stepped back 50 miles from the coast. Then when you try to put all that together, it doesn't fit. Then you have all the census data and all your socio-economic data on a country basis and somewhere we have got to put together and collect our data in a manner which can be simplified and analyzed in a meaningful manner. Right now, it's impossible. Therefore we should sit down and make a decision on the way the data is collected. In fact it's not even collected in the same units. Do you have any comments on that that might help us?

DR. MARDEN: You are absolutely correct about the chaos we find ourselves in and one of the advantages of your state and the other states of plowing along on the definition of budgets required to do the planning that is going to be required by the Muskie Bill and the Burke Bill is that you can define those needs and its 100% funding for the first two years, which solves one problem right away. Now how much there will be I don't know, but in Massachusetts we estimate a minimum of 7 million dollars over the next two years. And we very early hit the data problem exactly as you described it, and our office has responsibility for coordinating that as part of the joint planning of the communities in development the Environmental Affairs Secretariat, the Transportation Secretariat and the central administration and finance enterprise. And I would hope that you could assemble enough central authority to tackle this issue. It is absolutely mandatory. Not only is the data we have extremely fragmented and on an indefinite basis but there is a lot of data that turns up that nobody has and you have to put the two together.

CHAIRMAN MARSTON: Massachusetts has shown remarkable foresight over the years. You secured an ample water supply for Boston years before other northeastern cities found themselves in trouble. You were leaders in the formation of local planning commissions.

DR. MARDEN: As some of them you may know Hank Foster who is now Secretary for Environmental Affairs, and Governor Sargent, who was formerly head of the Division of Fisheries and Games, started this out with coastal wetlands and about 1965 extended it to inland wetlands, the flood plains and the marshy areas inland, which we have a good many. In 1967, we had some bad floods, and encroachment on flood plains was one of the reasons why we didn't have much trouble getting the law through. Basically it does not affect private ownership. It affects what an owner can do. There are a lot of hearings, but it does prevent the development of land by filling, by dredging, and so forth either in the coastal zones or the inland wetlands. We have been enforcing that in my office, through a view of all federal aid projects. Fortunately we find that many of them are lands which require at least clearance under the Lands Act as to whether or not there is an encroachment, particularly in inland areas.

MIDAS—A TOOL FOR NATURAL RESOURCE DATA MANAGEMENT

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INTRODUCTION

Maine's planning function, briefly stated, is divided into 15 work areas. They deal with resources inventory; species use and abundance; land and water use; habitat availability, current and future; human use opportunity and demand; formal problem identification and analysis; all culminating in the development of broad species management plans and programs coordinated with other environmental users, both public and private (Appendix 1).

Acceptance and funding of the planning proposal was obtained in June, 1969, from the U.S. Department of Interior, Bureau of Sport Fisheries and Wildlife; and National Oceanographic and Atmospheric Administration, Marine Fisheries Service, as a joint undertaking. Completion of the initial effort is expected in mid-1972-73. At that time, broad plans for high priority species will be available with program recommendations and alternative avenues of management suggested.

The key to successful completion of such an undertaking is a comprehensive data base, cutting across the traditional lines of mandated agency responsibilities.

The intent in this presentation is to discuss techniques for data inventory, processing and management. Throughout the years, an enormous investment has been made by local, state, federal and international governments and agencies for the acquisition of knowledge relative to natural resources and man's impact on them.

The cornerstone of this information pyramid (Figure 1) is the individual data collector at the field level. This professional has, in his particular discipline, identified certain items of information specific

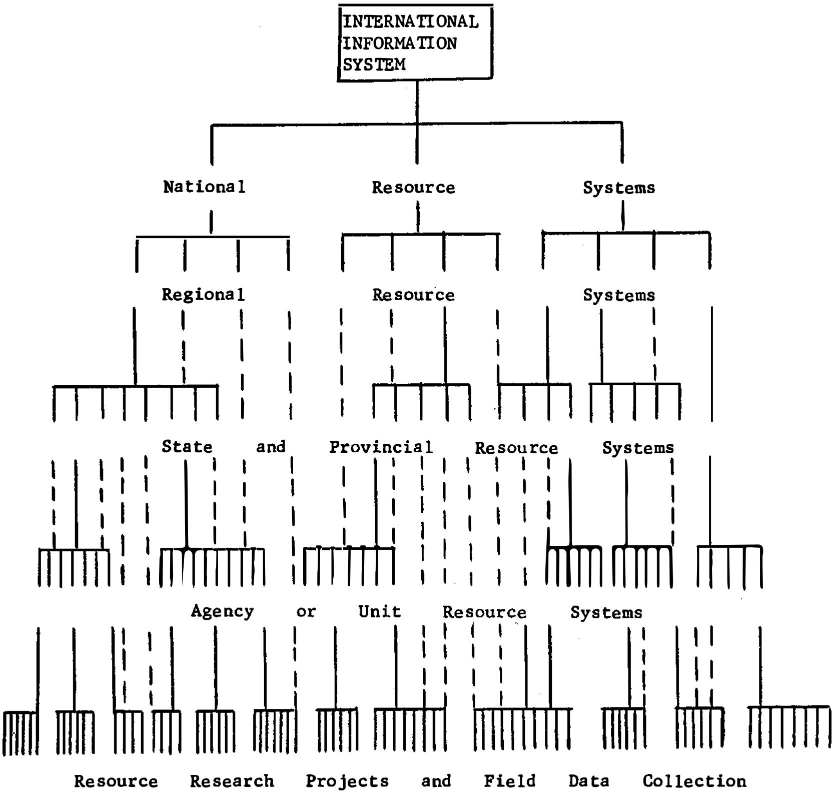

Figure 1.—Information Pyramid

to his technical requirements. However, due to lack of time, money and personnel, the professional has been unable to develop sophisticated computer programs or build and access other data bases that would be valuable for analytic and forecasting processes. This is because many of the data bases, often manual, are collected, stored and manipulated by agencies or groups over which he has no direct control. Thus, he cannot access or use these data as input to his analytic or modeling programs. The result is enormous duplication of data collection efforts, coding and processing of resource information that is required by many agencies but totally inaccessible or usable by these agencies.

Having outlined the dilemma, this leads to the *first step* in the development of a comprehensive inventory—*Search and Identification of Existing Data Sources.*

The principles for investigating existing data sources include the following:

1. *What* files are being maintained?
2. *Who* maintains them?
3. *What* is in them?
4. *Where* are they?
5. *When* were they instituted?
6. *Why* are they maintained?
7. *How* are the data maintained?

Fifteen criteria for information evaluation were established in order to standardize the investigation of existing data sources from the many areas of activity relating to or affecting natural resources. These criteria include:

1. Identification of the collector and user of the data in relation to the functional requirements of the file or agency.
2. Specific purpose and relevance of the items of information in the files (data elements).
3. File size (volume of records).
4. Data source—map interpretation, field survey, questionnaire, etc.
5. Purpose of the file.
6. Year the file was instituted (base year).
7. Frequency of update (daily, weekly, monthly).
8. Frequency of data use (daily, weekly, monthly).
9. Data reliability if sampling techniques were used in collection of the information.
10. Extent and accuracy of geographic coverage (state, biological zone, coordinates).
11. Method used to identify units of measurement (kilometers, feet, quantity).
12. Confidence level of the edited data.
13. Format of the information.
14. Capability for cross-reference to other files.
15. Data processing techniques applied to the file.

After selection of the criteria used to relate and evaluate data, a detailed survey was instituted to identify potential generators of natural resource information. This was not restricted to the two coordinating Departments, but included 35 federal, regional, state and private agencies.

DATA SURVEY

The initial data survey contained characteristics of over 300 data files. Subsequent analysis identified 170 data files of critical significance to an environmental data resource system.

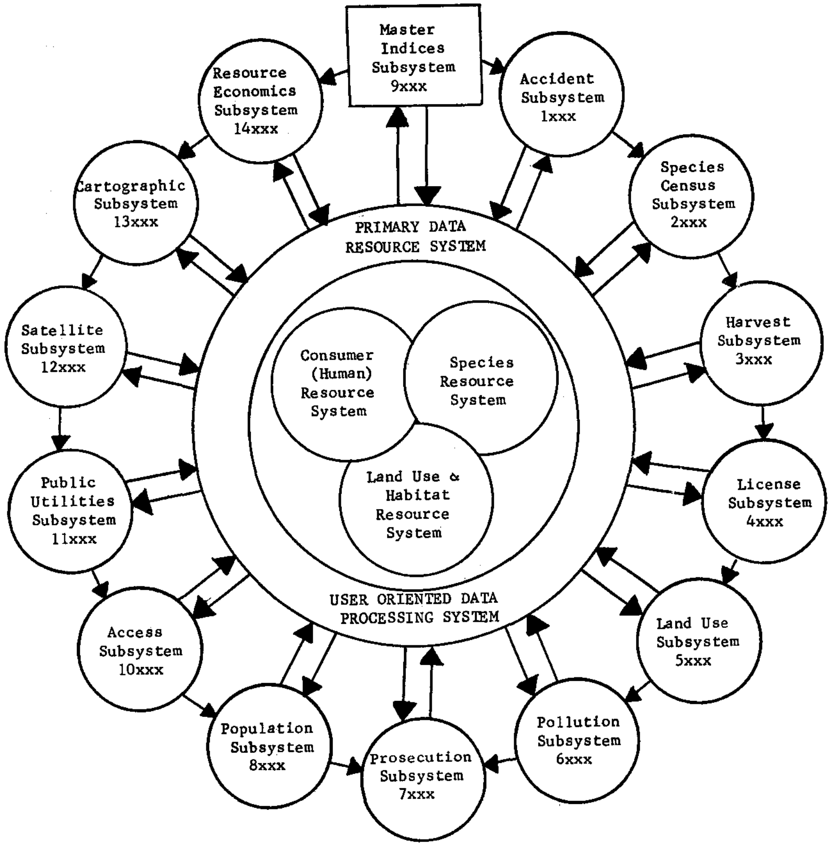

Figure 2.—MIDAS Schematic

First level analysis of the existing data files revealed that they could be divided into three basic categories:

1. Those relating to *Resources*—primarily concerned with data files that pertained directly to the various fish, wildlife and marine species.
2. Those relating to *Habitat*-natural factors making up individual living environs (land, water, air and vegetation).
3. Those relating to *Demand*—aspects dealing with human, commercial and natural competitors for Habitat and the Resource.

Secondary analysis classified the information into 12 functional areas: (Figure 2)

1. *Accident* Subsystem which maintains data files relating to

natural resource accidents (e.g., hunting, boating, snowmobile).

2. *Census* Subsystem which maintains data files of the population characteristics relating to fish, wildlife and marine species.
3. *Harvest* Subsystem which maintains files relating to removal of fish, wildlife and marine species from their natural habitat.
4. *License* Subsystem which maintains all hunting, fishing, and trapping licenses issued to potential harvesters of fish, wildlife, or marine species, as well as corporation licenses to do business in Maine, both Domestic and Foreign.
5. *Land Use* Subsystem which maintains information files relating to land development, both existing and potential.
6. *Pollution* Subsystem which maintains data files relating to environmental quality.
7. *Prosecution* Subsystem which maintains data files relating to violations of fishing, hunting, and trapping statutes, both recreational and commercial.
8. *U. S. Census* Subsystem which maintains data files relating to human population and housing characteristics.
9. *Master Indices* Subsystem which maintains data files on political boundaries, functional geographic units, and fixed geographic characteristics such as lakes, islands, rivers and streams.
10. *Access* Subsystem which will maintain data files on road networks, public and private.
11. *Public Utilities* Subsystem which will maintain data files on power usage as collected by public electric utility companies.
12. *Satellite* Subsystem which will maintain data files as collected by the NASA-ERTS, EROS, NIMBUS, and SKYLAB experiments.

DATA MATRIXING

As part of the classification of the individual files into respective subsystems, a "Matrixing" procedure was developed for individual data elements.

This procedure consisted of a two dimensional cross reference of each file and its component data elements, by subsystems.

The procedure immediately identified duplication of data collection, data elements, alternate sources of compatible information and data voids.

PRIORITY ESTABLISHMENT THROUGH OBJECTIVE EVALUATION

Implementation priorities were established by objectively applying the 15 criteria to each data file.

DATA FILE PREPARATION

In preparing the 170 data files for processing by MIDAS, four basic steps were performed.

1. Establishment of the number of positions required for each data element (field size)
2. Identification of the codes and classification to be used in representing the information within a data element (coding scheme)
3. Construction of a combination of data elements that uniquely identified one record (control field) and finally
4. The logical arrangement of data elements (file format).

DATA MANAGEMENT AND PROCESSING

A data management system was found to be necessary due to the volume and intricacy of the files and the number of items of information contained in each of the 12 information classifications.

Of the several alternatives available, only one provided a reasonable answer to the problem. That answer was the computer based system.

DESIGN CRITERIA

In designing the computer programs (software) for MIDAS, the following criteria were established.

1. The system had to be *flexible* and *adaptive* to regional, national and international needs as well as those of the State.
2. The system had to be dynamic; *i.e.,* from the standpoint of new data sources entering the system, the content of output reports constantly being changed, and the inevitability of changes in existing data source forms.
3. Large investments in specialized talents of systems analysts and computer programmers could not be required for the system to be responsive to changing needs.
4. Routine control of data files entering the system, and data reports generated by the system, had to be the responsibility of individuals who had minimum knowledge of computerized data processing.
5. The software must be easily modified to correspond to changes in computer configurations.
6. Confidential data had to be protected by the system.

To meet these needs the English Language Information Analysis System (ELIAS) was developed.

SYSTEM SOFTWARE

ELIAS is a collection of computer programs controlled by a master program called the *Supervisory Module.* It is activated by commands directed toward specific actions to be performed on files contained within the system.

In summary form, the ELIAS functions are:

1. *Create.* This command instructs ELIAS to build and format a file of data elements from punched cards onto either magnetic tape or disk.
2. *Edit.* This command instructs ELIAS to verify the contents of data elements within a specific file.
3. *Update.* This command instructs ELIAS to change either the contents of a data record within a file or add new items of information to that file.
4. *Expand* instructs ELIAS to take items of information describing geographic areas from the master geographic index and add them to data files maintained within the system. This function is the key which allows aggregation and comparison of information collected by different agencies or groups.
5. *List* is the ELIAS command which allows a single file to be selected from a subsystem of many related files and printed out in its entirety.
6. *Copy.* This instruction causes ELIAS to make a duplicate magnetic tape of the file selected.
7. The *Merge* command causes ELIAS to combine data for the same file for more than one year to form a historic data base for trend analysis.
8. *Manuals* tells ELIAS to produce detailed instructions for preparing data files to be added to and processed by MIDAS.
9. *Report* allows the *user* to instruct ELIAS to produce summary reports by accessing any combination of relatable data files in the system. These consist of free form English language statements that supply the following kinds of information to the computer system.
   a. Report Requester.
   b. Records that are to be used in preparing the report.
   c. Sequence in which the data is to be reported.
   d. Calculations to be performed on the data for the report.
   e. The format of the report.

While some data can be presented in tabular form, it is realized that graphic presentations, in some cases, have much more meaning and utility to the user. Therefore, in addition to tabular reports, the user may request that a bar graph or a computer-produced map be generated. The bar graph function will convert each line of tabular data to percentages, and produce graphs that are scale flexible based on the highest percentage value contained on the graph. Maps will present summarized numeric values with the scale of mapping being variable.

To increase system effectiveness and efficiency, the retrieval software is capable of producing up to 256 reports with one "pass" of the data files. Production of reports can then be scheduled and batched for production instead of processing one report whenever the need arises.

ELIAS-VARIABLE DATA DICTIONARY

The purpose of the Variable Data Dictionary is twofold: (1) control all ELIAS functions by describing all data that can be processed by the system and (2) to provide the user with a source document containing all items of information in the system. Unique titles are used to describe these data. The same data element can be described by two or more completely different names. The Dictionary is established initially when the system is loaded, and does not have to be created each time the system is run.

INTERFILE LINKAGES

Interfile linkages are made through the Master Indices subsystem which maintains a hierarchy of geographic descriptors and UTM coordinate values. A common link between data bases exists when two or more independent files can be related for the same geographic area. If, for example, comparisons must be made between census of available species and the harvesting of those species, on a county basis, there must be a link between census and harvest by county. Through file expansion, the system will place county identifiers in both files.

Since all files contained in the system are linked through the MBI, changes in geographic boundaries, or the addition of new geographic levels (once reflected in the MBI) can be made to all other files in the system without manual interpolation.

In summary, MIDAS represents a versatile tool for the administrator, planner, or research specialist who is seeking facts in his attempt to shape and direct the future use and perpetuation of our vital natural resources.

This technique also provides the nucleus for an information management system capable of coordinating, processing, and displaying information so critical to decision makers in government and private industry. Sound decisions, made with the benefit of clear, concise, and current information, will result in positive action and not startled reaction.

APPLICATIONS

The Maine Information Display Analysis System became operational in July, 1971. During the first six months of data base implementation, a variety of diversified information has been provided to users of the system. Some examples of the use of this tool are:

1. The location and array of named Maine lakes by County and size in acres.
2. A profile of hunters and fishermen by license type and age group.
3. The identification of vulnerable coastal wetland areas by type of wetland, watershed, present vulnerability, and acre classification.
4. Analysis of beaver pelts by town of kill and pelt size.
5. An age profile histogram of lobster fishermen by region of residence (coastal *vs.* inland).
6. The relationship of posted land to total land to deer harvest by town.
7. The seasonal violations of recreation statutes.
8. A selection of trapping licenses for sampling by questionnaire.
9. Summaries of survey results for factoring and trend analysis.
10. Listings and maps of bobcat bounty harvest by hunter, town of kill and hunting method.
11. The identification of major environmental polluters by body of water and type of discharge.
12. The characteristics of lobster fishermen (Figure 3).
13. The revenue received from big game violations by residence of violator.
14. All recoveries of birds banded in Maine since 1920 by state of recovery and species.
15. Trends, since 1940, of water quality at sampling stations for selected lakes.

APPENDIX

Work Plan 1: An Inventory of Current Land and Water Use in Maine.

Land and water use data are being collected for the purpose of determining the overall environment of inland fish, wildlife and marine species.

Work Plan 2: An Inventory of Current Inland Fish, Wildlife and Marine Habitat.

This work plan is designed to describe and record basic characteristics of currently available habitat for major species groups and to determine the amount and distribution of these basic habitat types.

Work Plan 3: Current Inland Fish, Wildlife and Marine Species Use.

Current hunter and fisherman use estimates, recreational and commercial, consumptive and non-consumptive are being investigated for the primary species groups of the state.

Work Plan 4: Land and Water Use Projections.

Land and water use trends are being estimated to the year 1980, including methods development for periodic update.

Work Plan 5: Projection of Future Habitat Availability.

Habitat quality and quantity for the major species of the state are

The User Request was submitted as follows:

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Requestor H. Hasey, Department of Sea and Shore Fisheries
Display Format New Sequence 346R-Name-Town
Select 346R-Town > 0 and 346R-#-Traps-Average > 0
Compute Lobster-Days      = 346R-#-Days-Lobsters
Compute #-Fishermen       = 1
Compute Lobster-Months    = 346R-#-Months-Lobsters
Compute Common            = 1
Compute Average-Traps     = 346R-#-Traps-Average
Computed Average-Days     = Lobster-Days    / #-Fishermen
Computed Average-Months   = Lobster-Months  / #-Fishermen
Computed Average-Trips    = Average-Traps   / #-Fishermen
Computed Trap-Days        = Lobster-Days    * Average-Traps
TOTAL                                                          CT
                       STATE OF MAINE                          MH1
              LOBSTER FISHERMEN CHARACTERISTICS                MH2
               COMPLETED QUESTIONNAIRES ONLY!                  MH3
                           MIDAS                               MH4
Lobster  Number Number Number  Average Average Average    Trap HH1
Fisher-    of   Months   of      No.     No.     No.      Days HH2
 men      Days          Traps   Days   Months   Traps
#-Fishermen Lobster-Days Lobster-Months Average-Traps Average-Days HDO1
Average-Months Average-Trips Trap-Days                         HDO2
Town                                                           VHO1
346R-Name-Town                                                 VDO1
```

And the Output Report was:

```
    TOTAL    REQUESTER H. HASEY, DEPARTMENT OF SEA AND
                     SHORE FISHERIES
                     STATE OF MAINE
             LOBSTER FISHERMEN CHARACTERISTICS
              COMPLETED QUESTIONNAIRES ONLY!
                         MIDAS
```

	Lobster Fisherman	Number of Days	Number Months	Number of Traps	Average No. Days	Average No. Months	Average No. Traps	Trap Days
TOWN								
Sorrento	8	175	60	1,275	21.87	7.50	159.37	223,125
Shapleigh	1	20	12	100	20.00	12.00	100.00	2,000
Sedgwick	5	82	20	1,185	16.40	4.00	237.00	97,170
Sanford	6	104	35	455	17.33	5.83	75.83	47,320
Saco	16	303	96	2,455	18.93	6.00	153.43	743,865
Rockport	10	198	56	705	19.80	5.60	70.50	139,590
Rockland	74	1,480	511	9,300	20.00	6.90	125.67	13,764,000
Randolph	1	20	3	12	20.00	3.00	12.00	240
Prospect	1	20	3	150	20.00	3.00	150.00	3,000
Pownal	4	85	20	608	21.25	5.00	152.00	51,680
Portland	116	2,341	627	21,379	20.18	5.40	184.30	50,048,239
etc.								

Figure 3

being projected to the year 1980 with development of methods for systematic update of these trends.

Work Plan 6: Current Inland Fish, Wildlife, and Marine Species Abundance.

This work plan's objective is to determine major species population levels and trends, as well as their statewide distribution.

Work Plan 7: Current Human Use Opportunity Estimates for Inland Fish, Wildlife and Marine Species.

Current human recreational and commercial use opportunity will be determined for the major species.

Work Plan 8: Current Human Use Demand Estimates for Inland Fish, Wildlife and Marine species.

This work plan is designed to estimate current demand for hunting, trapping, and fishing on a statewide basis as well as estimation of current demand and supply levels for commercial marine resources.

Work Plan 9: Future Use Opportunity Projections for Fish, Wildlife, and Marine Species.

This work plan is designed to project future use opportunity on a state wide basis as well as economic supply information for commercial species, to the year 1980.

Work Plan 10: Future Demand Projections for Fish, Wildlife, and Marine Species Use.

Projection of future demand will be used for guiding current programs and as a base to justify new program development.

Work Plan 11: Analysis of Current Demand vs. Current Use Opportunity for Inland Fish, Wildlife, and Marine Species.

This work plan is designed to compare current use opportunity for recreational and commercial fish, wildlife and marine species against the demand for these species.

Work Plan 12: Analysis will be used to reveal what species will be available for use in the future and what demands people will place on them.

Work Plan 13: Inland Fish, Wildlife, and Marine Resource Problem Identification and Evaluation.

Before planning can proceed in a logical manner, problems of the resources must be identified and evaluated. This work plan sets forth guide lines for controlled analysis.

Work Plan 14: Species Management Plans and Program Evaluation.

Existing programs will be evaluated and broad species management plans will be developed for fish, wildlife, and marine species.

Work Plan 15: Coordination of the Fish, Wildlife, and Marine Resources Planning Process.

The objective of this work plan is to coordinate the planning efforts of the Departments of Inland Fish and Game and Sea and Shore Fisheries with those of other natural resources agencies through liaison with the State Planning Office.

DISCUSSION

MISS ROBERTA WINN, (Denver, Colorado): Since I am operating a computer system myself, I was interested in how you indicate in your file where your information comes from or have you lost that by the time you get your file set up?

MR. YOUNG: Every data record that enters the microsystem contains a 4-digit-number. This number identifies, first of all, the sub-system to which the data belongs; secondly the unique identification of the files in the sub-system and, lastly, the agency where this data came from. We are currently processing data from around 15 agencies in the State of Maine, in the federal area, and in the private sector, and we have not lost the identification of these records as they go through the system.

MISS WINN: May I make one other comment as long as I am at this microphone. What we have been operating, of course, is an information retrieval system with federal aid, wildlife reports, and literature. Some of you do not know about this in fisheries and wildlife. Here again, this is an attempt to bridge the gap between what is being done in one State to what is being done in another. Whereas this gentleman was interested primarily in what applied to Maine only, our system now is applying its information as to what is available that applies to many States in area researching in fish and wildlife.

MR. YOUNG: It's nice to know that we are both proceeding along the same lines. MIDAS was implemented and developed in the State of Maine, with the idea that the system could not remain in Maine. The master indices subsystem which I mentioned contains these geographical identifications and because it is a coordinated data system it does not pay any attention to major political boundaries such as county lines, state lines, the coast line, etc. We can extend this to cover any place on the earth.

CHAIRMAN MARSTON: When will documentation for the system be available?

MR. YOUNG: A complete set of all documentation is available in the State of Maine currently. There is not only all detailed specifications for all the computer programs in the system, but also a design for it and a manual for uses, and the computers have the capability of accessing the data themselves.

MR. HOWARD SPENCER (Maine Department of Fish and Game): As an administrator who has occasion to use this system that Bob has been talking about, I would simply like to say that it is as good as he says it is. In my opinion it works; it has worked for me on all occasions that I have made use of it. All of our problems, of course, are not solved by this thing immediately and it doesn't automatically bring all of our natural resources agencies within the state into the picture. I think this is the future need and the thing that we have got to strive very hard for in Maine to bring all of our natural resource planning under this MIDAS system and get this data loaded into the bank.

The Fish and Game Department itself certainly cannot carry the entire financial load of accomplishing this rather sizable task. I might point out also one rather unique feature in Maine which is the land ownership patterns which result in a very large proportion of the State, well over a third of it, and certainly in excess of 8 or 10 million acres being held by perhaps 15 or 20 large private landowners. These are commercial forest lands, of course, and this system is available to these people and we are encouraging these people to send their data into this system, too.

MODELS FOR SUPPLY AND DEMAND ANALYSIS IN STATE FISH AND GAME PLANNING

ROBERT K. DAVIS
Research Professor, George Washington University, Washington, D.C.; and

JOSEPH J. SENECA
Associate Professor, Rutgers University, New Brunswick, New Jersey

Concern for the problem of estimating demand for fish and game resources on a state-by-state basis arises out of amendments to the Federal Aid in Wildlife Restoration Act (H.R. 12475, 91st Congress, 2nd Session), which enables a state to prepare and submit to the Secretary of the Interior a comprehensive fish and wildlife resource management plan. "Such plan shall be for a period of not less than five years and be based on projections of desires and needs of the people for a period not less than fifteen years." The act further stipulates that plans will be updated at intervals of not more than three years.

In order to develop these plans state fish and game agencies first have to identify those factors over which they can exert some control. Because wildlife populations are influenced by the management of land and water resources for the most part under the control of private individuals and other government agencies, state wildlife administrations have an intricate problem in identifying an effective choice of actions. Within the limits of possible spheres of action for fish and wildlife agencies the chief problem for planners is that of analysis of the dynamics of the two interdependent variables, supply and demand.

As a working definition of the problem of state fish and game planning we propose that it is concerned with:

1. Modelling the factors of supply and demand which influence the recreational uses of the state's wildlife resources;
2. Estimating the quantitative influence of the causative factors on supply and demand;
3. Projecting the direction and magnitude of change of the causative factors over the planning period;
4. Evaluating the implications of the projections and responding with a program designed to maximize the net welfare effects of the changes foreseen (including their modification where indicated).

SUPPLY AS A VARIABLE IN PLANNING

Although this is a study of demand, it is useful to establish a perspective on supply. In fact, planning may be viewed as supply management by many fish and game agencies because they do not choose to manage demand and prefer to think of their role as doing all that is possible to satisfy a given level of demand. What this view omits, of course, is the fact that supply influences demand. Build a good fishing lake and the sale of fishing licenses in the vicinity will certainly be different than without it.

Supplies are often taken as derived directly and immutably from resource inventories, but there is seldom anything fixed in practice in the supplies of resources. Even fixed quantities of hunting and fishing resources can be managed in a variety of ways to give a variety of opportunities for enjoying wildlife resources. The actions which the state agencies can take to manage supply range from acquisition of lands and waters to influencing land-use policies. The important thing to the planner is that each possible action has an effect and a cost. The role of planning is to identify the actions which can be taken and to provide a ranking of them in terms of cost-benefit or cost effectiveness. Without this kind of analytical support correct choices can be little more than fortuitous.

DEMAND AS A VARIABLE IN PLANNING

Much of economic theory and statistical measurement has been preoccupied with the laws of demand.[1] In its purest form demand is a relationship between quantity and price. The quantity of a good taken by a consumer or a group of consumers is a function of the price they are required to pay. The fact that hunting and fishing or bird watching are not sold in markets does not mean that these activities are immune from the laws of demand but only that we must be somewhat inventive in studying the relationship.[2]

The price-quantity concept of demand for outdoor recreation is useful in making studies of benefits or willingness to pay, but where projection of future participation is at issue and where the markets are not organized. a broader concept of demand is useful. Demand, or more properly, use or participation, may be viewed as a function of the personal characteristics of the person or the population at issue. Thus, the quantity of a good taken or the user-days of a kind of recreation consumed by a population may be thought of as related to the income, age, education, location of dwelling, ethnic background, and other specific characteristics of the population. The opportunity for participation may be reflected in such variables as location or income level or population density, all of which can be used to

1Frederick V. Waugh, *Demand and Price Analysis*, USDA, Technical Bulletin No. 1316, Washington, D.C., 1964, presents a very informative discussion of demand.

2A review of the classic studies of outdoor recreation demand is found in Marion Clawson and Jack Knetsch, *Outdoor Recreation Demand*, Baltimore: Johns Hopkins Press, 1967.

identify urban areas with reduced access to the outdoors. If variables such as acres of high-quality habitat or of fishing waters can be found, they can be substituted for opportunity proxies and thus permit the study of the impacts of supply on participation.

If our model can successfully incorporate both the demand and supply variables, we will have an interaction model which offers possibilities both for projection and simulation. Our purpose in this paper will be to report on research with models of participation which integrate supply and demand factors and provide the basis for simulation as a method of planning.

A BRIEF SURVEY OF ALTERNATIVE MODELS

In order to be of practical value, the model employed should: (1) be applicable to state level planning, (2) incorporate the effects of supply available, (3) deal with the volume of use, (4) be as specific as possible in dealing with activities, and (5) provide a basis for projecting future levels of activity under alternative conditions.

Our examination of alternative models led quickly to the conclusion that the various studies based on national surveys by the Outdoor Recreation Resources Review Commission and the Bureau of Recreation would not produce results applicable to the individual states. Moreover, these nationwide studies have not been successful in dealing with the effects of supply, but for the most part have emphasized population characteristics.

Although a few states have household survey data on participation to match the nationwide surveys of ORRRC and BOR, all states have license sale data on a county basis. These licenses sometimes distinguished between different species of big game, cold and warm water fishing, and certain other activities, and county duck stamp sales identify the waterfowl hunters. Dealing with the county unit also permits the effects of supply to be studied if inventory data are available.

One shortcoming of county license sale data is that they represent participants rather than amounts of participation. In order to estimate volume of use, it is necessary to know the average number of days participation by activity. This information is available from hunter and fisherman surveys although all states do not have both kinds of surveys. Nonetheless, the information is routinely collectable from licensees.

With respect to providing for projections of the future, the issue is whether to employ time series models or cross-section models. While time series data are commonly used for projections, this method is not especially satisfactory on a number of grounds. First, historical statistics on county license sales are not likely to be kept. Second, inventories reflecting the supplies are not available over time. Third, if supply inventories are available, they are not likely to reflect much change so that supply effects will probably not be significant. A cross-section analysis, which permits many observations at a point in time, appears to be a more satisfactory method for detailed, policy-sensitive analysis of license buying behavior and should also prove satisfactory as a means for projection.

CROSS-SECTION ANALYSIS

This paper focuses on our efforts to apply a cross-section model in two states, Nebraska and Iowa, and indicates the appropriate extension of the empirical results to state resource planning. The model uses the county as the unit of observation. License sales of any particular category are functionally related to various demand characteristics of the county and to measures of recreation supply opportunities.[3] The primary objective of the cross-section county model is to quantify statistically significant supply (or opportunity) influences on license sales. The supply variables are the crucial aspect of the analysis since their elasticities (*i.e.*, ratio of percentage change of license sales to the percentage change in the supply variable) can be used to obtain latent demand measures. The primary importance of elasticities to the working of the model is that their use permits simulation or projections of changes in county license sales on the assumption that each county moves proportionately to the percentage changes in the supply and demand variables. This avoids the necessity of computing from scratch equations for each county with the attendant initial distortions between actual and computed values for many counties.

The data requirements involve obtaining statistics on various kinds of licensing and on demand variables (e.g., population density and median income) and supply variables on a county basis. Conventional demographic sources (such as *The County-City Data Book*) provide the demand variables. The supply variables are constrained to those available measures of wildlife habitat and water areas already gathered by state authorities on a county basis.

In Nebraska and Iowa supply measures were discounted by a weighting system according to their distance from the population center of the county. The purpose of discounting supply variables by distance is

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[3]Thus, the general form of the relation is:

(1) $L^i_j = f(D_{j,k}, S_{j,m})$

where L^i_j is license sales of type i in county j; $D_{j,k}$ are k demand variables of county j, and $S_{j,m}$ are m supply variables of county j.

TABLE 1. DISCOUNTING WEIGHTS FOR SIX EXPRESSIONS OF DISTANCE-WEIGHTED SUPPLY VARIABLES

Mode	Opportunity Variable
11	$\epsilon_j \left(\text{Supply variable for county i / mi.}_{ij}^{1/2}\right)$
12	$\epsilon_j \left(\text{Supply variable}_i \text{ / mi.}_{ij}\right)$
13	$\epsilon_j \left(\text{Supply variable}_i \text{ / mi.}_{ij}^{3/2}\right)$
21	$\epsilon_j \left(\text{Log. supply variable}_i \text{ / mi.}_{ij}^{1/2}\right)$
22	$\epsilon_j \left(\text{Log. supply variable}_i \text{ / mi.}_{ij}\right)$
23	$\epsilon_j \left(\text{Log. supply variable}_i \text{ / mi.}_{ij}^{3/2}\right)$

Note: The weights used in the discounting procedure were various expressions of distance and are referred to as modes.

that distance acts as a deterrent to recreation participation because it involves costs (money and time). Thus, distance is frequently regarded as a proxy for price and a potential demand schedule and benefit measure. Our interest centers on exactly how much of a deterrent distance represents and we specify six weight schemes in forming the discounted supply variables. (See Table 1).

Examples of equations tested by the model and their results are presented in Table 2.[4] The first equation (which used Nebraska data) expresses county hunting licenses (THL) as a positive function of aggregate county income (AGY) and is negatively related to population density (POD) and the percentage of households with incomes less than \$3000 (Y3L). Specific supply variables—lagged pheasant (PEH) and cottontail (COH) harvests—were positive influences on total hunting license sales. The fit of the equation is high ($R^2 =$ .9762) and all the variables are significant at the 95 percent level. An equivalent equation for fishing license sales was used and also yielded satisfactory results.

Equations (1) and (2) are illustrative of the entire Nebraska results. From these equations and many others a series of conclusions were reached which determined the direction of further empirical work:

1. Although the results were encouraging and confirmed the applicability of the county cross-section model, the statistical dominance of the demand variables, and in particular, aggregate income, hampered the efforts to include a number of supply variables and to derive

4A complete treatment of the county model results for Nebraska is given in R. K. Davis and J. J. Seneca, *An Evaluation of Techniques for Demand Analysis in State Fish and Game Planning,* Natural Resources Policy Center, George Washington University, 1971, Chapter 4.

usable supply elasticities. The basic cause of this was a size effect, *i.e.*, where aggregate income (population median income) was high so were license sales and this relation statistically excluded, through its strength, the more interesting (policy-oriented) supply variables. Accordingly, any further work would attempt to reduce this size effect.

TABLE 2. EXAMPLES OF EQUATIONS TESTED IN THE MODEL AND THEIR RESULTS

Nebraska(1)

$$THL = \underset{(233.75)}{1099.08} - \underset{(2.374)}{11.667(POD)} + \underset{(3.239)}{50.021(AGY)} - \underset{(5.598)}{20.286(Y3L)} + \underset{(.0076)}{.0126(PEH)} + \underset{(.0182)}{.0626(COH)}$$

$R^2 = .9762$

$F(5,85) = 739.2$

(Note: THL = total hunting license sales)

Nebraska(2)

$$TFL = 326.27 - \underset{(2.613)}{23.624(POD)} + \underset{(3.505)}{78.518(AGY)} - \underset{(6.487)}{14.816(Y3L)} + \underset{(12.601)}{52.855(FOR)} + \underset{(.0199)}{.1652(DEW)} + \underset{(.055)}{.1464(FW2)}$$

$R^2 = .9802$

$F(6,86) = 708.14$

(Note: TFL = total fishing license sales)

Iowa(3) Mode 23*

$$PCF = \underset{(.04)}{.084} + \underset{(.0024)}{.0051GPL} + \underset{(.0043)}{.0138GCS} + \underset{(.0016)}{.0029GMA}$$

$R^2 = .189$

$F(3,95)=8.66$

(Note: PCF = per capita fishing license sales)

Iowa(4) Mode 11* Subgroup A

$$PCF = \underset{(.01739)}{.06134} + \underset{(.000000016)}{.000001GPL}$$

$R^2 = .5516$

$F(1,28) = 37.55$

(Note: PCF = per capita fishing license sales)

Iowa(5) Mode 12* Subgroup A

$$THL = \underset{(1194.70)}{-7718.50} + \underset{(0.2905)}{1.5258\ (MEY)} + \underset{(.0257)}{.0491\ (GPH)} + \underset{(3.651)}{13.964\ (GEH)} + \underset{(.0043)}{.0129\ (GPL)}$$

$R^2 = .7363$

$F(4, 25) = 21.25$

$E_{MEY} = 3.141$ $E_{GPH} = .583$

$E_{GEH} = .757$ $E_{GPL} = .214$

(Note: THL = total hunting license sales)

Definitions for Supply and Demand Variables in Sample Equations

POD — Population density
AGY — aggregate income (1959) of population (1960)
Y3L — % families with incomes < $3,000 (1959)
PEH — pheasant harvest
COH — cottontail harvest
DEW — degraded flowing water acres
FW2 — acres of flowing water (state-wide significance)
GPL — acres of public land
GCS — cold stream acres
GMA — marsh acres
MEY — median income (1959) of families (1960)
GEH — deer harvest
GPH — pheasant harvest

*The weights used in the discounting procedure were various expressions of distance and are referred to as modes. (See Table 1.)

2. A disappointing aspect of the Nebraska hunting results was the failure of habitat measures to relate significantly with license sales. Where supply measures for hunting were isolated they were game harvests in the preceding year rather than game habitat measures. Considerable policy and planning difficulties result from this since harvests would have to be predicted, simulated, and costed out. The objective is to have, wherever possible, specific habitat measures which lend themselves more readily to a planning and cost effectiveness analysis.[5]

3. The distance-weighted supply variables generally outperformed the unweighted measures in terms of equation fit.

4. The diversity in habitat, species, topography, etc., typical of large states may indicate that smaller, more homogeneous geographical units are the appropriate planning units. It would therefore be desirable to adapt the cross-section model towards this objective.

5. Finally, the model expressed in license sales captures supply effects on the number of participants (*i.e.*, license holders) but does not reflect levels of participation (*i.e.*, days of the activity), which would permit a more complete planning and cost-effectiveness analysis.

With these observations from the results of the Nebraska cross-section model, the technique was extended to Iowa data. The results were still not acceptable because median income retained a dominant effect and prevented strong supply relations from being estimated. One encouraging result, however, was the appearance of acres of public recreation land, a prime policy variable, in both the hunting and fishing license equations. In order to reduce further the income-license sales relation, county license sales were expressed on a per capita basis and related to the county supply variables. This proved completely successful in removing the dominant income effect. Moreover, specific supply variables retained their significance including the public land measure. An illustrative equation for per capita fishing license sales using Iowa data is shown in Table 2. Of particular interest in equation (3) is the elasticity of public land (GPL) with respect to per capita fishing license sales (PCF) which, computed at the means, is .336. This indicates that a 10 percent increase in acres of public land (GPL) will generate a 3.36 percent increase in per capita fishing license sales (PCF). Knowing how population is expected to change during the time period encompassing

[5] In addition to the planning and cost analysis advantages of habitat measures over harvests, some criticism of an identity existing between the number of hunters and harvests (even though we have lagged harvests one season) is valid. One interesting result from the Nebraska analysis was the generally *poor* relation between county harvests and county habitat measures.

the (GPL) change will enable us to project how total license sales will increase.

In a further attempt to improve on the Nebraska results, a subgroup analysis of Iowa counties was conducted on grounds that it might be desirable to subdivide the state into areas with similar physical characteristics. These subareas could be used as the administrative planning unit. If successful, this technique removes the considerable criticism of treating the entire state as the policy unit, thereby masking important physcial and user differences within the state.

There are, however, two statistical difficulties associated with disaggregating the county model from a state basis to a subgroup of counties. First is the need to maintain a statistically sufficient number of observations in any given subgroup. A more worrying problem is to insure a good degree of statistical variation in the supply variables for a given subgroup of counties. While the purpose of subgrouping counties within a state is to obtain homogeneity with respect to certain physical characteristics, the county regression model requires statistical variation in order to establish valid coefficients (and elasticities) for the key recreation supply variables. This dilemma makes county subgroup selection a crucial concern.

Figure 1 indicates the four subdivisions delineated for Iowa and the number of observations in each. For each subdivision, all six modes of the independent variables were tried for both the total and per capita expressions of license sales. Subgroup A, the northern tier of counties in the state, proved to be particularly well suited to the subgroup analysis. Equation (4) in Table 2 records one of the per capita fishing results of this subgroup. For equation (4) the elasticity of acres of public land (GPL), computed at the mean, is .62, indicating that a 6.2 percent increase in per capita fishing license sales (PCF) will follow a 10 percent increase in acres of public land (GPL).

Table 3 simulates the results on total fishing license sales under various changes in (GPL) and population. Calculations such as those in Table 3 offer valuable assistance for recreation planning by

TABLE 3. SIMULATED RESPONSES FROM EQUATION (4) $E_{GPL} = 0.620$ (ELASTICITY)

%ΔGPL / %ΔPOP	0%	5%	10%	15%	20%
5%	3.1%	8.1	13.1	18.1	23.1
10%	6.2	11.2	16.2	21.2	26.2
15%	9.3	14.3	19.3	24.3	29.3
20%	12.4	17.4	22.4	27.4	32.4
25%	15.5	20.5	25.5	30.5	35.5

% TFL = E :Δ% GPL +Δ% POP

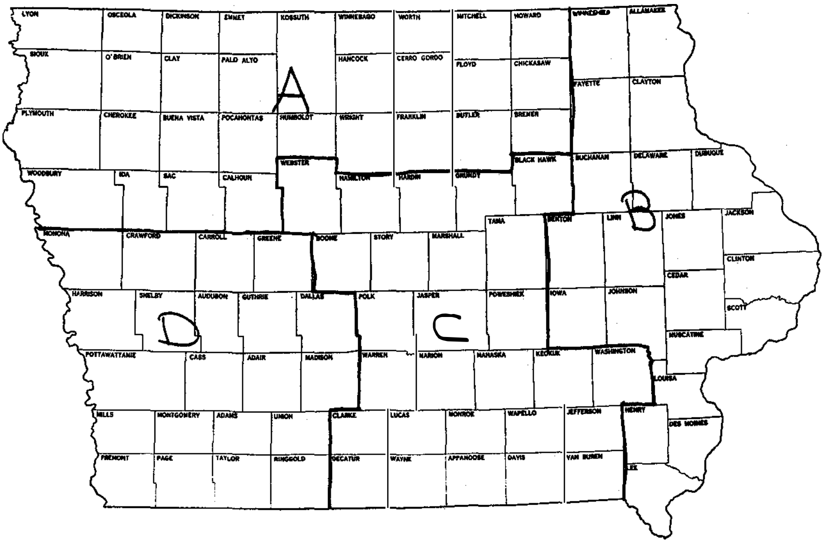

Figure 1.

IOWA SUBGROUPS

Subgroup A: 30 counties | Subgroup C: 27 counties
Subgroup B: 21 counties | Subgroup D: 21 counties

indicating the results forthcoming under numerous possible changes in supply opportunities and/or demand conditions. Numerous other equations for all of the subgroups were estimated for hunting and fishing license sales and the corresponding simulation tables were computed. Equation (5), dealing with total hunting license sales in Subgroup A, provides an example of the results of employing this methodology.

NEED FOR ESTIMATES OF AMOUNTS OF RECREATION PARTICIPATION

As a final link in the model, current efforts are underway to apply the county model to estimate the extent of recreation participation as a function of the county supply variables. The data requirement is a measure of average recreation days (hunting, fishing, or both) measured by counties. Our efforts are now concentrated on two Iowa hunter surveys and a similar survey for Nebraska. The county model in its subgroup form (both for per capita and total sales) proved successful in establishing significant supply variables and quantifying their effects on the decision to *participate* in hunting or fishing via estimates of the elasticities. The equivalent relationships for the extent of recreation participation will complete the inputs necessary for a formal approach to state fish and game resource planning.

APPLICATION TO PLANNING

From the estimated set of equations for a given subgroup, one equation may be selected as the vehicle for policy analysis. Given the selection of an equation for a given subgroup and license type, the following hypothetical example illustrates how the planning procedure could take place. Let us assume the equation selected was one similar to equation (4) in Table 2. Within the particular subgroup which it represents, a given county currently has a value of acres of public land (GPL) of 100. Further, assume that the distance weight was simply distance in miles. This may be expressed as $GPL_j = 100$ which means that the value of GPL in county j is 100 (or 100 acres of GPL per mile). If a 10 percent increase in GPL_j is to be achieved, then the percentage change of $GPL_j = 10$. This value of 10, however, has two components—public land acres and their position in space relative to the county population center. A number of options to achieve this increase of 10 exist. For example, this increase could be brought about by the acquisition of 20 acres two miles distant, or 40 acres four miles distant, or 500 acres 50 miles distant. State planners, familiar with the particular land areas, can admit all *realistic* options to achieve this increase. Thus, an array of these options exists and can be formally expressed as a vector (O_i), where O_i indicates a particular option in acre-distance terms. The number of options (N) is constrained by the actual conditions in the area. Moreover, each option is likely to carry its own cost; therefore there is another vector (C_i) expressing the cost of each option.

From the estimated equation it is possible to predict the percentage change in total license sales on the basis of the elasticity of (GPL), the specified percentage change (GPL) and the expected population change. This gives an indication of the percentage addition of new license holders following the specified percentage change in GPL. From the county recreation days model currently being developed, a similar elasticity of GPL with respect to number of days of activity is estimated. Knowledge of the existing stock of license holders in county j and the percentage change in license holders forthcoming from the postulated percentage change in GPL affords the capability for computing the number of new license holders. This number, multiplied by the average number of recreation days per license holder in county j, yields the total recreation days for the new participants. The elasticity of GPL with respect to days activity can then be used in a similar manner to compute the additional days of activity of the original stock of license holders resulting from the percentage change of GPL. The sum of the days of the new participants (license holders) and the additional days of the existing license holders represents the total increase in recreation activity days generated by the 10 percent change in GPL_j. Given the array of cost options available to the county, a division of cost by total days would yield an array of costs per additional day of activity. Since costs differ over the N options and the number of total days generated is a constant for the fixed percentage change in GPL_j, a cost-effectiveness criterion would select that option which minimizes costs per day.

If recreation days can be assigned dollar values (derived from the demand curve), then a formal cost-benefit analysis is possible. In any case, a critical implicit price per day is contained in the option actually selected by the cost-effectiveness criterion. That is, $C/TD = P$, which tells planners what a recreation day must be worth if the option is to be justified.

The model offers a robust planning tool capable of analyzing numerous important and recurring resource management problems. It systematizes the effects of supply change on recreation activity in the context of a formal cost analysis. It can incorporate the constraints of real world conditions (through limitations on the number of feasible options and their costs). If can be used to maximize returns under budget constraints where "returns" are measured by increases in recreation activity. Of crucial value is the ability to rank and rationally choose among various outlets for public expenditures on fish and game development. While many difficulties remain, the overall indication of the results of the cross-section county model point to a useful role of the elasticities concept in planning.

DISCUSSION

MR. RON JONES (Director of Planning, Texas Parks and Wildlife Department): I am a little confused. I have about 110 questions I could ask since we are doing basically the same thing in Texas or trying to. The first question I have is this: In hunting, are you confining the participant to a particular region? If he lives in a certain region, he buys his hunting license in that region, but does he have to stay in that region or are you allowing him to hunt outside that region?

DR. DAVIS: We're allowing him to go any place. The point is that he lives in a particular area, let's say a given city or a county. The introduction of these supply variables was a regional concept, if you want to call it that, but it is simply based on the radius factor. We looked at the data and found out what appeared to be the limiting rate for travel by hunters from a particular county, and we used that to define the region for the simple purpose of quantifying our supply variables. We are really not predicting where the hunter is going to hunt or the fisherman is going to fish.

MR. JONES: Isn't that very important though, from a planning standpoint?

DR. DAVIS: They will hunt where the opportunities are, within a certain radius.

MR. JONES: My point is that the deer hunters from Houston in Texas, travel 250 miles to the Edwards Plateau or they may go to East Texas or to the Big Bend country to hunt. Now, how do you find from the original demand where the guy actually participates? We've just about got a model worked out in which we are using an econometric model plugging in the supply along with these demand variables and then using a gravity model to dissipate this to various regions around the state.

DR. DAVIS: My important point is that implicit in our supply variables is the assumption that the hunters will continue to behave in a system as the statistics say that they are behaving. The closer you locate an opportunity, whatever kind it is, to a given population center, the more effect this will have on demand—demand expressed as the number of participants or the per capita participants in a particular market center. You are really standing our model on its head. We could have taken the number of hunters or the hunter days in a particular county and explored the relationship between hunter days in a particular county and the demand variables and probable supply variables as well, as there would be some substitutions between opportunities or the supply effect from one county to another.

MR. JONES: Is your publication available?

DR. DAVIS: There are some papers here and we will be writing a final report to the Bureau of Sports Fisheries and Wildlife this summer.

MR. RONALD ANDERSON (Washington): I would like to address a question to Mr. Seneca. My question has to do with the confidence of results of a study along these lines but based on a check on species. Both controls are about the same size, 35 or 40 square miles, in a definable habitat. One is a semi-natural system of dry lands, State lands, under State control for 30 years where the species is artificially maintained in the winter. The other area is a similar square mileage area but in the western part of the State and under a clearcut and selective logging program. Do you think that those two would provide a cross-index result? I'm looking at what they are getting for the resource dollars as to the input the user has made financially.

MR. SENECA: Sir, could you clarify the variables that you have?

MR. ANDERSON: We have one elk herd in eastern Washington within a definable boundary that it never leaves. We have the user figures for many years. The users for this particular herd of elk provide 30 percent of the state's harvest, but the herd is maintained artificially in the wintertime so requires considerably more financial cost to operate. The other area is similar in size, but is controlled by private forestry. My point is that the habitat has not changed say for the last 25 years. They are now going into a different type of forestry but basically those variables can be corrected, and I'm getting at the cost of production—the resource dollar.

MR. SENECA: I think you can see that the product has two ways of production, and associated with each way of production are different costs. Presumably the evaluation would attempt to incorporate those cost differences before it would be of any value to look at the use generated in each area without adjusting the use for the cost per unit of use; however, that may be measured. Essentially there may be a trade-off between the two and in an economic analysis you would want to maximize the return, allocating dollars where the margin of benefits is highest between the two uses.

CRITERIA FOR BIG GAME PLANNING: PERFORMANCE MEASURES VS. INTUITION

JACK E. GROSS
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This paper discusses a critical step in big-game planning: the selection and interpretation of criteria used to guide and evaluate management activities. The viewpoint is based on interpretations of dynamic processes in big-game population-habitat systems. The interpretations suggest criteria for planning which are contradictory to traditionally accepted criteria.

Misinterpretation of the roles of criteria used in planning may be largely responsible for the occurrence of unexpected management results. Wildlife managers have focused so much attention on developing techniques for measuring population and habitat parameters that insufficient attention has been focused on developing an understanding of the relationships among population and habitat parameters.

PERFORMANCE MEASURES IN MANAGEMENT

The initial step in developing the perspectives of this paper is to clarify the basic concept of management and the roles of planning and planning criteria in the management process. Forrester (1962) defined management as the process of converting information into action (Fig. 1). The conversion process is usually spelled out in a management plan that details the basis for decision making. However, Forrester (1962) stressed that management success depends basically on what information is selected for use in the decision-making process.

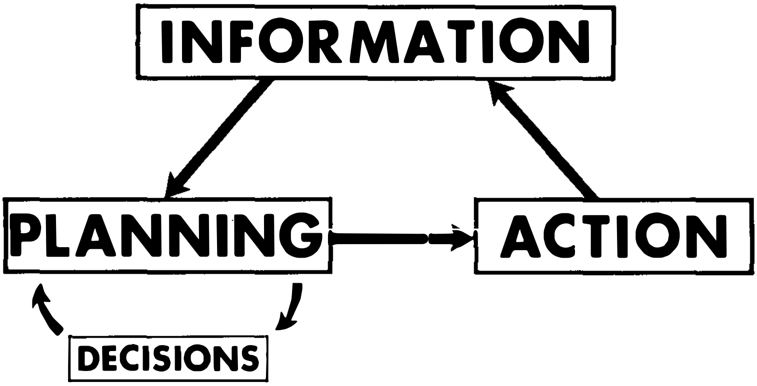

Figure 1.—Flowchart of the Management process, illustrating the basic components and sequence of events. (Adapted from Forrester, 1962).

The necessity of obtaining dependable information for sound planning and decision making is a central theme in the field of systems analysis. Quade (1966) stressed that the foremost task of the systems analyst is to define management objectives and then to decide how to measure the extent to which the objectives are attained by various management alternatives. Churchman (1968) maintained that the ultimate aim of systems analysis is to discover components whose values are truly related to the values of the system's output. The values of such components are called performance measures by Churchman (1968).

The place of performance measures in the system and the relationship between performance measures and the system's output are shown in the conceptual model in Fig. 2. The problem confronting the planner is to select from the internal processes of the system (components labeled 1, 2, 3, and 4) one or more components whose values are predictably related to the values of the system's output. In Fig. 2, the volume and pressure of component No. 4 best match the volume and pressure of the output and thus would provide the best performance measures of the system's output. If the component is appropriate, the performance measures will provide the planner with information on the status of the output, the relationship of the output at any time to a desired output, and by observing change in the performance measures, whether or not a management plan is adjusting the output toward a desired level.

INTUITIVE PLANNING

Lack of emphasis on understanding dynamic processes in big game population-habitat systems has led to frequent selection of manage-

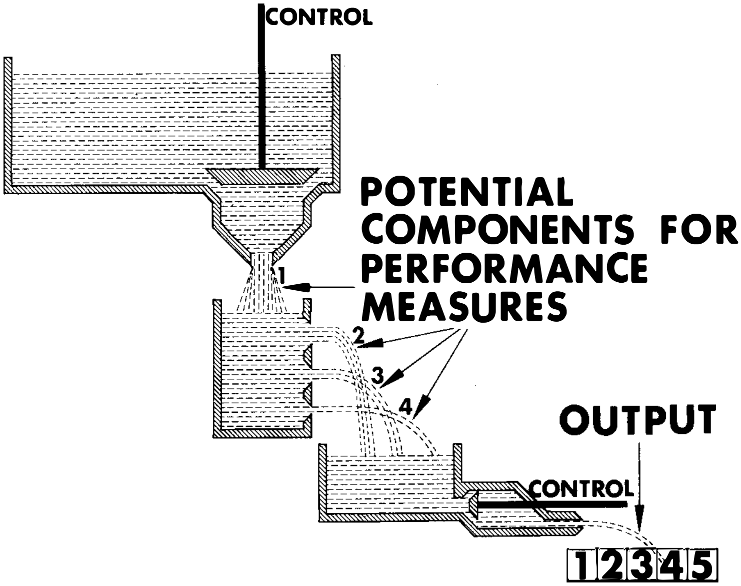

Figure 2.—Schematic illustration of a system, showing components whose individual behavior accurately reflect or do not reflect the behavior of the system's output.

ment (planning) criteria by intuition. Selection of criteria for planning frequently occurs as a result of the following circumstances. The population-habitat system contains an array of potential components that overwhelm the planner with their variety and complexity (Fig. 3). Depending on his experience, education, field of training, professional associations, etc., he is cognizant of only a portion of the potential components. Selection of a planning criterion usually occurs as the planner scans the components he is familiar with, observes that the value of a particular component is different from a preconceived desired value, and thus selects that component for adjustment to a more desirable value.

It is at this stage that the planner's intuition may have led him to select a faulty planning criterion. Usually the management criterion is the minimum or maximum value that is known or suspected to be possible for the selected component. The assumption then follows that manipulating the population-habitat system so that the criterion is moved toward the minimum or maximum value will produce the desired performance in the population.

Perhaps an appropriate analogy for judging the validity of planning criteria selected on the basis of intuition comes from the field of industrial dynamics and social systems. Forrester (1970) stated:

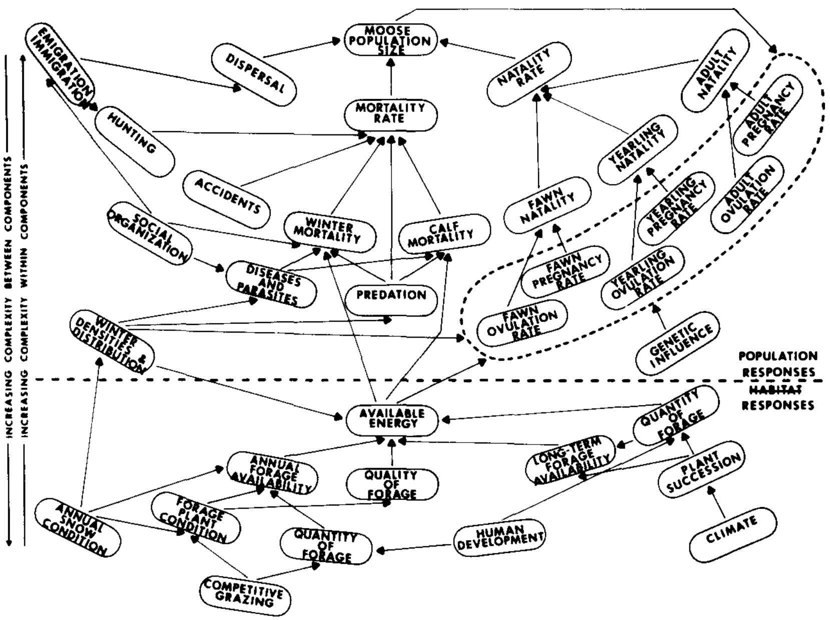

Figure 3.—Flowchart illustrating population and habitat components that constitute potential planning critèria for managing a population-habitat system. (Adapted from Houston, 1968).

> "There are orderly processes at work in the creation of human judgement and intuition that frequently lead people to wrong decisions when faced with complex and highly interacting systems—social systems are inherently insensitive to most policy changes that people select in an effort to alter the behavior of a system. In fact, a social system tends to draw our attention to the very points at which an attempt to intervene will fail—it seems that all (social systems) have a few sensitive influence points through which the behavior of the system can be changed. These influence points are not in the locations where most people expect."

Forrester referred to this phenomenon as the counter-intuitive behavior of systems. He maintained that management of a system with information based on happenstance or collected on a basis of what is intuitively obvious will usually be unstable or ineffective. The interpretations that follow in this paper are intended to illustrate that big game population-habitat systems are as rich in counter-intuitive behavior as are industrial and social systems.

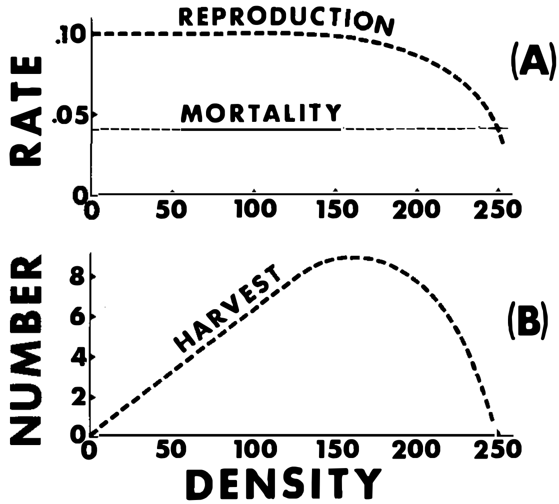

Figure 4.—Illustration of basic reproductive-rate and mortality-rate patterns, and the resultant impact on harvest pattern. Density represents the number of reproducing animals. Mortality in Part A represents non-hunting losses.

A COUNTER-INTUITIVE MECHANISM

The processes upon which the counter-intuitive perspectives of this paper are based are relationships among reproductive rate, mortality rate, production (harvest) and population density (Fig. 4). The basic feature of the processes is the decline of reproductive rate as population density increases, as shown by the curve in Part A of Fig. 4. Such density-dependent changes in reproductive rate have been observed in a number of deer and elk populations (Gross, 1969). Although the relationship may not occur in all deer and elk populations, it does appear to be sufficiently common to warrant consideration in planning and management.

Net-production values shown by the curve in Part B of Fig. 4 are the differences between total number of animals produced (reproductive rate multiplied by density) and the total number of animals dying (mortality rate multiplied by density). Since net production is also the number of animals that can be removed from a population to maintain any given density, the net production curve is also a yield or harvest curve.

Patterns of the curves in Fig. 4 illustrate three characteristics of natural populations that create their counter-intuitive behavior; non-linearities, thresholds, and limits. A non-linear interaction is illustrated between the reproductive-rate curve in part A and the harvest curve in part B. Harvest at first increases as reproductive rate remains constant, then stabilizes as reproductive rate starts to decline and finally declines as reproductive rate declines, all while density steadily increases. A threshold occurs on the reproductive-rate curve in part A at a population density of 100. Changes in reproductive rate due to increases in density do not become effective until the population passes a density of 100. The same density threshold is apparent in the harvest curve where its initial linear increases becomes a curvilinear increase. A limit is illustrated in the apex of the harvest curve in part B.

The presence of non-linearities, thresholds and limits (and other characteristics not described in this paper) cause populations (and interacting components) to behave in fashions which commonly are different than expected from intuitive evaluation. Two components may interact in a certain manner over part of their ranges and interact differently, or perhaps not at all, over another part of their ranges. Such characteristics are pitfalls for the planner as he selects criteria for building management plans.

PERSPECTIVES ON TRADITIONAL PLANNING CRITERIA

Reproductive Rate

Intuitive perspective.—A common measure of the performance of big game populations is reproductive rate. Units of measure are commonly expressed as adult-young ratio. A survey of the literature indicates that the widely pursued criterion for this component is a maximized reproductive rate, *i.e.*, the attainment of the largest number of young per 100 females. If not specifically stated, there is the implication that a management plan is successful when it attains the highest reproductive rate that is possible for the population.

Counter-intuitive perspective.—In Fig. 5, maximum sustained harvest is achieved at a density of about 160 and maximum reproductive rate is achieved at a density of 100. Thus, if maximum harvest is the management goal for a population, a planning criterion that calls for maximization of reprodutive rate is not an appropriate measure of population performance. Since maximum reproductive rate and maximum harvest are achieved at different densities, both cannot be attained simultaneously and are thus incompatible planning criteria. If reproductive rate is used as a planning criterion, then a value somewhere below the maximum rate must be defined as the desired measure.

Population Density

Intuitive perspective.—Population density is a second component

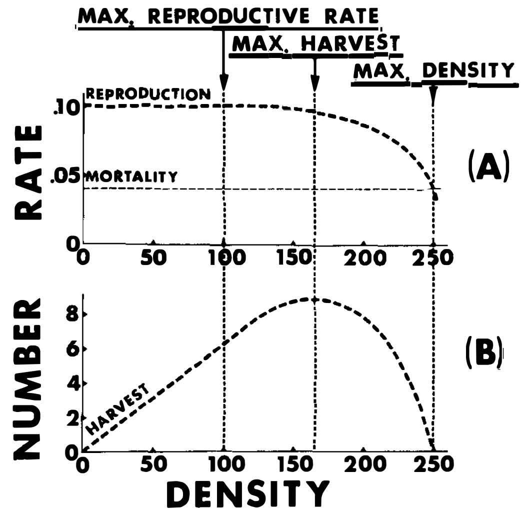

Figure 5.—Basic reproductive-rate, mortality-rate and harvest patterns and relationships of maximum reproductive rate and maximum harvest to maximum density.

popularly used for gauging the success of a management plan. The intuitive appeal is to assume that maximum harvest can be obtained by managing a population so that it attains its maximum density.

Counter-intuitive perspective.—In Fig. 5, sustained harvest is maximum at a density of 160 but is zero at the maximum density of 250. Thus, a management plan that succeeded in producing maximum density would fail to produce the desired population performance of maximum sustained harvest.

An interesting management problem is illustrated in part B of Fig. 5, wherein a management plan that increased density can produce opposite results. At density levels above 160, a management plan that adjusted population density toward the maximum of 250 would adjust the sustained harvest toward zero. At densities between 0 and 160, a management plan that adjusted population density toward 250 would move the sustained harvest toward the maximum. Thus population density (or density indices) may be used for manipulation of the population toward the goal of maximum harvest, but the desired criterion for maximum sustained harvest is an intermediate density, not the maximum density.

Nutritional Competition

Intuitive perspective.—The occurrence of real or suspected deleterious effects on a population due to nutritional competition among species is a frequent concern in big game management. As a consequence of intuitive appeal, maximizing population performance is associated with the adjustment of densities in competing populations so that nutritional competition is either eliminated or reduced to minimal proportions.

Counter-intuitive perspective.—Although the criterion to increase population performance by eliminating competition between populations may have merit, a criterion to eliminate all nutritional competition, which would include competition within populations, is probably invalid. Numerous studies have shown that nutritional deficiency is a principal factor responsible for submaximum reproductive rates. Thus, in Fig. 6, the decline of reproductive rate after the population passes a threshold density of 100 is in part due to the occurrence of nutritional deficiency in the face of increasing density. The impact of nutritional deficiency on the population parameters in Fig. 6 thus occurs over two-thirds of the population's density range.

The shape of the harvest curve also reflects effects of nutritional deficiency. The peak of the harvest curve occurs at a density where, in a sense, nutritional deficiency is optimized. Thus, nutritional deficiency is not only a normal situation in natural populations, it is probably part of an evolved balancing mechanism in the natural dynamics of populations.

In Fig. 6, maximum harvest is attained at a density of 160 where nutritional deficiency has reduced reproductive rate to a value about 10 percent below the maximum value. Hence, a planning criterion calling for total elimination of nutritional deficiency is analogous to a planning criterion calling for maximum reproductive rate. Neither is an appropriate criterion for obtaining maximum harvest from the population.

Range condition

Intuitive perspective.—Widespread recognition that nutritional deficiency results in reduced reproductive rates has caused much deductive evaluation of range condition based on reproductive-rate measurements. Typically, one or more annual observations of submaximum reproductive rates are interpreted as a measure of unsatisfactory range forage conditions.

Counter-intuitive perspective.—Submaximum reproductive rates do not necessarily indicate unsatisfactory range conditions. In Fig. 7, the range of values over which reproductive rates can vary in

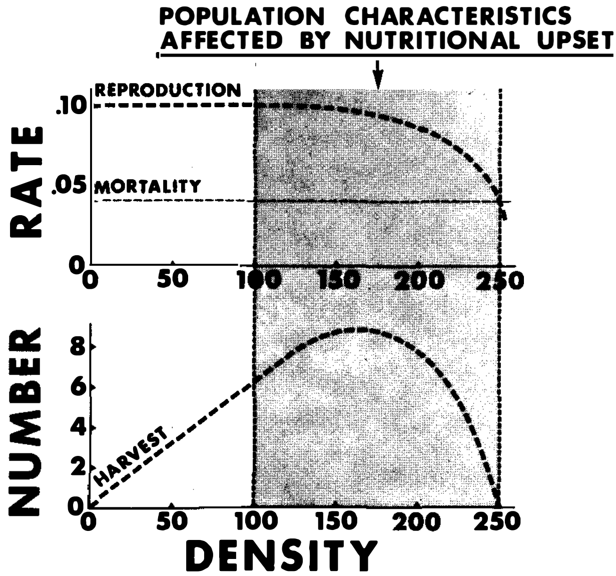

Figure 6.—Illustration of density ranges where nutritional deficiency affects reproductive-rate and harvest.

response to density changes is almost as wide for poor range conditions as it is for good range conditions. In particular, equally low reproductive rates (.04) can occur under good and poor range conditions when the populations in both cases are at their maximum densities. Thus, a low reproductive rate does not by itself reflect any particular level of range condition.

The occurrence of a low reproductive rate (.04) could be interpreted objectively as indicative of poor range conditions only if it could be determined that the slope of the reproductive-rate curve at a given density was steeper than it had been at some other time. Thus, a more valid range-condition planning criterion would be the degree of slope of the reproductive-rate curve. The steepening of the reproductive-rate curve would indicate deteriorating range conditions.

DISCUSSION

Despite the foregoing indictment of intuitively-selected planning criteria, decisions based on intuition will be difficult to eliminate from the planning process. It is deceptively easy for the analyst or planner to adopt a faulty hypothesis concerning the relationship of a criterion with population performance. Intuitive decisions flavor all analysis, planning and management. The arguments in this paper are no

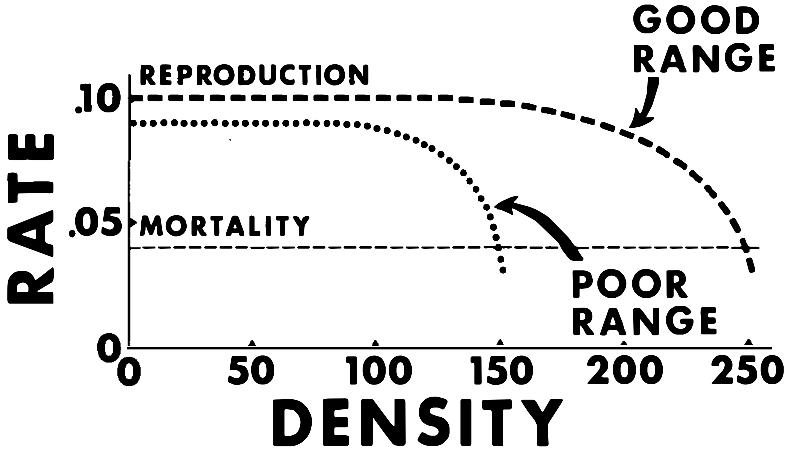

Figure 7.—Reproductive-rate patterns illustrated for populations on good range conditions and poor range conditions. (Adapted from Leopold, 1955).

exception and contain their share of intuitive errors. Such is the nature of the problem to which this paper is addressed.

Because of the everpresent probability of falling victim to the pitfalls of intuitive planning, planning operations should continually strive to develop performance measures for planning criteria. But how does the management agency, the planning team, or the individual planner pursue a program that continually tends to eliminate intuitive errors? Numerous mathematical and statistical approaches are available to analyze features such as the degree of correlation between components. However, non-linearities, thresholds and limits not only create the distinctive nature of systems, they also create functional interactions that are intractable with current mathematics (Holling, 1966).

Since the principal difference between a performance measure and an intuitive criterion is knowing the relationship between the component and the output, the problem of eliminating intuitive criteria from planning seems to be one of establishing functional relationships between components and output. Such problems are particularly appropriate for solving through simulation modeling. Forrester (1961) pointed out that the value of a model lies in its tendency to improve understanding of obscure behavioral characteristics of a system. Quade (1966) defined a model as a simplified representation of the real world that mimics the cause-and-effect relationships essential to the question(s) being asked. A comparison of the ills of intuitive planning and the strengths of simulation modeling should convincingly demonstrate that simulation modeling is an ideal tool to help overcome intuitive errors such as those discussed in this paper.

Unfortunately, the current state of simulation modeling in the management of natural resources is ill prepared to function as a comprehensive planning tool in wildlife management. Although some wildlife-oriented simulation efforts have appeared in the literature (Davis, 1967; Dean and Galloway, 1965; Walters and Bunnell, 1971; Walters and Gross, 1972; and Lobdell *et al.,* in press), the concepts of simulation modeling are poorly developed in the field of wildlife management. Since a variety of philosophies, approaches and techniques are being experimented with, the average planner may be unable to decide which approach may form a sufficient framework to initiate a modeling effort.

Major conceptual contributions have been made by Holling (1966) and Forrester (1962), and although their efforts may take some time to assimilate into the wildlife field, some immediate benefits should be pointed out to wildlife planners. First, one of the greatest misgivings of the planner who might be interested in simulation modeling is the belief that he must have a certain mastery of advanced mathematics before he can begin to build simulation models. At every turn he encounters a maze of mathematical equations and is led to believe that he must produce a mathematical model. Even though mathematical approaches are common, the modeling philosophies of Holling (1966) and Forrester (1971) demonstrate conclusively the fallacy that modeling must be based on advanced mathematics. In fact, Holling (1966) concluded that the most realistic biological models cannot be based on advanced mathematics. Forrester (1971) stated:

> "Many mathematical models are limited because they are formulated by techniques and according to a conceptual structure that will not accept the multiple-feedback-loop and nonlinear nature of real systems."

A second concept in the modeling philosophies of Holling (1966) and Forrester (1971) also provides an alternative to the mathematical approach: the most realistic simulation models, and particularly decision-aiding models for applied management, require the carefully considered assembling of the system's biological functions. Thus, the aspiring modeler, regardless of the magnitude of his efforts, must be adept in thinking about how the components in his system function together. This requirement is the greatest hinderance in the development of simulation models and thus the development of performance measures in wildlife management. The opinion held in this paper is that the wildlife profession has failed to develop an adequate appreciation and understanding of the functional aspects of biological systems. In a more comprehensive sense, there has been insufficient awareness that components which are commonly treated as isolated entities are actually part of complex but well-integrated systems. As a result, the planner commonly finds himself with a great deal of data, but no means to get it all together, or to interpret it as a package.

Forrester (1971) stated that a model is only as good as the expertise which lies behind its formulation. The same can be said for the selection of performance measures, management plans and decisions.

SUMMARY

A basic need for efficient decision making in management is information that accurately reflects the results of management activities. Components whose values are predictably related to a system's output are the system's performance measures. A big game system's components exhibit features such as non-linearities, thresholds and limits. As a result, the system's output may not behave in a manner dictated by intuitive evaluation of the components. Such a counter-intuitive mechanism in some deer and elk populations indicates that several traditional planning criteria are not valid performance measures for producing maximum output. Simulation modeling is suggested as a means to help eliminate intuitive judgement and to help develop valid performance measures.

ACKNOWLEDGMENTS

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LITERATURE CITED

Churchman, C. W.
1968. The systems approach. Dell Publishing Co., Inc., New York. 243pp.

Davis, L. S.
1967. Dynamic programming for deer management planning. J. Wildl. Mgmt. 31(4):667-679.

Dean, F. C. and G. A. Galloway.
1965. A FORTRAN program for population study with minimal computer training. J. Wildl. Mgmt. 29(4):892-894.

Forrester, J. W.
1962. Industrial dynamics. The M.I.T. Press, Mass. Institute of Technology, Cambridge. 464pp.

Forrester, J. W.
1970. Counterintuitive behavior of social systems. Testimony for the Subcommittee on Urban Growth of the Committee on Banking and Currency House of Representatives, Washington, D.C. October 7. 27pp.

Forrester, J. W.
1961. Counterintuitive behavior of social systems. Tech. Review, M.I.T. 73(3):1-16.

Gross, J. E.
1969. Optimum yield in deer and elk populations. Trans. N. Am. Wildl. and Natur. Res. Conf. 35:372-386.

Holling, C. S.
1966. The functional response of invertebrate predators to prey density. Mem. Entomol. Soc. Canada. 48:1-86.
Houston, D. B.
1968. The Shiras moose in Jackson Hole, Wyoming. Grand Teton Nat. Hist. Ass. Tech. Bull. 1. 110p.
Leopold, A. S.
1955. Too many deer. Sci. Amer. 139:101-108.
Lobdell, C. H., K. E. Case, and H. S. Mosby.
Evaluation of harvest strategies for a wild turkey population through simulation. J. Wildl. Mgmt. In press.
Quade, E. S.
1966. Systems analysis techniques for planning-programming-budgeting. Executive orientation in Planning, Programming, and Budgeting Workshop, U.S. Bureau of the Budget and U.S. Civil Service Commission, Washington, D.C. 1-31.
Walters, C. J. and F. Bunnell.
1971. A computer management game of land use in British Columbia. J. Wildl. Mgmt. 35(4):644-657.
Walters, C. J. and J. E. Gross.
1972. Development of big game management plans through simulation modeling. J. Wildl. Mgmt. 36(1):119-128.

DISCUSSION

QUESTION (Unidentified): Have you expanded this model to include the needs of people, the socio-economic aspects? You make a strong case for modeling at the biological and basic management levels, but have you looked into the possibility of modeling at the higher level of social and economic needs?

MR. GROSS: Since I am primarily a population ecologist I have not attempted to apply the sociological and economic aspects of modeling to what we are doing. However, since everybody else has mentioned their sponsors, I might mention that Resources for the Future, Inc., is in part supporting our research effort and we fully intend to bring in the economic aspect when the basic ecological model has reached the state where it is operable in real world systems. A comparable modeling effort in Canada, at the University of British Colombia, follows the same line of thinking—or perhaps we follow the same line of thinking that they do, since they originated this whole thing—is doing extensive work on urban modeling which brings in socio and economic aspects. When we get this model operational on several fenced refuges that we are now working on, and when we get it operational from the standpoint of basic biology, then the social and economic packages will be attached, and they can be attached very easily with our approach.

MR. RON JONES (Director of Planning, Texas Park and Wildlife Department): As I previously stated, I have been fooling around with supply and demand in the field of outdoor recreation through the Bureau of Outdoor Recreation for several years. I am now responsible for developing a plan for fish and wildlife in Texas, and by the regulations that are put out by the Federal Government, we are going to have to take into account in our planning efforts, supply and demand. I would just like to request this. We are going to need strong direction, some good direction from the federal level, if we are going to make other plans very meaningful in this area because I think everyone is unsure just how we are going to proceed in our planning efforts, especially taking into account supply and demand, because it is a very complicated process.

MR. ROBERT DAVIS (National Audubon Society): You mentioned that you will make some economic inputs into this very interesting model at some future date. I predict that when that happens, your resource management goal may no longer be maximum harvest because, as an example of conflicts between landowners and sportsmen which may prevent the measures necessary to afford a maximum harvest, or the conflicts between summer tourists who like to see big game animals and the hunters. The relationships between the harvest and the size of the population may mean that something more or less than the maximum harvest may turn out to be the optimum when social values are applied to the output, to say nothing of the cost of the input.

MR. GROSS: I fully agree, Bob, I just pointed out that you must have a goal before you start doing this sort of thing. I pointed out that harvest was the particular goal for these comparisons. The actual operating model brings in a great deal of sub-optimization, managing the same sort of analysis but managing for trophies and other things. The output at this point is getting to be at the level to be useful to a person like yourself who is interested in sub-optimization in an effort to maximize the whole system. It won't be easily accomplished.

MR. DAVIS: I fully agree.

DISCUSSION LEADER BOSSENMAIER: Jack, you make a very strong case for simulation modeling. One of these days it's going to be operational. If you were State Game Director, what would you do now to prepare yourself for the day when simulation modeling becomes operational, assuming that perhaps some of the States are not aware of this new tool which is undergoing development?

MR. GROSS: I am not sure that I can respond to that since I have never been a state director, but I think there are some very encouraging suggestions that can be made. Although the data collecting process and the data banks are underway. I do think there needs to be a certain basic change in the attitudeor the philosophy of what a management plan is. The primary tack, I believe, that could be taken at the high administrative level is essentially the plea thatadministrators not to be turned off for some of the more sophisticated and highly specialized systems analysis and modeling efforts that are now going on. I'll have to be specific here and point out the efforts of the Colorado Game and Fish Parks Division in their current planning efforts in which systems analysis has taken a very active role and in which an attempt is now being made to bring simulation modeling into the applied management aspect. If once or twice we can demonstrate that simulation modeling can help an administrator make a decision and generate tsome information that he heretofore has not had, then I believe that much of the skepticism and much of the criticism will halt. I would encourage the administrator not to close his eyes totally, to look around at some of the that is going on.

* * *

TOWARDS MORE EFFECTIVE NATURAL RESOURCE PLANNING

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As the world and society become more and more complex, the need for more effective planning for the use of natural resources becomes more urgent. Population and technological growth have resulted in increasing and changing demands for consumptive and nonconsumptive uses of natural resources. Technological advances have also increased interdependencies in the economic system, making technological external (dis) economies pervasive in society and the environment. These increasing and changing demands and interdependencies have resulted in conflicts over natural resource use. More effective natural resource planning is necessary to resolve these conflicts in ways that contribute to maximization of social welfare.

The magnitude of the probable increase in the resource needs of the United States was shown in a study by Landsberg (1964). Landsberg concludes that by the year 2000 there will be: "a tripling of requirements for both energy and metals . . ., almost a tripling for timber, and a doubling for farm products and for withdrawal depletions of fresh water." In addition to these materialistic demands on the environment there are the less easily quantified, but no less real, increasing demands for a quality environment.

Several authorities believe the quantitative needs can be met, if we work at it (Landsberg, 1964; McKelvey, 1972). But it is not just a matter of resource quantity; nor is it just a matter of resource quality. We must be concerned about quantity and quality in a world where the resource and resource use interrelationships are complex and difficult to describe, much less measure. The question is, can we attain a desirable balance of quantity and quality in a total living standard?

The role of natural resource managers in providing an affirmative answer to this question will be of increasing importance. To fulfill our role we must apply the planning process in the management of natural resources to a greater degree than ever before. To accomplish this will require more planners, better planning information, better planning models, more favorable planning climates, and more coordination at all levels. n order to fulfill these requirements we will need the best efforts of everyone in the field of natural resource management: educators, researchers and administrators.

EDUCATION

In order to discuss the role of education in providing more effective natural resource planning it is necessary to define the role of the natural resource manager in planning. While every natural resource manager need not be a professional planner, some should certainly attain that degree of competency, and others will be needed as resource specialists on multi-functional planning teams. Thus, it seems that, at a minimum, a natural resource manager should be sympathetic to planning, have a broad mind with respect to disciplines and resource specialties other than his own, and have an ability to recognize and contribute to objectives larger than those represented within his own area of expertise.

Based on my experience in several planning efforts, this minimum is not being met. Too many natural resource managers do not recognize the value of formal planning processes. They are men of action who have little patience with the apparent, but necessary, wheel-spinning typical of many planning efforts. They want to get the job done so they can get back to what they regard as the important things, the pile of paperwork on their desks.

Natural resource managers often are committed to specific resource uses and/or clientele groups and, when such commitments are strong, they stand in the way of effective planning. As resource use priorities change, these commitments become obstacles to the needed realignment of management objectives and efforts. Rigid commitment can lead to unbalanced natural resource planning. Another consequence can be unnecessary conflict among members of multifunctional planning teams. Of course, some conflict is worthwhile in bringing out all viewpoints in a planning situation. Blind commitment to particular resources uses or obsolete priorities also leads natural resource managers to be more concerned with means than with ends and unable to identify new management alternatives (Churchman, 1968).

Beyond the minimum, which is primarily a matter of attitude and philosphy, few natural resource managers have sufficient educational background in the application of planning techniques, the organization of planning efforts, and the utilization of available decision-making tools. They are poorly educated for the task ahead. Since education is a continuous process, professional schools of natural resource management and the natural resource agencies must work together to improve the situation.

With respect to attitudes and philosophy, it seems that there is a need for a reorientation of natural resource management education. The schools need to give the students a different image of what a natural resource manager is and does. Because planning is so important and the need for managers who can participate in the planning process is great, students must be taught that they will be contributors to planning and that planning is the essence of management. Students must be indoctrinated with the concept that the goal of natural resource management is to serve the needs of society, not the resource *per se* or some segment of society.

Changes also need to be made in natural resource curricula and course content. Responding to criticisms of the narrowness and technical orientation of their curricula, most schools have developed four year curricula that provide a very liberal education during the freshman and sophomore years. But not very large changes have been made in the final two years of these curricula. However, some schools are making changes and breaking with tradition. One school has collapsed all of its forestry courses into a single program during the junior and the first semester of the senior years. The objectives are to obliterate the boundaries between courses and to utilize a systems analysis approach. (Schultz and Thompson, 1971). Other schools have introduced integrated management and planning courses in which students learn to apply their knowledge to management decision-making and planning (University of California, 1971; University of Montana, 1970). Another change being made is to make basic professional courses common to all natural resource majors within a school.

Without changing curricula or introducing new courses, much can be done through modification of course content and greater coordination among course instructors. In too many instances, instructors do not force students to utilize what they have learned in earlier courses, nor do they relate the content of their course to that of other courses. Students find it difficult to understand why they are required to master the calculus when they never see it used in their professional courses. Perhaps professors are guilty of underestimating the abilities of their students.

One of the responsibilities of the natural resource agencies is to keep the schools well informed about their changing personnel needs. The agencies should also recognize that they need a variety of talents to get the job done and to communicate this need to the schools. There is no single mold that will provide a "man for all seasons" in the field of natural resource management.

The other major educational responsibility of the agencies is career training. Most agencies at the federal level have active training programs utilizing a variety of methods. The state agencies could do more along these lines. More emphasis on planning is needed in these programs. The schools are willing to participate in these programs and perhaps more use should be made of them by the agencies.

RESEARCH

Planning Information

Research provides much of the information, data, and input-output relationships necessary for effective planning. In the typical planning situation there is insufficient information of both kinds, as well as insufficient time and money to develop it. While it is true that a planner can never know as much as he would like, more and better information can be produced by research without large increases in research budgets. And greater utilization of existing information is possible.

The simple lack of information is one kind of information problem. This indicates that the problem is so new that no research has been done or that the problem has not attracted the attention of research. The result is that the planner must guess or use the judgements of experts. We typically lack information about the demand for resource uses. It is terribly difficult, if not impossible, to have timely demand information available because of changes in the elements of demand over time. When more physical and biological information is available than demand information, the result can be an excellent specification of the situation, but very poor development of alternatives and analysis of their consequences.

Often a planner may not be able to use available information properly because he can't interpret it relative to the planning situation or he is unable to recognize the assumptions underlying the research results. This can lead to invalid or incomplete application of the information.

A third information problem exists when a planner doesn't find useable, existing information. The result is the same as a complete lack of information.

When no information exists and the problem is not new, research must bear a large portion of the blame. Researchers in the field of natural resources need to realize more fully that they are working in an applied field. The prestige factors and the reward system under which researchers operate encourages pure research rather than applied research. And much so-called applied research is not useable because of a lack of contact between researchers and planners. A feedback system between researchers and planners is needed. Greater efforts must be made by researchers to identify researchable problems related to current or foreseeable management problems. A very good way to do this is for the researcher to get involved in a real world planning situation to the extent, at least, of discovering what the planning information gaps are. Planners can help by coming to researchers for information, ideas, and help. University researchers also need to instill in their graduate students the desire to work towards solutions to real world problems.

When information is available but the planner is unable to use it properly, it is all too easy to blame the planner. But more often than not, the researcher has not interpreted his findings in a way that is helpful to management. The planner needs to come to the researcher, or another researcher in the particular subject, and ask for interpretation. When asked, it is the responsibility of researchers to ensure that research results are properly used in planning. No one knows the limits of a research study's results better than the person who conducted the research and he should be called upon for help when there are any questions of applicability.

When available information is not found by a planner, again it is easy to blame the planner. But the planner simply cannot be aware of everything; he needs help, should ask for it, and be given it. In addition, researchers should make every effort to get their results to planners.

Planning Models

Another of the functions of research is the development of planning or decision-making models. It is my judgment that the development of these tools is outstripping the availability of input data and the ability of planners to use them properly. There is a strong impetus for quantification of decision-making and, where quantification is obviously impossible, to express nonquantifiable decision elements as constraints. This can be dangerous because it gives the appearance of a greater reduction in uncertainty and subjectivity than is actually the case.

Uncertainty can never be completely eliminated and, therefore, value judgments can never be completely eliminated. Rather than mask these value judgments, it seems far better for planners to recognize them explicity so they can be tested by public opinion.

ADMINISTRATION

Planning Climate

The natural resource agencies have not yet fully recognized the need for more effective planning. While planning is done at the top levels, planning at the basic management unit level has been primarily a facade, and, if not that, oriented to management based only on physical resource potential without regard for the various needs of society. Too many administrators view the goal of planning as avoiding conflict or minimizing public displeasure. Planning does not avoid conflict; it resolves conflict in a way beneficial to society. This means, most often, that some segments of society will be unhappier than other segments. Since natural resources are scarce, this situation cannot be avoided.

Land use planning for the basic management units of many agencies is something that is done in addition to other work. Planning is a full-time job and a planning team must be freed from the day-to-day administrative work in order to be effective. Specific budgeting for planning as a permanent function at the planning unit level should be instituted.

Too often planners are called upon to justify prior decisions. If planners are to be useful, they must be given the freedom to develop and consider all feasible alternatives. This does not mean that line officers should be excluded from planning efforts, but it does mean that the planners must feel perfectly free to disagree and pursue their own analyses. Line officers can contribute to the planners' efforts by aiding in problem definition and providing information on political constraints.

Support services for planners must be provided. Where planning is conducted at basic management unit levels, upper level administrative units should provide basic data and sources for additional information. They should also provide access to planning models and computer services.

Administrators need to encourage their planning personnel to utilize the talents of researchers and educators in planning efforts. I think natural resource managers are not aware of the willingness of academic and research people to help them. The benefits of such cooperation go both ways. The planners have the benefit of good information properly applied and, perhaps, of a different perspective. The researchers and educators have the opportunity to test their results and ideas in the real world and to identify new research problems.

In some agencies the functional organization of staffs based on resource uses can stand in the way of effective planning. This type of organization reinforces commitments to specific resource uses. The planning function and personnel should be separated, organizationally, from the other functional divisions.

Planning that is not used is useless. When plans are not used, a negative attitude towards planning develops and planners lose dedication and desire. Agencies must give more than lip service to planning as a way of making management decisions.

Planning should be a continuous process; no plan is ever complete. Day-to-day management decisions should be made in the context of the plan and line officers should be expected to demonstrate this. However, slavish devotion to a plan can be disastrous if the plan is not updated as conditions and priorities change. Using the plan is the best way of discovering and correcting obsolescence.

Coordination

There is a great deal of overlapping responsibility for resources and resource uses among agencies. Because of the interdependencies among resources and resource uses, an agency unit cannot plan in isolation and do it effectively. Yet, removing this isolation is difficult unless it is made clear to management unit planners that it is expected by the upper echelons of the involved agencies.

An important factor here is interagency jealousy and bureaucratic politics. Agencies have tended to become defenders of more or less specific clientele groups. Here we see a reflection of resource use commitment. It is sometimes argued that competiveness among agencies results in bringing out more points for consideration by legislative committees. However, when different agencies report to different committees, the effectiveness of such competition is questionable.

Coordination among federal agencies could be improved by creation of a single Department of Natural Resources. Even then there would be the problem of coordination among bureaus within the agency and with other departments. Effective coordination will not occur until managers and planners recognize, accept, and attempt to implement the proper goal of public natural resource management: the management of public natural resources so as to contribute to the maximization of social welfare. The responsibility of achieving this change in attitude lies with the natural resource professional schools, government leaders, and the natural resource professional societies.

CONCLUSION

The changes that are needed require the efforts of everyone in the field of natural resource management. While I think these changes are important, I also am convinced that natural resource managers have built a strong foundation upon which to make them. No other group has been so concerned, for so long, with the general problem of environmental management for tangible and intangible benefits. No other group has the basic background and orientation required to provide effective natural resource planning.

There does seem to be recognition of the need for change as evidenced by the changes that have already been made. We need to encourage these changes and to continue to make progress. Further progress is necessary because, if more effective natural resource planning is not achieved, the needs of society will not be met.

LITERATURE CITED

Churchman, C. West
1968. The systems approach. Dell Publishing Co., Inc. New York 243 pp.
Landsberg, Hans H.
1964. Natural resources for U.S. growth. Johns Hopkins Press, Baltimore. 266 pp.
McKelvey, V. E.
1972. Mineral resource estimates and public policy. American Scientist 60 (1): 32-40.
Schultz, A. J. and William P. Thompson
1971. A new era in environmental education. American Forests 77 (4): 28-31, 54-55.
University of California
1971 School of forestry and conservation. University of California, Berkeley 65 (6), 48 pp.
University of Montana
1970. University of Montana bulletin, 1970-71 catalog issue. Missoula, 88 pp.

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DISCUSSION

MR. ROBERT MACE: I am not sure that Dr. King can answer my question, and I'm not sure it's a question, but I think that one of the main concerns that the fish and game administrator has today is attempting to define the public. When we talked this morning about public demands and public needs—and I'm not sure that the bulk of the public is concerned at all with our natural resources—I think that many of them are concerned about their daily bread and that we have special interests groups. In our hearings, believe me, we are trying to respond to the public, but we are seeing publics arise every day that seem to come up over the horizon with the sun every morning, groups that we have never even thought of five years ago. What hope do we have for developing some guidelines, some perspective in analyzing supply and demand as related to our need to maintain resources? Can you give us a little encouragement?

DR. KING: I think I may have had an experience similar to what you may be facing in a planning situation last summer where we had to do it in three months with no money and no time. We held public input meetings, the vested interest group public came and not the general public. The only way we had of getting at the general public was through a household survey which I had done in 1967. And our publics, as you know, are more sophisticated now than they used to be, and they were not quite willing for us to accept 1967 data on preferences for recreation. I think the work of Davis and Seneca is our hope in this area. The problem is to have the demand information available when you need it and one of the problems is that the elements in and behind demand, change over time. I'm not sure but what you will have to go to what I am involved in right now, another planning effort in Arizona national forest land in which they are financing a demand study specifically for that—for the planning area. I think that natural resources administrators always seem to be willing to spend another buck to find out a little bit more about the grass and the trees and the animals but less willing to spend another buck to find out about people's needs. I think you have expressed concern in that you recognize that this is a need. You have to expect to spend a little money to get the information.

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TECHNICAL SESSION

Wednesday Morning—March 15

Chairman: Steve Gallizioli
Research Chief, Arizona Game and Fish Department, Phoenix

Discussion Leader: Rollin H. Baker
Director, Michigan State University Museum, East Lansing

SPECIES OF INTERNATIONAL INTEREST: MANAGEMENT AND PROBLEMS

THE MANAGEMENT OF CAPYBARA IN VENEZUELA

Juhani Ojasti and Gonzalo Medina Padilla
Ministerio de Agricultura y Cría, Dirección de Recursos Naturales Renovables, División de Fauna, Caracas, Venezuela

The capybara, *Hydrochoerus hydrochaeris,* is widely distributed in the Orinoco River basin of central and southern Venezuela. Around Lake Maracaibo there lives a smaller form closely related to *Hydrochoerus isthmius* of Panama. In most localities the capybara is scarce but in some places of the lower Llanos region (mainly the States of Apure and Barínas) it attains moderate population levels. The seasonally flooded grasslands of the region provide good natural habitats which are improved further by factors related to cattle raising, such as control of predators e.g. the jaguar, *Felis onca,* provision of permanent water sources, and by cattle grazing which keeps the grass lower and thus more suitable for capybara.

The capybara is hunted in many South American countries for hides and, to a lesser degree, for local meat supply and for sport. In the Venezuelan Llanos this rodent is subject of market hunting for meat since early last century (Codazzi, 1841, p.165). The dried, salted capybara meat is used for Lenten dishes, according to the tradition that capybara meat may be consumed during the "meatless" days of Lent, due to the amphibious habits of the rodent. A good, although temporal, market exists in Venezuela for capybara meat, which is not much esteemed elsewhere in South America. At present, the capybara is the only game animal which may be legally hunted for commercial purchase and sale in Venezuela. Being a native and free-living mammal it is considered officially a game species, but at the same time its established use as a commercial animal requires management procedures more related to game ranching than to game management for sport hunting.

In spite of suitable habitat conditions and some official control of exploitations since 1953, capybara populations decreased over the years, probably because of excessive hunting. The reduced populations resulted in a decree being issued in 1962 prohibiting the hunting of capybara for five years. During this period the market was supplied by imports from Colombia. The Game Division of the Venezuelan Ministry of Agriculture also began a basic biological investigation of capybara (Ojasti, 1971), supported by the Fondo Nacional de Investigaciones Agropecuarias, Caracas, aimed at establishing a sound management policy. The present paper deals with the exploitation, productivity and management of the capybara in Venezuela from 1968 to 1972.

We want to express our appreciation to M. Ilija and O. Linares, game officers, who made most of the population estimates since 1969; and to P. Schwartz of the Rancho Grande Biological Station; C. Houseknecht of the Williamsport Community College; and S. Gallizioli of the Arizona Game and Fish Department for critically reading and correcting the manuscript.

EXPLOITATION

Capybaras are hunted to some degree throughout the year for immediate consumption by rural people whereas market hunting takes place in the dry season (January—April) when the animals concentrate around the remaining water holes and are readily taken. This time of year is advantageous also because reproduction is at a minimum (Ojasti, 1970) and the animals have less subcutaneous fat, which sometimes has a distasteful flavor. The best cropping time varies from one locality to another depending upon conditions during the advancing dry season which concentrate the herds and affect transport conditions. Since the demand for capybara meat in the markets declines after Easter, the hunting must be completed before this day.

Market hunting normally takes place early in the morning or in late afternoon when the animals graze in open savanna. Several workers on horseback round up and drive a herd of capybaras to an open place where other workers on foot surround the animals. Tired from running, the capybaras stand quietly huddled together. Most of the killing is done by one or two experts who club the adult animals while other workers keep the herd together or kill those that run out. An animal struck by the club of an expert dies in a few seconds. The procedure is quick, efficient, inexpensive and allows selective cropping. Only animals weighing about 35 kilograms or more are killed, but visibly pregnant females or those with newborn young are usually spared.

The above described method produces good results only in open terrain. In forested areas shotguns are used (hunting with a rifle is prohibited in Venezuela), while a harpoon is used on animals that take to water. The carcasses are transported, usually by truck, to a camp or slaughterhouse; when only a few animals are involved, they may be dressed on the hunting ground.

The animals are skinned, the meat is separated from the skeleton in one piece, and the blood is washed out. The meat is then treated with coarse salt, salted again the next day, and dried by hanging in the sun for a week or more. All remains of subcutaneous fat are separated from the drying meat. The skeleton, viscera and hide are usually discarded, although there recently has been a tendency to preserve the hides for exportation.

An estimate of kilograms of meat per average capybara was obtained from a random sample of 50 commercially taken animals. Two skilled workers processed the carcasses in the customary way and the meat passed through the normal salting and drying process. The following weights were obtained at different steps of the processing.

Total body weight (excluding foetuses in pregnant females) averaged 44.2 kilograms (29.5 to 56.0 kilograms). The mean dressed carcass weight was 22.9 kilograms (52 percent of the total), and the fresh boned meat averaged 17.3 kilograms (39 percent of total). In the drying process the weight decreased to an average of 7.5 kilograms per animal, 17 percent of the total weight and about a third of the dressed carcass weight. The relation between total weight (x) and salted dried meat (y) is given by $y = -2.55 + 0.23x$ ($r = 0.97$), from which it is apparent that bigger animals yield proportionally more meat. For example an animal of 55 kilograms should yield 18.2 percent of its weight in dried salted meat but one of 30 kilograms would yield only 14.5 percent.

In recent years the producer has been getting about four bolivars per kilogram of dried meat, making the average gross value of a processed animal about 30 bolivars (approximately $6.70 U.S. currency). Considering the cropping and processing costs, the net profit is about 23 bolivars per animal. There are, however, other costs in capybara raising since the rodent is a heavy grazer and, at high population levels, may reduce the forage supply normally available for cattle. The herds must also be protected against feral dogs and poachers. Despite the various problems many landowners engaged in a capybara management program find it a profitable by-product of livestock raising.

CAPYBARA MANAGEMENT

There was no official control over the harvest of capybara until a regulation was passed in 1953 providing a special license for commercial hunting. This license was issued after payment of a tax for each animal to be taken. The harvest permitted was therefore related to the amount paid, not to the population level of capybara. Moreover, many license holders were not landowners and practiced destructive wholesale slaughter on the property of others. Under this system capybara populations were reduced with a consequent drop in harvest. By 1960 the amount of capybara meat imported from Colombia exceeded Venezuela's own production. During the protected period (1962-1967) population levels recovered on some privately owned lands, even reaching overcrowded conditions in some cases. However, the recuperation was not uniform because much illegal hunting took place due to poor law enforcement.

A preliminary survey of capybara populations in the State of Apure in 1967 showed that high population densities were associated with well-attended ranches where the owners fought poaching at their own expense. This rodent was generally scarce on public lands and on less well-attended ranches. The landowner who appreciated the value of the species thus became a key factor in its management. Under a new regulation passed in 1968, commercial hunting licenses are restricted to ranchers with an exploitable capybara population on their properties. On each ranch which requests a license a survey is made to get an estimate of numbers. In an effort to maintain a stable population, the permitted harvest is based on population level, modified by a productivity factor as discussed later.

Population Estimates

On any ranch the distribution of capybara is irregular because the animals live in herds along more or less permanent bodies of water. They often tend to be more numerous in central rather than peripheral parts of a ranch because of more poaching near the edges. Sometimes the population density is high in some areas and low in others for no apparent reason. Sampling methods that assume a random distribution would therefore given misleading population estimates. However, the tendency of these rodents to concentrate along bodies of water facilitates estimates based on direct counting of the observable animals.

Game officers make population estimates either in January and February, before the hunting season, or after it, in April. The ranches vary in size from 1,000 to 100,000 hectares and the field work takes two or three days on a medium-sized ranch (about 20,000 hectares).

Counting is done from horseback, by car, or on foot depending on the type of terrain and cover. An airplane was used in some cases. The work is facilitated greatly by an expert local guide, often the ranch owner or his foreman, who knows all the places inhabited by capybaras and is eager to show a maximum number of animals in order to obtain a large license quota. The vicinity of ponds, *caños* (natural channels varying in size, often dammed to hold some water for the dry season), marshes and all other places indicated by the guide are searched systematically and the capybaras counted. Counts are easily made where the cover is low or sparse and the animals relatively unwary. In gallery forests and thickets the work must be done on foot, requires more time and tends to be less accurate. In the most difficult situations counts can be made only in the late afternoon or at night when the rodents emerge from thickets to graze in open savanna. Because of the sedentary habits of the species, a herd is unlikely to be counted more than once.

In open habitats direct counts are believed to yield reliable estimates of population size, but some corrections based on personal experience are necessary in forested areas. In spite of imperfections, the procedures used have provided adequate data for routine management. At present the available time and personnel do not allow more elaborate techniques.

Productivity estimates

Preliminary surveys of capybara populations indicated that juveniles of less than one year comprised on the average about a third of the population in the dry season. Thus, when the management program began in 1968, an exploitation rate of 30 percent of estimated numbers (or less in some cases if the landowner requested) was established as a tentative goal, subject to readjustments. How the system works in practice can be shown by reviewing data from the El Frío ranch in the northern part of the State of Apure. This ranch has an area of 78,200 hectares, some 48,600 of which are occupied by capybaras. The ranch also supports about 28,000 head of cattle. In general the habitat is open savanna with a number of pond and *caños*.

TABLE 1. CAPYBARA POPULATION LEVEL, HARVEST AND NET PRODUCTIVITY FOR EL FRIO RANCH. NET PRODUCTIVITY IS EXPRESSED AS THE SUM OF ANNUAL INCREMENT AND HARVEST DIVIDED BY THE POST-HARVEST POPULATION OF THE PRECEDING YEAR AND AS KILOGRAMS PER HECTARE, BASED ON AN AVERAGE CAPYBARA WEIGHT OF 44.2 KILOGRAMS.

Census date	Post-harvest population	Annual increment	No. of animals harvested	Net productivity Percent	Kilograms per hectare
April 11, 1967	19,610				
May 3, 1968	22,783	3,173	5,000	41.7	7.4
April 24, 1969	25,765	2,982	8,000	48.2	9.9
April 16, 1970	27,250	1,485	12,000	52.3	12.2
April 27, 1971	28,180	930	15,000	58.5	14.5

Censuses were conducted in April each year (after the hunting season) by the senior author and the ranch foreman. Counting procedures and effort were equal in all years except 1971, when the stock was counted at the same time by the senior author and a game officer. On that occasion the mean difference between the daily counts of both observers was 4 percent of the total counted each day. The total number of capybara tallied was considered to be the total population of the ranch. The magnitude of the error involved was probably comparable from year to year and is believed to have been less than 10 percent of the total.

The annual net productivity rate, as used in this paper, averages 50 percent of the post-harvest population of the preceding year but appears to increase with a higher harvest rate (Table 1). Actually, the rather low apparent productivity of the first two years may have been due to more poaching in these years, the amount of which was unknown but significant according to the ranch owner. Although the net productivity rate must vary locally and from year to year within a given area, the average value of 50 percent is probably satisfactory for management of moderately dense populations in Apure. In most cases population estimates are made immediately before the hunting period, and include the production of the previous year, approximately one third of the total. It is worth noting that the observed productivity rate is about a third of the birth rate calculated from reproduction data (Ojasti, 1970).

Administration and control

The current procedure for administering the harvest of capybara is as follows: Ranch owners interested in participating in the program must request a license and certify ownership of their land at the Game Division's head office. A game officer is then sent to the ranch to estimate the size of the capybara population and to make his recommendations as to the number to be harvested. In normal cases, when the population density is moderate in suitable habitats, the permitted harvest is one third of the population for estimates made just before the harvest, or half of the stock when estimates are made after the harvest (in the later case the license is for the following year). A license is denied when sparse initial or overexploited populations are found. In cases of overcrowding and evident pasture damage the permitted harvest may exceed one third of the population estimate so as to reduce the population.

The license holders may harvest the allotted number of animals on their properties without direct supervision. However, every load of capybara meat moved from ranch to market requires a transportation permit, issued by local offices of the Ministry of Agriculture. This permit must be shown at the National Guard check points along the transportation routes. The wholesalers receive the transportation permit with the meat and must show it if requested. In spite of such controls much illegally hunted or illegally imported meat finds its way to the market. Individual marking of legally taken animals, programmed for 1972, will allow a closer control and should decrease poaching. However, the hunting for local consumption will still remain essentially uncontroled.

On the side of commercial hunting there are licenses available for sport hunters for one capybara per season.

RESULTS OF NEW MANAGEMENT PROGRAM

The data on the legal harvest of capybara (Table 2) indicate some trends and results of the present management policy in comparison with the earlier situation.

As mentioned previously, population estimates have been made only since 1968. Prior to that time licenses were sold to anyone requesting them. Fewer licenses are issued under the present system and the number tends to be similar each year, indicating no apparent increase in the number of ranchers operating under the system. In

TABLE 2. LEGAL HARVEST OF CAPYBARA IN VENEZUELA. PERMITTED HARVEST IS THE SUM OF THE NUMBERS OF CAPYBARA OF ALL COMMERCIAL HUNTING LICENSES IN A GIVEN YEAR.

Year	Number of ranches surveyed to determine capybara numbers	Number of licenses granted	Permitted capybara harvest
1958	—	41	12,300
1959	—	185	17,543
1960	—	48	5,011
1961	—	54	5,420
1962	—	57	8,805
1963-1967	hunting closed		
1968	29	21	17,700
1969	26	20	21,385
1970	28	14	22,400
1971	35	21	25,150
1972*	43	29	40,070

*Data available up to March 10.

fact, only about twenty ranches are producing capybaras in a regular manner.

Under the former system, the number of capybara permitted by a license was probably the number actually taken, since the hunter had to pay in advance for each unit and undoubtedly made every effort to secure the number of animals permitted by his license. At present there is no charge for licenses but all conditions favor realizing the authorized harvest because the standing crop of capybara is in all cases about three times the allowed kill. Total transportation permit data are available for 1969-1971, thus providing a check of the harvest. Curiously enough, in 1969 the amount transported exceeded the total permitted harvest due to serious faults in the local services of the Ministry of Agriculture. In 1970 the harvest was 92 percent of the number allowed, and 97 percent in 1971. Regarding the sport hunting, 764 licenses were issued in 1971, each for one capybara.

Noteworthy in Table 2 is the decrease of the legal harvest under the former system, in contrast to the gradual increase under the present. Most of the increase was produced by one ranch, El Frío. Some other ranches exceeded the permitted harvest in the early years of management, and in doing so seriously reduced their populations of capybara. Now, however, more ranch owners have come to trust the Game Division's management system and new populations are developing in many areas. The present production provides about half as much capybara meat as was consumed in 1965 and 1969 (the only years when the market was saturated and reliable statistics are available). The main producing areas are the District of Muñoz and Páez in the State of Apure which produce 78 percent of the capybara legally harvested.

DISCUSSION

In spite of the positive results achieved with the current management system, many problems remain. The program is aimed at maintaining moderate capybara populations and exploiting them properly throughout that portion of the Llanos that is suitable for them. Its effectiveness depends on the voluntary cooperation of ranch owners. The ranches where population estimates have been made cover only about 9 percent of the States of Apure and Barinas where market hunting is permitted. Much more area should be put under management.

Some of the ranches now under the system are already heavily grazed both by cattle and capybara, precluding any increase in the population levels of capybara. On the other hand, many areas, not now involved in capybara management, have few or no cattle, and in such cases this rodent would be specially valuable for converting the surplus pastures to edible meat. Unfortunately, illegal hunting keeps capybara numbers low in those areas.

Another weakness of the present system derives from the use of population size and net productivity estimates alone for determining the allowable harvest. Such a method is well fitted to moderate population densities but is inadequate when overcrowded or low populations are concerned. Some empirical adjustments are made in such cases but a standard based on population density would be preferable. In order to have ecologically meaningful results, the population level should be adjusted to the area suitable for capybara in the dry season rather than to the total area of the ranch. This would require a detailed mapping and measuring of the suitable habitat of the rodent on every ranch concerned, a procedure not feasible at present due to scarcity of funds and trained people.

The capybara is widely distributed over the Venezuelan Llanos and is abundant in some places when afforded protection against excessive hunting pressure. This rodent is regarded as a pest by some ranch owners and as a meat producer by others. As it is attractive for market but not for sport, the economical aspects are most important in its management. Because of its size, the quality of the meat and the hide, its productivity, relative tameness, gregariousness and sedentary habits, the rodent represents a valuable additional resource on large livestock ranches. Its heavy and localized grazing, the fact that it attracts poachers, and the archaic procedure of meat utilization diminish its value. However, the realizable monetary value of capybara in proportion to the food it consumes probably exceeds that of cattle in the same region. This may reflect the rather poor conditions of the local cattle industry (Estrada, 1966), but much improvement is also possible in the case of the rodent. A selective cropping of males, control of predators and poaching, and properly distributed additional ponds can improve its productivity. Also the marketing of fresh, smoked or canned meat, sausages etc., instead of a dried salted product, would surely increase its commercial value and strengthen the bases of management.

The experience acquired, although limited, indicates that the management of capybara for market hunting is feasible with moderate efforts. Moreover, this huge rodent could prove to be an increasingly important native meat producer in the Llanos region of Venezuela and other parts of tropical America.

LITERATURE CITED

Codazzi, A.
1841. Resumen de la geografia de Venezuela. H. Fournier & Comp., Paris. 648 pp.

Estrada, H. J.
1966. La ganaderia en el Estado Apure. Consejo de Bienestar Rural, Caracas. 215 pp.

Ojasti, J.
1970. Datos sobre la reproduccion del chiguire (*Hydrochoerus hydrochaeris*). Acta Cient. Venez. 21 (suppl. 1): 27. (abstr.)

1971 Informe sobre la investigacion biologica del chiguire (unpublished). Min. Agric. Cria, Caracas. 315 pp.

DISCUSSION

CHAIRMAN GALLIZIOLI: The speaker will accept questions and comments in English or Spanish. This is an interesting animal. I have always heard of the capybara as the largest of the rodents and now we find that it is a grazer that competes more with livestock than we thought.

DR. GERARDO BUDOWSKY (Switzerland): I would like to ask Dr. Ojasti two questions. One refers to the capybara as a sport hunting animal. I wonder if it really qualifies as one according to the habits he has described to us when he referred to hunting. The second question refers to competition with cattle. The capybara was for many years considered as a plague by the cattle people. Can you give a few more facts on how much competition for grass there is between the capybara and the cattle?

MR. OJASTI: The capybara is unlikely to become of interest to those hunting for sport in Venezuela. It is a very tame animal, and it is as easy to kill a capybara as to shoot a steer on the plains. We do issue sports hunting licenses for capybara, one per hunter, and per year; but there is little demand for such licenses.

Insofar as competition between capybaras and cattle for food is concerned, that is still a fairly delicate problem. Fieldwork has shown that during the rainy season capybaras and cattle feed on different things, but during the very dry season, when grass is scarce, there is more or less direct competition between them. Also, the capabara is a more efficient grazer when grass is scanty, and may eat it right down to the ground level. In spite of this, particularly in the State of Apure, it cannot be said that there is much real competition for food between capybaras and cattle, but rather that cattle herds are too numerous for the productive capacity of the savanna.

DR. MIGUEL ALVAREZ (Mexico): What acceptance does capabara meat find among people in nonrural areas and in the cities?

MR. OJASTI: So far the only commercial product is dry and salted meat. It is consumed only during Easter Week. In attempting to diversify these products, preliminary tests have been made with smoked and sausage meat, with very favorable results; however, effective commercialization of this type of product will naturally require the same kind of advertising campaign as is needed to popularize any other kind of article.

DR. ALVAREZ: What relation is there between the price of the capybara meat in city markets and its consumption?

MR. OJASTI: The demand for the capybara meat is quite independent of price levels since its consumption is a part of Easter Week traditions in certain Venezuelan cities. It is purchased extensively even when the price gets high.

DISCUSSION LEADER BAKER: Do you have any data on the forage consumption of the capybara in comparison with cattle?

MR. OJASTI: We have made tests on the amount of food consumed by both the adult and the young. On the average, an adult capabara consumes 4 kilos of fresh grasses per day. It is difficult to compare this with consumption by cattle, because no figures exist for forage consumption by cattle in this same environment, but it is estimated that a medium-size steer consumes approximately 10 times more food than an adult capybara.

* * *

WILDLIFE MANAGEMENT IN MASAILAND, EAST AFRICA

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Wildlife in East Africa is a tremendous asset to the countries concerned and to the world at large. The Governments in East Africa acknowledge this asset, and wildlife as a tourist attraction plays a prominent role in their existing and proposed national development programs. Funds, that are becoming progressively more difficult to obtain, are being used to build game lodges to accommodate more tourists. Highways are being built and improved to complete tourist circuits and to ease travel discomfort between stops. New airports are under construction and existing ones are undergoing reconstruction and expansion to accommodate jumbo jets and the anticipated throngs of passengers. Luxury hotels are springing up in Nairobi, Kampala, and Arusha to serve as bases and transit facilities for tourists on the game park circuits, and to give them a welcome respite from tight schedules, heat, dust, and crowded mini-buses.

Thus tourism and wildlife are solidly linked together and are so recognized by the formation of a single Ministry of Tourism and Wildlife in the Kenya Government and by the prominence that wildlife plays in tourist promotional programs carried on worldwide by all three countries.

ECONOMIC IMPORTANCE OF TOURISM

In Kenya, tourism is the second greatest foreign exchange earner, exceeded only by coffee. Government estimated that tourism brought in about $52.5 million to Kenya in 1971, and it is estimated that this will grow to $105 million by the end of 1974 (Shako 1970). Twenty thousand Kenyans are employed in the tourist industry now, and the projections are that this number will double by 1975.

Mitchell (1968) stated that "tourism is an extremely efficient earner of foreign exchange, so much so that one pound's worth of resources devoted to tourism earns more foreign exchange than would be saved by two pounds worth of resources devoted to a wide range of import substitute industries." He also said "The Government is the largest single beneficiary of tourism. In 1966/67 the rate of return on Government assets devoted to tourism (including the value of the land in National Parks) was between 20 percent and 30 percent," which is a phenomenal return on an investment.

Thus we can see that governments are actively supporting tourism and are interested in the welfare of the wildlife which is the main motivating force drawing tourists to East Africa.

THREAT TO THE TOURIST INDUSTRY

Population Pressure on the Land

Population growth rate in East Africa now exceeds 3 percent per annum, among the highest in the world. The population in Kenya doubled from 1928 to 1953 and has doubled again since then, and now stands at eleven and one-third million. At the present rate about 30 million Kenyans will occupy the 219,790 square miles of the country by the year 2000. The problem is accentuated by the dependence of the people on agricultural production and the aridity of the country which permits only about 15 percent of the land to be used for production of crops. The remainder produces only domestic livestock or wildlife, hence supports a sparse population of people.

In all three of the East African countries Governments are pushing land development in an effort to increase production and reduce unemployment. Kenya now has 230,000 unemployed and, as in the developed countries, people are flocking to the cities, accentuating the problems associated with overcrowding. This is in spite of Government's policies and efforts to get them to stay on, or go back to, the land.

Resettlement areas where the people can depend upon farming for a livelihood are becoming more difficult to find, and there is a growing tendency to put people in marginal land areas with deficient rainfall where crop failures can be expected at frequent intervals. Basically, even with the present population there is not enough land with adequate water to consistently meet the demands for vegetable and animal products. Government's development programs therefore stress increased productivity of the land through more advanced methods of management and techniques. Masailand is such an area.

LAND ADJUDICATION AND LIVESTOCK MANAGEMENT IN MASAILAND

The Masai are semi-nomadic pastorialists whose culture revolves around livestock, with cattle assuming the greatest importance. Sheep and goats are used as every-day currency and as a supplement to the Masai diet of cow's milk. Cattle are considered as capital stock and there is a great reluctance to convert them into cash. In Masai society cattle represent prestige, power, social standing, trading stock for marriage, and in the marginal environment in which they live, a necessity for their survival. Thus their livestock management is not designed to produce cattle for slaughter, but is a system where many people are supported by many cattle, in contrast to a developed ranch situation where many cattle are tended by few people, and the excess livestock sold for meat production.

Thus in order to increase the cattle supply from Masailand, the Kenya Government began a program in 1966 which if successful, will be almost total revolution in Masai customs. Essentially the program calls for the adjudication of former Masai trust lands to individuals or groups of Masai and the development of these ranches as self-sustaining units, with emphasis on encouraging the sale of cattle produced to pay for the improvements. In order to discourage overgrazing, plans call for the termination of the old Masai custom of moving herds to take advantage of available water and green grass following rain patterns. The theory is that if the Masai own the land and are forced to confine their livestock to the area they own, they will have an incentive not to overgraze the range. The International Bank for Reconstruction and Development and the Swedish International Development Agency loaned $7.2 million to the Kenya Government in 1968 for the development of the Masai ranches. The loans to the ranchers will be for a term of 12 years with 4 years of grace at an interest rate of 7½ percent on the principal.

Masailand in Kenya consists essentially of Narok and Kajiado Districts, an area of 15,617 square miles. The area is typically East African with gently rolling hills and plains and scattered flat-type *Acacia* trees. The ground cover is predominantly golden waving red-oat grass (*Themeda triandra*) at the end of the rainy season which is replaced by a deep velvet green effected by a burn-off of the old grass and new growth after the first showers. The area is one of the best for wildlife in East Africa with a biomass of 14,785 lb. per square mile. (de Vos *et al.* 1970). These two districts contribute 58 percent of the total game animals harvested by hunters taken from control area blocks in Kenya, and contain the highly used tourist areas of Nairobi National Park, Masai-Amboseli Game Reserve, and Masai-Mara Game Reserve. Amboseli and the Mara form important links in the Kenya-Tanzania loop that in Tanzania contains Lake Manyara, Ngorongoro Crater and Serengeti National Parks. Also in the area are the proposed Ngurman Escarpment Wildlife Area and the Trans-Mara Wildlife Area which is already under development. Intensification of management and development of the area for maximum cattle production poses a direct threat to the wildlife reserves because many of the game animals leave the reserves and spend a portion of the year on the areas that are being developed as ranches. While on these areas the existence of the wildlife is at the discretion of the landowners because Kenya law provides that any landowner may protect his property from wildlife. Wildlife using forage and water in competition with domestc livestock can legally be eliminated. It therefore is essential that a program be developed that will provide an economic incentive to the landowners to repay them for permitting wildlife to use their water and range resources.

WILDLIFE-LIVESTOCK COMPETITION

In the evolution of the fauna occupying the East African area, within the wide variety of herbivores, there are species that utilize all types of vegetation at some stage of growth. A few, such as giraffe and gerenuk, do not compete with livestock because they normally feed higher than domestic animals can reach, but most of the plains game antelope and buffalo compete with domestic livestock to various degrees. Preliminary results of a joint study by Texas A & M University through the Caeser Kleberg Foundation Program and F.A.O. has shown that 90 percent of the food items taken by Thomson's gazelle and 75 percent of the food items taken by impala are also utilized by cattle grazing in the same area. (Blankenship, L. *et al.,* 1971). Wildebeest, zebra and kongoni compete with cattle for available foods both during the dry and wet seasons (Casebeer and Koss 1970). Available free drinking water is a limiting factor in utilization of much of East African rangelends by livestock. Cattle distribution is confined to areas where water is accessible and reduced water intake reduces food intake. This decreases growth and maturity, which increases age to slaughter, thus increasing costs. Ranchers therefore have justification for their concern about the water consumed by wildlife, and some ranchers go so far as to eliminate zebra on their lands because of the large quantities of water that they consume.

In view of this competition between livestock and wildlife it is only proper that, on private land, wildlife should pay its fair share, commensurate with the resources that it uses.

THE KENYA WILDLIFE MANAGEMENT PROGRAM

Objectives.

The Kenya Wildlife Management Project, a Kenya Government, FAO/UNDP project, began in March, 1971. Its long-range objective is "to assist the Government in formulating plans and implementing programs that will increase the economic return from developing rangelands. The project will emphasize wildlife utilization aspects of rangeland use but, in order to place wildlife in proper perspective, will take into consideration other components of the ecosystem."

The immediate objectives are:

1. To determine biological factors influencing wildlife populations.
2. To develop and implement wildlife utilization programs,

including wildlife viewing, sport hunting, and direct cropping and marketing.
3. To determine the degree of competition for food and water between various species of wildlife and between wildlife and domestic livestock and establish their efficiency in converting forage to meat.
4. To evaluate the economic potential for wildlife utilization.
5. To provide biological and economic information generated by the project that will permit landowners to consider wildlife as an option in land-use programs.
6. To provide wildlife inputs into land-use plans for developing rangelands.

Initially the project will work in Kajiado District, an area comprising 8,094 square miles located south and east of Nairobi. Wildlife census by airplane has indicated there is a wildlife biomass of 7,000 lbs. per square mile, with 60 percent of the population almost equally divided between wildebeest and zebra. The other 40 percent is dispersed among 12 other species (Table 1). Wildlife makes up only one-third of the herbivore biomass, the remainder consisting of domestic livestock.

Wildlife Utilization: Viewing

On some areas of the district the highest economic return may be from wildlife viewing. Scenic locations where wildlife concentrates when outside the boundaries of the national parks and game reserves offer apparent possibilities. Feasibility reports will be prepared and if favorable, investment opportunities will be outlined and the money for wildlife viewing enterprises will be allocated.

TABLE 1. WILD ANIMAL NUMBERS AS DETERMINED BY AERIAL CENSUS, KAJIADO DISTRICE, 1969. (DE VOS ET AL. 1970)

Species	Number
Buffalo, *Syncerus caffer*	400
Eland, *Taurotragus oryx*	8,844
Elephant, *Loxodonta africana*	1,464
Grant's gazelle, *Gazelle granti*	15,880
Thomson's, gazelle, *Gezella thomsonii*	3,364
Gerenuk, *Litocranius walleri*	76
Giraffe, *Giraffa camelpardalis*	3,094
Impala, *Aepyceros melampus*	5,952
Kongoni, *Alcelaphus buselaphus*	7,072
Oryx, *Oryx beisa*	512
Ostrich, *Struthio camelus*	1,480
Rhinoceros, *Diceros bicornis*	28
Wildebeest, *Connochaetes taurinus*	24,832
Common zebra, *Equus burchelli*	34,192
Total	107,190

Sport Hunting

Increase in the level of sport hunting will be encouraged. In 1969 the legal hunting off-take in the District amounted to 2,019 animals of 27 different species, whereas our population data indicates this off-take could safely be increased to 10,700. We believe sport hunting will bring a higher economic return per animal than will direct cropping because of the additional fee and local expenditures made by the hunter. Sport hunting will be encouraged by permitting higher bag limits, more liberal seasons, fewer regulations and, if economically desirable, adjustments in fees. Wildlife management in Kenya, and in fact in all three of the East African countries, has been and still is much more preservation-orientated than programs in North America. The regulations governing hunting are complicated and numerous, and many of them of dubious value because of difficulty of enforcement. In many respects the purpose of the laws are to regulate "sportsmanship," a desirable objective but in practice a facet which has long been recognized in North America as impossible to accomplish by regulations.

Short-term safaris of three or four days offer good possibilities of increasing hunting, once regulations are simplified. Thousands of tourists pass through Kenya each year, and without doubt many of them would take advantage of an opportunity to participate in a hunt for plains game and birds, if it were made convenient and costs were within their means. The hunting would be a short diversion from the regular tourist route through the game parks and reserves. In order to reduce costs the regulation requiring a professional hunter for every two hunting visitors would have to be changed, and many of the "frills" now provided would have to be eliminated. Current costs for a hunting safari in Kenya are now $250 per day for two hunters, which includes all facilities except personal items, licenses and fees, ammunition and spirited drinks. To put such a safari on a competitive basis with other types of tours these fees would have to be reduced to $50 per day, which could be done with four hunters per professional. Comforts but not "frills" could be provided and overall costs should not exceed $75 per day. A program such as this should prove quite popular, increasing the off-take and the income from the wildlife. It would also provide the opportunity to present to a large and receptive audience the facts on wildlife management and utilization, and their importance to the future of wildlife in East Africa.

Wildlife Cropping

To accomplish the desired off-take in Kajiado District, in addition to hunting, it will be necessary to develop a program for direct cropping and marketing. If the off-take were doubled by hunting, which seems optimistic, there would still be a surplus of about 6,000 animals to be removed on the basis of an annual 10 percent off-take. At the present this appears to be a conservative off-take because productivity data indicate that for a species like Thomson's gazelle the off-take could be 40 percent (Hvidberg-Hansen and de Vos 1971), and for slower producers like buffalo a 10 percent removal should not be excessive. Roughly it is estimated that 600,000 kilograms of meat could be produced by cropping the surplus wildlife in Kajiado District, but that 25 percent would be rejected for human consumption because of parasites and other causes. Wildlife meat produced from an experimental cropping program is now bringing the producer Kenya Shs. 3/75 per kilogram (24 US cents per pound) picked up by the buyer at the field abattoir. This is about the same price received for cattle. On the assumption that this price would decline with increased supply it can be assumed that the meat will bring in 1½ million shillings. About 3,000 skins of zebra would be produced bringing in the equivalent of Kenya shillings 400 each (US $57.14) dry salted, for a total of Shs. 1,200,000. An additional half million shillings should be realized from the skins of other animals, making a total return for meat and skins of 3.2 million shillings. This is equal to 395 shillings per square mile or 0.6 shillings (9 US cents) per acre for Kajiado District.

The costs for harvesting and processing the animals is difficult to assess because of our limited experience. Getting the animals at the time and in quantities desired is still a problem in wildlife cropping. Briefly, in the Kenya project we plan to herd the animals into wing traps with helicopters, a method used successfully in the past three years to catch animals in Natal (Oelofse 1970). Animals to be harvested will be processed through a mobile abattoir, and the remainder will be released. Initially it is planned to sell the meat fresh but possibilities for marketing processed meat and meat products will be investigated. Markets for exporting fresh meat are limited because of prevalence of foot and mouth disease in East Africa, but outlets in the Middle East and the Orient that now take meat from East Africa will be investigated.

Net revenue from all forms of wildlife utilization will go to the landowners, which should be of great assistance in repaying loans for the land and livestock improvements.

Research Program

Benefits of the research program will probably equal those of the development program.

In addition to population, information is being collected on sex and age composition and mortality of the wildlife to determine productivity of the herds. Movements and seasonal concentrations are noted and this is correlated with habitat and availability of water.

The influence of diseases, parasites, and nutrition on wildlife population levels and productivity will be determined. Blood values and metabolic profiles will be made of a portion of the animals cropped, antibody levels to viral, bacterial and protozoal diseases will be tested, parasite levels will be monitored, and this information will be correlated with reproductive status, body condition and population density, as well as range condition on the area from which the animals were taken. The relationship of diseases between domestic livestock man, and wildlife will be investigated.

Studies on competition for food by the various species of wild animals and wild and domestic animals will indicate the most efficient mix of herbivores to use on the range. Other projects being carried on by the African Wildlife Leadership Foundation and the Caeser Kleberg Research Program in Wildlife Ecology by Texas A & M University are investigating the feasibility and economics of domesticating African antelopes, the results of which can be compared with this project which is using wild stocks. All aspects providing information essential to making decisions on the best use of arid and semi-arid lands will receive attention.

CONCLUSION

Africa is in a period of dynamic change. Populations are exploding and governments are using all resources at their command to bring the lands up to maximum production. Developed countries and international agencies are accelerating the transformation by providing capital and experienced personnel with the result that most efforts are channelled along the lines of land use long established in the more developed countries. Wildlife that now occupies relatively large expanses of under-developed lands must now compete economically with proposed and potential forms of land development and use.

The Kenya Wildlife Management Project is a pilot operation designed to maximize the economic returns from wildlife on semiarid lands where game and domestic livestock co-exist. Results from this project will have wide application in Africa. Wildlife proponents in other African governments are keenly awaiting results to assist them in salvaging a situation of shrinking wildlife habitats brought about by land development.

The success of the Kenya project rests upon getting the highest possible monetary return from the animals. Skins and trophies will be an important portion of the revenue, and since major markets for these products are in developed countries, public acceptance of these items will greatly influence the success of the program. Recent publicity in North America and elsewhere aimed at curtailing the illicit market in game skins and trophies could well decrease the price of wildlife products from legitimate programs. Individuals and organizations initiating and supporting this publicity should clearly differentiate between the source of the products, and consider the possible consequences of their programs. Make no mistake about it, in Africa the course is clear. Wildlife will either compete economically with other forms of land use or it will perish.

LITERATURE CITED

Blankenship, L. H., C. R. Field and S. Qvortrup
1971. Utilization of wildlife in East Africa. Annual report, Caeser Kleberg Research Program in Ecology, College of Agriculture, Texas A & M University. 325 pp

Casebeer, R. L., and G. G. Koss
1970. Food habits of wildebeest, zebra, hartebeest and cattle in Kenya Masailand. E. A. Wild. Journ.: VIII 25-36

de Vos, A., R. L. Casebeer, R. K. Davis, L. D. Fay, W. G. Swank
1970. Wildlife management in Kenya UNDP/FAO Mission Report FO:SF/Kenya/1. Food and Agriculture Organization of the United Nations, Rome Italy. 53 pp

Hvidberg-Hansen, H., and A. de Vos
1971. Reproduction, population and herd structure of two Thomson's gazelle populations. Extrait de Mammalia 31(1): 1-16

Mitchell, Frank
1968. The costs and benefits of tourism in Kenya. Report for the Kenya Tourist Development Corp. Institute for Development Studies, University College, Nairobi. 59 pp

Oelofse, Jan
1970. Plastic for catching game. Oryx X(5): 306-310

Shako, J. L. M.
1970. Tourism—Kenya's second largest single industry. East African Standard, December 14, 1970.

DISCUSSION

DISCUSSION LEADER BAKER: Our speaker brought up two interesting points that usually do not come out when we talk about African animals. One is the problem of cropping. Owing to the strange customs of the local people there is necessity for this. The other is the matter of some of this wild meat being harvested but containing parasites which may render it unfit for the market. Are there questions for Dr. Swank?

DR. GUSTAV SWANSON (Colorado State University): Are these animals migratory or are they more or less resident animals?

DR. SWANK: An important problem involves the animals that come out of Amboseli and Nairobi Parks. Amboseli and Nairobi Parks are relatively small areas; the animals concentrate there during the dry season because of the Auki River in Nairobi Park and the Amboseli lake bed at Amboseli. As soon as the rains come, these animals disperse. Nairobi Park is practically empty of wildlife and so is Amboseli. These animals go to private lands, and now about 80% of the land in Kajiado District has been adjudicated. By 1974 it will all be adjudicated to private individuals, cooperatives, and Masai families, and the animals will then be at the discretion of the landowners.

DR. ROBERT DAVIS: I wonder if Dr. Swank would say a word about the nature of the opposition to any concept of game cropping if such opposition exists and whether it is political on the part of veterinarians or what its nature is.

DR. SWANK: Any new concept is going to have opposition, and this proposal has its share. The Veterinary Service has opposed the program. It has been a three-year project of mine to overcome this opposition. We now have the endorsement, and even enthusiastic support in Kenya. This has been accomplished by working with these people, demonstrating to them that we are as much interested in their livestock and their livestock problems as they are, and I think the opposition will likely decrease and probably will disappear. We have some opposition from the commercial livestock operator who sees this as a possible threat to his industry. It may reduce his prices. At the present time we hope initially to sell the meat as a specialty item and that's the way we are selling it now. And we have had the support of the Kenya Meat Commission. I see no immediate opposition there. One of the big factors that may lead to the failure of the program is the reluctance to utilize wildlife products. The present trend in developed countries for non-utilization of wildlife products may carry over into the wildlife utilization program in which we are engaged. Again the success of the program will depend upon getting the highest possible monetary returns from the finished products. If this depresses to the point where we can't compete with livestock, then the program will be a failure and I think that wildlife, at least on lands outside the Parks in Kenya, will be finished.

MR. RICHARD BURNS (Biologist, Mexico): From the information you gave us on population, it appears that this is going to be an ever-increasing problem. Is anything being done to control the population of Keyna?

DR. SWANK: Yes, the government is aware of the problem. They have family-planning programs and they realize that if the population problem continues, it will be impossible to educate their children, the quality of living will go down, and they are looking at population growth as a direct threat to the way of life that now exists in Kenya.

THE PROBLEM OF BAT RABIES, MIGRATORY BATS, LIVESTOCK AND WILDLIFE

ARTHUR M. GREENHALL
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Although bat rabies was not discovered in the United States until 1953, there is no reason to believe that the problem only arose then. As awareness of the problem increased, greater numbers of rabies-suspect bats were brought to the health officials to be tested for rabies infection (Constantine, 1970). The numbers of infected bats tested has increased steadily in the United States from eight in 1953 to 484 in 1965, which was the peak year; however, the ratio between infected and non-infected bats, among those examined, did not change. Infected bats are more likely to be picked up than non-infected ones.

To date 48 States of the United States, south of Canada, have reported rabid bats. More States reported cases of rabid bats in 1970 than in any previous years: 296 cases of infected bats were reported by 45 States (CDC, 1971).

At least 25 species of insectivorous bats (out of approximately 40) in the United States have been found to be infected, so it can safely

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by assumed that any species of bat may contract this disease. Bites from rabid insectivorous bats have caused human deaths and each year many people must receive the anti-rabies treatment due to having been bitten by bats.

Since bat rabies was first diagnosed in the United States, six deaths in humans have been attributed to exposures to insectivorous bats; four of these occurred as a result of bat bites, while the other two resulted from exposure to airborne virus in a heavily populated bat cave in Texas. This same cave was used for experiments (Constantine, 1967) in which a variety of animals, including foxes and coyotes, became infected with rabies through aerosol transmission.

It is essential that the public be warned to avoid densely populated bat caves; all people bitten should be given anti-rabies treatment immediately. All carnivorous pets, particularly dogs, should be vaccinated against rabies. In buildings that are frequented by children, bats should be eliminated from roosts; infected bats often drop from their roosting places to the ground, where a child could pick them up out of curiosity.

Constantine (1970) stated that the rabies infection rates generally appear to be higher in migratory than in non-migratory types of bats. The migratory species most often found rabid is the Mexican free-tailed bat, *Tadarida brasiliensis mexicana,* which inhabits the western United States. Carlsbad Caverns, in New Mexico, are famous for the thousands of these bats issuing from the caves at dusk during the summer. In the fall there is a rapid southward movement of this species. There is evidence indicating that only a relatively small number of these bats migrate over great distances into Mexico and possibly farther south. But banding studies of *Tadarida* have revealed migrations of 1,000 miles from Oklahoma into Mexico (Greenhall and Paradiso, 1968), where this species was found roosting in caves that also shelter the common vampire bat, *Desmodus rotundus.* This vampire bat is the most important transmitter of paralytic rabies in the American tropics. Weather front activities, especially cold fronts moving south, probably influence the longer migrations of *Tadarida.* As the cold weather moves in, this species flies farther south.

Bats often bite each other, so that transmission of rabies could occur normally in a roost between vampire bats and the Mexican free-tailed bats. However, it must be remembered that airborne transmission of the disease does not require fighting or other direct contact between bats of the same or different species; the bats need only be within the same roost.

Transmission of rabies virus from bats to wild animals is not fully understood. More work is required, especially on the question of whether rabies can be transmitted to wild carnivores through the ingestion of infected bats (Bell and Moore, 1971), particularly in the case of predators such as raccoons and opossums that are known to feed upon vampire bats.

Whether big game, such as large carnivores and ruminants, are involved in the cycle of paralytic rabies is a question still to be answered.

More clearly defined is the problem of the vampire bats, which subsist exclusively on the blood of wild and domestic animals (including man) and in consequence may cause great damage in the course of normal feeding, whether or not they are infected with rabies or other pathogens. Vaccination will protect animals against rabies, but it can not protect livestock from being bitten by vampire bats.

VAMPIRE BAT PROBLEM

Restricted to the Western Hemisphere, the vampire bat family, Desmodontidae, is comprised of three genera: *Desmodus, Diaemus* and *Diphylla,* all of which are known to be infected with paralytic rabies over a large part of their respective ranges.

The most important transmitter of paralytic rabies is the commonest vampire bat, *Desmodus rotundus.* This is also one of the most abundant of all tropical American bats. It is found from northern Mexico to central Argentina, from sea level up into the high mountains, inhabiting forests, savannahs, deserts and swamps. Before Latin America was settled by Europeans, the indigenous vampire bats must have fed upon wild animals. With the introduction of domestic animals by the European settlers, the vampire bats had available to them a more easily accessible, plentiful supply of blood than the native wildlife had afforded them. Man-made structures, such as mines, wells, culverts, irrigation tunnels and buildings, added new roosting possibilities for the vampire bats, which had previously roosted in caves and hollow trees. Being adaptable creatures, vampire bats, especially *Desmodus,* have benefited from this plentiful supply of food and roosts; thus, their populations have increased to a point that has brought them to pest status.

Repeated nightly attacks by vampire bats debilitate livestock, because the open wounds they make continue to ooze blood for many hours, due to the anti-coagulant contained in the vampire's saliva (Hawkey, 1966). These oozing wounds may attract blood-feeding insects. Also, pathogens other than rabies may be transmitted by vampire bats, such as trypanosomiasis to equines.

A single vampire bat consumes a daily average of 20 ml of blood (7.3 liters, or 15 pints, per year). Since hundreds of *Desmodus* may occupy a single roost, their predation in the surrounding area can be intense. For example, the milk yield of severely bitten dairy cows drops markedly; sows bitten on their teats are unable to nurse their young; and poultry can be ex-sanguinated. In certain parts of Latin American raising cattle is very difficult, while pig and poultry production is almost impossible unless bat-proofed enclosures are provided for the livestock.

Therefore, the World Health Organization's Expert Committee on Rabies has stated that: "Vampire bat rabies is the major cause of death in cattle in Latin America and has proved a major obstacle to the expansion of its agricultural economy." (5th Report, 1966).

Normally, when tremendous population increases occur in an animal species, the numbers are lowered, or controlled, by nature—often by means of a disease such as rabies. Rabies is fatal to most mammals, but vampire bats have developed an unusual tolerance to the virus and can recover from the disease, thereafter transmitting it for long periods of time as asymptomatic carriers. New vaccines will probably prevent rabies in livestock, but more effective methods of vampire bat control need to be investigated.

BATS AND CONSERVATION

As most species of bats are useful and beneficial, their feeding habits should be carefully considered before the wholesale destruction of any species is undertaken. Diets vary according to species and include: insects, fish, reptiles, birds, mammals, fruit, nectar and blood. It has been estimated that some bats consume about one-half their full weight in insects each night, so that without some agent to control insects effectively, there could be a tremendous upsurge in their numbers if insectivorous bats were eliminated. Some bats act as useful predators, others are essential pollinators, while still others are specific seed disseminators of economically important trees.

VAMPIRE BAT HOST PREFERENCES

Apart from the fact that vampire bats subsist exclusively upon blood, their feeding preferences have not been determined in sufficient detail. Knowledge of the complete spectrum of vampire bat host preferences could assist in their control as well as possibly indicating presently unsuspected animals involved in the epizootiology of vampire bat rabies. Using specific laboratory tests, it is possible to determine from the ingested blood (removed from the bats' gastrointestinal tract) what animals the bats have fed upon.

My studies in Trinidad indicated that *Desmodus* and *Diaemus* feed upon a wide variety of domestic animals, cattle being preferred (especially by *Desmodus*), as well as upon a number of wild animals, so far unidentifiable (due to lack of anti-sera).

Our studies in Mexico indicate that *Desmodus* here feeds primarily upon cattle, although horses, donkeys, pigs, poultry and humans are also attacked. The blood of some wild animals, such as squirrels, has been identified in vampire bat blood meals.

To determine the original hosts of vampire bats, it will be important to conduct studies of the blood meals of these bats in areas where domestic animals have not yet been introduced. Laboratory studies in Mexico have shown that *Desmodus* will feed upon snakes, lizards, turtles and toads (as well as wild mammals and birds). This unexpected finding may cast some light on the epizootiology of vampire bat rabies (Unpublished data).

VAMPIRE BAT CONTROL

Since the balance of nature has already been disturbed in favor of the vampire bat by the introduction of domestic animals, conservationists need not be concerned that the destruction of vampire bats will interfere with a natural balance, provided the control measures employed are specific for vampires. A biological equilibrium undoubtedly existed between the vampire bat and its environment prior to the introduction of this new food source and new roosts, which have permitted the vampire to invade new territories. Their range has been extended to the north as well as to the south: northward in Mexico, closer to the United States, and southward in Argentina to the Cordoba area, which is in the temperate zone.

The original equilibrium in nature for vampire bats probably today only exists in the ecosystems in remote virgin forests and other areas where domestic livestock have never been introduced and the vampire bats still feed upon wild animals. The problem will become more acute as more countries in Latin America attempt to raise more livestock to feed increasing human populations. This will inevitably increase the vampire bat populations further, as the basic pattern has remained the same from the time domestic animals were first introduced into the New World.

Since total eradication of vampire bats seems an impossibility (whether desirable or not) due to their wide distribution, abundance, adapability and often inaccessible roosts, it is at present more practical to approach the problem from the point of view of integrated control of local bat populations, using all known methods until newer, more effective, specific control measures are developed. Priority should be given to areas where there is a high incidence of rabies and/or intense vampire bat predation, since either the disease or the predation alone can make the raising of domestic animals extremely difficult, where not impossible.

Recognizing the link between control of vampire bats and the survival of other types of bats the International Union for the Conservation of Nature and Natural Resources (IUCN) has pointed out that many species of bats, either found roosting with vampires or mistakenly identified as vampires, play an important role in the ecosystem. This organization has therefore passed a resolution recommending that the necessary control of vampire bats be based on sound biological and ecological studies and that "personnel charged with the application of control measures be *properly trained to identify vampires and their roosts* and to avoid indiscriminate and mass destruction . . . of caves and roosts sheltering large numbers of bats and other animals and plant species beneficial to man or of great scientific interest." (IUCN, 1968).

LITERATURE CITED

Bell, J. F. and G. J. Moore
1971. Susceptibility of carnivores to rabies virus administered orally. American Journal of Epidemiology, Vol. 93, No. 3, pp. 176-182.

Center for Disease Control
1971. Summary Rabies, 1970. Center for Disease Control, Zoonoses Surveillance, U.S. Public Health Service, Lawrenceville, Georgia, 30245.

Constantine, D. G.
1967. Rabies transmission by air in bat caves. NCDC Monograph, U.S. Public Health Service, Publication No. 1617, pp. ix & 51.

———
1970. Bats in relation to the health, welfare and economy of man. "The Biology of Bats", Vol.2, Chap. 7, pp. 319-449.

Greenhall, A. M. and J. L. Paradiso
1968. Bats and bat banding. Bureau of Sport Fisheries and Wildlife, Resources Publication No. 72, pp. iv & 48.

Hawkey, C.
1966. Plasminogen activator in saliva of the vampire bat, *Desmodus rotundus*. Nature, Vol. 211, No. 5047, pp. 434-435.

International Union for the Conservation of Nature and Natural Resources (IUCN)
1968. Resolution No. 1, vampire bats. Proceedings IUCN Latin American Regional Conference on Conservation of Renewable Natural Resources. San Carlos de Bariloche, Argentina, 27th March to 2nd April, 1968, p. 446. IUCN Pub. new series, No. 13.

World Health Organization
1966. WHO Expert Committee on Rabies, Fifth Report, WHO Technical Report Series, No. 321, pp. 1-28.

DISCUSSION

CHAIRMAN GALLIZIOLLI: Rabies has always been a strange disease to wildlife biologists. As we learned way back in school days, a good parasite doesn't kill its host, as it dies too. Now we hear that in bats, the vampire bat is a reservoir for rabies. Maybe you should change the name of this disease so that it signifies the fact that there is a reservoir. I don't think we have the whole story as Dr. Greenhall as indicated, but we have no bats that are blood feeders in the United States.

I would like to ask Dr. Greenhall to elaborate a little on the assumption that control, that is to say reduction of numbers of the vampires, will control the disease. This is an assumption we often make and it is very difficult to prove, I know. Do you have any data at all?

DR. GREENHALL: If it appeared feasible to remove all the vampires, then we would remove the disease but I don't think this will happen. The control of the disease will come from an effective vaccine which I think is coming.

MR. DALE ALSAGER (Coordinator of Rabies Wildlife Control Program for the Province of Alberta, Canada): I'd like to ask you if you have any theories on one of our problems in the western prairie provinces, the major wildlife problem that we are dealing with now is skunks. More recently in Alberta, in the past year we have had three cases of rabies in bats. Do you have a theory as to whether there is a transmission mechanism between our bats, which are primarily the little brown bat. and skunks. Secondly I'd like to mention that our control program for bats has been limited to roosts which have contained the infected bats. We have analyzed bats from a number of other summer roosts and have not been able to demonstrate rabies infection, and I wonder what your figures are on infection in the roosts that you have investigated.

DR. GREENHALL: If I can remember all the questions, there has been some work done in laboratories in Hamilton, Montana whereby carnivores, have been able to become infected with rabies by consuming other infected animals, including bats. One of the things that I think that our project would do, if it were to continue would be to find out whether or not carnivorous animals such as skunks and opossums and animals like that contract rabies particularly since we know as I mentioned in passing, that vampires are fed upon by various types of carnivorous animals. Now just for theoretical reasons, if a coyote or a skunk or a 'coon or a 'possum were to eat an infected bat, vampire or otherwise, according to the work that has already been done and what we think will happen; it could contract rabies. What was the other question?

MR. ALSAGER: I stated that I was disturbed because we could not demonstrate rabies infection in some of the roosts in Alberta and yet infected bats were turning up in other areas. Out of the bat roosts that you have investigated what is the percentage of rabies infection that you have found?

DR. GREENHALL: Well I can't speak for Canada and the United States but infection rates for vampire bats in roosts is very low—about 1% of whatever the population happens to be. But one vampire flying around can create a lot of damage, so that you really don't need many, but the infection rate is low and one of the things that is puzzling is why rabies does not affect more bats than it actually does. In the U.S. it is curious that migratory bats, those that are solitary, have a higher rate of infection than the "colonial" bats. For example, at the height of the epidemic of rabies in Carlsbad where there were millions, there was a reasonably high rate of infection, something like 30%, but in the migratory solitary bats you could find a much higher rate among much fewer animals. It's one of these things that needs a lot of extra work.

MR. ALSAGER: Do you have any information on the rabies rate of infection in various species of bats?

DR. GREENHALL: No, except that a great number are rabid, practically half the species in the U.S. Theoretically it is possible for any bat to contract the disease. Whether or not the disease manifests itself in the same way as it does in the common vampire, *Desmodus*, hasn't really been worked out.

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CURRENT STATUS OF THE ENDANGERED MASKED BOBWHITE QUAIL

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INTRODUCTION

The masked bobwhite quail, *Colinus virginianus ridgwayi,* is related to bobwhites in the eastern and mid-western United States, but it more nearly resembles the bobwhite forms of southern Mexico (Aldrich, 1946). The masked bobwhite is characterized by a robin's red breast and a black head containing a varying amount of white above the eye and occasionally on the throat. The female is nearly identical to the Texas bobwhite female, *C. v. texanus.*

Past distribution of the masked bobwhite encompassed several areas of central and northern Sonora, Mexico, and a small area in southern Arizona (Figure 1) (Brown, 1885; Brewster, 1887; and Tomlinson, in press). The past range of the masked bobwhite overlapped, at least partially, the habitats of four other species of quail: The Gambel's quail, *Lophortyx gambelii,* ranged throughout Arizona and Sonora; the scaled quail, *Callipepla squamata,* was found only at the extreme northern edge of bobwhite habitat in southeastern Arizona; the elegant quail, *Lophortyx douglasii,* was common to the east and south in Sonora; and the Mearn's quail, *Cyrtonyx montezumae,* ranged at higher elevations throughout masked bobwhite habitat. The nearest habitat of other bobwhite races was across the Sierra Madre Mountains in Chihuahua to the east and in the uplands of Nayarit to the south, distances of several hundreds of miles.

The masked bobwhite inhabited a flat, mesquite-grassland habitat at elevations of approximately 800-4,000 feet above sea level, whereas other quail species preferred a more wooded or broken terrain. (Brown, 1885; Ridgway and Friedman, 1946; Monson and Phillips, 1964; and Tomlinson, in press). Because of their rather unique habitat needs, it is theorized that masked bobwhites probably never were as abundant as other endemic quail species in any particular location, nor were they as widely distributed within their range.

In the late 1800's, extreme overgrazing coupled with a series of severe droughts caused deterioration of the grasslands of southern Arizona (Brown, 1900; Hastings and Turner, 1965; Hollon, 1966). Coincident with the extreme overuse by livestock, the masked bobwhite began to decline. The exact cause of the decrease in bobwhite

[1] Assigned to a field station in Tucson, Arizona.

numbers was not ascertained, but the evidence strongly suggested that destruction of habitat through overgrazing was the major factor.

Probably because the masked bobwhite could not compete successfully with these prevailing conditions at the northern edge of its

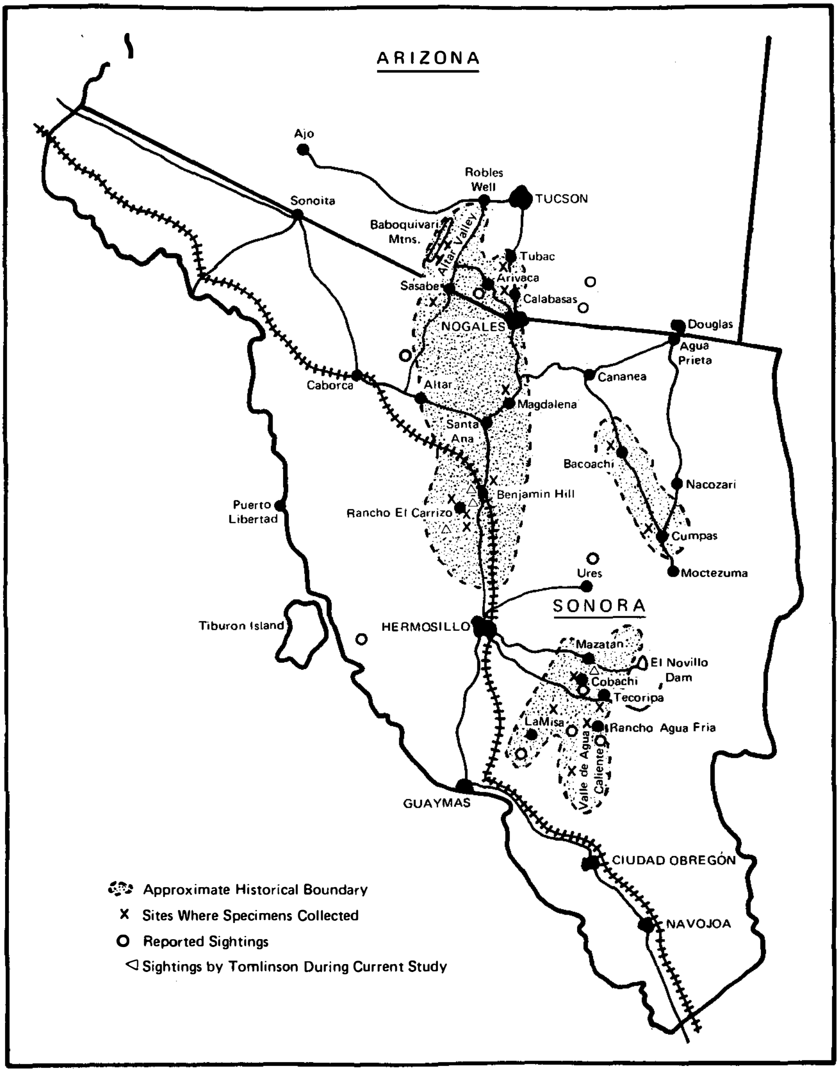

Figure 1.—Past distribution of Masked Bobwhite Quail (1884-1900).

range, it was completely extirpated in Arizona by 1900 (Brown, 1904; Tomlinson, in press). In Sonora, the livestock industry did not become big business until the 1940's and 1950's. However, once begun, overgrazing in Sonora has continued unabated to the present time, and bobwhite populations have dwindled correspondingly. In the late 1930's, moderate populations of masked bobwhites were still encountered in most of the Sonoran range (Ligon, 1942). By the early 1950's, ornithologists feared that this bird might already be extinct (Ligon, 1952). However, in 1964, Arizona Game and Fish Department biologist Steve Gallizioli and Tucson taxidermists Seymour and Jim Levy relocated a population near Benjamin Hill, Sonora (Gallizioli *et al.*, 1967); this was the first known wild population to be observed by ornithologists in approximately 14 years.

Several attempts have been made in the past to reintroduce the masked bobwhite to Arizona and to save the remaining populations in Sonora. In the 1940's and 1950's, J. Stokley Ligon (in conjunction with the Game and Fish Departments of Arizona and New Mexico) trapped wild birds in Sonora and made several releases of both wild and propagated birds in southeastern Arizona and southwestern New Mexico (Lawson, 1951; Ligon, 1952; Tomlinson, in press). None of these attempts, was successful in reestablishing populations, possibly because most of the release areas were outside the former range of the subspecies. In 1963 and 1964, the Levys and the Arizona-Sonora Desert Museum in Tucson began separate studies of the birds (Gallizioli *et al.*, 1967; Walker, 1964). The latter study had to be terminated when breeding pens were entered by vandals and many propagated birds were destroyed. The Levys, with the help of the Arizona Game and Fish Department, tried to induce a Sonoran landowner to set aside a portion of his ranch as a bobwhite management area. This attempt also failed. In 1966, the Levys donated four pairs of propagated masked bobwhites to the Bureau of Sport Fisheries and Wildlife, and the present study began in June 1967. The immediate objectives were to determine the present distribution, possible limiting factors, and overall status of the masked bobwhite.

RESULTS

Present Distribution

The search for present populations began in late summer of 1967 and continued through early 1970. Following leads obtained in the literature, numerous areas which were known to harbor the birds in the past were searched. Several methods were used. First and foremost, hundreds of Mexican nationals were interviewed on ranches and farms and in small towns. To aid in the interviews, a sheet illustrating five species of quail was shown to each person encountered. Each person was asked if he recognized any of the birds depicted and where they could be found; the bobwhite was never pointed out as the bird which was sought. The pictures were very helpful since the local name for both bobwhites and Mearn's quail is "*perdiz*"; other species of quail are commonly called "*cordorniz*" or "*cuiche.*"

During the fall and winter seasons, searches were made on foot with a dog. The nests of cactus wrens and verdins, which are lined with feathers of other birds found in the area, were dismembered and searched for bobwhite feathers. In addition, a sharp lookout was maintained for bobwhite roosts which are distinctive from those of most other quails. During the summer breeding season, reliance was placed on listening for the "bobwhite" calls of the male. Taped female calls were useful in soliciting male responses (Levy *et al.*, 1966). Habitat type was also taken into consideration during the searches.

Eight major areas of Sonora were investigated thoroughly. Results of these searches follow:

1. *Benjamin Hill-Carbo Area*—At 2,400 feet in elevation, this area is typical Sonora plains type which has been invaded by woody plant species. Brush control by bulldozing has been intensively implemented on one large ranch since 1963. Masked bobwhites had been collected in the area by J. T. Wright (a scientific specimen collector) in the early 1930's, but nothing had been heard of the population until 1964 when Gallizioli and the Levys relocated bobwhites there. Undoubtedly populations existed throughout the 1930-1964 period, but brush control by the ranch owners and an accompanying policy of good land management probably served to increase the bobwhite numbers in the early 1960's. Subsequent investigations have revealed that an area of approximately 500 square miles is occupied by scattered masked bobwhite populations.

2. *Mazatan-Cobachi Area*—At 1,700 feet in elevation, this area was once a rolling grassland with brush species in river bottoms. Woody species have invaded the area following heavy grazing. J. Stokley Ligon obtained breeding stock on Rancho Tecolote in 1950 (Lawson, 1951). In 1967, I received several reports that masked bobwhites were still in this area but that populations had declined drastically during the past 25 years. I finally located a small population of birds on a ranch just east of Mazatan in the summer of 1968. One pair of birds was observed and three males were heard calling. Searches in the vicinity indicated that the population was very small. The ranch

foreman and cowboys stated that a few other small populations still existed in this area but that they were nearly gone. Heavy grazing continues in this vicinity, and brush and tree species are rapidly invading the whole area.

3. *Rancho Agua Fria-Valle de Agua Caliente Area*—This area ranges in elevation from about 1,000 to 1,300 feet. It is rolling foothill country with intervening valleys containing some grassland habitat which is being invaded by woody plant species. In the early 1900's, masked bobwhites were collected in this vicinity, and J. Stokley Ligon obtained breeding stock here as late as 1950 (Ligon, 1952). In 1964, Jim Levy found two bobwhite feathers in a cactus wren nest on one ranch in this locality (Gallizioli *et al.,* 1967). In 1968 and 1969, several visits to the area were unsuccessful in locating bobwhites in spite of a most positive statement by one ranch owner that bobwhites were definitely at a specific location west of Suaqui Grande. Because of the failure to locate bobwhites in this general area, it is concluded that they are either gone or nearly so. Overgrazing here is commonplace, and the lack of grasses combined with heavier growths of brush species make the area increasingly unsuitable for bobwhites.

4. *Tecoripa-Rancho La Cuesta Area*—The elevations here vary from about 1,200 to 1,700 feet. J. T. Wright, who collected masked bobwhites at Rancho Noria de Pesqueira in 1931, told me that the country at that time consisted of wide, grass-covered valleys with certain grasses reaching over the heads of the native white-tailed deer. Bobwhites were moderately plentiful. Wright revisited the area in the early 1950's and was appalled at the denuded areas caused by overgrazing. He would have been even more amazed if he had visited the area in 1968 when I first saw it. Woody species had almost completely engulfed the area at the time and few spots could be termed suitable as masked bobwhite habitat. Despite intensive searches, no bobwhites were located in the vicinity. Numerous reports of birds being in nearby areas were never substantiated. In 1969, three ranches, owned by brothers of one family, were subjected to intensive brush removal practices. The resultant growth of exotic and native grasses has approximated the early conditions, and the bobwhites might once again become established if reintroduced into the area.

5. *La Misa-San Marcial Area*—The elevation in this vicinity is approximately 300 to 850 feet. The habitat, which once consisted of wide, grassy *"llanos,"* has been extremely overgrazed, causing heavy cutting by arroyos and invasion by woody species. J. Stokley Ligon captured 130 bobwhites near San Marcial in 1938 (Ligon, 1942) and Johnson Neff (1947) observed a large covey of masked bobwhites near

Punta del Agua in 1942. However, by 1949 Ligon reported that livestock grazing had completely denuded the land and that no bobwhites could be located in the area (Ligon, 1952). I was also unable to locate bobwhites there in 1969, and most natives of the area were unfamiliar with the birds. Those people that recognized bobwhites indicated that the birds were last seen in other areas. Very little suitable habitat still exists here.

6. *Cumpas-Bacoachi Area*—This area lies in the river drainages of the Rio Sonora and Cumpas Arroyo at elevations ranging from 2,600 to 3,450 feet. Masked bobwhites were collected here in 1887 by J. C. Cahoon (Brewster, 1887), but extreme overgrazing coupled with intensive irrigated farming of the river bottoms has rendered the area unsuitable for these birds now. Interviews with local people (including old men) revealed that no one recognized the bobwhite. It is believed that masked bobwhites probably disappeared from this area at about the same time as in Arizona.

7. *Sasabe-Molinos Area*—This area lies in a relatively flat mesquite-grassland at elevations of 2,300 to 3,250 feet. Overgrazing has caused an invasion by woody plant species; however, certain areas are still fairly open, and grazing seems to have lessened in portions of the area. The Type Specimen for the masked bobwhite, *C. v. ridgwayi*, was taken in 1884 only 18 miles southwest of Sasabe in Sonora (Stephens, 1885; Allen, 1886; Scott, 1886). The birds were probably eliminated here at the same general time as those in Arizona. Persistent reports in the period 1966-1969 placed this bird in the San Juan Mountains near Molinos. A search in that area confirmed my suspicions that the birds referred to were actually Mearn's quail at an elevation of about 4,500 feet. Interviews with local people indicated that they were familiar only with other endemic species of quail.

8. *La Costa-Siete Cerros Area*—This area lies between Hermosillo and the Gulf of California at an elevation of from 300-800 feet. It is characterized by a Sonoran desert scrub grassland which is being rapidly converted into irrigated farmland. There were no historical records of birds being in this area, but several separate and recent reports were received that masked bobwhites inhabited the area. Brief investigations here failed to locate bobwhites, and local people only identified the Gambel's quail.

In addition, two other areas were mentioned as possible masked bobwhite habitat. The Puerto Libertad-Puerto Lobos area near the Gulf of California coast was investigated, but the habitat is so unlike bobwhite habitat elsewhere that it is extremely unlikely that these birds were ever in this area. The San Javier mine area, which is about

20 miles east of Tecoripa and at an elevation of about 4,000 feet, also was visited. As expected, Mearn's quail were quickly located, but bobwhites probably never occurred there.

Life History Studies

In 1967, preliminary reconnaissance was made in Sonora to select an area where the masked bobwhite could be studied on an intensive basis. Only the area near Benjamin Hill contained populations which were considered stable, so in 1968 a landowner in this area was contacted. He kindly gave permission to carry out the research on his large ranch holdings. The study thus began in July, 1968.

A weather station, containing a 31-day hygrothermograph and a rain gauge, was established at ranch headquarters; two permanent call-count routes were established; a trapping and banding program was initiated; and general field observations were maintained.

Vegetation and Habitat—The study area lies within fairly extensive and rather flat former mesquite-grassland range at an elevation of approximately 2,400 feet. The habitat is a Sonoran plains type which consists mainly of annual grasses and forbs with woody shrubs and trees in and surrounding the water drainages. The grassy *"llanos"* have been steadily invaded by woody species because of overgrazing by livestock and a lack of fire. To combat the encroachment of woody species, the rancher initiated a brush-control program in 1963 which has continued intermittently to the present. Large expanses, totalling at least 10,000 acres, have now been cleared, and many isolated or long-strip brush piles have been left in the wake of the bulldozer.

The clearing and subsequent heavy stands of grass appear to have increased masked bobwhite populations, and the brush piles now are used as cover and as perches for calling by males during the summer. However, the birds are most abundant in areas where brush and tree growth abuts the open grassland. This situation is no doubt similar to the "edge effect" and interspersion of habitats which have been described for proper eastern bobwhite management in the central United States (Stanford, 1952).

Plant specimens have been collected and/or identified from this general area. The most common trees or shrubs are ironwood, *Olneya tesota*; palo verde, *Cercidium* spp.; mesquite, *Prosopis juliflora*; several species of *Acacia*; and ocotillo, *Fouquieria splendens*. The most common forbs are partridge pea, *Cassia leptadena*; rattlebox; *Crotalaria* spp.; western ragweed, *Ambrosia psilostachya*; pigweed *Amaranthus* spp.; and Mexican poppy, *Kalstroemia grandiflora*. The area has a tremendous variety of weed and forb species, many of which undoubtedly provide food and cover for the bobwhite population. Of the grasses, the most common are four species of grama *Bouteloua rothrockii; B. aristidoides; B. parryi,* and *B. filiformis;* several species of three-awn, *Aristida* spp.; several foxtails, *Setaria* spp.; panic grasses, *Panicum* spp.; tanglehead, *Heteropogon contortus*; and many others. Several cacti, including the sahuaro, *Carnegiea gigantea*; organ pipe, *Lemaireocereus thurberi*; cholla and prickly pear, *Opuntia* spp., are also present.

Masked bobwhites were found to prefer weedy growths in conjunction with moderately dense stands of Rothrock's grama and three-awns. They appeared to avoid dense stands of coarse grasses such as tanglehead. It is thought that these situations were sought out not only for food but to afford cover while providing a relatively clear view and a rapid escape route. Bobwhites are rarely observed in openings such as roads, bare spots, and arroyos. In this respect, they differ greatly from Gambel's quail and to a lesser extent from the eastern bobwhite. During the winter, bobwhite coveys used woody thickets for resting and protection.

Weather—Through the use of a 30-day hygrothermograph, maximum and minimum temperatures and humidities have been recorded on a daily basis since initiation of the study. Precipitation data were provided by the ranch owners, who have recorded daily rainfall for 40 years. The average annual rainfall is 13.5 inches, with 10.25 inches (75 percent) falling during the 3-month period of July-September (Table 1). Another small precipitation peak occurs in December and January when 1.45 inches (11 percent) of rain are received. Very little rain falls during the 5-month period of February through June.

Generally, the humidity data reflect the precipitation patterns. However, maximum daily humidities usually build to a peak in July and remain fairly high until the following March when they decline

TABLE 1. SUMMARY OF PRECIPITATION AT SONORAN STUDY AREA, 1932-1971 (IN INCHES).

Month	Average 1932-1941	Average 1942-1951	Average 1952-1961	Average 1962-1971	Average 1932-1971
January	0.47	0.60	1.06	0.37	0.62
February	0.24	0.34	0.21	0.37	0.28
March	0.11	0.29	0.60	0.26	0.32
April	0.08	0.01	0.14	0.08	0.08
May	0.00	0.04	0.00	0.01	0.01
June	0.29	0.44	0.23	0.12	0.27
July	3.16	3.71	4.15	4.09	3.78
August	4.94	4.67	5.34	4.18	4.78
September	1.50	1.57	1.11	2.57	1.69
October	0.68	0.51	0.55	0.55	0.57
November	0.30	0.11	0.39	0.48	0.32
December	1.02	0.50	0.47	1.28	0.82
Annual Average	12.79	12.79	14.25	14.32	13.54

again until mid-June. On the other hand, minimum daily humidity readings fall in October and do not rise again until June. The highest maximum temperatures are recorded during the period of June through September (usually averaging 95° F. or above). Temperatures commonly reach 100-106° F. during the hot periods. During the winter, minimum temperatures average in the mid-30's, but extreme lows reach the 20's. Each year, both temperature and relative humidity gradually build up in May and June. Summer rains almost always begin during the first 10 days of July. When the rains start, maximum temperatures usually drop from the 100's to the mid-90's, but relative humidity remains high. The rainy season usually lasts through September 15.

Prior to the onset of the summer rains, the range in Sonora has a parched appearance and practically no green vegetation is in evidence. During this period (April-June), the livestock have grazed most pastures to the ground and little food is available for herbivorous and seed-eating animals. In addition, insects and other invertebrate life are scarce. When the rains begin, the mesquite grassland is transformed. Grasses and forbs spring up almost overnight, and shrubs and trees which have been dormant for months suddenly bloom and develop leaves. Insects emerge by the thousands.

Masked Bobwhite Habits—Masked bobwhites remain in coveys until at least late June. As with most species of quail, pair bonds appear to be formed within the covey unit, and each pair gradually separates from the unit as the breeding season approaches. Normally very secretive, the masked bobwhite is most frequently observed during this period. Loose coveys containing several pairs and single males are common in late June and early July. Trios, containing two males and one female, are often encountered at this time. Because of the ease with which the birds are seen, it is suspected that a considerable amount of movement takes place immediately prior to the nesting season, a phenomenon which is also common with other races (Stanford, 1952).

Females are seen less frequently after the rains begin, but range conditions resulting from the preceding year's grazing practices appear to influence the onset of nesting. If sufficient grass cover has been left, calling by the males increases substantially, and fewer females and/or pairs are encountered. If grazing has denuded the area, male calling is depressed and observations of females remain high until sufficient new grass growth provides better cover.

The eastern and midwestern races of the bobwhite begin their breeding seasons in April and continue through September 15, with a wide peak occurring sometime in June and July (Stoddard, 1936; Stanford, 1952; Speake and Haugen, 1960). Early in this study, it was learned that the masked bobwhite does not begin its breeding season until July, with the commencement of the summer rains. Accordingly, a permanent 20-mile call-count route (similar to the national mourning dove routes) was established on the study area in 1968. The route was run at near weekly intervals from the initiation to the termination of calling each year (Figure 2).

These counts showed that male calling begins between June 25 and July 15 and terminates between September 14 and 20 for an average calling period of approximately 70 days. Calling increases until the peak period, between August 10 and 24, after which calling intensity declines rapidly.

Preliminary analysis of weather data suggests that male masked bobwhites do not begin to call until minimum daily temperatures and relative humidity average at least 55° F. and 25 percent, respectively. Furthermore, nesting success, as reflected by length and frequency of male calling, seems to be dependent upon the amount and distribution of summer precipitation. In 1968 and 1971, summer rainfall was below average and, during the latter year, the rains did not begin until after July 15. As a result, male calling seasons were very

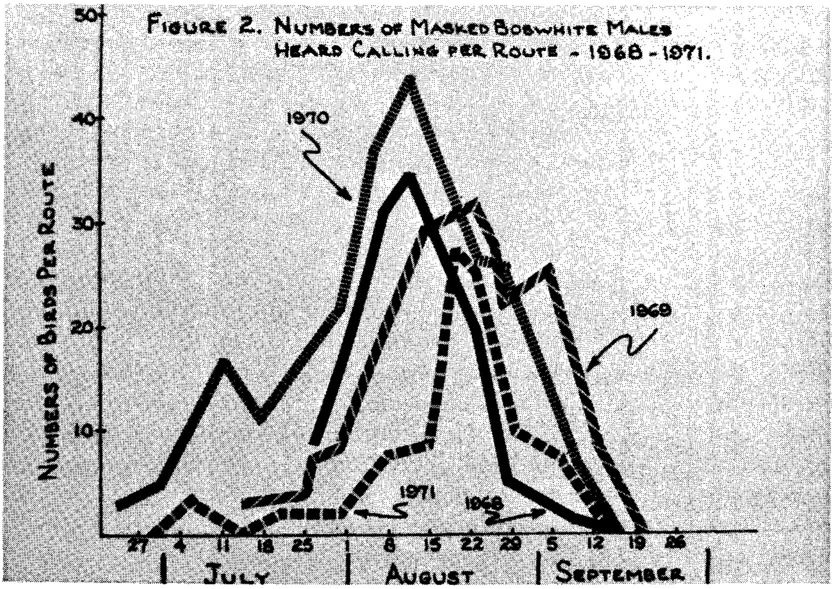

Figure 2.—Number of Bobwhite males heard calling per route on Rancho El Carrizo, Sonora—1968-1971.

restricted in length, although at the peak, nearly as many calling males were recorded as in the wetter years. In 1969 and 1970, when above normal or average precipitation was recorded, calling began early and was maintained at a high level until September 1 or later (calling in 1969 was delayed somewhat, probably because of poor range conditions prior to the rainy season). Autumn field observations also indicated that higher nest success occurred during the wetter years.

The masked bobwhite calling season is less than half as long (70 vs. 165 days) as that of the eastern races. The breeding season is also much shorter, and the hatching peak much later than for the eastern bobwhite. If for any reason, a nesting attempt is aborted, the masked bobwhite has only a short period in which to renest. This situation is thought to be a definite disadvantage in coping with the environment, particularly in the face of habitat destruction as evidenced throughout its recent history.

Although Stoddard (1936) and others believed that calling bobwhite males represented unmated birds, this does not appear to be entirely true of the masked bobwhite. Mated males are probably responsible for the increased calling during August. This conclusion was reached because of several observations. First, known mated males have been seen calling. Secondly, estimates of population numbers (using Stoddard's technique of applying the current sex ratio to a total count of calling males and assuming that all calling males were unmated and all females were mated to the remaining males) were vastly higher than the actual numbers observed during fall searches. Furthermore, since the peak of hatch occurs during the middle third of September (to be discussed later), an incubation period of 23 days would place the average initiation date for incubation on or about August 15. Therefore, it is my belief that the peak of calling during August 10-24 signals the initiation of egg incubation by the females, when their mates increase calling in response to being left alone for long periods of time.

The first masked bobwhite broods are seen in late September, and the number of brood sightings increases until late October. Immediately after hatch, broods consist of from 5 to 15 young and average about 11 birds. The brood is the nucleus of the fall covey; unproductive adults and young separated from other broods may join a covey, but covey size rarely exceeds 20 birds; average covey size is about 12 birds in November. This behavior is similar to that of the Mearn's quail, but different from other western quails in which literally hundreds of birds may form one large covey.

Trapping and Banding—A trapping and banding program was initiated during the winter of 1968-69, and continued through January 1971. The trapping period extended from October through January each year. A total of 183 birds were trapped; 57 were sent to Patuxent Wildlife Research Center for propagation, 74 were banded and released, 42 were repeated trap captures, and 10 died in trap-associated mortality. The 141 initial captures consisted of 28 adult males, 22 adult females, 44 immature males, 46 immature females and 1 immature of unknown sex. The sample age ratio was 182:100 or 65 percent young. If the trap sample is assumed to be unbiased, the average annual masked bobwhite mortality rate would be approximately 65 percent in a stable population. The immature sex ratio approached the expected equal proportion (96:100), and the adult sex ratio of 127:100 reflects a normal quail population containing an excess of male birds.

Primary feather molt data were used to back-date to the time of hatching as determined by Petrides and Nestler (1943) for eastern bobwhites (Figure 3). Although some differences may occur in molt rate between races, they probably are not great. According to this information, hatching of young masked bobwhites began in late July, reached a small peak during the middle third of August, declined again, and then reached its main peak between September 5-20 before tapering off into late October and early November. Field observations of broods during the fall support this information; the earliest brood sightings were made in late September and most broods consisted of very small chicks at that time. Thus, when most birds have concluded their nesting season, and migratory birds are in the midst of their southern travels, masked bobwhites are just beginning to raise their broods. Although the short nesting season is a liability in some respects, the peak of hatch is ideally timed to exploit the invertebrate foods, seeds, and green feeds which are then abundant.

Reintroduction Attempts

My early investigations indicated that a substantial number of birds existed in the Benjamin Hill area and that removal of at least 36 birds in a given year would not unduly harm the population. With written permission from the Mexican Government and oral permission from a Sonoran landowner, 36 birds were captured in November and December, 1968, and an additional 21 birds were secured in January, 1970. In each case, the captured birds were flown to Mexico City, thence to New York, and from there they were taken to the U.S. Department of Agriculture quarantine station in Clifton, New Jersey. After the mandatory 21-day quarantine period, the birds were trans-

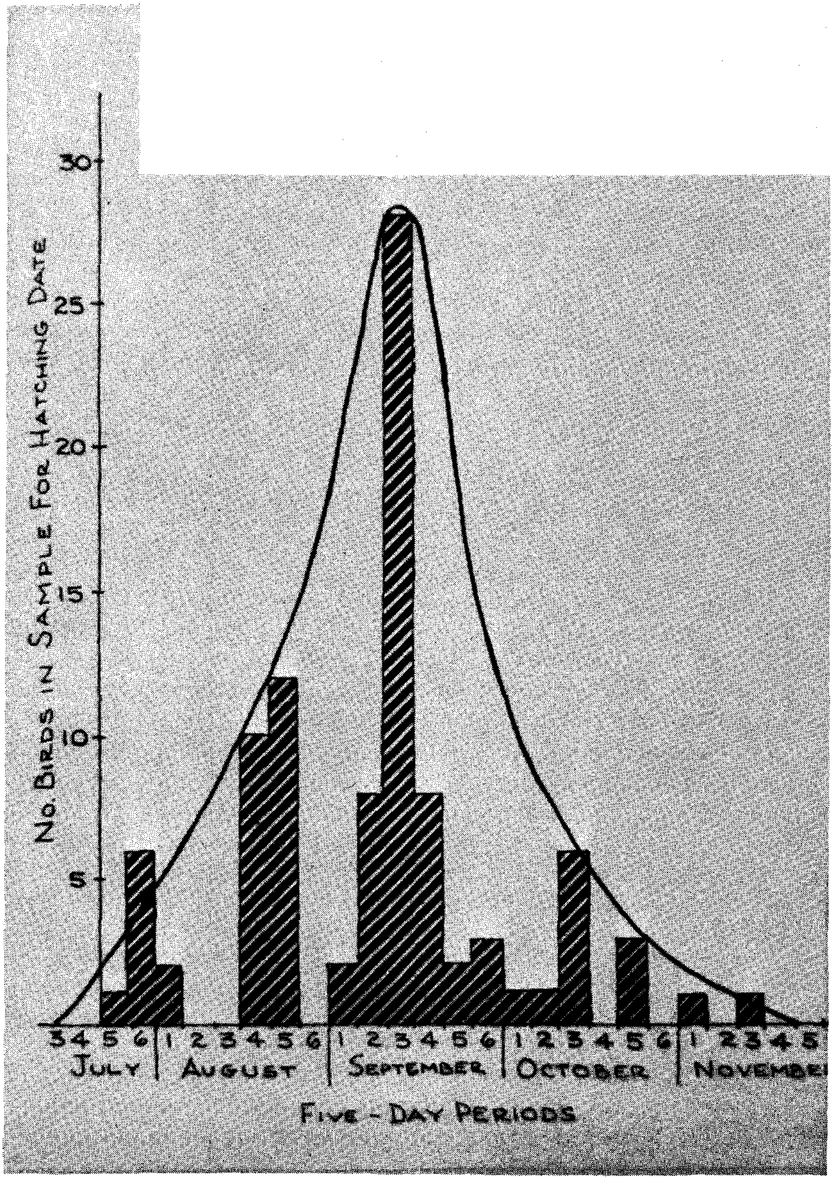

Figure 3. Hatching Summary of Immature Masked Bobwhites determined from back-aging by replacement of primary feathers.

ferred to the Patuxent Wildlife Research Center. All birds survived the transportation and were the source of all masked bobwhite production at Patuxent.

In 1969, searches to locate suitable Arizona habitat in which to place propagated birds were begun with the cooperation of the Arizona Game and Fish Department. Because a life history study had just begun, not enough was known about masked bobwhite habitat requirements to make the best possible evaluations. The major criterion in selecting areas, therefore, was whether a specific location fell within the historical range of the subspecies. Other factors that were considered were the availability of ground cover throughout the year, recent land rehabilitation, land use practices, and altitude. Although little was known about masked bobwhite food habits, an effort was made to choose areas that contained an adequate quail food supply including weed and grass seeds and small invertebrates. Four areas were selected.

During the search for suitable release sites, no area within the past Arizona bobwhite range was found to be exactly comparable to that in Sonora. Generally, most of the Arizona habitat is higher in elevation 2,300-4,000 feet) than the Sonoran habitat (800-2,500 feet). In addition, the terrain in Arizona is rockier and the vegetation is somewhat different, but in both regions, much of the land has been heavily overused by livestock. Although selected areas were somewhat less than ideal for the intended purpose, they represented the best available at that time.

During 1970-1971, 603 propagated birds were shipped from Patuxent to Tucson and gently released into the wild; of these, 160 were released in March 1970, 73 in May 1970, 118 in October 1970, and 252 in July 1971. The 1970 released birds were held for a 24-hour period, during which they were fed and watered before release; the 1971 birds were held in captivity in Tucson for three months prior to release. Follow-up studies in 1970 were discouraging. Most of the birds disappeared within two months of release. At least eight cases of predation by avian predators were located, and the numbers of birds in those coveys that were located declined rapidly. Results of the July, 1971, releases were more encouraging. Birds almost immediately began to mate, and copulation among pairs was observed several times. The birds rapidly dispersed from the release areas, and little predation was noted. One pair is known to have produced and raised two young at the time of writing. This adult pair is known to have survived for nearly six months. Further releases are contemplated for July, 1972.

SUMMARY AND DISCUSSION

In summary, masked bobwhites remain in covey units from late September until late June each year. Coveys average between 10 and 15 birds and are composed of two adults and their young, with the addition of adults that were unsuccessful in nesting and occasional inmatures separated from their original brood. Masked bobwhite coveys are thus essentially a family unit. The coveys break up in late June and early July when pairs gradually move off in search of nesting locations. Male calling usually begins in early July and terminates on about September 15. The peak of calling occurs during the middle of August and is thought to be synchronized with the period when most females begin to incubate. The peak of hatch occurs at approximately the same time that male calling ends. The nesting season is therefore about 70 days in duration. Results of the present study strongly suggest that a combination of high temperature, high humidity, and the onset of summer rains stimulates nesting by the masked bobwhite. The success of the nesting season definitely seems to be correlated with the amount and distribution of summer precipitation. Since its nesting season is so much shorter than that of the eastern bobwhite, the masked race is thought to have a decided disadvantage in successfully hatching a clutch of eggs.

Another limiting factor directly concerns land use practices. Abuse of the land appears to be a common cause for the disappearance of many endangered wildlife species. With masked bobwhites, overgrazing by livestock is at fault. Overgrazing eliminates natural food and cover, which adversely affects bobwhite survival and reproduction. Heavy grazing in Sonora also encourages invasion of the grasslands by woody species, particularly mesquite. When brush species become established in dense, continuous stands, the area is no longer attractive to bobwhites. From what has been learned during this study, vast areas have been so altered. It is my belief that nearly all of the former areas of masked bobwhite distribution have now become unsuitable for this race.

Masked bobwhites have persisted only in two areas of Sonora, but nowhere in the United States. The bobwhite population near Mazatan is very small, and only a few other such populations can be expected to exist nearby. The habitat has been deteriorating and is continuing to deteriorate. The bobwhite population near Benjamin Hill is estimated to be in excess of 1,000 birds. Populations there were thought to be relatively stable, particularly on the study area. However, recent heavy grazing on surrounding ranches has caused a depression in their numbers for two years. Only a reversal of the present practices on the depleted ranches will restore bobwhite populations to their 1969 levels.

Although bobwhites were not located elsewhere, a few remnant populations may still exist in the Rio Matape and Yaqui River Valleys. Most promising localities are the Valle de Agua Caliente, Mazatan, Tecoripa, and La Misa areas. However, if populations still remain there, they are threatened by continued overgrazing and subsequent invasion of the habitat by woody plant species. If the overgrazing is continued, eventual disappearance of the birds can be expected. Except for the habitat in and surrounding the study area near Benjamin Hill, little hope can be foreseen for continued survival of masked bobwhites in Sonora without drastic improvements in land use.

In Arizona, masked bobwhites have been reintroduced to four areas in their historical range. These areas were not ideal because of various factors; they were selected mainly because they were available and less intensively grazed than most other rangeland examined. Control of land use practices was possible at only one of the four areas, a parcel administered by the Bureau of Land Management. The future of masked bobwhite populations in Arizona depends not only on how well the birds adapt to the areas, but to a large degree on how well the lands are managed. Even if the early releases succeed initially, the birds could soon be eliminated by changes in grazing practices. Although much has been learned from the trial liberations, it is thought that areas for future releases should be purchased or leased so that proper management procedures can be implemented on them. Only in this way will the masked bobwhites get a satisfactory trial in Arizona.

LITERATURE CITED

Aldrich, J. W.
1946. The United States races of the bob-white. Auk 63:493-508.

Allen, J. A.
1886. The type specimen of Colinus ridgwayi. Auk 3:483.

Brewster, W.
1887. Further notes on the masked bob-white (*Colinus ridgwayi*). Auk 4:159-160.

Brown, H.
1885. Arizona quail notes. Forest and Stream Vol. 25(23):445.

———. 1900. Conditions governing bird life in Arizona. Auk 17:31-34.

———. 1904. Masked bob-white *Colinus ridgwayi*). Auk 21:209-213.

Gallizioli, S., S. Levy, and J. Levy.
1967. Can the masked bobwhite be saved from extinction? Aud. Field Notes 2(5):571-575.

Hastings, J. R. and R. M. Turner.
1965. The changing mile. Univ. of Ariz. Press. Tucson. 317 pp.

Hollon, W. E.
1966. The great American desert: then and now. Oxford Univ. Press. N.Y. 284 pp.

Lawson, L. L.
1951. Masked bobwhite and benson quail trapping in Sonora, Mexico. Ariz. G&F Dept. F.A. Proj. W-40-R-2, W.P. 2, Job 2 Comp. Report.

Levy, S. H., J. J. Levy, and R. A. Bishop.
1966. Use of tape recorded female quail calls during the breeding season. J. Wildl. Mgmt. 30(2):426-428.
Ligon, J. S.
1942. Masked bobwhite quail in southern Arizona and notes on efforts at restoration. Typewritten memo of information and reference dated July 3, 1942.
———.
1952. The vanishing masked bobwhite. Condor 54(1):48-50.
Monson, G. and A. R. Phillips.
1964. A check-list of the birds of Arizona. Univ. of Ariz. Press. Tucson. 74 pp.
Neff, J. A.
1947. Notes on some birds of Sonora, Mexico. Condor 49(1):32-33.
Petrides, G. A. and R. B. Nestler.
1943. Age determination in juvenile bob-white quail. Am. Midl. Nat. 30:774-782.
Ridgway, R. and H. Friedman.
1946. The birds of North and Middle America. U.S. Nat. Mus. Bull. #50. U.S. Gov't. Print. Off. Wash., D.C. Vol. 10, iii-xi and 484 pp.
Scott, W. E. D.
1886. On the avi-fauna of Pinal Co. with remarks on some birds of Pima and Gila counties, Arizona. Auk 3:383-389.
Speake, D. W. and A. O. Haugen.
1960. Quail reproduction and weather in Alabama. Proc. 14th Ann. Conf. S.E. Assoc. G&F Comm. 85-97.
Stanford, J. A.
1952. Whirring Wings: the bobwhite quail in Missouri. Mo. Consv. Comm. Bull. Jefferson City, Mo. 1-96.
Stephens, F.
1885. Notes on an ornithological trip in Arizona and Sonora. Auk 2:225-231.
Stoddard, H. L.
1936. The bobwhite quail, its habits, preservation, and increase. Charles Scribner's Sons, N.Y. 559 pp.
Tomlinson, R. E.
1972. A literature review on the endangered masked bobwhite quail. In press.
Walker, L. W.
1964. Return of the masked bobwhite. Zoonooz Feb. 1964: 10-15.

DISCUSSION

CHAIRMAN GALLIZIOLI: This of course is another example of international cooperation. It seems to me it is indeed a subspecies or a local variant of the bobwhite itself. Presumably it came from the southern coastal area of Mexico and it is at the northern limit of its range in northern Sonora and in southern Arizona. I would like to ask the speaker if he might consider the fact that it may be in a marginal environmental situation and that this may be important in its survival.

MR. TOMLINSON: I think that is probably true. Any species that is at the northern or at the extreme edge of its distribution, has a much more difficult time to survive in that area, and I think that applies to the bobwhite. One of the reasons, of course, that we haven't tried to do too much in the way of establishing or trying to reestablish populations in other areas of the range is that we have somewhat more control over what occurs in the U.S. than we do in Mexico.

However there are plans now to release some birds in Sonora in Mexico soon, in fact next month.

MR. ERIC BOLEN (Texas Tech University): Are you at the point yet where you can evaluate such habitat influences as fire on the habitat improvements for this species? Might you consider using prescribed burning as a habitat improvement method for this species?

MR. TOMLINSON: This is something that we haven't done yet. However on one study area, they did, for the first time, have controlled burning last year on about a 500-acre area, and this occurred during the driest period of the year. I think, although I wasn't there at the time, that it must have been in May or possibly April. There were good stands of grass, and they had a good hot fire. The reason was to control the woody growth that was emerging again. My call-count route along the edge of that burn where I had gotten 9 to 12 birds in the past at the peak showed that there were no birds during the breeding season immediately following the burn. I am looking forward to this year's information to find out whether they now have come back into that area and whether the population has increased or decreased. But I have not really had a chance to evaluate that yet.

DISCUSSION LEADER BAKER: In view of the fact that the northern bobwhite was at the northern edge of this historical range and the fact that the bird we are now trying to introduce is coming from maybe a hundred miles south and a somewhat different habitat, what is your prognosis at this time about the possibility of the successful re-establishment of the masked bobwhite in Arizona? I'm going to put you on the spot.

MR. TOMLINSON: That is just what I was going to say; you did put me on a spot. I must say I feel relatively positive in my own mind that if land management agencies are able to either purchase or lease land in the area, and then apply good management practices to that land—and that means taking cattle off it mainly—taking out some of the brushy species, leaving some for a type of an edge effect, that we can re-establish the bird. It may not be with propagated birds; we may have to eventually go to wild trapped birds, but through the use of either or both of these, I think that eventually we can. It is just the matter of obtaining the land and managing it.

DR. WILLIAM ELDER (University of Missouri): I would like to ask if there is any evidence that the birds kept at Laurel, Maryland, have any different reproductive season than those which he observed in the wild. It is a rather unique species that he describes and its entire reproductive season is beyond the summer solstice and during the declining day period, and this is outside the tropical zone.

MR. TOMLINSON: That's real interesting, Bill, because we have noticed a difference. In fact, some of the birds that were sent back there came into breeding conditions a month or so prior to what they would have done if they had been in Sonora or Arizona during that time. There was an increased-light experiment done. It wasn't a very good one because it wasn't controlled too well. But at least they made some increased-light experiments during the winter months. Both eastern bobwhites and masked bobwhites were used and when the required length of day was achieved, the eastern bobwhites began to lay eggs but nothing happened to the masked bobwhites. So they decided that they would increase humidity and temperature and within three days after increasing these, eggs of the masked race started popping out like the eastern bobwhites. So they do change apparently when they come to Eastern areas where there is more precipitation and greener grass.

* * *

MOVEMENTS AND MORTALITY OF WHITE-WINGED DOVES BANDED IN TAMAULIPAS, MEXICO[1]

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The eastern white-winged dove, *Zenaida asiatica asiatica,* is an important migratory game bird which breeds in concentrated nesting colonies in the Lower Rio Grande Valley of Texas and in northeastern Mexico. The post-breeding-season movements and possible interrelationships of the Texas and Mexican populations have interested game biologists and hunters for years. Increasingly rapid clearing of nesting habitat in the Tamaulipas colonies has aroused the concern of conservationists in both the United States and Mexico. Locations, vegetative characteristics, and populations of the Mexican whitewing colonies were described by Blankinship (1970).

Objectives of this study of white-winged doves banded in Tamaulipas were to determine: (1) the migratory habits and migration routes, (2) the affinities of Mexican birds to Texas whitewing populations, (3) the homing fidelity of whitewings to their natal or breeding colonies, and (4) mortality rates.

During the summers of 1966 through 1970, field parties from the Department of Wildlife and Fisheries Sciences, Texas A&M University, trapped and banded adults and immatures capable of flight in five major whitewing breeding colonies in Tamaulipas. The project was under the direction of Dr. J. G. Teer and W. H. Kiel, Jr. Field operations were directed by D. R. Blankinship during 1966 through 1969 and by Dr. Harold D. Irby in 1970. Thirty-eight undergraduate students of the Department of Wildlife and Fisheries Sciences participated in the banding efforts and their indispensable assistance is gratefully acknowledged.

LOCATIONS AND METHODS

Two trapping stations were located near the town of San Fernando (San Fernando Hill and San Fernando Lake), two near Cd. Mante

[1] Project financed by contract funds from the U.S. Bureau of Sport Fisheries and Wildlife and by the Caesar Kleberg Research Program in Wildlife Ecology, and Texas A&M University. Information presented herein will be used in D. R. Blankinship's dissertation as partial fulfillment of requirements for the Ph.D. degree from Texas A&M University.

(Rancho los Santos and Agua Marina), and one south of the town of Soto la Marina near the village of San Jose de los Rusias (San Jose) (Figure 1).

Trapping stations were operated as follows: San Fernando Hill, 1966-1970; Agua Marina, 1966-1969; Rancho los Santos, 1967-1970; San Jose, 1967; and San Fernando Lake, 1968. Changes in station operations resulted from shifts in whitewing populations and from occupation of trapping sites by banding crews of the Mexico Department of Game.

Trapping operations were conducted during June and early July of each year. The birds were trapped along roads and trails and around earthen stock tanks in the nesting areas. Funnel-type dove traps were constructed of 1-by-2-inch-mesh welded wire and baited with grain sorghum.

RESULTS AND DISCUSSION

This paper presents some results of a preliminary examination of shot recoveries and trapping returns of 71,674 whitewings banded in Tamaulipas (Table 1). Considered in the analysis are 1,063 recoveries of birds reported as "shot" as of July 31, 1971, and 684 banded birds that were retrapped one or more breeding seasons subsequent to the year of banding.

The authors plan a more comprehensive analysis of the band recoveries and trapping returns after more data have accumulated. Among factors which hamper analysis at present are (1) lack of information on band reporting rates among persons hunting in Mexico and Central America, and (2) the large number of band recoveries yet to be received from the bandings.

General Movements

White-winged doves begin to arrive in the nesting areas of Tamaulipas in large numbers during early to mid-April. Nesting activity is closely tied to the onset of spring or early summer rains which trigger foliage development. Nesting continues well into August in the San Fernando area but often ends in June or July in the more

TABLE 1. SUMMARY OF WHITE-WINGED DOVE BANDINGS IN TAMAULIPAS

Year	Adults	Immatures	Total
1966	2,558	2,234	4,792
1967	18,329	3,823	22,152
1968	10,533	13,390	23,923
1969	6,763	7,731	14,494
1970	6,038	275	6,313
Total	44,221	27,453	71,674

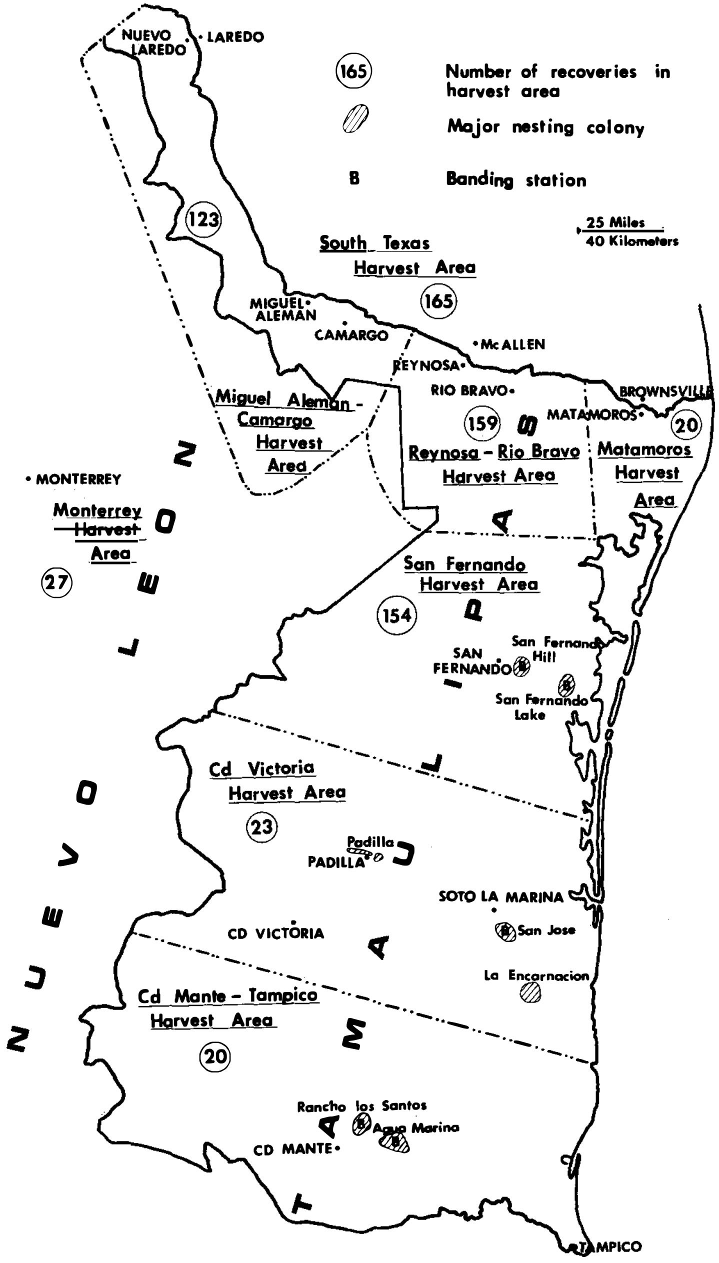

Figure 1.—Distribution of recoveries of Tamaulipas-banded white-winged doves and locations of harvest areas, banding stations, and major breeding colonies.

southern colonies where long dry periods following the spring rains can cause the vegetation to defoliate again.

With the termination of nesting, a portion of the southern-nesting whitewings move northward and join the San Fernando birds in the extensive grain sorghum (milo) fields east and north of San Fernando. By late August and September some birds from each of the five colonies have moved to sorghum and corn fields in the Lower Rio Grande Valley of Mexico and Texas. As an extreme example, one bird, banded as an immature near Cd. Mante, was recovered the following September near San Antonio, Texas, approximately 250 miles north of the Lower Rio Grande Valley and 460 miles north of Cd. Mante.

Southward movement of these birds usually begins in mid- to late September, the exact date and rate of movement varying considerably from year to year. Most whitewings usually have moved south of Tamaulipas by the end of October or early November.

The whitewings continue south through the states of Vera Cruz and Oaxaca and then southeastward through Chiapas into Central America as shown in Figures 2 and 3. Some birds winter in Chiapas and Oaxaca. The bulk of the population, however, apparently spends December, January, and February along the Pacific coasts of Guatemala, El Salvador, Honduras, and Nicaragua before beginning to retrace their path northward in March and April.

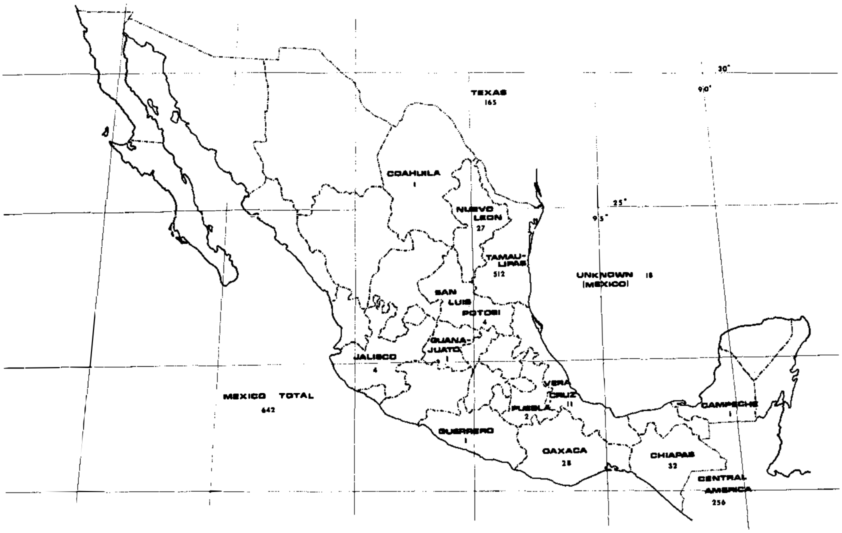

Figure 2.—Distribution of Mexico recoveries of white-winged doves banded in Tamaulipas, Mexico.

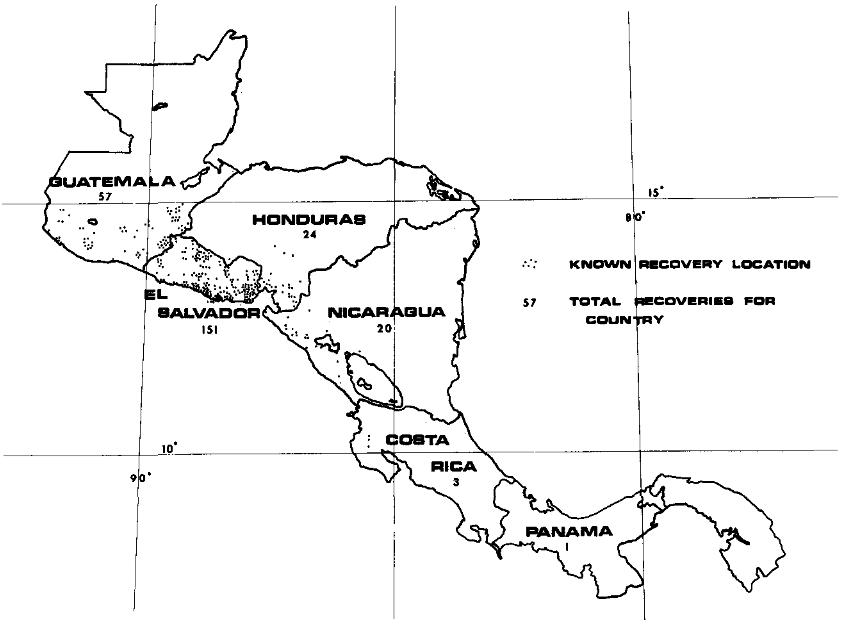

Figure 3.—Distribution of Central American recoveries of white-winged doves banded in Tamaulipas, Mexico.

Hawkins[2] reported that hunters in El Salvador said the migrant whitewings begin to arrive in early October and reach a peak about November 1. Our band recovery dates support this with larger numbers of recoveries in November and March for both Guatemala and El Salvador. These peaks probably correspond to increased migrational activity. George B. Saunders observed the northward passage of large numbers of whitewings along the Pacific coast of Chiapas in early April (Cottam and Trefethen, 1968).

HOMING AND RELOCATION

Fidelity to Natal or Breeding Colonies

Five hundred eighty-eight whitewings banded as adults and 96 birds banded as immatures were recaptured at the five banding stations in Tamaulipas during nesting seasons subsequent to the year of banding. Four additional birds were recaptured during the breeding season through limited trapping efforts in the Lower Rio Grande Valley of Texas. Also thirteen birds were reported as shot in Central America during June, July, and August, presumably the nesting

[2] Unpublished manuscript to be submitted to U.S. Bureau of Sport Fisheries and Wildlife. A. S. Hawkins, Jr. conducted a survey of whitewing wintering grounds in Central America, January—May, 1970, under the Caesar Kleberg Research Program in Wildlife Ecology, Texas A&M University.

season in Tamaulipas. Three of these were recovered in Guatemala, six in El Salvador, and four in Nicaragua (Table 2).

The 37 recaptures and recoveries of birds banded at San Jose in 1967 were not considered as normal as the habitat of this colony was altered by a hurricane in the fall of 1967. Flood waters washed out a roadbed dam which had created a lake around which the colony had nested in the previous summer. Only a few of the whitewings returned in 1968. The majority dispersed to other breeding sites, which may be the typical response to habitat changes. The breeding population of whitewings in the Texas Rio Grande Valley dropped by 89 and 49 percent respectively following freezes in 1951 and 1962 which destroyed nesting habitat (Cottam and Trefethen, 1968).

Of the remaining 660 nesting-season recaptures and recoveries, 20 were from areas other than the place of banding. Nine of these were banded as adults and 11 were banded as immatures. These data suggest that immatures are more apt to relocate. The data presented above (9 adult versus 11 immature recoveries) is strengthened when one corrects for the disproportionate number of adults and immatures banded (33,366 versus 24,351). The adjusted data becomes 9 adults and 15 immatures. Moreover, if band recovery rates (discussed in a subsequent section) of the two age classes reflect mortality rates, the adjusted number of immatures that relocate is still greater because immatures would have higher first-year mortality rates and thus fewer are available to shift.

TABLE 2. DISTRIBUTION OF WHITEWINGS RETRAPPED OR RECOVERED DURING NESTING SEASONS SUBSEQUENT TO BANDING YEAR.

Retrapping Location	Banding Location: San Fernando Hill	San Fernando Lake	San Jose	Rancho los Santos	Aqua Marina
San Fernando Hill	64*/18				
San Fernando Lake		**			
San Jose			**		
Rancho los Santos	0/1	0/2	10/0	65/13	2/3
Agua Marina			21/2	1/2	425/55
Lower Rio Grande Valley of Texas	1/0		1/0		0/2
Central American Shot Recoveries	2/1	0/2	3/0	2/2	1/0

*Top figure represents birds banded as adults, bottom figure represents immature bandings.
**No recaptures as banding station was operated one year only.

All colonies had one or more birds which shifted to another location. No birds were detected as shifting to the San Fernando area.

Six hundred forty birds, 554 banded as adults and 86 banded as immatures, or 97 percent of the recaptures, were retrapped in the same colony where they were banded. Of these, 23 were recaptured in two subsequent breeding seasons in the same location as banded and one was recaptured in three subsequent breeding seasons in the same location as banded. Here again, the ratio of recaptures of adults to immatures (6.4 to 1) is very different than the proportions in which they were banded (1.4 to 1). These data are rather conclusive that immatures have a higher tendency to shift than adults, or vice versa, adults have a higher tendency to return to the colony where they have nested at least once.

This would seem to indicate a high degree of fidelity but should not be construed to mean that 97 percent of all whitewings home to their previous area of nesting or natal colony. Our study of homing has the same bias as Clark's (1964) as discussed in Cottam and Trefethen (1968). Trapping stations were not distributed so that all geographic areas had an equal chance to be represented in the sample. In order to be recorded as homing or shifting a bird had to be recaptured at one of the five banding stations or happen to be in an area where birds were being shot during the nesting season in Central America. Any number of birds could have shifted to one of the colonies not sampled or to an area not hunted in Central America and not have been detected. Certainly, the small area of trapping operations would not sample equally all the birds nesting in a large colony. Thus if birds shifting from one colony to another tended to locate in a nonrandom pattern, they might not be detected even in a colony where trapping was conducted.

In addition to the recaptures discussed above, 14 birds were recaptured which had been banded as nestlings by the Texas Parks and Wildlife Department at San Fernando (3) and Agua Marina (11). Thirteen had been banded in 1962 and one in 1960. These birds were recaptured at varying intervals after banding: one after seven years, two after six years, seven after five years, and four after four years. Only one bird was taken at a location different from the place of banding. This bird, banded in 1962 at San Fernando Hill, was recaptured in 1967 at San Jose.

Mexico-banded Birds in the Texas Breeding Population

That whitewings produced in Mexico move into the Lower Rio Grande Valley of Texas to nest in subsequent years has been shown in Cottam and Trefethen (1968). Six birds banded as nestlings, four near San Fernando and two near Cd. Mante, were retrapped as breeding adults in Texas. When weighted by the population a banded bird represents, these recaptures could indicate thousands of birds from Mexico in the Texas breeding population.

In the present study one bird, banded as an adult at the San Fernando Hill Colony in 1967, was recaptured in a group of 436 whitewings trapped during the 1968 nesting season in the Texas valley. Three birds, two banded as immatures at Agua Marina in 1968 and the other banded as an adult at San Jose in 1967, were recaptured among approximately 800 whitewings trapped in the Texas valley during the 1969 nesting season.

Considering the number of unbanded birds each of these banded birds represents and comparing the size of the trapped sample with Texas whitewing breeding populations, estimated at 520,511 in 1968 and 416,000 in 1969 (Evans, 1970), it is probable that many thousands of whitewings that had nested or were produced in Mexico came to Texas to nest.

Future research should further probe the important question of whether or not Mexico-produced whitewings are an important component of breeding populations in the Texas Rio Grande Valley.

Central American Recoveries in the Nesting Season

The 13 recoveries in Central America (Table 2) during the months of June, July, and August were not unexpected because Cottam and Trefethen (1968) reported nine birds banded in Texas in the nesting season as recovered in Central America during the same months. Here are birds, which had presumably nested or were hatched in northeastern Mexico and Texas in previous years, now spending their breeding seasons on the wintering grounds. Unfortunately, we have no way of knowing if any of these birds were breeding.

The southern portions of Guatemala and El Salvador and western Nicaragua, where the birds were shot, is the home of two resident subspecies of whitewings, *Z. a. alticola and Z. a. collina* (Saunders, 1968). Apparently the migrants from Texas and Mexico mingle with the resident birds in feeding areas and perhaps in roosting areas as well. One or both of the subspecies mentioned above are breeding while *Z. a. asiatica* is in the area. Another subspecies, *Z. a. monticola,* breeds in Oaxaca during the time that *Z. a. asiatica* is wintering in or migrating through the area (Hawkins) (Saunders, 1968). The relationships of these subspecies in Oaxaca, Chiapas, and Central America warrant more study.

Each of the 13 recoveries in the present study represents several hundred unbanded birds and may well indicate the presence of several thousand *Z. a. asiatica* in Central America during the spring and summer.

Additional birds were recovered in Central America during the month of May. These are of more questionable significance as there is some possibility they could have been late migrants on the way northward. Of the 13 recoveries, two were shot in August and there is a slight possibility these were very early fall migrants.

Whitewing Harvest Areas

Figures 1, 2, and 3 show the distribution of band recoveries from whitewings banded in Tamaulipas and shot from South Texas to Central America. Two areas stand out as important harvest areas: (1) the State of Tamaulipas and adjacent South Texas and northern Nuevo Leon; and (2) Central America, particularly Guatemala and El Salvador. It should be pointed out that while distribution of shot recoveries may suggest relative abundance of whitewings, the concentration of recoveries in certain areas may be influenced by abundance of birds, hunting pressure, and band reporting rates.

Tamaulipas, Texas, and Nuevo Leon

Seven hundred and four recoveries of Tamaulipas-banded whitewings were reported from this area. This is 66 percent of all (1,063) shot recoveries reported. This large harvest is predominantly the result of one factor, the availability of the birds to hunters from the United States. Relatively few Mexican nationals hunt whitewings.

Several thousand Mexico-produced whitewings apparently cross into Texas each fall, the actual number varying greatly from year to year. Here they are subjected to heavy shooting pressure during the short (2 to 6 half-days) but very popular Texas whitewing season. Most of these birds are shot along the Rio Grande in an area some 20 miles wide extending from east of McAllen upriver to near Roma or opposite Miguel Aleman, Tamaulipas.

An abundance of birds, long season, more generous bag limit, excitement of a foreign hunt, favorable newspaper and magazine articles, and advertisements by both Mexican governmental agencies and American hunt organizers have resulted in a rapid and continued increase in United States citizens hunting in Mexico. U.S. Customs offices at ports of entry along the Rio Grande report five to six-fold increases in numbers of United States hunters in Mexico over the period, 1964-1969. Four hundred and five band recoveries from Tamaulipas and Nuevo Leon contained the address of the hunter. Of these recoveries, 387 or 96 percent were reported by hunters from the United States. The United States hunters may be more likely to report bands than Mexican hunters.

The Tamaulipas-Texas-Nuevo Leon region is broken down into eight harvest areas (Figure 1). Boundaries of harvest areas are based on several factors such as concentrations of recoveries, flight patterns to feeding and roosting areas, and political boundaries.

The Reynosa-Rio Bravo, Miguel Aleman-Camargo, and San Fernando harvest areas are the locations where most of the hunting takes place. In the Miguel Aleman-Camargo harvest area most of the hunting occurs along the Rio Grande where there are numerous sorghum and corn fields. In the Reynosa-Rio Bravo harvest area there is heavy shooting pressure along the Rio Grande opposite brush tracts on the Texas side, such as the Santa Ana National Wildlife Refuge and tracts owned by the World Wildlife Fund. Considerable hunting also occurs in grain sorghum and corn fields to the south and east of Reynosa and Rio Bravo.

In the San Fernando harvest area most of the hunting takes place east of San Fernando and to the north particularly around the settlements of El Tejon and Santa Teresa. These areas have extensive grain sorghum fields and are adjacent to large brush tracts which are used by the birds for both nesting and roosting.

The Matamoros harvest area is comprised of extensive grain sorghum fields with few brush tracts. Hunting is perhaps heaviest in the southern portion and along the Rio Grande.

Chief hunting areas in the Cd. Victoria harvest area are north and east of Padilla, east of Cd. Victoria, particularly near the village of Casas, and in the region around the town of Soto la Marina. Once again grain or corn fields with brush tracts nearby attract the whitewings.

In the Cd. Mante-Tampico harvest area whitewings are hunted mainly in the extensive grain sorghum and safflower fields to the east and south of the town of Cd. Mante. There are large brush tracts in this area which are used for both roosting and nesting. Most recoveries from the Monterrey area are from the agricultural areas to the east of the city.

Central American Harvest

Two hundred fifty-six recoveries or 24 percent of all shot recoveries of Tamaulipas-banded whitewings are from Central America (Figure 3). Eighty-one percent of the Central American recoveries were reported from Guatemala and El Salvador. El Salvador alone is credited with 59 percent of Central American recoveries. Cottam and Trefethen (1968) reported remarkably similar results from a review of 153 Central American recoveries of Texas-banded birds. They found 82 percent were recovered in Guatemala and El Salvador. Fifty-seven percent were recovered in El Salvador.

As Cottam and Trefethen (1968) suggest, this does not mean that the majority of Tamaulipas- or Texas-banded whitewings winter in El Salvador but may simply reflect greater hunting pressure or a higher band reporting rate. Hawkins (unpublished manuscript) states that hunters in El Salvador appear to be more familiar with the significance of bands and the reporting is probably slightly higher than that for the other countries. He believes the reporting rate is very low in Central America, an opinion shared by Cottam and Trefethen (1968).

Hawkins reports that seasonal and regional variations in winter whitewing abundance throughout Central America are closely related to availability of grain crops, particularly rice and sorghum. The birds feed in coastal rice fields when they first arrive and then move into inland grain sorghum fields as these mature. Grain farming is more extensive in Guatemala and El Salvador than elsewhere in Central America. Whitewings apparently cause losses in these areas by feeding on unharvested grain.

Whitewings migrate in large flocks along the Pacific coasts of Guatemala and El Salvador and Hawkins reports they are often shot from the beach or from small boats in the mangrove swamps. Locations often mentioned in recovery reports are Champerico, Tiquiste, Chiquimula and Jutiapa, Guatemala; and Sonsonate, La Libertad, La Union, La Herradura, Usulutan, Sensuntepeque and Chalatenango, El Salvador.

Other Harvest Areas

The numbers of recoveries in the Mexican states of Oaxaca (28) and Chiapas (32) are twice as large as numbers in any other Mexican state except Tamaulipas and Nuevo Leon. Recoveries from Oaxaca comprised 2.6 percent of our total recoveries and 4.4 percent of total Mexico recoveries. Those from Chiapas comprised 3.0 percent of our total recoveries and 5.0 percent of all Mexico recoveries. These data and those reported by Cottam and Trefethen (1968) concerning Texas-banded birds, suggest that the states of Oaxaca and Chiapas are important harvest areas.

Band Recovery Rates and Mortality

A necessary prelude to a realistic discussion of band recovery rates, and in fact, almost any analysis of band recovery data including the distribution of the hunting kill, is the statement that an important unknown is the rate at which hunters who shoot banded birds report the bands to the Bird Banding Laboratory, Laurel, Maryland. That the proportion reported (band reporting rate) varies between time periods and regions in the United States has been shown (Martinson, 1966; Tomlinson, 1968). Earlier studies had shown that for waterfowl, one-half or less of the bands were reported (Bellrose, 1955; Geis and Atwood, 1961). What the band reporting rates are in various regions of Mexico and Central America is an open question. Blankenship and Reeves (1970) in calculating the mourning dove kill in Mexico used, as examples, band reporting rates that were 50 percent higher and 50 percent lower than the United States rate. In Arizona, Stair (1957) on the basis of check station studies, calculated only 35 percent of the dove hunters reported bands they found on shot birds. Mourning dove hunters in the United States reported 32 percent of the bands they recovered in an experiment using reward versus standard bands, but in states that actively solicited band reporting through publicity, check stations, and other activities, the reporting rate was 66 percent (Tomlinson, 1968).

In the formative stage of this banding project in 1966, we proposed to incorporate a study of band reporting rates by using some reward bands and/or to increase reporting rates by using bands with an inscription in Spanish giving a Mexico City address. The U.S. Bureau of Sport Fisheries and Wildlife advised against our proposal for use of reward bands on whitewings in Mexico with the explanation that this would upset the normal reporting rate for all birds of all species taken in Mexico and Central America. We now have underway studies to gain information on band reporting rates during the 1972 hunting season and for earlier years as well using mail and telephone surveys of hunters.

The five-year banding period ended in 1970 and many recoveries are still outstanding. By conservative estimate, 300 additional recoveries can be expected; hence it is premature to draw conclusions from many aspects of the recovery data. However, preliminary analyses indicate:

(1) Immatures are more vulnerable than adults to hunting. In four years out of five, immatures had higher direct (1st-year after banding) recovery rates than adults; overall, about 50 percent higher (Table 3). Direct recovery rates for adults more than doubled from 1966-67 to 1969-70, but immatures did not follow this pattern.

TABLE 3. DIRECT (FIRST-YEAR) BAND RECOVERY RATES FOR ADULT AND IMMATURE WHITE-WINGED DOVES BANDED IN TAMAULIPAS.

Year banded	Adults No. banded	Adults No. Recov.	Adults Rate	Immatures No. banded	Immatures No. Recov.	Immatures Rate
1966	2,558	11	0.004	2,234	19	0.009
1967	18,329	74	0.004	3,823	49	0.013
1968	10,533	70	0.007	13,390	113	0.008
1969	6,763	60	0.009	7,731	73	0.009
1970	6,038	52	0.009	275	7	0.025
	44,221	267	0.006	27,453	261	0.009

(2) San Fernando-banded birds have band recovery rates over twice as high as Mante-banded whitewings. San Jose appears to be intermediate in recovery rates and is located between the San Fernando stations to the north and the Mante stations to the south. San Fernando-banded birds tend to move northward into the Rio Grande Valley of Mexico and Texas and are apparently exposed to greater hunting pressure than are whitewings banded in the Mante area. The San Fernando area also is easily accessible and well-known to hunters from the United States.

(3) Recoveries still outstanding are needed before definite statements can be made about average annual mortality, but at this stage it is evident that the birds are rather long-lived with a relatively low annual rate of mortality. Hunting pressure is increasing overall. Blankinship (1970) reported a three-year average production of 42 percent young birds in the populations of the major colonies. Presumably, the population could withstand an annual mortality rate of that magnitude and remain stable.

SUMMARY

Data from this study, as examined thus far, suggest the following conclusions:

Whitewings from Tamaulipas breeding colonies move northward into the Lower Rio Grande Valley of Texas and Mexico following the nesting season. Tamaulipas- and Texas-produced whitewings follow very similar migrational patterns in movements to and from the common wintering areas in Central America.

Whitewings appear to have some degree of homing fidelity to their natal or former breeding locations. Birds one-year old, which have not nested, are more likely to shift to another area to breed than are birds which have nested. Large numbers of whitewings which were produced or had once nested in Tamaulipas are present in the summer in the Texas Lower Rio Grande Valley, apparently as part of the breeding population. Birds which were produced or had once nested in Texas or Tamaulipas are present in Central America during subsequent nesting seasons. The significance of this is not understood at present.

Two regions, (1) South Texas, Tamaulipas, and northern Nuevo Leon, and (2) Central America, particularly Guatemala and El Salvador, stand out as major harvest areas for Tamaulipas-produced whitewings. First-year (direct) recovery rates indicate immature whitewings are more vulnerable to shooting than are adults by some 50 percent. The Tamaulipas-breeding whitewing population does not appear to be overharvested.

LITERATURE CITED

Bellrose, F. C., Jr.
1955. A comparison of recoveries from reward and standard bands. J. Wildl. Mgmt. 19(1):71-75.
Blankenship, L. H., and H. M. Reeves.
1970. Mourning dove recoveries from Mexico. U.S. Bureau of Sport Fisheries and Wildl. Spec. Sci. Rept.—Wildlife No. 135. 25 pp.
Blankinship, D. R.
1970. White-winged dove nesting colonies in northeastern Mexico. Trans. N. Am. Wildl. and Natur. Resources Conf. 35:
Clark, T. L.
1964. Birds across the border. Texas Game and Fish. 22(4):4, 5, 24.
Cottam, C. and J. B. Trefethen (Editors)
1968. Whitewings, D. Van Nostrand Co., Inc. Princeton, N. J. 348 pp.
Evans, P. K.
1970. Spring breeding population census. Texas Parks and Wildlife Dept. Job Completion Report., P.-R. Proj. W-30-R-24, Job. No. 13. 5 pp.
Geis, A. D., and E. L. Atwood.
1961. Proportion of recovered waterfowl bands reported. J. Wildl. Mgmt. 25(2):154-159.
Martinson, R. K.
1966. Proportion of recovered duck bands that are reported. J. Wildl. Mgmt. 30 (2):264-268.
Saunders, G. B.
1968. Seven new white-winged doves from Mexico, Central America, and Southwestern United States. North American Fauna, 65. 33 pp.
Stair, J.
1957. Dove investigations. Arizona Game and Fish Dept. Job Completion Report., P.-R. Proj. W-53-R-7, WP3, J9. 32 pp.
Tomlinson, R. E.
1968. Reward banding to determine reporting rate of recovered mourning dove bands. J. Wildl. Mgmt. 32(1):6-11.

DISCUSSION

DISCUSSION LEADER BAKER: The white-winged dove is a denizen of many of the countries of Central America. Much work has been done on it. I view that whole Tamaulipas area in a somewhat pessimistic way because in watching it over the last twenty or thirty years, it is steadily being cleared off much like our Rio Grande Valley in Texas. I wonder how long we can expect these high populations of white doves to be maintained in that rather choice agricultural sector of northeastern Mexico.

* * *

MOVEMENTS AND HUNTING MORTALITY OF COLORADO BAND-TAILED PIGEONS

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Band-tailed pigeons, *Columba fasciata,* occur in areas of western North America, throughout Central America, as far south as northern and western South America (Goodwin, 1967). Two populations are recognized north of Mexico, with the coastal group, *C. f. monilis,* occurring principally west of the Sierra and Cascade Mountains of California, Oregon, Washington, into central British Columbia. The interior population, *C. f. fasciata,* is seasonally resident in the forested mountains of Utah, Colorado, New Mexico, and Arizona, wintering in northern and central Mexico (Amer. Ornithol. Union, 1957).

Systematic studies of regional or state populations of bandtails are lacking; most publications refer to distribution, finding of a nest, or trapping and census techniques. Notable exceptions are the nesting studies of Glover (1953) and MacGregor and Smith (1955); general life history work of Neff (1947) and Smith (1968); mortality studies of Wight *et al.* (1967), Smith (1968), and Silovsky (1969); and the behavior work by Peeters (1962). Of the important contributions to understanding the ecology of band-tailed pigeons, only the general life history information presented by Neff (1947) refers to the interior population. Efforts were initiated by the Four Corners States (Arizona, Colorado, New Mexico, and Utah) in 1967 to conduct cooperative studies on this little-known population. Colorado initiated intensive trapping and banding efforts in June, 1969. This paper summarizes results of the banding program through 31 December 1971.

METHODS

Bandtails were trapped throughout Colorado wherever flocks of 30 or more birds were located. Most pigeons were trapped through use of cannon-projected nets (Dill and Thornsberry, 1950; Dill, 1969). All nets were used with three cannons, with one net 30 by 75 feet with 1½-inch mesh and three nets 30 by 60 feet with 1¼-inch mesh. In addition, 3-foot-square modified cage-type funnel traps (Reeves, *et al.,* 1968) were utilized, mostly at sites too small for cannon nets. Bait varied with the site; barley, *Hordeum vulgare*; corn, *Zea mays*; wheat, *Triticum aestivum*; and field peas, *Pisum sativum* were used most frequently.

All pigeons trapped were separated into adult or immature age classes (Silovsky *et al.,* 1968), with some subadults (classified as adults for this paper) being identified in 1970 and 1971. In 1969, sex of most adults was determined by either cloacal inspection (Miller and Wagner, 1955) or visual inspection of plumage characters. Following testing of the validity of plumage characters for sex determination from a sample of 144 birds collected in 1969 (unpublished data), visual examination alone was used for sex determination in 1970 and 1971. Reliability of determining sex from plumage characters was 94.1 percent in 1969 (N = 144) and 96.6 percent (N = 135) in 1970. Following age and sex determination, pigeons were banded with U.S. Fish and Wildlife Service bands (size 5) and released.

Banding terminology follows that of the U.S. Bird Banding Laboratory. Recoveries are those birds shot or found dead and reported, while direct recoveries are those recovered in the first year after banding. Repeats are recaptures of birds within 90 days of initial capture in the same degree block as initial capture. Returns are recaptures of birds banded in this study and subsequently retrapped at the banding site in one or more following years. Foreign returns are recaptures of birds banded at other sites in Colorado (outside of the degree block of original capture) either during this study or by private banders. This category also includes birds initially banded outside of Colorado and subsequently recovered in Colorado.

RESULTS

Banding

In 1969, trapping was conducted at five different locations in Colorado with 1,600 pigeons being newly banded. This total included 377 immatures and 1,223 adults (673 males, 550 females). Efforts were increased in 1970, and 3,292 pigeons were trapped at 13 different locations, including the five 1969 trap sites. Of this number, 548 were immatures and 2,744 were adults (1,781 males and 963 females). Trapping efforts were expanded in 1971, and 4,006 pigeons were newly banded, comprised of 288 immatures and 3,718 adults (1,789 males and 1,929 females). In 1971, pigeons were trapped at 18 different locations including three of the five areas initially trapped in 1969 and seven of the thirteen 1970 sites. Distribution of band-tailed pigeons and trapping sites in Colorado is shown in Figure 1.

Trapping in 1969 was conducted from June through August; in 1970 birds were banded from May through August, while trapping was initiated in May in 1971 and continued into September. Since Colorado is at the northernmost limit of the range of the interior population of bandtails and few, if any, pigeons occur north of Colorado, all birds trapped were considered summer residents. Birds

COLORADO

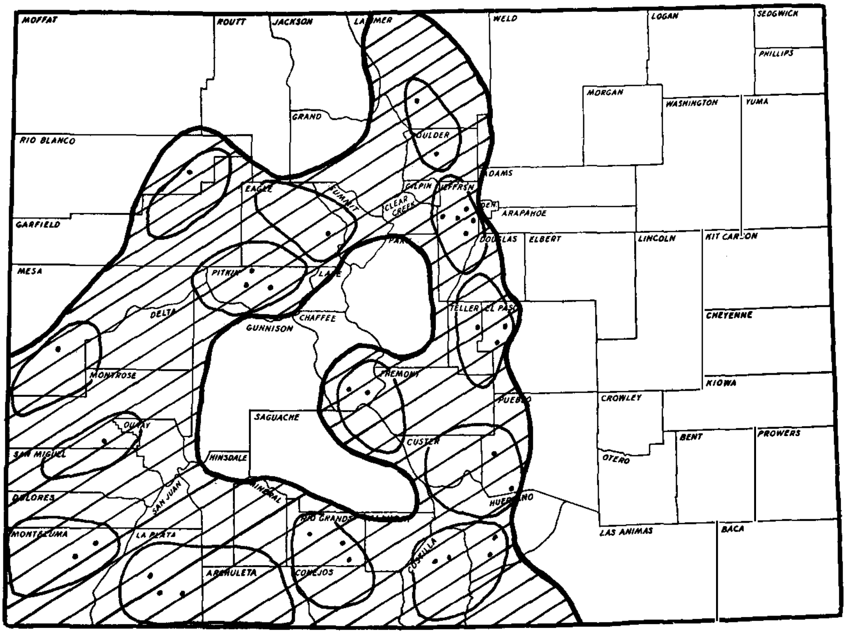


Figure 1.—Distribution of band-tailed pigeons, banding stations and subpopulations in Colorado.
(Dots indicate banding stations; circular areas indicate subpopulation boundaries)

trapped during June through August were undoubtedly summer residents of the individual area where they were trapped. This assumption was also mostly true for those birds trapped in May. Only 8 of 404 (2.0 percent) birds in one flock banded in southern Colorado (Huerfano County) in May 1971 were subsequently recaptured north of this area during the 1971 breeding period. It is believed that the reason for this occurrence was simple; some birds at this trap site had not completed their northward migration. These eight birds were the only individuals recaptured north of the original trapping site in the same year of 1,315 pigeons banded in May. Considering all bandings in the 3 years, only 27 different individuals were retrapped north of their initial banding location, suggesting that most pigeons trapped were summer residents of the area where initially banded.

Returns

Of the 8,898 band-tailed pigeons banded in Colorado from 1969 through 1971, 1,251, including repeats, were recaptured at least once. One hundred fifty-nine were recaptured in 1969, 289 in 1970, and 803 in 1971. All of the 1969 recaptures occurred in the degree block of banding, while 263 of 289 (91.0 percent) and 686 of 803 (85.4

percent) were recaptured in the same degree block where initially trapped in 1970 and 1971, respectively. Of the 143 birds retrapped away from original banding location, 93 returned to areas less than 40 air miles from original banding sites and were considered to be still within their original "home range." There were no important physical barriers between sites where initially banded and subsequent recaptures for this group of birds. Those birds that did move substantial distances (up to 260 air miles) had to cross high mountain ranges (up to 14,000 feet), semi-arid valleys, and major drainage systems. Patterns of movement for this group were irregular as 27 of the 50 birds moved north and 18 moved south. Distance traveled between trapping sites for those birds moving more than 40 air miles was extremely variable; 23 were retrapped less than 100 miles from original banding site, 18 moved from 100-200 miles, and 9 moved over 200 miles.

Of the 1,251 pigeons recaptured, only 283 were captured the year after initial banding, while 54 were recaptured after 2 years. Examination of the records for these 283 birds revealed that a high percentage (92.0) returned to the area of initial banding in successive years. This further suggests bandtails in Colorado have great fidelity to given areas. This finding does not support Neff's (1947) contention that band-tailed pigeons are extremely nomadic.

Sex and age class of those birds moving over 40 air miles was examined to learn if one sex or age class dominated. No pattern was apparent; both adult males and females each made up 42 percent of this group, while birds banded as immatures comprised 16 percent of the total. Six of the eight immatures in this category were retrapped at least one year after initial banding and five of the six were classified as females. Of 48 birds moving substantial distances, 26 (54.2 percent) were females, suggesting that both males and females have about equal fidelity to given areas.

During the period studied, 15 pigeons banded outside Colorado were retrapped in addition to five different birds banded within the state by private banders. All five birds were retrapped within 20 air miles of initial banding, with one being banded in 1965 (retrapped in 1970) and four being banded in 1967 (four retrapped in 1970; one in 1971). Three of the out-of-state returns were banded in Utah, 11 in New Mexico, and 1 in Arizona. Nine of the 15 were classified as adult females; the remainder were adult males, again suggesting that no pattern exists in the probability of either males or females being more likely to move away from banding areas.

Recaptures of Colorado-banded pigeons outside of Colorado are uncommon. Five have been reported to date; four in New Mexico and the other in Utah. Four of the five were retrapped 1 year after initial banding. One banded 24 May, 1971, was recaptured in New Mexico on 23 June, 1971. Three of the birds were initially banded as adults (two males and one female), with the remaining two being young of the year when banded. It should be mentioned that banding activities in adjacent states are not of the same intensity as in Colorado.

Recoveries

Through 31 December, 1971, band recoveries were reported for 191 birds, of which 183 were shot recoveries. Only one recovery was reported in 1969, 34 in 1970, and 156 in 1971. First-year (direct) shot recovery rates for all age and sex classes were 0.0006, 0.0060, and 0.0217 for 1969, 1970, and 1971, respectively. The exceedingly low recovery rate in 1969 is attributed to the lack of a hunting season in Colorado that year. However, all birds banded in 1969 were theoretically exposed to hunting in New Mexico during migration, and in Mexico during the winter. The one bird recovered in 1969 was banded as an immature; none of 548 immatures banded in 1970 was shot that year, while 15 of 288 (0.0520) immatures banded in 1971 have been reported shot. Second-year recovery rates were 0.0075 and 0.0137 for all birds banded in 1969 and 1970 respectively. The third-year recovery rate for all 1969 bandings was 0.0050.

Recovery rates presented in Table 1 are not comparable because hunting seasons in Colorado and New Mexico were not concurrent. Hunting was not allowed in Colorado during 1969 but was in 1970 (September 12-20) and 1971 (September 4-26). In New Mexico, hunting seasons were open in September all 3 years (9 days in 1969 and 1970 and 23 days in 1971). In addition, the size of area open to hunting increased over 1969 in 1970 in New Mexico but remained unchanged in Colorado. Hunting pressure increased in both states from 1970 to 1971. Also, not all pigeons banded in Colorado in 1970 and 1971 were in areas open to hunting. While the situation concerning hunting in Mexico is unknown, it is assumed that there were no changes from 1969 to 1971. Reporting rates in Colorado and New Mexico are probably high due to publicity and hunter surveys, but

TABLE 1. RECOVERY RATES OF COLORADO BAND-TAILED PIGEONS.

		Number of Recoveries			Recovery Rate		
		Year of Recovery					
Year	Number banded	1	2	3	First year	Second year	Third year
1969	1,600	1	12	8	0.0006	0.0075	0.0050
1970	3,292	20	45		0.0060	0.0137	
1971	4,006	97			0.0217		

reporting rates in Mexico are unknown. Thus, data in Table 1 relate only the general picture of hunting mortality on Colorado bandtails.

Of the 183 shot recoveries reported to date, 142 (77.6 percent) were recovered in Colorado, 27 (14.8 percent) were from Mexico, 13 (7.0 percent) were from New Mexico, while 1 (0.6 percent) was recovered in Utah. Thus, band-tailed pigeons banded in Colorado are subjected to hunting pressure primarily in breeding and wintering areas. Apparently, hunting mortality during migration is low, with only 7.6 percent of the bands reported being from pigeons shot outside of Colorado during presumed migration. While reporting rates in Colorado and adjacent states are presently higher than for other migratory game birds, the unknown reporting rates in Mexico could alter the present apparent distribution of the harvest.

Hunting recovery sites in Colorado were compared in order to test the hypothesis that distinct subpopulations do occur. Only 14 of 142 (10.1 percent) shot recoveries were taken more than 40 air miles from original banding site. Six of the 14 were recovered south of their initial banding location and possibly were migrating at time of death. No pattern in sex or age class could be detected for those birds harvested away from their "home range," as seven were adult males, four were adult females, and one was an immature.

Distribution of recoveries in New Mexico of bandtails banded in Colorado were clumped in the north-central and southwest portion of the state, suggesting a southwestern movement from Colorado. The single recovery in Utah was taken about 40 air miles west of the initial banding site and could indicate a normal movement. In Mexico, recoveries have been reported from the States of Durango (14), Sinaloa (6), Chihuahua (4), with one each from Sonora, Nayarit, and Jalisco. It appears that most pigeons breeding in Colorado winter along the Sierra Madre Occidental Range in north-central Mexico.

Five pigeons banded outside of Colorado (three in New Mexico, one in Utah, one in Oregon) have been reported shot within the state. The recovery of the bird banded in Oregon is of interest because it represents the first documented movement of a pigeon between the coastal and interior populations. This bird was banded as an unsexed adult, 20 April, 1968, near Milwaukie, Oregon, and was recovered 20 September, 1970 near Durango, Colorado.

Discreteness of Subpopulations

From analyses of return and recovery data, it is apparent that band-tailed pigeons in Colorado have great fidelity to specific areas and occur in individual flocks. There is little evidence to suggest that flocks are extremely nomadic, moving large distances within a given season in order to satisfy their needs. Observation and banding data in Colorado suggest that pigeons readily move throughout chosen areas, with these regular movements being quite restricted, less than 40 air miles in distance. It is probable that these movements are related to food preference and availability. It is therefore possible to recognize fairly discrete subpopulations occurring in rather well-defined areas. Areas utilized by individual flocks are presented in Figure 1 in relation to pigeon distribution and banding stations in Colorado. It is recognized that the present boundaries are not absolute and may be modified through additional bandings, returns, and recoveries. Flock areas containing only one banding station are least accurate and may not exist as depicted. It is also possible that additional subpopulations may be recognized if bandings become better distributed. Distribution of pigeons within Colorado is not uniform and may be termed clumped with respect to suitable habitats. This is probably true for band-tailed pigeons throughout their range. If the flock concept is valid, management practices can be applied to individual groups of birds in order to maximize recreational opportunity or to protect flocks from overharvest. Using this concept, specific regulations for individual flocks can be formulated.

SUMMARY

Intensive banding studies of band-tailed pigeons which were summer residents of Colorado were conducted from 1969 through 1971. In all, 8,898 pigeons were trapped at 33 different locations during the 3-year period. Banding data suggest that northward migration in the spring is not gradual, with flocks appearing first in areas they occupied the previous year. Most pigeons banded were summer residents of the area where initially trapped.

Recaptures of 1,251 pigeons were documented with only 143 retrapped away from original banding location. Of this total, 93 returned to areas less than 40 air miles from original banding site. Movement patterns for the 50 pigeons moving more than 40 air miles were irregular, but some birds moved over 200 miles. Recapture data indicate that both males and females have high fidelity to area.

Recoveries from 183 pigeons shot during 1969-1971 were reported. First-year recovery rates for all birds increased from 0.0006 in 1969 to 0.0217 in 1971, with immatures banded in 1971 having a recovery rate double that for all birds. Due to a number of variables, recovery rates between years were not comparable. Most shot recoveries were from Colorado (77.6 percent) with lesser numbers from Mexico (14.8 percent). Hunting mortality during migration was indicated to have been low (7.6 percent of all shot recoveries). Analysis of locations of

banding and harvest of individual pigeons further indicated the presence of distinct subpopulations since only 10.1 percent of the shot recoveries in Colorado occurred more than 40 air miles from banding sites.

All present data indicate that fairly discrete subpopulations of pigeons occur in rather well-defined areas of Colorado. It appears possible to manage band-tailed pigeons in Colorado on a specific flock basis.

ACKNOWLEDGMENTS

Special thanks are extended to Student Assistants William Carpenter, J. Edward Kautz, Chet McCord, Brett Petersen, Michael Robinson, Michael Watkins, and J. Allen White for their assistance in trapping, banding, and recording information. Mark Stromberg compiled all of the banding, return, and recovery data, and his attention to details is gratefully acknowledged. Howard D. Funk, Colorado Division of Game, Fish and Parks, initiated this study and has fully supported it throughout the duration. His interest and help are deeply appreciated. Dr. Ronald A. Ryder, Department of Fishery and Wildlife Biology, Colorado State University, and Howard D. Funk critically reviewed the manuscript, and their helpful criticisms are appreciated. This study was supported through Federal Aid in Wildlife Restoration funds, and is a contribution from Colorado Project W-88-R.

LITERATURE CITED

American Ornithologist's Union
1957. Check-list of North American birds. 5th ed. Lord Baltimore Press, Inc., Baltimore. 691 p.

Dill, H. H.
1969. A field guide to cannon net trapping. Bureau Sport Fisheries and Wildlife, U.S. Fish and Wildl. Serv., Div. Wildl. Refuges, Minneapolis, Minn. Mimeo Rept., 21 p.

Dill, H. H., and W. H. Thornsberry
1950. A cannon-projected net trap for capturing waterfowl. J. Wildl. Mgmt. 14(2): 132-137.

Glover, F. A.
1953. A nesting study of the band-tailed pigeon (*Columba f. fasciata*) in northwestern California. Calif. Fish and Game 39(3): 397-407.

Goodwin, D.
1967. Pigeons and doves of the world. British Museum Nat. Hist., London. Publ. No. 663. 446 p.

MacGregor, W. G., and W. M. Smith
1955. Nesting and production of the band-tailed pigeon in California. Calif. Fish and Game 41(4): 315-326.

Miller, W. J., and F. H. Wagner
1955. Sexing mature Columbiformes by cloacal characters. Auk 72(3): 279-285.

Neff, J. A.
1947 Habits, food and economic status of the band-tailed pigeon. U.S. Fish and Wildl. Serv., No. Am. Fauna 58. 76 p.

Peeters, H. J.
1962. Nuptial behavior of the band-tailed pigeon in the San Francisco Bay area. Condor 64(6): 445-470.

Reeves, H. M., A. D. Geis, and F. C. Kniffin.
1968. Mourning dove capture and banding. U.S. Dept. Interior, Bureau Sport Fisheries and Wildl. Spec. Sci. Rept. Wildl. No. 117. 63 p.

Silovsky, G. D.
1969. Distribution and mortality of Pacific Coast band-tailed pigeons. M. S. Thesis, Oregon State Univ., Corvallis. 70 p.
——————, H. M. Wight, L. H. Sisson, T. L. Fox, and S. W. Harris.
1968. Methods for determining age in band-tailed pigeons. J. Wildl. Mgmt. 32(2): 421-424.
Smith, W. A.
1968. The band-tailed pigeon in California. Calif. Fish and Game 54(1): 4-16.
Wight, H. M., R. U. Mace, and W. M. Batterson.
1967. Mortality estimates of an adult band-tailed pigeon population in Oregon. J. Wildl. Mgmt. 31(3): 519-525.

DISCUSSION

DR. HOWARD WIGHT (Oregon): I have had some experience with this species in Oregon and I don't know whether people realize what a feat Clait has accomplished with his banding of immatures. We find this almost impossible to accomplish in our West Coast work. Therefore I am quite interested in some of the results regarding immatures. Dr. Braun pointed out there was no significant difference between males and females, that is, adult males and females, in their locations in subsequent years based on returns. I'd ask the same question: Was there a difference between returns, the fidelity shown to the natal area in immatures as opposed to adults?

DR. BRAUN: That's an important point, Howard. Yes, immatures have at least the same fidelity to natal areas, like banding locations, as adults. I looked at this closely, but, of course, our recoveries of immatures, returns, recaptures, whatever you want to call them, are quite low. We have banded about 1,200 immatures now in three years but the returns of these birds are extremely low. It is much lower than for adults percentagewise.

DR. WIGHT: Perhaps they are going places where you are not operating a trapping station. Is that a possibility?

DR. BRAUN: It is a possibility. You noticed on my map that we operated up to 33 different trapping locations. We trap in every area of the state that we can get into that has a flock of 30 or more pigeons. Yes, there are areas that we should be trapping in that we haven't been trapping in. Realistically, we may never be able to trap in some of these locations, but it is very possible that the immatures may be going there. They may be going to other states. The trapping effort in the other three Four Corner States is not equal to that in Colorado. I didn't mention the number of bands that we have recovered from other states—I think we retrapped 15 birds from New Mexico, Utah and Arizona, one from Arizona, three from Utah and I think 11 from New Mexico. I might also say that the two sub-populations north of Mexico appear to be fairly discrete. This is based primarily on size and measurements of the birds. However, we have recovered one bird banded in Milwaukie, Oregon in 1968 and recovered in Durango during our hunting season in 1970, indicating that there could be some movement between the Interior and the Coastal populations of birds. In taxonomical studies that we are doing, there is some overlap in size of the two populations, and this is something to be considered in future studies.

DISCUSSION LEADER BAKER: Thank you very much. In closing I want to say I enjoyed very much being involved today and I hope that subsequent meetings of the North American Conferences will include perhaps annually topics of this sort, with more emphasis on them. Before I turn the microphone back to our Chairman, I want to remind you, particularly some of our friends from Mexico, that copies of the printed Transactions of this conference can be purchased. They have forms down at the desk and if you will fill those out and provide what money they need for this purpose, they will mail you one when it comes out. With that, I will turn this back to our Chairman.

TECHNICAL SESSION

Wednesday Morning—March 15

Chairman: THOMAS MADDOCK, JR.
Research Hydrologist, U.S. Geological Survey, Washington, D.C.

Discussion Leader: KENNETH L. BOWDEN
Professor, Department of Geography, Northern Illinois University, DeKalb

WATER, FISH, WILDLIFE AND SOCIETY

IMPACTS OF ENVIRONMENTAL CHANGES ON GULF COAST ESTUARIES

RICHARD A. GEYER
Department of Oceanography, Texas A&M University; College Station, Texas

INTRODUCTION

Environmental changes in Gulf Coast estuaries can be attributed to two major causes—man, as well as nature. The primary purpose of this paper is to present two examples in each category out of the wealth of those that exist. Man can alter the environment in many ways including pollution, mosquito control, dredging for canals and non-living resources; for recreation including extensive boating activities and the building of marinas, as well as using the region for real estate developments to provide building sites for homes, industry, ports and governmental facilities. Similarly, nature through variations in key oceanographic and meteorologic processes and phenomena can markedly alter the normal environmental characteristics of Gulf Coast estuaries. Some of the critical parameters include waves, storm tides, currents and hurricanes, as well as pronounced and rapid changes in temperature, salinity, oxygen and turbidity. Seasonal or other changes in the amount and rate of flow of fresh water from streams and rivers into estuaries can also play an important role in the otherwise normal life of an estuary.

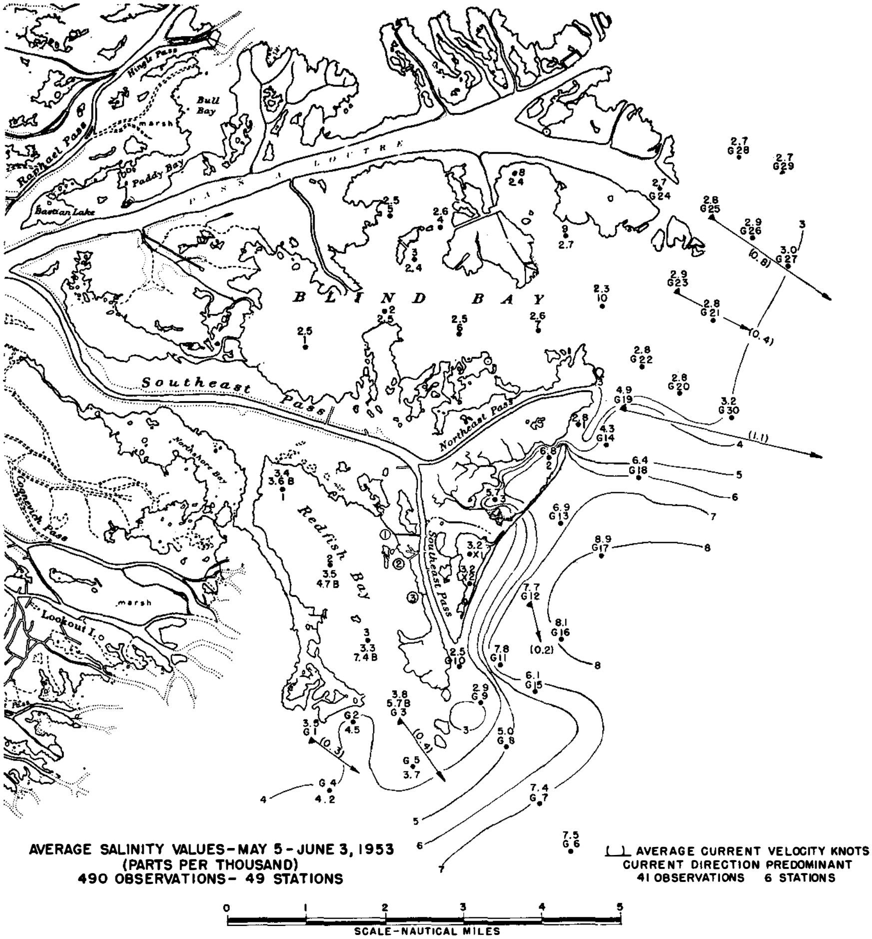


Figure 1. (Geyer, 1955)

EXAMPLES

Hydrography of Redfish Bay and Blind Bay, Louisiana

Effect of large quantities of fresh water discharged by the Mississippi and its distributaries on the salinity of these two bays and immediate offshore areas is evident in Figures 1 and 2 (Geyer, 1955). The general salinity pattern remains consistent over the period of the survey from month to month, although the isohaline contour values change with variations in the stage of the Mississippi. A wedge of

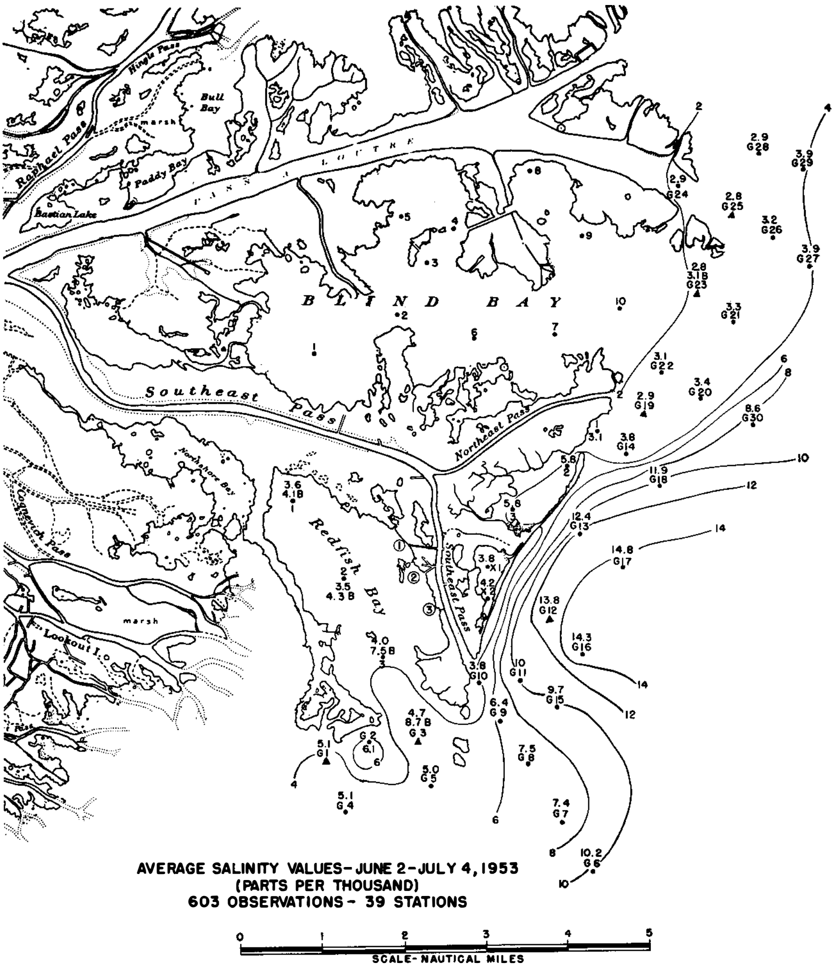
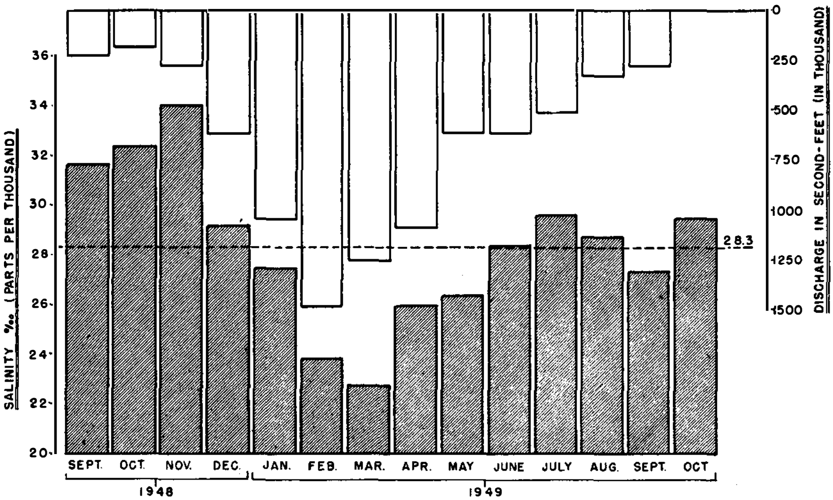


Figure 2. (Geyer, 1955)

high salinity Gulf water occurs close to shore, but it is surrounded to the north and south by less saline Gulf waters. These have been diluted by fresh water issuing from Southeast Pass and Pass à la Loutre, as well as from Redfish and Blind Bays.

The configuration of the isohaline contours for the two periods, May 5 to June 3 and June 4 to July 2 is nearly the same, although the individual values average about six parts per thousand higher during the second period. This increase in salinity again can be attributed to the decrease in the volume of fresh diluting water available from the Mississippi during the second period. Higher salinity values correlate well with the fact that the average stage of the river dropped from 12 feet for the period, May 5 to June 3, (Figure 1), to approximately 8 feet for the period, June 4 to July 2, (Figure 2). The volume of river water discharged decreased markedly, but the path taken by the river water was the same.

The correlation between the stage of the Mississippi River and the salinity of coastal waters of the Gulf of Mexico has been demonstrated from information obtained from offshore drilling platforms (Geyer, 1950) and also in (Günter and Geyer, 1955) (See Figures 3 and 4). Data for the study (Geyer, 1950) were gathered at seven drilling platforms during a 14-month period for a zone paralleling the coast for about 60 miles, approximately 6 to 8 miles offshore, and in water depths varying between 40 and 50 feet. This correlation (Figure 3) demonstrates that seasonal variations in the salinity of offshore coastal waters correlate with variations in amount of water discharged by the Mississippi River. Since this effect makes itself felt so far offshore, it is not surprising that a correlation exists in estuaries immediately adjacent to distributaries of the Mississippi. It is based



COMPARISON OF MONTHLY AVERAGE SALINITIES IN COASTAL WATERS OF GULF OF MEXICO WITH DISCHARGE IN SEC.-FT. OF THE MISSISSIPPI RIVER AT VICKSBURG

Figure 3. (Geyer, 1950)

on more than 700 seawater samples taken in the area over this period.

Other effects of the interaction of Mississippi River water and the saline waters of the Gulf of Mexico on the hydrography of the estuaries and adjoining offshore areas are demonstrated in Figure 4. In this figure, maximum and minimum salinity values for 1,093 salinity observations are plotted for 49 locations used in this survey.

The volume of river water entering Blind Bay is so large that the maximum salinity observed during the period of May 5-July 2 was only 3.5 parts per thousand, and at several stations studied, fresh water was found (Figure 5). But the maximum salinity observed for

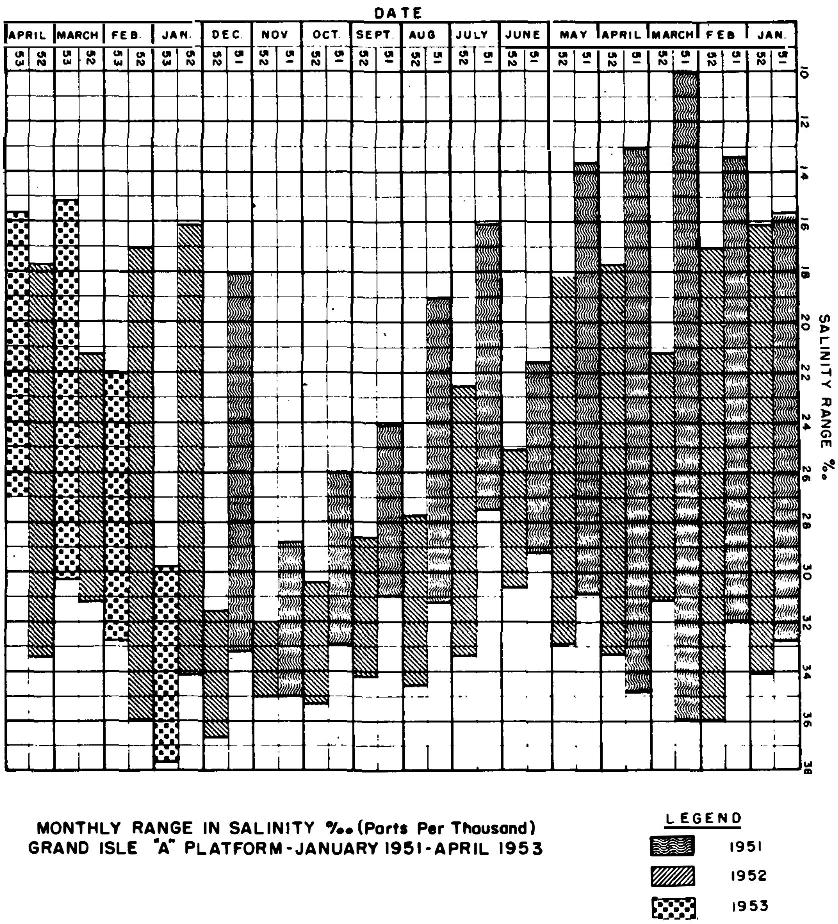
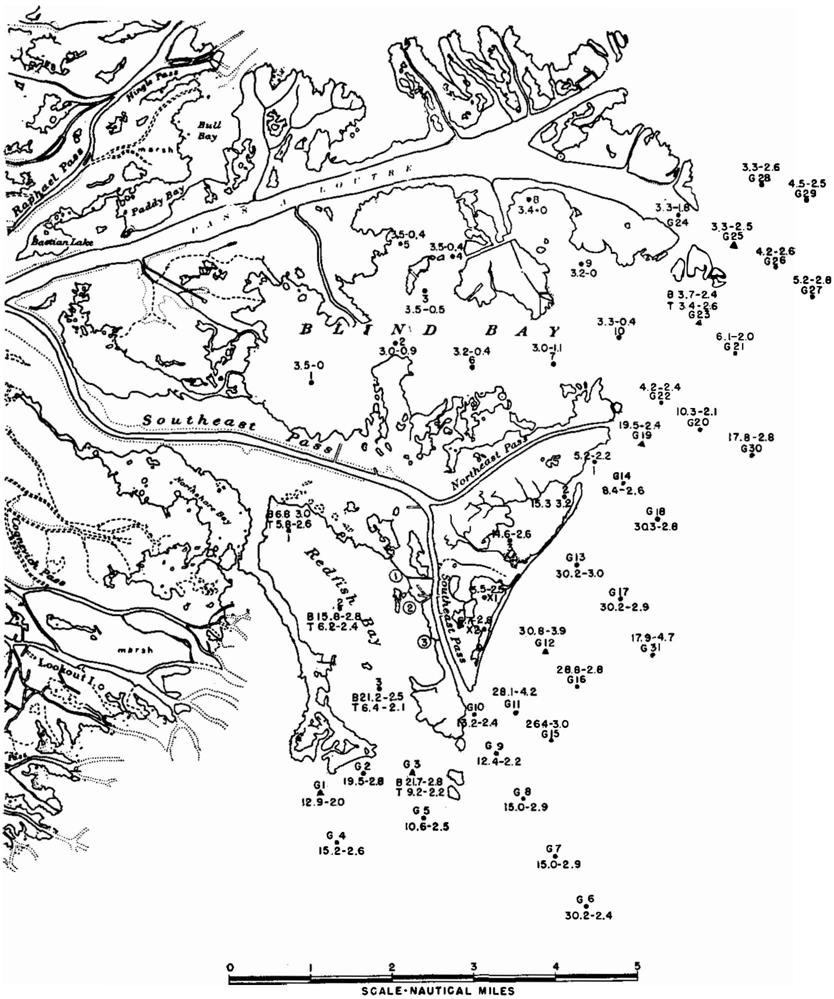


Figure 4. (Gunter and Geyer, 1955)



MAX & MIN. SALINITY VALUES – MAY 5 – JULY 2, 1953
1093 OBSERVATIONS – 49 STATIONS

Figure 5. (Geyer, 1955)

the surface waters of Redfish Bay was generally about twice that observed in Blind Bay, or about 6 parts per thousand. In addition, maximum salinity values recorded for the water at the bottom of Redfish Bay increases progressively from 6.8 at the head of the bay to 21.2 at the mouth. Similarly, minimum salinity values for Redfish Bay, both for surface and bottom waters, were never less than 2 parts per thousand. Generalizations made for Redfish Bay also apply to two small unnamed bays situated between Redfish and Blind Bays along the edge of the delta.

During certain stages of the tide, more saline Gulf water enters along the bottom of Redfish Bay and two smaller unnamed bays (Figure 5). Redfish Bay is deep enough so that more dense saline Gulf waters tend to flow into the Bay below the lighter river water, as evidenced by uniformly higher salinity values of the bottom waters.

The fact that these conditions were not observed in Blind Bay can be explained by the availability of a very much greater volume of river water for Blind Bay from Pass à la Loutre and Southeast Pass. This is corroborated by the fact that average current velocities observed at Stations G-19, G-23 and G-25 (Figure 1) are from 1 to almost 3 times as large as the average current velocity for Station G-3 located at the seaward entrance of Redfish Bay. This also explains the position of the 4 parts per thousand isohaline contour (Figures 1 and 2) which was found farther out in the Gulf away from the mouth of Blind Bay than from the mouth of Redfish Bay. During the period June 4-July 2 (Figure 2) when the volume of fresh water carried by the Mississippi was greatly reduced as compared with the period May 5-June 3 (Figure 1), the 4 parts per thousand isohaline contour extended about a mile into Redfish Bay. This is in contrast to its location of about a mile beyond the mouth of the bay during the previous month. However, the position of this contour is almost 2 miles beyond the entrance of Blind Bay (Figure 2) as compared with 2.5 miles offshore the previous month (Figure 1).

Currents and Tides

The average current velocity and direction for the 6 current stations are based on 41 observations (Figure 1). As would be expected, the predominant current direction at the mouths of the passes and bays is toward the Gulf. Station G-12 was situated offshore between the passes, and the current flows in a southerly direction with an average velocity of 0.2 of a knot. Current direction and velocity of Station G-1, just south of the entrance to Redfish Bay, is determined primarily by the flow of water from several of the minor distributaries located between South and Southeast Passes. The current direction at this station parallels the movement of the water off the distributaries, and the velocity is 0.3 of a knot.

Some idea of the comparative amounts of water flowing from the mouths of bays, as compared with the mouths of the distributaries, can be seen by comparing the difference in current velocity for the two locations (Figure 1). The average current velocity at the mouths of Redfish Bay and Blind Bay is 0.4 of a knot; wheras, off the mouths of Southeast Pass and Pass à la Loutre, the average current velocity is 1.1 and 0.8 of a knot, respectively.

Direction and velocity of currents in this area are effected in general by the astronomic and wind tides prevailing when observations are made. When the wind blows from the north at a high velocity for sustained periods of time, the waters in the marshes, bays and bayous of this region are forced toward the Gulf of Mexico, leaving a minimum of water in the bays. Conversely, when strong winds, associated with storms in the Gulf, blow from the south, the Gulf waters are forced into the bays and marshes covering them at times to great depths. Although the range in astronomic tides is very low, about 2 feet, the storm tides associated with hurricanes have been known to reach a maximum of 10 to 12 feet in this general area.

Based on an analysis of hydrographic factors considered during the surveys, it is evident that the hydrography of Redfish and Blind Bays, at any given time, is dependent primarily upon the prevailing stage of the Mississippi River. But shoreward movement of the saline Gulf waters associated with tide and wind action serves to modify the major hydrographic patterns determined by variations in the stage of the river.

Naturally Occurring Hydrocarbons in the Gulf

Tar has been reported from many segments of the Gulf Coast beaches, and obviously some of this can be attributed occasionally to human error. There is evidence, however, that a significant amount of this pollution comes from natural hydrocarbon seeps situated within and around the Gulf. There is historical evidence dating back to pre-Columbian times of tar on western Gulf Coast beaches. For example, more recently, the Karankawa Indians used this material to line their crude pottery so it could hold liquids and early Spanish explorers caulked their ships with it.

Research expeditions conducted by the Oceanography Department of Texas A&M University have found tar at different levels in cores from the Sigsbee Knolls and elsewhere in the Gulf, as well as in numerous dredge samples. At the turn of the Century the U. S. Coast and Geodetic Survey published annually charts of the Gulf of Mexico showing oil seep locations, and the U.S. Geological Survey published accounts with maps of the location of oil seeps along the coast of Louisiana and Texas (Hayes and Kennedy, 1903). Many large natural seeps occur in the area south of Tampico on the coast. Because of its viscosity, the heavier tars initially will remain on the bottom or within the sediment mass. However, much material, particularly as a result of wave and current action associated with storms, will come to the surface.

A research program of the Department of Oceanography now in its second year and sponsored by the Sea Grant Office of NOAA and eleven oil companies has as its major objective to study and monitor areas of active seeps. Current studies in cooperation with the U.S. Coast Guard are being conducted to determine where the material might go after it reaches the surface. Samples of the material are being collected to identify and chemically fingerprint them for later identification. Periodic beach patrols are being instituted to determine the amount and kind of hydrocarbon washing up onto the beach.

Biological studies are also being conducted in areas of known seeps to determine the effect of natural seeps on the ecology. In addition, chemical studies are being conducted to determine what happens to the heavier hydrocarbons in the water. If we can learn to predict the rate of discharge, then methods to control the distribution once in the water may be developed. Similarly, by determining dispersal rates and direction of transport from current studies, then it may be possible to predict when certain beach areas may expect large accumulations of these naturally occurring hydrocarbons, and steps can be taken to confine and collect these before they reach the beaches.

Anomalous Growth of a Delta in Matagorda Bay, Texas

A few centuries ago the Texas Colorado River changed course and discharged into Matagorda Bay. Natural log jams in its lower reaches prevented normal sediment transport. Several attempts by man were carried out during the last century to dislodge the log jam. In 1929 enough material was removed from the largest jam to enable the flood of 1929 to free the river from obstacles. In three years a delta was built half way across the lagoon with an average growth of one mile per year. Dredging of the river and a channel through the lagoon and the barrier island changed the direction and aspect of further delta growth. In 1936 the entire lagoon was dammed by the delta of which the sedimentary characteristics do not differ from any other Gulf Coast delta.

The evolutionary growth of this delta during the period prior to the log jam being broken and subsequently with the resulting changes in rapidly increasing areal extent is graphically summarized in Figure 6 (Bouma and Bryant, 1969). The delta doubled in size during this period of 1930-1933 after 75 percent of the river clearing project was completed in 1929. In addition to the marked increase in size resulting from the major break in the log jam this growth tendency

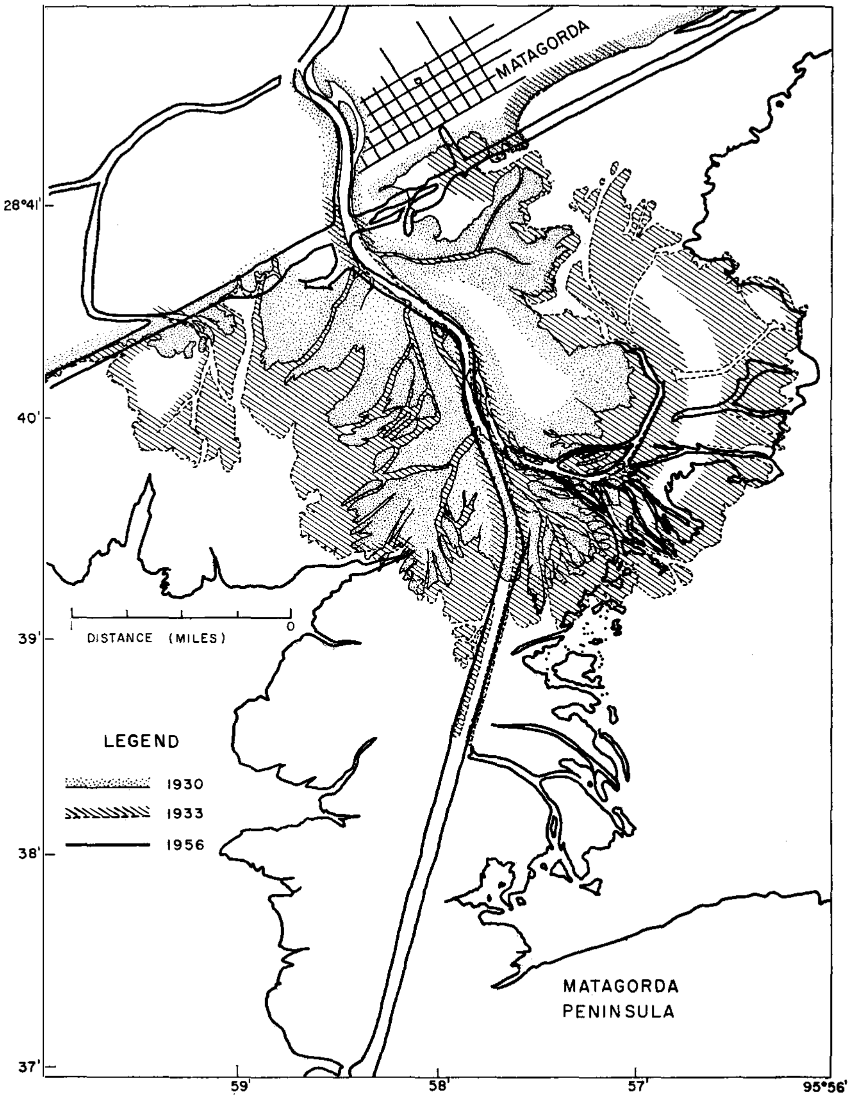


Figure 6. (Bouma and Bryant, 1969)

was accentuated by dredging one of the channels. This changed both the direction of its growth and its character. Dredging of a straight channel and dumping the spoil parallel to it caused the sediment load to be carried directly to the Gulf. After dredging ceased silting of the channel started and more sediment was deposited in Matagorda Bay.

Little delta growth activity for almost 70 years was evident from a study of charts made in 1839, 1881 and 1908. In 1908 it only covered 45 acres, increasing to 3470 acres in 1933, 4890 acres in 1936, 7098 acres in 1941 and 7200 acres in 1953. It is evident from these figures that the major period of growth occurred during 1930 to 1941 and that it correlates closely with the activities of man in this area.

Boca Ciega Bay, St. Petersburg, Florida

This bay is an excellent example of the modification of a major estuary for eventually almost the exclusive use of man for a wide variety of his activities. In the relatively short span of 25 years from 1940-1965 this estuary has been almost entirely altered by dredging and filling and the construction of various types of facilities for man. Hence, it can no longer effectively serve the primary ecological purpose for which estuaries are intended. This condition is summarized in Figure 7. Unfortunately, it is only one example of an ever

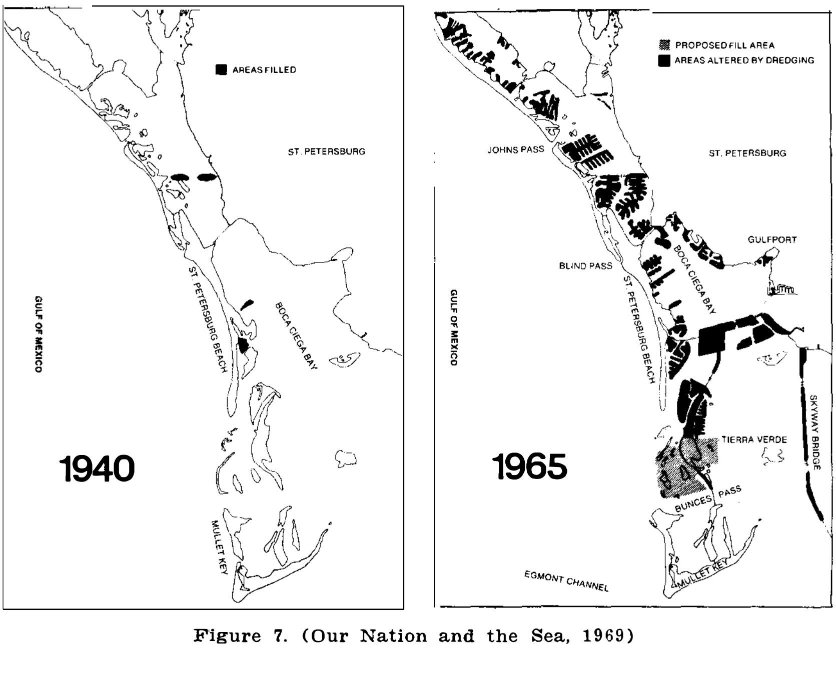


Figure 7. (Our Nation and the Sea, 1969)

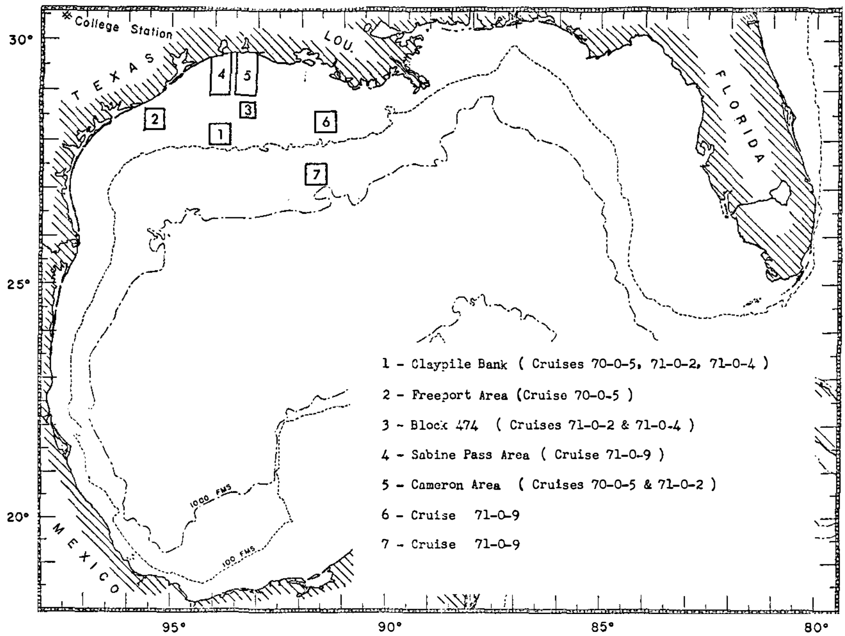


Figure 8.

increasing number that can be cited along the extensive shore line of the United States. To be more specific, eighty percent of the 300 square miles of tidal wet lands surrounding San Francisco Bay have been filled. In addition, sixty-seven percent of the estuaries of California are no longer available for their original use and fifteen percent for New York and New Jersey. Turning now to the states bordering the Gulf Coast, 68,000 of the 828,000 acres of prime estuaries (eight percent) of the State of Texas have been diverted from their original use and the percentages lost to date for Louisiana, Florida and Mississippi are three, eight and two, respectively. The impact on the fishing industry can be substantial.

The conflict between competing objectives such as navigation, aquaculture, sports fishing, shell fishing and flood control too can be substantial. For example, the Bonnet Carne Spillway located on the Mississippi River near New Orleans is illustrative of this problem. Whenever this spillway is opened for flood control the vast quantities of fresh water released dilute the salinity of large areas to the extent that the oyster industry could occasionally be affected under certain conditions.

Nevertheless, it should be emphasized in conclusion that although the estuaries comprise a major component of the Coastal Zone—the nation's most important geographical feature, both economically and sociologically—they can and must be developed in an optimum manner for the best interests of everyone. This means it must be done in a way compatible with the best short and long term interests of the diversified public, private and governmental segments comprising our society, as we know it today. Otherwise it will not be possible to cope successfully with the myriad of problems that must be solved to make the best use of this area for this nation and its citizens.

BIBLIOGRAPHY

Bouma, Arnold and W. R. Bryant.
1969. Rapid delta growth in Matagorda Bay, Texas, Lagunar Costeras, un Simposio: 171-190.
Geyer, Richard A.
1950. The occurrence of pronounced salinity variations in Louisiana coastal waters, Jour. Mar. Res., 9(2):100-110.
————.
1955. Effect of the Gulf of Mexico and the Mississippi River on hydrography of Redfish Bay and Blind Bay, Inst. of Mar. Sci., 4(1): 159-168.
Gunter, Gordon A. and Richard A. Geyer.
1955. Studies of the fouling organisms of the Northwest Gulf of Mexico, Inst. Mar. Sci., 4(1):40-67.
Hayes, C. W. and William Kennedy.
1903. Oil fields of the Texas-Louisiana Gulf Coastal Plain, Bull., No. 212, Series A, Econ. Geol., 104-112.
Our Nation and the Sea, Panel Report Vol. I. President's Commission on Marine Sciences, Engineering and Resources, 1969, III, 129, Government Printing Office.

DISCUSSION

DR. CLARENCE COTTAM (Texas): Visitors to islands off the Texas coast do a tremendous amount of damage. Some of these islands should be used for recreation, but I think it should be regulated and organized in a way that the birds will be left some areas for nesting. We have a number of species—for instance, the Brown Pelican—that are almost things of the past. I've been in Texas now for 16 years. When I went there, there were 20 or possibly 30 thousand pelicans. This last year, there were less than 100 along our coast. These birds nest in some of these islands. The reddish egret is another one that's on the endangered list. It nests commonly on these islands and they're excluded when a single solitary squatter comes along. It's a disgrace to the public, the people of Mexico as well as the United States, to have those islands managed as they're being managed. We've raised enough Cain in the last few weeks and I think some action may be taken. If you hear some rumblings, we hope that some of you "loyal soldiers" will come to our defense.

CHAIRMAN MADDOCK: Thank you for the plea for a more rational approach to managing some of these areas.

QUESTION (Unidentified): I'm very pleased to have had a short talk about lagoons or estuaries. Of course, one cannot really do justice in only 15 minutes. What I would like to say is that there is also concern about lagoon areas or estuaries farther to the south. Here in Mexico, we have approximately 1.5 million hectares of coastal lagoon areas and brackish water areas, probably one of the largest areas in the entire world for any one country to have. In 1970, we had a take of 7.8 million kilos of shrimp from lagoon areas in Mexico alone. This is quite similar to what we find as we go farther through Latin America into South America. In view of this, an organization, or a loosely formed organization, called CICAR started its investigations in the Caribbean and adjacent regions. In their last meeting in Trinidad in 1971, members recognized the need for immediate research of lagoon areas throughout the CICAR region stretching from the Gulf

Coast of the United States down as far as Brazil, taking in a great number of countries, and some of the richest lagoon areas in the world. The request made was for research before we have trouble with such things as pollution, housing development, industrial siting and such. Not so much from the environmental point of view now, as from the point of view of what a lagoon can produce for these rather poor countries. The question is how to make the fullest use of lagoons. In view of this, a program is now being formulated for the entire CICAR area for coastal lagoons and marine culture.

SPEAKER (Unidentified): On Monday afternoon Dr. Gunter indicated that perhaps the dredging of oyster shells was actually beneficial. Would Dr. Geyer care to speak on this subject?

DR. GEYER: Without trying to appear to dodge the question asked by the speaker, I would like to say that at the moment, we are just about to undertake a rather major study in San Antonio Bay. We will obtain information from a practical and factual standpoint covering the myriad of ecological factors that go into replying to your question. We make this study in the hopes that we will be able to come up with some facts which tell just what effects, both good and bad, may be resolved from this sort of oyster dredging. In about a year from now, we will be in a much better position to answer your question because by that time we will have results of this research. To me, it's a wonderful example of that which we hear so much about, interdisciplinary research, these days, in coastal waters and the oceans. This program is supported by the Corps of Army Engineers and the shell dredgers, and working on this project is Texas A and M University. Although it is headed up and coordinated by the Oceanography Department, we have people not only from our own department but also from the Geology Department. There are also people from the Biology Department, from the Wildlife and Fisheries Department, from Engineering and right across the board. So this will be a multidisciplinary attack to provide answers or at least shed some light before too long. I don't make any claim that we're going to have all the answers in this period of time, but at least we shall have some factual information to shed some light so that we can try and answer your questions objectively.

DR. E. L. CHEATUM (Georgia): We recently conducted a study of dredging effects on estuary lands in Georgia, in relation to the proposal to mine estuaries for phosphate in Chatham County, Georgia; and I believe that this report on proposed phosphate mining in Georgia, which encompasses projecting data which would be pertinent to increased oxygen demand in the estuarine waters as a result of dredging bottoms, might be useful to the San Antonio study. I'd be glad to send a copy of that report if youll give me your name and address.

QUESTION (Unidentified): What would a major increase in salinity do as far as the biological environment of some of these estuaries in Texas and Louisiana is concerned?

DR. GEYER: This would depend upon the salinity tolerance of the particular species involved. It would take quite a long time to answer your question in detail, but just to take, in the interest of time, one species—the oyster. Releasing some of the flood waters of the Mississippi, upon occasions lowers the salinity to the point where the oysters are affected in the areas over which the water flows and have great difficulty in surviving. So conversely, if you increase the salinity beyond the upper level salinity of tolerance of the oysters, then it would also have a deliterious effect on production. In summary, I think the answer to your question depends upon what species you're talking about and what the tolerance of the species is. Another thing, it's not so much the actual difference in salinity, but the rate of change in which this difference occurs. In other words, rapid salinity change might be more disadvantageous to an organism or to a species because it wouldn't have time to adjust.

* * *

WATER DEVELOPMENT AND THE ENVIRONMENT

BUD BRISTOW
Arizona Game and Fish Department, Phoenix, Arizona

For the past three years wildlife organizations and professional societies have been sponsoring conventions and conferences with themes referring to an apparent renaissance of public concern for the natural resources. Speakers at these meetings emphasize the opportunity for accomplishment in wildlife conservation because of new enthusiastic public support. The field of federal water resource development has been identified as the prime candidate area for major accomplishment.

It seems apropos that we review the social and administrative changes occurring during this period of public awareness and enlightenment. For the purpose of this paper, the public related conservation activities involving water projects in Arizona will be briefly analyzed—other areas of the country have experienced similar public concern and awareness relating to water development projects.

Arizona is unique in that it has a closed water system. By a closed system I mean that all flowing streams are consumptively used by man within the state. Waters of our three major rivers: the Gila, Salt, and Colorado, are presently over-appropriated. A general 50-year trend of decreasing water yield from the watersheds has stimulated an intensive demand for more efficient methods of yield and delivery. Historically, development in Arizona has occurred around the agricultural centers and the political tenor is strongly oriented to consumptive water-use projects.

Most water projects in Arizona are designed to serve two basic objectives: to decrease transportation losses and to control stream flows. The projects attempting to accomplish the first objective are the most detrimental to wildlife. The volume of riparian vegetation existing along a stream channel is a good indication of the amount of water lost during transit.

Prior to 1968 the achievements of the Arizona Game and Fish Department, while working with federal agencies under authority of the 1958 amendment to the Fish and Wildlife Coordination Act, left much to be desired. We won a few minor battles, but we were effectively losing the war.

The Topock Gorge Division of the Lower Colorado River Front Work and Levee System Project of the Bureau of Reclamation serves as an excellent case in point.

This reach of the Colorado River, separating Arizona and California, contains 5,000 acres of excellent marsh habitat and 14 miles of highly scenic river canyon. The Topock Gorge Division is contained within the Havasu National Wildlife Refuge.

This Bureau of Reclamation project, comprising nine divisions, includes 230 miles of the Lower Colorado River from Davis Dam to the Mexican Border. The project was authorized in 1927 and amended in 1946 for the purpose of controlling the floods, improving navigation, and regulating the flow of the Colorado River.

The plan in the Topock Gorge Division was to channelize the entire 14-mile reach of the river and drain or fill adjacent backwater marshes with dredge spoil. After cursory coordination with federal and state fish and wildlife agencies the development agency incorporated wildlife mitigation features into the project. Mitigation was limited to deepening of 300 acres of shallow water for fishery purposes. This token effort was unacceptable and the project was formally opposed by the state fish and wildlife agencies of Arizona and California. Channel dredging began in October, 1967. Following the initiation of dredging at Topock the Arizona Game and Fish Department began a public information program in December, 1967 to bring this matter before the public. It should be noted that both state and federal fish and wildlife agencies had been attempting to develop a working relationship with the construction agency for 16 years. However, these previous efforts to preserve fish and wildlife habitat along the Lower Colorado River had been largely unproductive.

At this point in time, 1967, the Arizona Game and Fish Department was of the opinion that the following factors were working in our favor for successful opposition.

1. The project was justified on questionable water salvage benefits.
2. Benefits to be derived would not be accrued by interests in Arizona. Thus, local support for the project existed in philosophy only.
3. The chief administrator in charge, the Secretary of the Interior, was a recognized conservationist.
4. The scenic beauty and refuge status of the project area had broad public appeal.
5. Possible loss of mitigation measures was insignificant.

In addition, several factors discouraging initiation of a public relations effort to halt the project were evident:

1. An apathetic public.
2. Lack of existing access to the news media or lack of understanding regarding newspaper support.
3. Localized independent conservation organizations with conflicting objectives.

4. Difficulty of discrediting the accepted, if not sacred, objective of water salvage.

Public information activities consisted of numerous weekly news releases, an article in the monthly Game and Fish Department magazine, six Department-sponsored field trips, and numerous slide-show presentations. Maximum effort was expended in coordination of the various conservation organizations' actions. With development of a favorable press and state political support, including the Governor of Arizona, the project was suspended in June, 1968 by Secretary of the Interior Udall. Approximately 10 percent of the channelization had been completed.

The segment of the public contributing to the success of this program was apparently only those contacted directly by Game and Fish Department personnel at public meetings, on field trips or individually. There was no evidence of independent, recurring or spontaneous action by conservation organizations. In addition, other civic organizations expressed no interest in the project although contacts were made.

A more harmonious relationship between the active conservation organizations developed and no doubt the feeling of success stimulated additional interest.

Then came the renaissance, and a general public concern for deleterious environmental change seemed to emerge in the fall of 1968. Initially, attention was focused on the air pollution problem in Arizona due to active state legislation establishing emission standards. Increased sensitivity to other environment changes was evident in water project controversies.

A decision was made to expand the public relations program to include other water projects. An assessment of the Topock Gorge program revealed that we had preserved only one 14-mile reach of 230 miles of river to be dredged. Conservationists were concerned and knowledgeable about Topock but had little information on the multitude of other similar projects encompassing the entire Lower River.

It seemed desirable to broaden the scope of the public relations program concerning projects detrimental to wildlife habitat and the environment and to concentrate critical attention on single purpose water-salvage projects. In effect the objective was to question the principle and methodology of water-salvage programs.

The phreatophyte eradication method of decreasing transit water use in streams had been under intensive development and study in the Southwest. The objective of this method is to prevent transpiration losses of stream flow by eradication of adjacent riparian vegetation. Justification for the program is based on the assumption that use of water by vegetation is non-beneficial. With vegetation eradication programs the surplus water can be used for economic purposes. State game and fish agencies maintain that riparian vegetation is beneficial to wildlife and that water used by vegetation is beneficial.

Nine major project areas were authorized or were under study for riparian vegetation in 1968. The area included most major stream habitats in the state. A significant portion of habitat for numerous game and nongame wildlife species would have been removed upon completion of these projects.

The Department's public education program was redirected and intensified in the fall of 1968. The major thrust was to publicize the scope and anticipated impact of proposed phreatophyte eradication projects. Slide presentations were made to most of the conservation organizations or to anyone who would listen. A bimonthly series of five articles on the subject were published in the Department's magazine and numerous news releases were submitted to the state's newspapers.

Public reaction to the program was strikingly different than on the Topock project. Numerous requests for presentations from civic organizations, local governmental entities, schools, professional societies, and church groups were received. The most noteworthy and rewarding development, however, was in the individual initiative displayed by conservation leaders and university professors. Public forum and television panel discussions were organized and often accomplished without encouragement or assistance from the Game and Fish Department. The Department's role in the effort evolved into one of simply providing information on request.

Evidence of the success of the public education program was revealed in May, 1970, when a major phreatophyte clearing project was tested in the Federal District Court of Arizona under provisions of the National Environmental Policy Act of 1969. Department personnel supplied an evaluation report on the proposal and also testimony in the court action. However, the litigation procedure was initiated and accomplished by a coalition of conservation organizations. The court ruled in favor of the plaintiffs, an injunction was issued, and the phreatophyte control project came to a halt.

Further response to the vegetative eradication programs and evidence of public concern for natural resources were again revealed in 1971. In this case the Department released a minimum amount of publicity regarding an authorized phreatophyte clearing-channelization project in the final design stage of planning. Several organizations publicly opposed the project and took steps to circumvent construction before the Game and Fish Department had established its position.

A total of 27 organizations formed a citizen coordinating committee to prevent construction of the project. As the constructing agency was fulfilling the requirements of various federal guidelines, the committee investigated the project in its entirety. The project design and hydrology were analyzed by an engineer and two hydrologists and a report drafted. Economists evaluated the benefit-cost ratio and submitted their findings. With a thorough evaluation of the project design, hydrology, and economics, coupled with the Department's evaluation of the wildlife resource, a very impressive and comprehensive report was published by the committee.

A public relations and political action effort was made by the committee concurrent with the project investigations. Signatures of 13 percent of the area's population were obtained on a resolution opposing the project. Legislative bodies were contacted individually and in formal session at the city, county, state, and federal level. A letter-writing campaign was maintained for the duration of the controversy. Some student support was sought and obtained at the high school and college level. A large number of articles were published in the local and major state newspapers. Funding for project construction was withheld in Congress. In addition, federal agency support for other projects involving phreatophyte control has been withdrawn or significantly diluted.

A significant point in the phreatophyte eradication controversy in 1971 was the well-established political support of the Irrigation District sponsoring the project. The District maintains a local public relations system and legal counsel. Further, professional representation in Washington is provided for appropriation hearings.

Although the Game and Fish Department was working on the project, leadership and decision making responsibility passed from the Department to the conservation organizations in both phreatophyte eradication project controversies. Some coordination effort and much information were provided by the Department.

The leadership of the organizations was composed largely of professional people including university professors, doctors, lawyers, hydrologists, and journalists.

Presently, conservation groups in Arizona independently take positions and action on most water development projects. Reliance is still placed on the Department for identification of problems and information.

Side effects of the new public awareness which inhibit game management are also apparent. Conservationists often question the

Department's activities involving water manipulation and development in marsh areas for waterfowl purposes. In some cases opportunities for development of waterfowl and fisheries habitats are forgone to preserve habitat for non-game bird species.

In addition to water development projects public resentment to the visual impact of power transmission lines had preempted location of new routes adjacent to highways. Thus, new power corridors and the attendant construction of maintenance roads are often located in remote wildlife areas. Additional access in remote areas promote increased human activity which is often detrimental to the resident big-game populations.

These problems are small in comparison to the favorable impact public awareness of the environment has had on Arizona. No state legislation has been passed comparable to the National Environmental Policy Act of 1970. However, a very effective functioning conservation body has materialized. Our duty is to give it direction.

Ernest F. Swift states in *A Conservation Saga* (1967): "In a complete culture, material progress must be balanced with civic, social and aesthetic values. To obtain these ends it is the duty of national, state and community leadership to find the fulcrum which will balance the conflicts that inevitably arise with increasing populations and greater use of resources. Only in direct ratio to individual responsibility will we have any national responsibility in the management of resources."

With the public concern and awareness for the environment that we are experiencing today we have evidence of individual responsibility. All we have to do is cultivate these individual responsibilities and we can have the national responsibility that we all seek in the management of our resources and the sensible preservation of the environment.

LITERATURE CITED

Swift, Ernest F.
1967. A conservation saga. National Wildlife Federation, Washington, D. C.

DISCUSSION

QUESTION (Unidentified): In respect to 1970 court decision, was this that the construction agency had not met the provisions of the Environmental Policy Act and the injunction was issued until the agency met the conditions of the act, or was it a deliberate overturn of construction per se because of environmental damage?

MR. BRISTOW: In 1970 of course, the act had just been passed, and there were several features that the conservation groups felt had not been considered by the constructing agency. Finally, the project was overturned by the fact that the Federal District Court said that they had not met provisions of The Environmental Policy Act of 1970. There were not details or specifics however.

QUESTION (Unidentified): So it would be an open case if the Agency had filed an environmental statement?

MR. BRISTOW: If the Agency filed an appropriate and acceptable Environmental Policy Act or a statement under the Environmental Policy Act, I assume that they could go ahead.

QUESTION (Unidentified): I think this is a splendid paper and I just have a suggestion. I have nothing but praise for the paper. It seems to me that the principles involved in this thing have much import for problems within the boundaries of Arizona. I would like to see the author include at least a bibliography of these other things and preferably a brief summary of the decisions on these because it would be of interest to every state and federal group, and to every group of people who are concerned with saving something of our environment. I remember some of these incidents. I was in Arizona quite a number of times during this fight and to me, it's one of the bright stars of conservation efforts to improve our environment, or rather to save the environment from complete destruction by bureaucracy.

QUESTION (Unidentified): In the lower Colorado, we can look on it as a productive unit composed of many different products; we might call it the social product. Among these would be wildlife, water, many recreational uses, as well as economic uses. I find that in these conflicts we are really talking about human values. It wasn't mentioned in this paper, but I remember reading a paper where you had written about the value of mourning doves in areas where the nesting habitat would be eliminated with major clearing operations. In that, you did tie in some economic costs and I can remember reading about it and thinking at the time that if you doubled the mourning dove population, would this increase the value of the harvest that much? Or even cutting back population by 50%—would this change the value to society in Arizona that much?

MR. BRISTOW: At the present time, the whitewing is primarily the species that we're concerned with in these areas, although they're very valuable for mourning dove. The whitewing population is harvested to the maximum amount. We feel that we take the annual surplus and the limiting factor on whitewings apparently in Arizona is free riparian vegetation. They nest primarily along our streams, and so any time you remove an acre, you remove an acre of doves, and dove nesting in these areas is a little different, I think, than in other areas. We have cases where we have found as many as 238 nests in one acre at one time, so you can see they're very valuable. Of course, we've come up with figures on it, and I think some of them exceeded a thousand dollars per acre for an acre of nesting habitat as the value for one year, using the guidelines established by the Water Resources Council.

QUESTION (Unidentified): Well, we've talked about bird populations in these areas. In your paper you imply that public access occasionally does have very adverse effects on resident big game populations and I was intrigued by the question, "Is the big game population to exist as a big game population for it's own benefit, or is it really to benefit man?" Public access, I think, would be a very important part of the man-oriented type of benefit.

MR. BRISTOW: Yes, that was what I was referring to. I had to leave out a major portion of the paper, and I can understand that it probably didn't follow too well. But I was referring to the fact that you can't really manage fish and wildlife in public form through newspapers or by political activity. You can't do this, but the fish and wildlife people have to recognize this method of getting their views known, and unless they can get public support, they really are on a very poor end of the table when the bargaining process occurs on a federal water project. Obviously, the real progress is going to be made when fish and wildlife people are placed on the same level with water interests, recreation interests, and all other interests. At that point, the agencies can get together and they can manage wildlife, but we have to be in a good bargaining position first. Now, on access—there is access for people who want to fish or want to see wildlife. However, the introduction of new highways and major construction in areas which primarily serve as refuge or escape areas for big game populations is detrimental to the population. We would much prefer, in some cases, to see these highways and also the power lines located adjacent to each other. That may be not very esthetic, but let's put all our "uglies" in one place instead of spreading them all over the countryside.

UNIDENTIFIED: I have served on the staff of the National Water Commission. Our mandate was to look at alternative ways of increasing water supplies. One of these was the removal of vegetation in control and timber harvesting techniques to increase water yield. I might just put in as a comment that your work was highly influential on our views, primarily in that it caused the Forest Service to downward revise their estimates of potential increases by such control to about 50% of the estimate that they had made roughly 3 or 4 years previous to this public relations effort.

DR. PAUL SPRINGER (South Dakota): I was wondering if there have been any before-and-after studies of the effects on wildlife of channelization in areas around our other Southwestern States. I'm speaking of wildlife rather than fisheries. I know there have been some studies on the effects of fisheries but I was thinking primarily of wildlife that uses the stream banks where the water courses.

MR. BRISTOW: Most of the research work in Arizona has been restricted to whitewing and mourning dove populations. There's also definitely an effect on other species, even big game species, but most of our work has been on the dove populations and we have information on these populations if you would like it.

I think that it's only reasonable that projects that have been authorized for any length of time, for example, 5 years, if they haven't been constructed they should certainly be re-evaluated under the new guidelines and new ideas that we have, before they are constructed. There's little question on that.

I think we have the procedures right now for evaluating these projects by the state wildlife departments. I think we have the coordination with the different agencies. We have the legal framework whereby this can be accomplished. It seems to break down somewhere in their planning process; although ideally, we should begin at the very ground level. Often we find that a project is authorized before we even see it. Of course, this is even contrary to Federal Law, but it occurs. One other point. I once canvassed our Department and attempted to determine how much effort our Department spends just on investigation and work with federal water projects and it came out to about 12% of the total budget. Now these are paid solely by the hunter, the fisherman, and also, of course, the Federal funds but they are paid to evaluate projects to prevent loss of fish and wildlife habitat. It would seem that as these programs, or projects, are going to benefit certain people, that perhaps the Federal Government should include these costs and reimburse the States to study the project. We're forced, in self defense, to expend a large amount of money on a project which is very unusual if it serves any benefit for wildlife, and usually the converse is true.

MR. DALE JONES: This is not a question but I wanted to comment a little bit further on Paul Springer's question. The Arizona Game and Fish Department and The Forest Service and the Museum in Arizona co-operated on the inventory of songbirds on the riparian type of the Verde River, comparing both the number of species and the density of these species between cleared areas, uncleared areas, and thinned areas and this is published information and showed a considerable difference, both in numbers and in species, and it's also helpful in preventing further destruction of riparian habitat on the Verde.

MR. BRISTOW: That is a published report. I might mention that the nesting levels that they found on these riparian areas in Arizona were the highest that had been recorded anywhere in the Continental United States, except for colonial nesting birds.

* * *

PERILS OF MODERN CIVILIZATION

FERNANDO DEL RÍO
Comisión Hidrológica de la Cuenca del Valle de México, S.R.H. México, D.F.

What has ocurred in the Valley of México is an example of what happens when the environment is modified by man.

THE PRE-CONQUEST VALLEY OF MEXICO

The Valley was formerly a closed basin of some 8,000 km^2 in area and 2,200 m. above sea level, surrounded by mountains that in places tower over 2,800 meters above it. Precipitation orginally formed a lake in the lower part of the Valley, but sediment carried by its tributary streams began to fill it. The hydrologic balance was maintained by evaporation from the lake and soil surface, and by transpiration from the forests that covered the mountains and part of the Valley (Fig. 1).

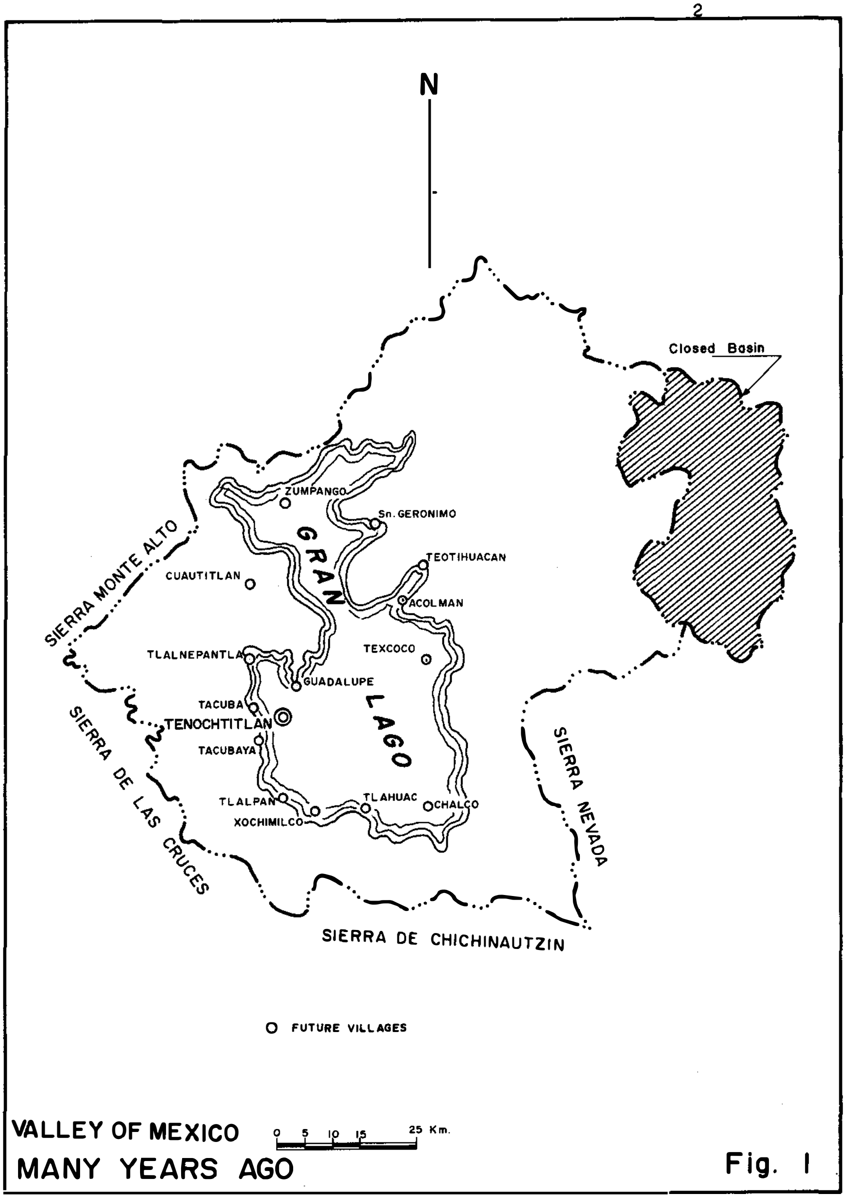
Although at one time the lake covered practically all the Valley floor, it gradually became divided into several small lakes. When the Spaniards arrived in 1519, there were several minor and six principal lakes: Texcoco, México, Chalco, Xochimilco, Zumpango and Xaltocan (Fig. 2).

Cortés described the Valley as an immense garden surrounded by forests that copiously bore fruits and flowers. The perennial streams carried little sediment, and were fed by the many springs that also supplied water to the city through the aqueducts and their appurtenant structures. The climate was cool, and the lakes increased the humidity just enough to make life pleasant.

During years of heavy rain the upper lakes would overflow into low-lying Lakes Texcoco and México. These in turn flooded the former Aztec capital of Tenochtitlan until flood-control projects were undertaken to protect the city.

THE SPANISH ERA

But the coming of the Spaniards and their conquest of Tenochtitlan dealt the first blow to the environment. Indiscriminate timber cutting for construction denuded the mountains, increasing the production of sediment and accelerating the obliteration of the already-dying lakes. In their zeal to obtain rock for their buildings, the Spaniards destroyed the protective levees around the city and ancient temples, little realizing the disastrous consequences. A predictable chain of events followed: the denuded mountains caused increased flood discharge in the rivers and higher flood crests, the weakened or destroyed levees collapsed, and the city was ravaged by floods. Never were the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MANY YEARS AGO
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Fig. I

Figure 1

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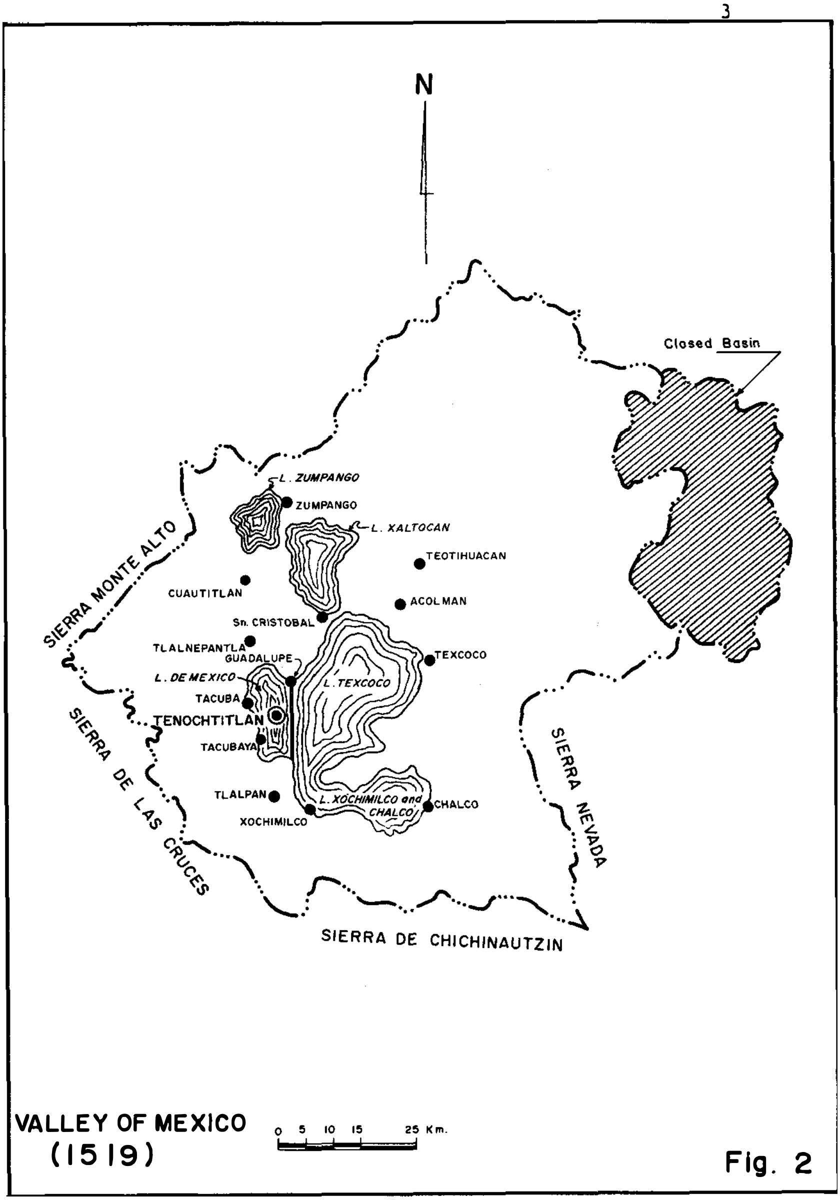
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SIERRA NEVADA
SIERRA DE CHICHINAUTZIN
VALLEY OF MEXICO
(1519)
0 5 10 15 25 Km.
Fig. 2

Figure 2

Spaniards able to protect the city completely against the overflowing lakes and rivers despite their extensive flood-control projects.

The first one of these, undertaken at the beginning of the seventeenth century, consisted in the trans-basin diversion of the Río Cuautitlán, the largest and most flood-prone river of the Valley. The diversion was not completed until 1789, when an open cut (El Tajo de Nochistongo) across the mountains was inaugurated. Thus began the integration of the Valley of México with the basin of the Río Pánuco. In 1899 the *"Gran Canal del Desagüe,"* the great dewatering and main sewage canal, a complex of open conduits and tunnels, intended to drain off both sewage and rainfall towards the Río Pánuco basin, was completed, definitely unifying the two basins. The desiccation of Lakes Xochimilco and Chalco, and a large part of Lake Texcoco continued at an accelerated pace—the two trans-mountain diversions presently convey annually some 800 million cubic meters of water from the Valley of México (Fig. 3).

ATMOSPHERE POLLUTION

Dust pollution presents a major problem. The dry lake beds contribute their powder-fine sediments to the atmosphere during the dry season of the year, and it is not unusual to have visibility reduced to a few meters by dust storms. Aggravating the problem are the farm lands northwest of the city, for the plowing season coincides with that of the greatest incidence of strong winds. On the average there are annually some 80 dust storms that last more than an hour and about 35 that last more than 3 hours. The ensuing health problems are severe, as are the hazards to air navigation and city traffic.

As the city began to grow and became industrialized, manufacturing complexes were short-sightedly built precisely along the paths of the inflowing prevailing winds. The outpourings from these plants combine with those of many other factories and with the exhaust from numberless motor vehicles to produce a perpetual and sometimes toxic pall of smog. The prevailing winds are ineffective as cleansing agents because of the circumscribing mountains.

WATER POLLUTION

During the twentieth century demands for fresh-water supplies have increased fifteen-fold. In 1900, 350,000 people were supplied by a flow of 2.1 m^3/s (cubic meters per second) of water. Now a population of over 8 million requires a flow of 33 m^3/s to meet its demands.

Ground water from the Valley itself provides 19 m^3/s. The neighboring Toluca Valley supplies another 14 m^3/s of ground water. As a footnote, the extraction of ground water from the Valley of

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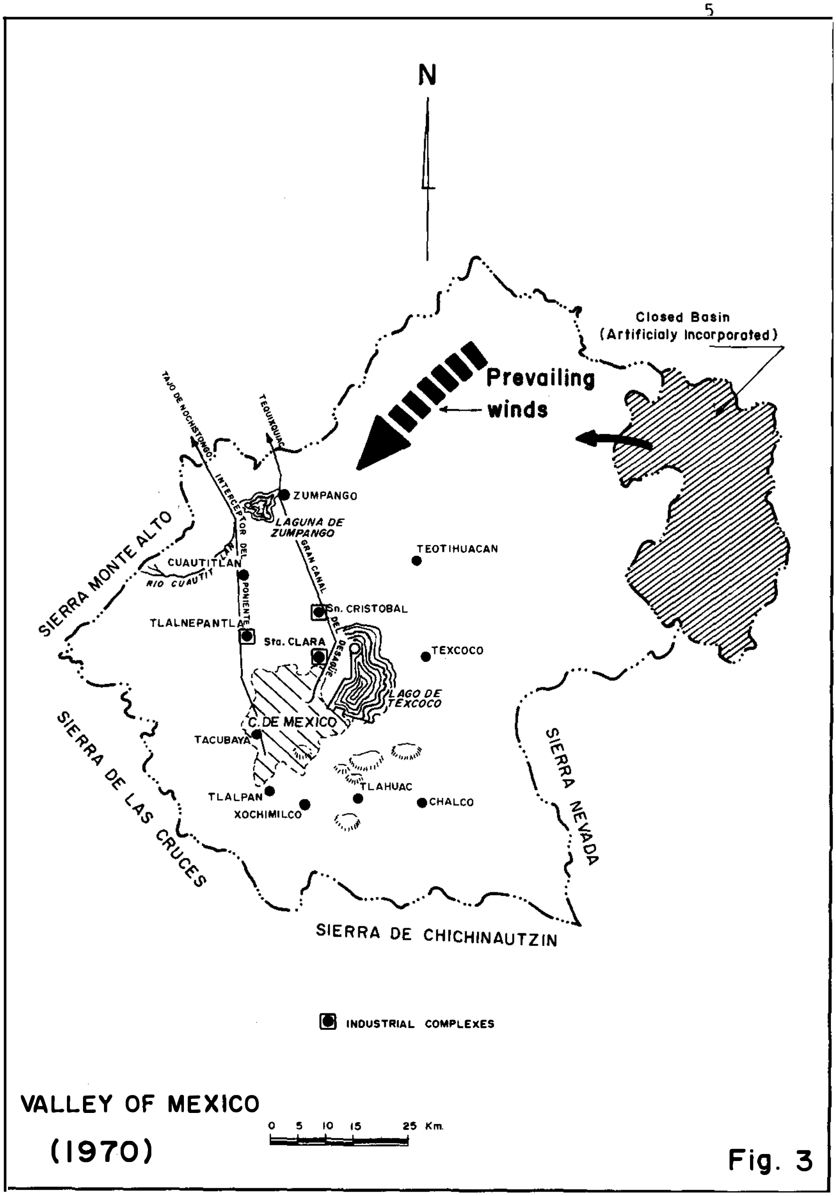
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GRAN CANAL DEL DESAGÜE
TEOTIHUACAN
SIERRA MONTE ALTO
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TACUBAYA
SIERRA DE LAS CRUCES
SIERRA NEVADA
TLAHUAC
TLALPAN
CHALCO
XOCHIMILCO
SIERRA DE CHICHINAUTZIN
INDUSTRIAL COMPLEXES
VALLEY OF MEXICO
(1970)
0 5 10 15 25 Km.
Fig. 3

Figure 3

Mexico has produced differential subsidences of up to 30 centimeters per year. Visible is the settling of large and small buildings, but invisible and of greater importance are the effects on the water-distribution networks and sewer systems.

The projected needs are in the order of 90 m^3/s for a metropolitan population of 25 million compared to the present 8 million inhabitants. Should this quantity of water ever be actually supplied (which I doubt), it must be imported from and at the expense of surrounding basins, whose needs would be pre-empted.

The city now produces a sewage flow of 23 m^3/s. The sewage is sent outside the basin and used raw for irrigation. However, return flows and unused parts of the flow contaminate the rivers into which they are discharged. Future sewage flow will be 65 m^3/s (2,000 x 10^6 m^3 per year).

MODERN CIVILIZATION AND THE ENVIRONMENT

What has happened? Why has the panorama of the Valley changed so radically? Man has modified the natural equilibrium of the elements, principally the forests and the water, and has condemned himself to suffer the consequences. His lack of foresight and his clamor for progress have forced him to live at the edge of a desert of pressures, pandemonium, smoke, and inconveniences. He has contaminated his air and his water and, in a few years, lest he acts now, will be faced with a worse fate, if possible.

Material progress, particularly on a large scale, favors ecological unbalance. The results of such unbalance did not exist or were not apparent prior to the population explosion, massive industrialization, and the technological progress that has now been reached. In general, up until the middle of the last century, industrial progress had not begun to taint the environment. But towards the end of the 1800's and the beginning of the 1900's the shadow of things to come began to appear.

Progress in medicine and in sanitary engineering have run a parallel course. Both have contributed to the extraordinary population growth which has produced the massive urban concentrations of humanity. To supply them, great manufacturing plants had to be built, and thus unbalance the environment and devour enormous quantities of raw materials, all the while belching its contaminated wastes to the atmosphere and rivers.

One must but wonder if humanity has not converted itself into a scourge that will eventually destroy its surroundings and itself. In a not very distant future we will have destroyed a great part of wildlife, animal and vegetal. Only the strongest species will survive—man may not be one.

This may seem like an exaggeratedly pessimistic view, but it is certain to pass unless measures are taken to reduce the unbalance. The technology exists to end or at least minimize pollution, but no steps will be taken because production costs would increase.

WATER

Water is but one of the demands of an increasing population. A need ranging from the indispensable one for survival, through municipal and industrial use, to the supplementary use for recreation. Water for survival implies not only that for man's physiological uses, but also for the use of the plants and animals on which he feeds. Great quantities of water are involved, and from wherever taken an unbalance will be created. That unbalance will be proportional to the total quantities available.

One need not dwell on water as a base for human existence, but it must be emphasized that equal priority must be given to the availability of water for the use of wildlife. For man, himself, must depend on wildlife for his own survival.

In any urban setting water implies two equally important problems, providing it, which causes unbalance, and its disposal as contaminated wastes. Ecologically, both problems are minor for small communities. But for the metropolis and megalopolis, the enormous quantities of water needed and wastes to be disposed create tremendous problems of ecological unbalance and disposal of wastes.

SUGGESTIONS

Civilization cannot retreat to the past century. But a stabilized population—less ambitious and less artificial—might guarantee a civilization that could last for centuries. Or at the very least a civilization that would remain where it now is. One that would review its advances and call a halt to those that threaten its existence. One who would weigh its progress and emphasize the human, the spiritual, and justice among man. As in all things, moderation is generally the best course, and this would be no exception. Perhaps retreating slightly from this super-civilization may be its answer, but it is impossible.

But above all, the pollution of our air and our waters must cease. Where there is clean air and pure waters, all is possible. It would be hoped that humanity, recognizing its peril, would provide economic means to implement effective measures. Since the problem is great, the cost of its solution will also be great.

RECOMMENDATION

It is almost impossible to recommend a solution to the problem. Perhaps concerned people in meetings such as this one may begin to evolve procedures and concepts to define the problem. But first it must decide if mankind is at present sufficiently reasonable and cooperative to undertake measures having some hope of success. And as a corollary, if this is the opportune time to initiate a program.

Assuming that the decision were made to act, the initial project should be to reduce or prevent further pollution of the air, land, and water. This first step would lend promise of success in the complementary stages of a plan to preserve the environment and human life.

DISCUSSION

VICENTE SANTIAGO, (Mexico D.F.): What progress is being made in the project to move the industries in the northeast sector of the Federal District out of this area?

MR. DEL Río: I have heard that there is a plan to relocate those industries, but the problem is so large and costly that the solution will probably be very difficult to find and slow in coming.

QUESTION (Unidentified): I was exceedingly interested by the most persuasive paper this speaker gave, and I was somewhat shocked by some of the data he gave. I want to be sure I heard right. Did the speaker say that in Mexico City, as a result of the pumping of water, the terrain is falling at the rate of one foot per year? Is that correct?

MR. DEL Río: That figure is correct. At present, the sinking problem is somewhat less serious, with sinking occurring at the rate of about 6 centimeters per year, but during the years when pumping was heaviest the terrain was indeed sinking at a rate of 30 centimeters per year.

MR. AGUSTIN RODRIGUEZ (University of Mexico): I would like to ask the speaker what is being done about Mexico's water problem, particularly in the Federal District, where the need for a solution is most urgent? We have problems here of water use by industries and of competition between industries and the population for available water. What is his department doing to solve these problems?

MR. DEL Río: Mexico City's potable water problem has been increasing due to the enormous population explosion. At the present time, water must be supplied to meet the needs of 8 million people living in the Valley of Mexico. At first, the water supply was drawn from the Valley itself, but later it became necessary to bring in water from the Toluca Valley subsoil. Work is now underway to bring in an additional 14 cubic meters per second to the cubic meters per second already obtained from the Valley of Mexico. Nevertheless, demand continues to increase at a vertiginous rate.

We have been considering new and very productive sources. The final choice has yet to be made, but among the sources being considered are the Tecolutla River and the Balsas River, which could provide Mexico City with about 100 cubic meters per second, enough to solve the problem for years to come. Meanwhile, pumping is going on in zones outside the urban area in order to avoid exacerbation of already existing problems.

IGNACIO MIRELES (University of Mexico): I wanted to ask you if the various government departments have proposed any solution to the smog problem?

MR. DEL Río: There is a campaign underway at present, but as far as I know it has not launched any definite and drastic measures yet. I think such measures should be taken as soon as possible, because the city is covered by a layer of smog that causes respiratory problems for many people—in fact, for everyone in general—and poisons the environment as well. We hope that a really well-defined plan will soon be put in motion.

SPEAKER (Unidentified): My question was answered, but because of the language barrier I'm not sure that I got it. The question is, are the Mexican people still taking ground water from the Valley of Mexico?

MR. DEL RÍO: Yes, the major part of the water used in Mexico City is pumped from water-bearing layers in the subsoil of the Valley of Mexico. About 19 cubic meters per second come from this source, and another 14 cubic meters are imported from the neighboring Toluca Valley area.

MR. BATES (University of Washington): Sir, I would like to know if any maps have been prepared of the aquiferous layers in this region? That is, do you have any plans for drawing up such maps?

MR. DEL RÍO: In the Valley of Mexico a fairly complete record is kept by means of observation wells, and water movement at different depths is controlled in such a way that the wells show that water is running toward the pumping stations. This control is maintained by several geochemical methods, and the same thing is being done in the Toluca Valley, which is the source of much of Mexico City's water. If you are interested in having more detailed information on this subject, we could easily supply you with some of the publications of the Hydrological Commission of the Valley of Mexico Water Basin.

JOSÉ M. CAMPERO (Division of Higher Studies of the National School of Architecture, Mexico): This is both a question and a proposal. We know very well that Mexico City almost doubled its population from 1950 to 1960. During that decade the population rose from 4 to 8 million, and it is expected that the numbers will have doubled once more by 1980. We are thinking about a city of the present size and with the present problems, but aside from finding ways to solve the problems we have now, it would also be very interesting if we began looking for ways to solve the problems that we will have ten years from now, particularly their legal, fiscal, and urban planning aspects. At present, urbanization is advancing on one of the most important water-bearing areas to the south of Mexico City, Xochimilco. The increasing tendency to build in that area demonstrates a complete lack of understanding of the importance of the aquiferous layers in that area and of the ill effects of changes in existing ecosystems. I know that none of this is new to you, but my feeling is that the government is not making enough of an effort at the moment to solve the problems arising from urbanization, and our most imminent problem is the extremely high growth rate of Mexico City. That is the point. What do you think of this urbanization of the southern area of the city, for example?

MR. DEL RÍO: Mexico City's rate of population and urban growth, because of its many social and political aspects, is a bogey that has brought many people here in the hope of finding new and better solutions to the problem. It is difficult, very difficult, to stop this growth. Probably the best thing we can do, in any case, is to intensify urban planning in order to provide decent living areas and urban services and utilities for all these people. In relation to your question about the aquiferous layers, I might mention that tests really have been made, and one has shown that there is a fairly serviceable layer to be found in the Mixcoac River. Three infiltration wells sunk at the foot of the Mixcoac Dam are taking in a maximum of one cubic meter per second. Although this is really quite an extraordinary case, it does not, of course, solve the problem of resupplying the aquiferous layers. Test will naturally have to continue, but I think it is going to be difficult to find a way to replace the water extracted from the subsoil.

Thank you very much.

HYDROLOGIC BEHAVIOR OF STREAM CHANNELS

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INTRODUCTION

In this paper discussion will be restricted to those channels moving sediment with median sediment grain sizes from about 0.05 mm to 2.0 mm; this is essentially the range of sand grains. These particle sizes are the median diameter of all the moving sediment, not solely materials on the bed of a stream. The dominant behavioral characteristics of channels in pure alluvium will be considered first. Then, the effect of vegetation and physical developments in modifying channel behavior will be discussed.

You must understand that all aspects of the hydraulics of alluvial channels are not agreed upon by all workers in the field. However, over a long period of years the author has identified and developed a number of important relationships which tie together observations that have been made in the laboratory and in the field and permit prediction of channel behavioral patterns with considerable accuracy.

BEHAVIORAL PATTERNS OF CHANNELS

Leopold and Maddock (1953) analysed the relations among velocity, depth, width, and discharge for a number of streams in the United States and found very similar behavioral patterns among them. These patterns were closely allied to those found in studies of stable canals in India and Pakistan. Nevertheless, there are many channels in which such patterns are not observed, particularly those which have been manipulated by man.

Further study has disclosed that channels which exhibit similar patterns are all self-formed. The identified patterns result from the movement of specific amounts of water and sediment under certain constraints which are only partially understood. However, it is well known that the relationships are such that the average values for channel depth, width, and slope and flow velocity must all change for varying discharges of water. It is also known that these channels have beds made up of alluvium, an incoherent material that must move and redistribute itself at some expected rates of discharge. The rate of moving sediment is as important as the rate of moving water in establishing channel characteristics. Therefore, channels in solid rock or even stiff clay, although they may be self-formed, do not behave like channels in alluvium.

The major differences between the hydraulics of channels with rigid boundaries and alluvial channels with movable beds is that the hydraulic roughness of alluvial channels changes with different patterns of deformation of the bed materials. Although how a bed deforms is not understood entirely, it is known as a very complex phenomenon that results from the discharge of water and *sediment.* Thus, the behavior of an alluvial channel cannot be described in terms of water flows alone. Its existing and anticipated sediment load must be included.

Vegetation growing on the banks of a stream influences the sediment load and behavior pattern of its channel. The smaller the stream, the greater the influence. Vegetation dampens the effect of fluctuating water discharges in alluvial channels by increasing the resistance to erosion and by offering resistance to the flow of water during the growing season and during periods of high discharge.

INTERRELATIONSHIPS OF FORCES WITH CHANNELS

Three equations representing equilibrium conditions in an alluvial channel are presented to express in concise form complex relationships among forces operating within channels.

The first basic equilibrium relationship can be expressed as:

$$VS \times 10^3 = C^{3/4}\ \phi\,(d) \qquad (1)$$

V is the mean velocity of a stream, S is the slope or energy gradient of the stream, C is the concentration, in parts per million by weight, of the sediment discharge, and ϕ (d) is a function of the median diameter of the particle sizes making up the sediment discharge. Values of ϕ (d) are shown in Figure 1. Values of ϕ (d) for sizes less than 0.5 mm are affected by temperature change, becoming smaller with lower temperatures.

This is an unusual equation. It holds that if size and concentration of sediment remain constant, velocity must be inversely proportional to slope. For example, in a channel of constant width with a constant discharge of water and sediment, the flatter slope has the higher velocity. Field evidence shows this to be true. This relationship is contrary to the usual assumption that the velocity of a stream will increase with an increase in slope. The equation demands that such an increase must be accompanied by an increase in either the size or the concentration of the sediment discharge.

How this is accommodated is shown in the second equation:

$$V = B\,\frac{\gamma^{1/4}(qS)^{1/2}}{\Delta\gamma\ d)^{1/4}}\left(\frac{\rho\ \omega^2}{\Delta\gamma\ d}\right)^{1/8} \qquad (2)$$

B is a coefficient, γ is the weight of water, $\Delta\gamma$ is the submerged weight

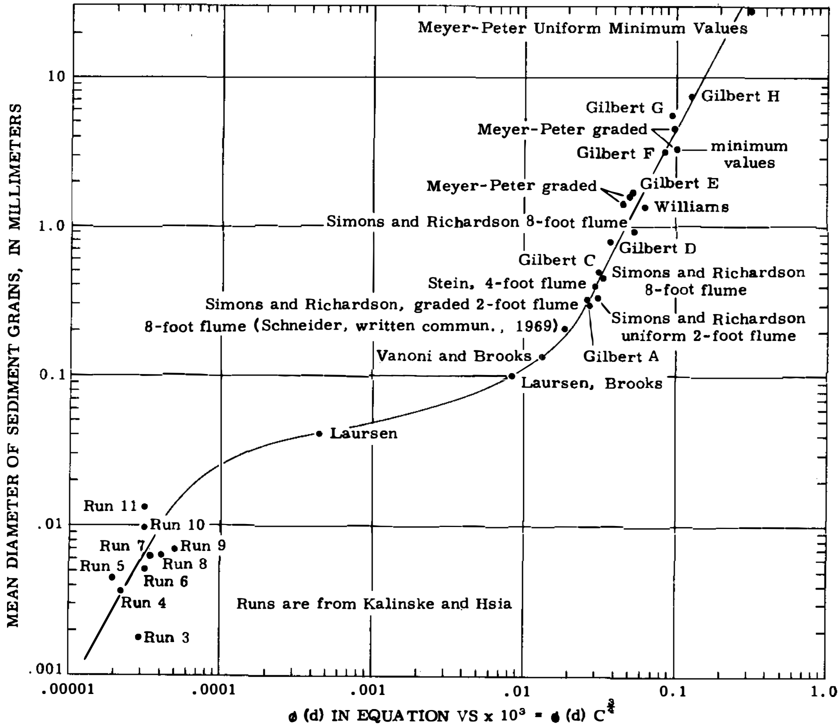

Figure 1.—Relation between mean diameter of moving sediment particles and ø (d) in the equation VS x $10^3 \equiv$ ø (d) $C^{3/4}$ from representative flume experiments.

of the sediment, q is the unit discharge of water or discharge per foot of width in cubic feet per second, d is the median diameter of the moving sediment particles, ρ is the mass density of water, g is the acceleration gravity, ω is the fall velocity of a characteristic sediment particle d.

Because q = VD, where D is the mean depth of water, this equation can be reduced to

$$V = B^2 \frac{Y^{1/2}\ DS}{(\Delta Yd)^{1/2}} \left(\frac{\rho\ \omega^2}{\Delta Yd} \right)^{1/4}$$

Again this is an unusual equation because V is proportional B^2DS, in contrast to the more common Chezy or Manning relations where V is proportional $(DS)^{1/2}$ or $D^{2/3}\ S^{1/2}$. Note the greater response of velocity to change in DS in the first equation. Nevertheless, other investigators have proposed equations of this type.

Several references are available for those wishing to examine additional information on Equation 1 (Maddock, 1969, 1970, 1971a and b), Equation 2 (Maddock, 1969, 1970, 1971a and b), and general background on the forces operating within channels (Leopold and Maddock, 1953).

In Equation 2 the variable coefficient B is a reflection of the means by which variation in discharge, sediment concentration and size, and slope are kept in dynamic equilibrium. It really represents the conversion of potential energy to kinetic energy. The coefficient has variability of about a factor of three, which represents the potential variation in bed deformation or bed roughness. In natural alluvial channels, any change in the independent variables, usually discharge of water and sediment or sediment size, is immediately reflected in a change in the value of B. Physically this represents a change in stream bed forms.

Departures from a mean value of B represent channel instability because changing forms of stream beds can result in such diverse effects as accelerated erosion, attacks on banks, deposition, or building of natural levees when overbank flows occur. Low values of B are associated with a small kinetic-potential energy ratio and channel scour or degradation and stream bank erosion. High values of B are associated with aggradation of the stream bed and reduction in channel width.

Determination of the value of B is complicated by the fact that it is influenced by frequent variations in the discharge of water and sediment. Frequent discharge fluctuations are found in headwater streams, and particularly in those sections of canals just downstream from their headings. Even though the discharge rate of water may be relatively constant at a canal heading, changes in the load and movement patterns of sediment, accompanying modifications of the stream bed in the main channel, occur past the heading. A stream is not forced to increase its value of B as perturbations are dampened out, but in a natural stream there is a tendency for flow to be at the flattest possible slope.

In an existing natural channel there is only one fully independent variable—discharge rate of water. Sediment concentration and particle size are only independent insofar as the amount entering a particular reach is concerned. Slope is a semi-independent variable. Velocity is strictly a dependent variable, as is the hydraulic friction factor. In a sense, the degree of dependency within the stream channel is a matter of the ease in which a change in discharge is reflected in changes in the other variables. This can best be visualized and explained by several examples involving physical modifications of stream channels and their associated flood plains and watersheds.

PREDICTED EFFECTS OF CHANNEL MODIFICATIONS

If a meandering stream channel is shortened through ditching or channelization, its slope will increase. Therefore, based on Equation 1, the flow velocity must decrease, the sediment concentration increase, the sediment size increase, or some combination of the four result in a decrease. From Equation 2, if stream slope increases, but water discharge per unit width remains constant, flow velocity will increase, unless the value of B declines or the size of the sediment particles increases. The first response is a decrease in the value of B. Of course, the stream itself "knows" nothing about B. But it reacts to the change in slope prompted by the man-installed channel modification by changing the distribution patterns of stream bed materials. Those patterns associated with an equilibrium status tend to persist. In contrast, those patterns of stream bed materials which do not lead to equilibrium tend to be destroyed. Thus, in reforming its bed the stream degrades, while bed forms increase in height and shorten in length. These reactions decrease the value of B initially, but as bed materials are increasingly reworked and redistributed reduction in sediment concentration and increase in sediment size all contribute to a reduced value of velocity.

These reactions of a stream to physical modification seek to satisfy the precise requirements of Equation 1. But the lowered value of B is accompanied by increased amounts of cross-channel component of flow which attacks the banks. Over time the banks erode, and decrease the unit discharge q in Equation 2. Erosion also increases the rate of sediment transport, although it may not increase the size of the sediment particles. As the channel erodes and widens, the value of B declines, as does the sediment transport. Equilibrium takes place on a wider channel with a steeper slope.

Because the rate of stream bank erosion is related to the resistance of bank materials, a natural channel meanders and is irregular because bank materials are quite variable over a long reach. Curvature tends to reduce channel width and decrease channel slope, introducing a new type of equilibrium. Because curved channels usually are actively modifying their banks, the average regime value of B is somewhat lower for curved channels than for straight ones.

If Equations 1 and 2 are combined, then channel width, W, is expressed by Equation 3.

$$W = \frac{10^6 B^2 g^{1/2}\ \Upsilon^{1/2}}{[\phi\,(d)]^2\, C^{3/2}\,(\Delta \Upsilon d)^{1/2}} \left(\frac{\rho\ \omega^2}{\Delta \Upsilon d}\right)^{1/4} Q S^3 \qquad (3)$$

Q is total discharge of flow. This equation is congruent with the description of effect of change in slope.

As a stream widens or deepens, flow which formerly went overbank onto the flood plain remains in the channel. This constraint on outward flow lowers the effective sediment concentration because the overbank flow usually carries a smaller concentration of sediment than does the main channel. As shown in Equation 3, this constraint also tends to increase channel width, size of sediment, or a combination or both. Materials removed by bank erosion tend to increase sediment concentration and bring the stream into equilibrium.

Downstream from a widening reach, the size and concentration of sediment increase. In this lower part of a streams channel the value of B must increase or the sediment size and concentration in the water become smaller as the larger sediment particles are deposited. At high values of B, overbank flow occurs and is accompanied by relatively high concentrations of sediment outside the channel. The overall result of bank erosion upstream is a channel downstream with a rising bed and rising banks through the creation of natural levees.

REQUISITES FOR CHANNEL STABILITY

Equation 3 holds that an increase in water discharge of a stream's channel must be accompanied by an increase in channel width or by an increase in concentration and size of suspended sediments if slope is to remain constant. Thus, the increasing concentration of suspended sediments observed with increasing discharge of water during periods of flooding is an absolute necessity for channel stability. In some areas water in large floods may not transport adequate amounts of sediment to minimize energy gains. Consequently, bank erosion accelerates and the channel widens. This new broader channel is too wide for the more frequent flows and the channel becomes unstable by filling at some discharge levels. The answer to this problem is to decrease the channel width. To do so will not increase the velocity as long as the slope and sediment concentration and size are unchanged. This channel modification is a very common type of navigation improvement. But the narrow channel is vulnerable to bank erosion at high volume discharges and banks must be protected to avoid accelerated erosion. Customary protective measures include rip-rapping banks with stones and planting vegetations.

It must be emphasized that channels will not widen with increasing water discharges if sediment concentrations increase commensurately to use some of the moving water energy. It is equally important to note that for a given stream bed slope and a given volume of water discharged, channel widening reduces the ability of the channel to transport sediment. Deposition of particles is enhanced.

These dynamic interrelationships prompt another question. What happens when the sediment concentration is sharply reduced? The long-term expectation is that channel width must increase, slope must decrease, size of sediment must increase, or discharge decrease for B to reach an average condition. Observations of channels below dams show that any or all of these things occur, depending upon the constraints on the system. If bank stabilization is provided, the stream will flow in a narrower channel with a sub-average value of B until the bed becomes armored and ceases to move.

Variation in the value of B is limited to about a factor of three. Consequently, the possibility of maintaining equilibrium through modification of stream bed form is also limited. Under extreme conditions of variation, as described in Equation 3, a channel will simply degrade or aggrade because B cannot be large enough or small enough, respectively, to reflect an equilibrium. Fortunately, such conditions are usually confined to particular erosion-susceptible regions, localities, and sites. Essentially these are gully problem areas.

VALUES OF VEGETATED BANKS

Vegetation modifies the behavior of purely alluvial channels. First, vegetation will grow on any portion of a stream bed and its banks if the soil or other substrate is exposed long enough in the growing season for plants to grow. Thus, vegetation exerts a constant pressure to reduce the size of a channel. Second, as previously noted, vegetation enhances the resistance of banks to erosion. And, third, vegetation tends to increase the hydraulic resistance of the channel, particularly during the growing season and during periods of high discharge. All of these effects are more important on small streams than on large ones.

Channels frequently reflect a relatively short history of past streamflow since vegetated channels tend to decrease in width during periods of low reunoff and to increase in width during periods with an abnormal number of high floods. Thus, natural vegetated channels are not completely stable and at time can be deficient in capacity.

Because vegetation tends to encroach on channel width, vegetated channels are usually narrower than those without vegetation. Where, particularly during the growing season, vegetation offers resistance to flow, velocities often are lower for a given value of q. But the resultant low value of B is not accompanied by bed forms that attack channel banks. Consequently, vegetated channels tend to be narrower and steeper than strictly alluvial channels transporting the same discharge of water and sediment.

Channel modifications that eliminate or reduce vegetative bank resistance release energy associated with the above-normal slope which accompanies a vegetated channel. Consequently, elimination of vegetation results in accelerated erosion and a wider channel. But, in time (years), the over-wide channel is particularly sensitive to encroachment by vegetation which, when re-established, assists the stream in regaining its original equilibrium.

RELATION OF CHANNEL BED TYPES TO BIOTA

There is a definite yet little-studied relation between types of channel beds and the aquatic biota. The types of channel bed materials control the distribution of flow velocities within the water prism. The degree of movement of channel bed materials controls the kind of biological communities present. Periodic use, reproduction, and survival of different species of flora and fauna are determined by the amount of movement of bed materials, the time of year this movement takes place, and the size of the transported load of materials. While limited information is available on these hydrological-biological interrelationships, much more fundamental information is needed on them immediately to improve understanding of where and how to carry out physical modifications of channels without degrading and destroying existing important aquatic biological communities. Likewise, the information is critical in identifying the types of physical modifications that could improve channel conditions for plants and animals.

SUMMARY

In conclusion, a stream and its associated flood plains must be reorganized as a functioning ecosystem always seeking to interlock its several forces at some dynamic equilibrium. This fact permits prediction with reassurable accuracy what changes will likely occur in stream channels over a period of time when one or more of the pertinent variables (slope, volume, velocity, etc.) is modified. Least predictable of all the responses is the time required for a stream channel to readjust and reach a new equilibrium. Because of this variation in time and the many degrees of freedom in stream behavior, it is very difficult to predict, a priori, exactly what a reach of a stream will look like following physical modification by man.

Many important chanarcteristics of stream channels, such as time of adjustment to physical disturbances, diffusion and dispersion coefficients, and reaeration are all subject to forecast in broad terms.

But like the biological elements of the problem, these subjects require further study to refine prediction capabilities.

In short, a great deal is known about the important characteristics of the environment of an alluvial channel. Greater use should be made of this knowledge in planning and executing physical alterations of stream channels. An intensified study of the relationship between the hydraulics af alluvial channels and their biological characteristics is needed immediately.

REFERENCES

Leopold, Luna B. and Maddock, T., Jr.
1953. Hydraulic geometry of stream channels and some physiographic implications: U.S. Geol. Survey Prof. Paper 252, 57 p.

Maddock, T., Jr.
1969. The behavior of straight open channels with movable beds: U.S. Geol. Survey Prof. Paper 622-A. 70 p.

———. 1970. The indeterminate hydraulics of alluvial channels: Am. Soc. of Civil Engineers Proc., J. Hydraulics Div., v. 96, no. HY-11, p. 2309-2323.

———. 1971. Closure to discussion, The indeterminate hydraulics of alluvial channels: Am. Soc. of Civil Engineers Proc., J. Hydraulics Div. In press.

———. 1971. Hydraulic relations for sand-bedded streams: Sedimentation Symposium to Honor Prof. H. A. Einstein. Editor, H. W. Shen, Fort Collins, Colorado.

DISCUSSION

QUESTION (Unidentified): I enjoyed your talk Dr. Maddock. One very interesting point you bring out is our relative lack of knowledge in terms if stream characteristics on the biota. This concerns me greatly and I think it concerns a lot of others particularly in fish and wildlife. We have an extensive program of channelization, at least, planned for the future. We are now submitting, as part of the requirements, one of two impact statements, and if I understand you correctly, you said that the functional relationships are between the sedimentary and the actual bottom of the stream are not particularly known. Yet, here we are going through, shall we say, the procedure of submitting environmental statements that are supposed to give environment impact, both in the primary and secondary phases. Secondly, shouldn't we be doing this sort of research and putting a moratorium on some of these channelization projects before we proceed further?

MR. MADDOCK: There is a large area of lack of knowledge with respect to the actual physics or the characteristics of energy consumption in the stream. But while we do lack that knowledge, we have a rather practical knowledge of what will happen in the stream. The only thing that we are very weak on is the time element. I think that we are in a position of being able to forecast, with some degree of accuracy, what the hydraulic and hydrologic changes will be. But what we can't forecast at the present time with any degree of accuracy is what the biological changes are going to be. We can do so generally, but we can't put any figures on it. The data collection of this type, which we are sorely lacking, is greatly different from the collection of hydraulic data. In other words, most hydraulic data today is collected at the point. We simply measure the flow of water and the amount of sediment and the disolved saline content.

In order to really get relationship between the biota or the entire environment, we've got to make our measurements in terms of streams and what that will require, instead of one man going out on a cable way and making a current meter measurement, is teams of people making synoptic studies on specified reaches of streams. Now this is a whole reorganization of the data collection effort, and yet it is definitely necessary, if we are going to be able to come to grips with any of these problems that have to do with the movement of sediment in water.

RESOURCE MANAGEMENT: WATER VS. WILDLIFE! IS THIS CONFLICT NECESSARY?

ROBERT E. MOORE
Salt River Valley Water Users Association, Phoenix, Arizona

This particular time in history is characterized by intensified public involvement in all factors of the world around them. Not only do more people have more time, energy and finances to explore and inquire of the out-of-doors, but they are increasingly curious as to the WHY? of the care and management of the vast physical, biological, cultural, and esthetic resources which lay before them.

It is not enough that the natural resources of air, animals, fish, fowl, land, minerals, vegetation, and water are available for their enjoyment. Today, the quality and quantity of these resources are a part of every citizen's concern.

As a representative of an irrigation district, this concern is viewed as a mixed blessing. We often feel much of the resource conservation work we have promoted is not appreciated by, or even well known to the public we serve. It seems that we have received some of the attention lacking in earlier times, unfortunately however, without the necessary understanding of WHY! the actions are taken.

The basic purpose of an irrigation district is to conserve the available water resource and provide for its equitable and lawful distribution over a given area. In carrying out this responsibility, the Salt River Valley Water Users' Association relies upon both surface and ground water to provide a continuing supply of water to central Maricopa County, Arizona. Approximately 80 percent of this water is utilized in agricultural endeavors and 20 percent is currently diverted for treatment and service by municipal and industrial users. According to the 1970 census the population of this service area is about 800,000 persons and it continues to expand.

More particularly, the responsibility of any irrigation district is the delivery of the ordered water on time, at pre-determined locations, and in the quantity specified by both the agricultural and municipal users. As we act to meet these needs, we find that adequate internal planning is no longer sufficient to satisfy the public. This brings me to the primary points I wish to review with you.

First, let me make it clear that I know of no resource manager who does not welcome intelligent, responsible inquiry from any segment of the public. One failing in the current wave of inquiry is the implicit and pervading distrust of any response offered.

As this relates specifically to the wildlife segment of natural resources, we find that this distrust frequently borders on the antagonistic. The initial query takes the form of reprimand rather than an earnest request for information. Of course, it is possible to overlook the tone and phrasing and attempt to respond impartially and factually. However, that assumes an unlimited depth of patience on the part of the resource manager being questioned. This utopian outlook is to be treasured but not truly expected. When attacked, most human beings either become defensive or counterattack. An irrigation district manager is no different from other people in this respect.

What gives rise to this situation? How is it that the inquiry is not more specifically, yet less emotionally, framed?

I am of the opinion that there are at least two referral points behind the antagonistic approach. The first is that for more than 50 years the irrigation districts of the arid Southwestern portion of the United States were providing a basic organizational service to primarily an agricultural constituency. The people had an inherent understanding of the problems and procedures involved in bringing water to a parched land. Stating it another way, the irrigation manager was closer to those he served and they saw one another as co-workers to the end that the needed water was supplied and accepted with a high degree of mutual understanding.

With the post-World War II change in population and composition of that population, the closeness, the empathetic relationship began to break down. Frankly, that breakdown is largely the fault of the water resource manager. He has not taken the pulse of this constituency as thoroughly as he might have.

The second referral point is that the scientific management of the wildlife resources is rather younger than that of water resource management. Certainly the emphasis for intensive, professional management has always been present in a small but dedicated corps of wildlife managers and laymen. But with the influx of people from the older population centers—people not inherently connected with the land—with the shorter work-week, with higher wages, this corps of well-informed wildlife managers and enthusiasts is experiencing new pressures on its activities.

These two factors, the changing constituency and its demands, have created the growing interest we see at every turn in the day-to-day workings of resource management. In and of itself, this interest is not bad. However, too often the volume of this interest is emotionally based. These people simply do not understand the facts involved in managing natural resources—wildlife or water!

This lack of factual knowledge is, in my view, not confined to the laymen. The true tragedy is that many water managers do not know facts about wildlife, and wildlife managers do not know facts about water management! This mutual ignorance creates conflict.

Not only does it create friction between the men and agencies involved, it serves absolutely no benefit to either the wildlife or water resource. I know of no example which can be cited to show how the deer, fish or doves have increased in either vigor or numbers due to ignorance. I know of no example in which the water resource was enhanced through ignorance. If we are to do the best possible job of resource management not only must we become better informed, we must be ready to accept the professional restraints of disciplines other than our own.

This brings me to another weakness exhibited in the current concern for environment and multiple-use management.

Factual information, gathered over significant periods of time, confirmed by both field and laboratory testing, and applied to operational situations is supposed to form the basis of each discipline in the category of natural resources. The professional in each discipline expects to maintain his proficiency by continued exposure to new data and current testing to separate facts from folly. For folly, please read emotionalism, biased viewpoints, and non-cooperative attitudes.

In short, much of the material we come in contact with is not professional or scientific, it is someone's unqualified and often volatile opinion. The volatility is often the only moving force behind such opinions.

An example of this is the expression that wildlife gains in watershed management are "in spite of" the very positive effects of such work. It has yet to be accepted within a large segment of wildlife management that vegetation manipulation—changing composition or density—for water yield benefits can and does improve the habitat as a direct, positive effect. No attention is given to the possibility that the land, vegetation and water manager has considered the relationship of this work to the resident or migratory wildlife in the area involved. This is what I term a lack of professionalism on the part of the wildlife manager.

That manager will counter with the fact that he was not consulted. Unfortunately, there is some truth in this. However, in much of our work, the problem is not lack of contact, but rather a lack of constructive response when contacted.

Phrases such as "We'd rather you didn't do any of this work" (woodland conversion to grass), and, "If the (species) survive here it will be proof of adaptability rather than due to any direct benefit of the work" (chaparral and upstream riparian vegetation treatments) do absolutely nothing to promote cooperation. When these statements are unsupported by factual information they tend to reflect on the professional stature of the person making them.

These attitudes frequently progress to the point that the disagreement is passed to the news media. The conflict moves then from the planning scene to the daily press. (I find it amazing that most newspapers have a regular wildlife columnist, but no regular, continuing reporter dealing with water resources. Yet, the presence of a dependable water supply dictates both the extent and level of life in every arid region. The consistency of this situation totally escapes me.)

In any event, while the conflict is apparently newsworthy, again I can point to no advantage gained by either resource through such a dissection. The winning or losing effect in such an exchange affects only the human egos, they do not improve the quantity or quality of water or wildlife.

Finally, let me touch on the approach to data from one discipline as received by the other discipline. I have, in previous paragraphs attempted to establish the desire for and importance of scientific inquiry and proven facts in both wildlife and water management. At this point in time there is still much factual information lacking in both fields. This does not suggest, nor do I believe, that there is insufficient data upon which to base action programs.

The problem is that there is a great chasm between what is known and how it can be applied in multiple-use management. Watershed management is one area of endeavor which holds the possibility that there need not be any losers. However, for that possibility to be realized, we must put the respective, pertinent facts together in the planning stage using the most professional, responsible approach that we can apply. This means that we cannot come to the conference table with unchangeable positions; we must come with facts not histrionics; we must include legitimate interests in and at the planning stage, not try to persuade them at subsequent steps. Then, too, there must be some recognition of basic responsibilities and thus a reasonable assignment of priorities.

And so the sum of my presentation comes down to this: Men are charged with the care of the air, animals, fish, fowl, land, minerals, vegetation and water that make up our environment. The attitude we have as we work together will determine whether these resources are wisely used and whether we shall survive. I have highlighted some past conflicts between respective management and interest groups. These were cited not to perpetuate them, but rather, to put them behind us. Conflict, if it continues, does not benefit either resource. But the earth, the water, the flora and fauna cannot stop the conflict—they are passive and they will not arbitrate or referee for us.

Reason, intellect, patience and the ability to resolve is the challenge of the active resource, Man. The fate of both the active and passive resources depends upon how Man meets that challenge.

If we sincerely work to analyze and solve the problems which confront us—if we work earnestly together, can we fail? Can we do less than try for the natural resources we say we represent?

DISCUSSION

DISCUSSION LEADER KENNETH BOWDEN: This particular time in history is characterized by intensified public involvement in all factors in the world around us. Conservation of natural resources awakens more and more interest, including that in water resource planning.

One matter touched upon in this paper that has been bothering me in recent weeks, has been a very concerted public relations campaign on the part of a coalition of conservation and environmental organizations, with reference to the type of discount rate which would be applied to Federal Water projects. Discounts rates determine whether or not projects are feasible or not, and in the past, many agencies have used unrealistically low discount rates which have tended to stimulate overdevelopment. This is a very valid complaint on the part of the conservation community. Recent regulations which were published in the Federal Register and are open for comment until March 31st, sought to change the methods of evaluation including using a much more realistic discount rate: if I'm not mistaken it's at the 7% level.

This coalition has sent out a number of flyers indicating that they felt that a 10% discount rate would be much more realistic. But if we want to look at reality, 10% when applied in the evaluation of the project, would kill virtually every water development project attempted by governmental agencies. This represents a doubling of time of 7.2 years, so if you are going to produce a hundred dollars of benefits over the next 7 years, you are only willing to spend 50 dollars today. A 10% discount rate would be an example of the emotional appeal that in this case, has a sound of legitimacy, because they do point out the importance of discount rates on evaluation; yet at the same time by picking an unrealistically high figure, it would be designed to stifle all water development. Certainly a person involved in water resource planning could not look at a 10% discount rate and feel that the proposal coming from the conservationists or the wildlife managers was in fact a real negotiating position. Rather it was an effort to stab the water developers in the back and put them firmly at rest for time eternity. I think that this is just one example of the type of proposal that I'm certain Mr. Moore would not think too very highly of. I don't know if Tom would like to comment on that.

CHAIRMAN THOMAS MADDOCK: The Salt River Valley Water Association is one of two irrigation projects in the United States that have repaid its investment to the United States and to the Federal Government. Furthermore, out of 5 dams on the system, the Salt River Valley Water Users borrowed the money in the open market and built them themselves. Not only that, but in this particular area, they pay all of the costs of all annual operation and maintenance, so that you work in an area where you haven't any subsidy. So what we have is an operation and maintenance problem. The people involved in the Salt River Valley Water Users Association are a municipal corporation of the State of Arizona. It's generally in conflict with the State Fish and Game Commission, so this is really an intrastate problem rather than a federal problem. It's very much a local example of the much larger problem we have when we talk about federal policies.

DR. BOWDEN: I was trying to broaden it a bit. I recognized that the Salt River

Valley Users were self-supporting in this case, but even there, when they went out to buy bonds in the open market, they did not have to face the discount rate, or anything comparable to this in terms of the interest payments that they had to make. It is cheaper to borrow money in the open market than under the value that the coalition of organizations is proposing to be used to evaluate Federal projects. I think this is unrealistic but the point I was trying to make was that in order to be creditable, the wildlife community, the conservationists, have to use creditable reasoning rather than an extreme position, and it works both ways. We can take on the developers in the same sense for past record of using inordinately low interest rates.

UNIDENTIFIED: In connection with the quarrel—if you wish to call it that, Dr. Bowden, since your comment seemed to call it that—with the conservationists in relation to increasing the discount rates in figuring cost benefits of water projects, the comment of the conservationists who have been looking critically at water resource projects proposals and completed projects, is that in the cost-benefit analysis, many long-range societal costs are not included. Therefore, I believe that many of th research projects which are now being mounted to critically look at the societal costs which we believe have been neglected in the cost benefit analysis are important. With the results from these studies, the 10% discount rate suggested by the conservationists and environmentalists may very well be borne out as being more realistic. So therefore I feel these should be this kind of comment to counter the one which you made.

UNIDENTIFIED: I'm puzzled that you have twice suggested that a 10% discount rate would be extreme or irrational without telling us why, essentially. Because it does seem to me that we're all agreed, or generally agreed, that the opportunity cost of money would be the ruling factor here. The Water Resources Council standards and criteria suggest this, particularly in view of the fact that if the cost-benefit ratio of a particular project falls below one, Congress can still have this project if it wishes it.

DR. BOWDEN: There are 2 points to the question. One is the opportunity cost of money, and I would agree that it should be the guiding factor. However, when we start comparing the opportunity cost of federal money, we have to look at how much it costs the Federal Government to borrow money, because we are in competition with other uses of the Federal Treasury, such as for health, education, and welfare. So we look at the value or the interest rate that Uncle Sam would pay to borrow money and nowhere do you see him paying 10% today. The Federal Government can float bonds at much lower interest rates.

The second point concerning the opportunity cost is that the Federal Government can borrow money much more cheaply than a citizen could. Primarily this is because we do have some so-called public benefits, or the government shouldn't be in the business in the first place.

Congress can overturn any decision. However, in most instances, the cost-benefit ratio has to be forced into at least a unity value. This has been abused in a number of instances that could be cited, and I won't defend the value of one as a cost-benefit ratio in any sense of the term. However, if it falls below one, then it is extremely difficult for Congress to overturn it.

STRENGTHENING FISH AND WILDLIFE CONSERVATION IN THE WATER RESOURCES PROGRAM

JAMES T. McBROOM[1]
Bureau of Sport Fisheries and Wildlife, Department of the Interior, Arlington, Virginia

I begin this paper with a truism:

Water is obviously vital to fish and wildlife.

To that I add a proposition:

Man's manipulation and use of water can destroy fish and wildlife.

To round out my text, I put in a third ingredient:

Water resources can be developed *without* a net loss to fish and wildlife.

In 1946, the problem of fish and wildlife in water development was solved—many people thought—by the new Fish and Wildlife Coordination Act. That Act, they said, would allow the Fish and Wildlife Service to put a halter on the Corps of Engineers and the Bureau of Reclamation—even put a stop to most of their projects.

That, of course, didn't happen; such a result was not in the new law nor in the cards from a policy standpoint.

So 12 years later, in 1958, the Fish and Wildlife Coordination Act was amended. Once again, the opinion was widely shared that we would finally do the job—there need be no further concern about the damage to fish and wildlife from water projects. Inevitably, once more, disillusionment and discontent soon set in. The results did not add up to expectations. Not only were the expectations inflated, but the performance under the Act had not been as strong as it should have been.

I do not stand here today to suggest that the whole program has been a dismal failure. Far from it. A great many worthwhile accomplishments in water for fish and wildlife and society have been realized. The emphasis in the program has been on minimizing the negative and maximizing the positive. There has not been a policy of general opposition to all or most water projects as some of our constituents would have liked. Rather the projects opposed outright have been relatively few and far between—only when there was a clear judgment that the damages to fish and wildlife outweighed public project benefits. For example, the Rampart Dam and Reservoir project on the Yukon River in Alaska was firmly opposed. For many years, channelization projects, especially those in the southeastern

[1] In the absence of the author, this paper was presented by Mr. Travis Roberts, Bureau of Sport Fisheries and Wildlife.

part of the United States, have been opposed. In 1970, the Bureau of Sport Fisheries and Wildlife was the principal opponent within the Federal establishment to continuing construction on the Cross Florida Barge Canal. This was after an earlier, misguided Bureau report which suggested fishery benefits from the reservoirs of that project but did not adequately assess the overall environmental damage.

The Bureau also played a leading role last year in stopping the construction of a proposed chemical plant by the Badische Analin und Soda Fabrik (BASF) Corporation on the Colleton River, a splendid estuary in South Carolina.

In recent years, the Bureau, in cooperation with state agencies, has brought a virtual halt to dredging and filling in the coastal wetlands and shallows of Florida. Thousands of acres of these coastal areas previously had been destroyed by the construction of Venetian housing developments.

But I didn't come here to brag about the number of water projects which our Bureau has blocked. I will just express my view that the Bureau's opposition to water projects is powerful and effective when used. This is so because that opposition has been highly selective, where the case against the projects was overwhelming. Widespread opposition to a majority of water projects would, on the other hand, make the Bureau's clout weak and ineffective. Not many water agencies would pay much attention to us because they'd know in advance we would simply oppose everything.

I like it much better to talk about the positive aspects of the Bureau's River Basin Studies program. I like to talk about examples like the Garrison Diversion Unit in North Dakota, and about the Bigstone-Whetstone project in Minnesota, and about the Cochiti Reservoir in New Mexico.

The Garrison Diversion Unit of the Missouri River Basin project was authorized primarily for the irrigation of 250,000 acres. As an integral part of the project, the Bureau of Reclamation will acquire and develop almost 150,000 acres of land for waterfowl. This will be at no cost to the Duck Stamp Fund. These waterfowl lands will be at some 66 sites around the project area. Each will have an assured water supply from the canals of the project, even when the drouths hit North Dakota as they have so many times in the past. While it is true that a large portion of this land and water will be ncessary for mitigation of project-caused damages, there is nevertheless a substantial bonus of enhancement.

A few hundred miles southeast of there—in Minnesota near the South Dakota line—the Bigstone-Whetstone project is authorized to be built by the Corps of Engineers. Eighty-five percent of the benefits and cost allocations are for waterfowl. While the project will have a flood control function, its principal purpose is the creation of a 10,000-acre waterfowl refuge in a place that the late, great J. Clark Salyer viewed as a vital location for such an area—at the crossroads of important flight paths.

At Cochiti, a Bureau of Reclamation reservoir on the Rio Grande River, water will be maintained at a suitable level for fishing and other forms of outdoor recreation in an arid area where such opportunities are scarce. The city of Albuquerque gave up some of its supply of domestic water to make this possible. A stable reservoir there is clearly a plus for fish and wildlife and hunters and fishermen.

On the other hand, there have been some rather serious failures. One of them is the early report on the Cross Florida Barge Canal, to which I have already alluded. The Fish and Wildlife Coordination Act has failed to stop drainage of important waterfowl production habitat in the northern prairie region although Bureau activities under other laws have had a strong limiting effect. The Bureau did not, until the last few years, significantly reduce the dredging and filling of estuaries. Neither did it bring a halt to destructive channelization projects.

I could try to explain the legal and policy reasons for these failures, but you probably wouldn't believe me anyway. It would sound like making excuses, so I won't do it.

In any event, by the late 1960's, an increasing number of people in the private conservation organizations and the state fish and game agencies became disenchanted with the Fish and Wildlife Coordination Act and the Bureau's River Basin Studies program. Something ought to be done about the situation, they thought.

The Bureau got the message loud and clear. In similar situations, most public and many private agencies begin to put up elaborate defenses. Not this time.

The Bureau reacted swiftly. We undertook an unprecedented and complete overhaul of all legislation, all policies, and all procedures related to River Basin Studies. Nothing was sacred; nothing was championed as unchangeable. From the outset, we recognized that we could not and should not undertake this complete overhaul by ourselves—that we had to work on it with our associates in the state fish and game agencies and the National conservation organizations.

The first step was the appointment of a Steering Committee to advise the Bureau on the effort. The following distinguished conservationists accepted the Bureau's invitation to become members of this Committee:

Mr. G. Ray Arnett, Director, California Department of Fish and Game, Sacramento, California

Mr. Robert J. Bielo, Executive Director, Pennsylvania Fish Commission, Harrisburg, Pennsylvania

Mr. Charles D. Kelley, Chief, Division of Fish and Game, Alabama Department of Conservation, Montgomery, Alabama

Mr. Carl R. Noren, Director, Missouri Department of Conservation, Jefferson City, Missouri

Mr. Daniel A. Poole, President, Wildlife Management Institute, Washington, D.C.

Mr. J. R. Singleton, Executive Director, Texas Parks and Wildlife Department, Austin, Texas

Mr. Richard H. Stroud, Executive Vice President, Sport Fishing Institute, Washington, D.C.

With the endorsement of the Steering Committee, we organized a National Symposium of fish and wildlife conservation in the national water resources program. We invited each of the state fish and game agencies and 22 national conservation organizations to send representatives to the Symposium. Forty of the states and 16 conservation organizations did so. Every person who attended was provided background materials in advance. The Symposium was held at a hotel adjacent to the Dulles Airport near Washington in October, 1970.

The conference was planned so as to provide every person who attended an opportunity to speak his mind about water problems and other phases of the River Basin Studies program. Everyone was a member of a small discussion group. Discussion group chairmen later reported on their group's conclusions at a general session. Every conceivable aspect of the water resources program in relation to fish and wildlife was on the agenda. It was a yeasty session, with lots of new ideas emerging.

One of the recommendations of the Symposium and the Steering Committee was to continue the process at Regional Workshops. Accordingly, four were held.

The Western Workshop was at San Francisco, beginning on December 8, 1970; the Southern Workshop was in Atlanta on February 24, 1971; the Eastern Workshop was in Philadelphia on March 4; and the Midwestern was in St. Louis on March 24. The Chairman of each workshop was one of the state fish and game directors on the Steering Committee. Once again, every state fish and game agency and each of the conservation organizations were invited to send representatives. Most did so. The procedure was the same at the workshop as it was at the National Symposium. That is, there were small discussion groups and reports of the discussion group chairmen at the general sessions.

A few weeks after the St. Louis workshop, the Bureau assembled a task force of state and federal men to distill out the most important recommendations from all the meetings. They worked in Washington for an entire week. Their report was subsequently reviewed by the Steering Committee. By this time, Mr. Thomas Kimball, Executive Director of the National Wildlife Federation, and Raymond Hubley, Jr., Executive Director of the Izaak Walton League of America, had been added to that Committee.

The final compilation of recommendations from this entire effort are incorporated in a document called *Action Report—Conservation and Enhancement of Fish and Wildlife in the National Water Resources Program*. This Action Report basically was prepared by the state-federal task force noted earlier. The Foreword of the Action Report says, in part:

> "The time has come finally to fulfill the promise of the 1958 amendments to the Fish and Wildlife Coordination Act that fish and wildlife shall receive equal consideration with all other features of water resources projects.
>
> "It is time for Federal and State fish and wildlife agencies to depart from their unsatisfactory role of reactors to the initiatives of the water resources agencies. It is time for them to take a full hand in planning for our Nation's water and related land resources from the very beginning on every proposed project."

In January of this year the Action Report was supplied to everyone who attended one or more of the five meetings, plus all state fish and game directors and heads of national conservation organizations whether or not they attended. Somewhat more than 500 copies of the report have been circulated thus far.

The Action Report contains 169 recommendations, organized under eight headings: legislation, policy, procedures, coordination, research and data, organization, administration, and financing. Every recommendation is designed to strengthen fish and wildlife conservation in the water resources program. The recommendations are for action not only by the Bureau of Sport Fisheries and Wildlife but also by state fish and game agencies, national conservation organizations, water project construction agencies, and others.

Obviously, time does not permit a review here of all or even a majority of the 169 recommendations. But let me highlight a few of them for you.

The first recommendation in the Action Report is that the Fish and Wildlife Coordination Act be amended in six respects. Responsive to that recommendation, we have already completely rewritten the Act, from stem to stern, in draft form. We incorporated all six changes proposed in the Action Report plus many others.

The Action Report recommends amendments to the Watershed Protection and Flood Prevention Act; the Water Resources Planning Act; and the Federal Water Project Recreation Act. It also proposes three new pieces of federal legislation and six pieces of new legislation for each state.

There are 20 recommendations for strengthing the policies of the Bureau of Sport Fisheries and Wildlife, 6 for strengthening those of state fish and game agencies, 9 for conservation organizations, 11 for water project construction agencies, 4 for the Water Resources Council, and 4 for the Council on Environmental Quality. The number one recommendation for both the Bureau and the state fish and game agencies is to place a much higher priority on the River Basin Study activity.

Another policy recommendation sets forth proposed guidelines for opposition to water projects. Projects should be opposed, according to the Action Report, whenever aesthetic or other natural values which would be destroyed are considered to be more important than project benefits—that is, when a project is judged to be environmentally infeasible. A project also would be opposed whenever it would destroy a significant proportion of a total supply of fish, wildlife, or habitat in high public demand; when recommendations for damage prevention, compensation, or mitigation are not satisfactorily adopted; when evaluation of all reasonable alternatives has not been satisfactorily demonstrated as required by the National Environmental Policy Act; or when destruction of habitat vital to rare and endangered species or damage to unique streams or habitat types such as significant wetlands or estuaries is likely.

There are 36 recommendations for strengthening the procedures of the Bureau, state fish and wildlife agencies, and national conservation organizations in the consideration of water projects. One of them is that the fish and wildlife plans for proposed water projects should be presented at public hearings by the directors of the state fish and wildlife agencies and by the regional directors of the Bureau.

In the area of coordination, the report proposes the establishment of a National Coordinating Committee, composed of a representative of each regional association of state fish and game commissioners, each regional director of the Bureau, a member from each of the principal national conservation organizations, and other Bureau personnel. This group would meet at least once a year to perform the functions which have been carried out by the Steering Committee. It would oversee and review the work of the Bureau and the states relating to fish and wildlife conservation at water projects and recommend stronger and more effective policies. There would also be a state-federal work group which would be the staff arm of the National Coordinating Committee. It would periodically review the status and needs of River Basin Studies and make recommendations to the National Coordinating Committee for improvements.

In the area of research and data, the Action Report proposes that the research programs of the Bureau and state agencies be reappraised and that particular research emphasis be placed on the fish and wildlife effects of water projects.

The principal recommendation under organization and administration is for the Bureau to establish a consulting center in a central location in the Nation. It would be staffed with a variety of expertise—engineers, economists, ecologists, hydrologists, and water resource generalists as well as biologists. This staff would be a mobile force to assist local River Basin Studies field offices anywhere in the Country in the solution of special problems.

Among other things, the section on finance proposes that the Bureau's budget reflect the need for increased funds for River Basin Studies and that these appropriation requests be vigorously supported in Congress by state and private conservation organizations and by regional, national, and international associations.

Obviously, no improvement of fish and wildlife conservation in the water resources program has actually been brought about solely by the preparation and distribution of the Action Report. Results will have to come from the action taken in response to the report by people in federal, state, and private organizations.

Unless there is such follow up, most of the considerable effort described here will have been wasted. Many of the recommendations will require substantial time and effort if they are to be fulfilled. Nevertheless, the climate for gaining acceptance of the proposals has never been better. It would be a tragedy if full advantage were not taken of that climate by vigorously going forward in this area.

We have made a start in responding to the recommendations of this Action Report. As I have mentioned, the Fish and Wildlife Coordination Act has been rewritten in its entirety. Also, draft amendments have been prepared for the Watershed Protection and Flood Prevention Act, the Water Project Recreation Act, the Federal Power Act, and the Water Resources Planning Act. We have prepared draft legislation to authorize the public acquisition of land subject to flooding and its use for fish and wildlife conservation and outdoor recreation. This would be an alternative to channelization, leveeing, and flood storage reservoirs as a way of reducing flood damage. All of these legislation proposals are under executive review. The Bureau will faithfully address its share of the other recommendations.

If the Bureau, the state fish and game agencies, and the national conservation organizations all vigorously follow through on the Action Report, we can look forward with some confidence to the dawn of a new day in Water: Fish, Wildlife and Society.

DISCUSSION

QUESTION: This new co-ordinating mechanism—how would it dovetail with the Water Resources Council which is already in an interdisciplinary role?

MR. ROBERTS: We're thinking in terms of a different level of coordination—getting people together in the early planning aspects for the field analysis aspects of these projects, not in the final determination of public benefits as opposed to public costs. We're talking about the grass roots study in project planning that is required to bring about a truly coordinated public project.

QUESTION (Unidentified): In cases where you have been able to bring to bear pressures to have the project either modified to take fish and wildlife benefits into account, or in fact to actually stop some projects, has this been primarily due to bringing out the social or wildlife costs that had been ignored in the early planning, or what other mechanism was used?

MR. ROBERTS: Obviously the one primary mechanism that always stands out in the ultimate determination of whether a project is or is not of adequate public benefit to be given consideration and that is based on the opinion of the people. Obviously, we're all aware of the fact that there is a tremendous change in the attitudes of the public. They are more informed, they are more concerned, they are more interested, and they participate more than ever before, and for this reason we do have a better climate in which to work from a standpoint of natural resource planning. We are, I think all of us—and I don't mean just fish and wildlife people or natural resource managers either, but all of us across the broad spectrum of water development management—are much more aware of our total responsibilities than we ever have been in the past. We're just taking a harder look at a lot of things than we ever did before in the field of water management.

PART III

SPECIAL PANELS

SPECIAL PANEL

Monday Morning—March 13

CHAIRMAN: DANIEL A. POOLE
President, Wildlife Management Institute, Washington, D.C.

CEREMONY MARKING THE AMENDMENT OF THE 1936 CONVENTION FOR THE PROTECTION OF MIGRATORY BIRDS AND GAME MAMMALS BETWEEN THE UNITED STATES of AMERICA AND MEXICO

REMARKS OF THE CHAIRMAN

DANIEL A. POOLE

The United Mexican States and the United States of America recently concluded negotiations on an amendment to the 1936 Convention for the Protection of Migratory Birds and Game Mammals. This action culminates more than three years of work by representatives of the two governments. The amendment brings under the protective terms of the Convention 32 new families of birds, including the birds of prey.

Representing the governments of Mexico and the United States this morning are the Honorable Eulogio De La Garza, Mexican Subsecretary of Agriculture for Forestry and Wildlife and Nathaniel P. Reed, Assistant Secretary of the U.S. Department of the Interior for Fish and Wildlife and Parks.

Before calling on these two gentlemen, I wish to invite to the head table as Honorary Observers several individuals who are associated with national conservation organizations or with the successor organizations to earlier groups that worked in the United States to develop support for the 1936 Convention.

These men are Elvis J. Stahr, president of the National Audubon Society; Ira N. Gabrielson, then chief of the U.S. Bureau of Biological Survey, now board chairman of the Wildlife Management Institute; Seth Gordon, then secretary of the American Game Association; Ralph A. MacMullan, president of the International Association of Game, Fish and Conservation Commissioners; Lee C. Howley, president of Ducks Unlimited, formerly More Game Birds in America; and Roland C. Clement, co-chairman of the International Council for

Bird Preservation, then the International Committee for Bird Preservation.

We also would be honored if Dr. Enrique Beltran, Director, National Institute for Renewable Natural Resources, and Dr. Bernardo Villa, Director General of the Mexican Department of Wildlife, would come to the head table to similarly represent the conservation interest of their great country.

Now, may I call on our first speaker, Assistant Secretary Reed.

STATEMENT IN BEHALF OF THE GOVERNMENT OF THE UNITED STATES OF AMERICA

NATHANIEL P. REED
Assistant Secretary of the Interior for Fish and Wildlife and Parks, Washington, D.C.

It is my great honor and pleasure to represent the Government of the United States at this important ceremony—a ceremony which is symbolic of a greater good.

The Federal Government of the United States recognizes a responsibility for the protection of all wildlife in cooperation with our individual state agencies and our counterparts in Mexico and Canada. For this reason we are gratified that the Convention between the United States of America and the United Mexican States for the Protection of Migratory Birds and Game Mammals has been amended and was ratified here in Mexico City last Friday. The amendment affords federal protection to 32 families of birds, in addition to the 31 families protected under the Convention since its inception in 1936. We see inclusion of these 32 additional families of birds in the International Convention as a means of affording uniform protection and management to many birds heretofore regarded as legal orphans. Among these are the birds of prey—some persecuted and some revered—but none, until now, adequately provided for throughout their range.

Equally as important as the content of this amendment is the spirit of cooperation in which it was drafted, reminiscent of the original Convention, itself, and the organizations instrumental in its birth. Those organzations, or their predecessor agencies, are represented here today by these distinguished representatives who are witnesses to this reaffirmation of the original commitment between our two Nations.

Although the Convention we recognize here today deals primarily with migratory birds, there are other species of wildlife and other wildlife problems that require our joint understanding and cooperation. It is with satisfaction and pride that I view the cooperative effort to manage the white-winged dove in the lower Rio Grande Valley of Texas and Tamaulipas. Likewise, we are appreciative of the cooperation give to U.S. Game Management Agents whose successful work along the border is dependent upon a good working relationship.

Of particular significance is the action very recently taken by the Government of Mexico that established a sanctuary in Scammon Lagoon on Baja California for the gray whale. Not only will this safeguard the breeding ground of this unique species, but it will also protect a major wintering area of the Pacific black brant, one of the species involved in the Convention we are commemorating here today.

With respect to sanctuaries, I think that the development of an international refuge for the desert bighorn sheep would present an ideal area for cooperation between our two Nations. At present the Cabeza Prieta Game Refuge of 860,000 acres extends along the international border in southwestern Arizona. An adjoining refuge of comparable size on the Mexican side of the border would complete an ecological unit sufficient to maintain the fauna and flora of this unique desert. We already have a very successful cooperative venture in this area, the restoration of the endangered masked bobwhite quail. The breeding stock of quail we have received from the Government of Mexico has aided greatly in the restoration of this species on the United States side of the border.

We see no real shortage of problems and projects. The immediate goal is to continue developing our partnership for their joint solution. This ceremony is a significant step in that direction.

The need for the United States Government to do more on behalf of birds not heretofore afforded federal protection has been expressed with increasing urgency for the past several years by citizens everywhere. With such assurance of public support, I can confidently pledge my Government to uphold its responsibilities recently ratified with the Government of Mexico and recognized here today.

Thank you for the opportunity to help commemorate this event.

RESPONSE IN BEHALF OF THE GOVERNMENT OF MEXICO

EULOGIO DE LA GARZA O.
Undersecretary of Forestry and Wildlife of Mexico, Mexico City, D. F.

Secretary Reed has pointed out the urgent existing need to protect the various species of wildlife and to repopulate those areas where it is about to become extinct.

He has pointed out, too, the spirit of cooperation that exists between his country and mine in developing joint international programs that the United Mexican States endorses with enthusiasm. Among these are programs relating to the white-winged dove and the masked bobwhite quail, species of mutual interest to both of our nations. As recently as last February we had the satisfaction of receiving 50 pronghorn antelope donated by the Game and Fish Commission of the State of New Mexico in exchange for five bighorn sheep livetrapped in Sonora. The antelope have been transferred to the State of San Luis Potosí for the purpose of re-establishing the species in that part of our country.

The National Reserve and Bird Refuge on Isla Rasa in the Gulf of California, established in 1964 through collaboration between interests in the United Mexican States and the United States of America, is a source of national pride. The populations of terns and gulls for whose benefit it was created and which a few years ago were almost extinguished, again now number in the millions, thanks to the cooperation between our two nations.

Our international cooperation gives priority to the protection of migratory species. In keeping with this interest we have a number of projects under study and consideration. Among them is the establishment of a refuge for migratory birds on Lakes Ojo de Liebre and El Vizcaino and in the desert zones around those lakes, which will provide protection for native mammals in danger of extinction. Other projects of mutual interest involve the creation of a sanctuary for the California condor in the southern part of Consituyentes National Park in the Sierras of San Pedro Martir, Baja California; the initiation of studies designed to develop programs to protect the reduced population of Mexican grizzly bear, and those leading to the establishment of a national park and wildlife refuge near El Sumidero and around La Angostura Dam in the State of Chiapas.

We have also noted Mr. Reed's suggestion for the establishment of a wildlife refuge in the State of Sonora that would complement the Cabeza Prieta National Game Range in Arizona and create an international ecological unit of sufficient size to protect and preserve the fauna and flora of this desert zone.

Thank you very much.

SPECIAL PANEL

Tuesday Afternoon—March 14

Chairman: Daniel A. Poole
President, Wildlife Management Institute, Washington, D.C.

RESULTS AND IMPLEMENTATION OF THE COUNCIL ON ENVIRONMENTAL QUALITY-DEPARTMENT OF THE INTERIOR PREDATOR CONTROL STUDY

REMARKS OF THE CHAIRMAN

Daniel A. Poole

This special panel will consider the results and implementation of the recent report submitted to the President's Council on Environmental Quality and the Department of the Interior by the Advisory Committee on Predator Control.

With us are two members of the Advisory Committee, Dr. Stanley A. Cain, chairman, and Dr. A. Starker Leopold. Here, too, are Nathaniel P. Reed, Assistant Secretary of the Interior for Fish and Wildlife and Parks; and Dr. Lee M. Talbot, Senior Scientist of the Council on Environmental Quality.

Please let me caution you that this is a tightly scheduled panel, calling for adjournment at 2:15 p.m. It is necessary to adhere to this schedule to avoid impinging upon the many related meetings that will be held later this afternoon.

The first of our distinguished panelists to speak will be Dr. Talbot.

VIEWPOINT OF THE COUNCIL ON ENVIRONMENTAL QUALITY

Lee M. Talbot
Senior Scientist, Council on Environmental Quality, Washington, D.C.

Thank you Mr. Chairman Poole, ladies and gentlemen, it is a pleasure and privilege to have a chance to discuss this predator control action with you today.

Some of you are not acquainted with the Council on Environmental

Quality, which is new to the wildlife scene. You may wonder why it is concerned with predator control.

The Council is located in the Executive Offices of the President of the United States and it serves as the President's advisor on environmental affairs. Among other things, it has the responsibilities of maintaining an overview of the environmental quality of the nation, of keeping the public informed, of coordinating all federal activities that involve the environment, and of serving as a focal point in the development of government policy and legislation on the environment. Clearly wildlife, predator control and the condition and use of our public lands are all central to environmental quality and consequently are of direct concern to this Council.

In his thoughtful opening address to this conference, our chairman, Dan Poole, made several remarks which drive straight to the heart of the predator control problem. He noted that an impatient public's rising interest in environmental issues poses serious challenges to the scientific foundations of the wildlifer's work. He noted that, increasingly better informed about what is happening to the environment and anxious for early remedial and preventative action, the concerned public is challenging the organizational, administrative and operational structures of resource programs. He concluded that these public demands raise serious questions about the professional conduct of resource work. Our authorities, institutions, policies, and practices must relate to public aspirations for environmental protection and enhancement. If they do not, or if the discrepancies cannot be explained, resource professionalism risks serious erosion of public support and confidence. Resource professionals must prove the social value of their work; no longer can they presume that the public will accept glowing generalities in the absence of tangible proofs of accomplishment. Mr. Poole's remarks are of deep significance to the wildlife profession, which up to now, in large part, has served a constituency which is narrow in scope and small, relative to the presently concerned American public.

Yesterday, Dr. Durward Allen, in advocating the need for a new American wildlife policy, noted that today our concern is with wildlife in the broad sense; it is a recreational and environmental resource serving many aesthetic and social functions in addition to hunting, fishing and a few commercial uses. Mr. Poole's remarks also have particular relevance to the question of predator control and management of our public lands. Our national policy was to open and exploit our public lands as rapidly as possible; now our policy is to manage them and to protect the many additional values of these lands to assure that present and future generations will derive maximum continued benefits from them. Formerly the demands of the immediate users, such as miners, ranchers, and lumbermen, were considered to be of paramount importance, and essentially the lands were managed for them. Today, public lands are recognized as just that—lands owned and to be managed for the public, whether that public lives on a ranch in Wyoming or in New York City. This principle is central to present national policy; the public recognizes and increasingly expects this.

Many resource managers have yet to get the message. At the annual meeting of the Society for Range Management held in Washington, D.C., last month, the opening speaker emphasized this principle and I feel that this vignette has direct application here to wildlife. Several days later, at the end of the Range Management meeting, several of the Society members—and I might add, significantly they were younger members—told me that when they heard the opening speech talking about the public values of public lands, they thought "How out of touch can he be?" But after the week in Washington, they realized it was they who had been out of touch.

With this growing public environmental awareness and the growing sensitivity to the public nature of public lands there has been increasing concern with predator control in general and the use of poisons in particular. This concern has been felt by the general public and by many wildlife biologists. One of my first jobs as a wildlife biologist involved research in 1948 on the primary and secondary effects of the poison 1080. Since that time I have become increasingly convinced of the indefensibility of the widespread use of this and other poisons and the indefensibility of the prophylactic method of predator control in general. Over the years the vast majority of wildlife biologists with whom I have discussed this have agreed, and during the past two years, a frequent question to the White House and to this Council by wildlife biologists and by the general public is "When are you going to do something about predator control?"

About mid-1970, the CEQ initiated a review of predator control. This was a staff review and, except for unanimous opposition to the existing program by the general public, the review showed that there had been little change in or clarification of the situation since the Leopold Report prepared for the Secretary of the Interior involving predator control in 1964. There were still widely divergent views, strong and diametrically opposed opinions and conflicting information. It became clear that the Government needed advice from the most competent and objective sources possible and we developed a plan for an outside advisory committee. Discussions were carried out in order to profit from the experience of the earlier committee, with Dr. Leopold and others, in the fall of 1970. I should note that the Department of the Interior had been on the receiving end of predator control questions for many years. It has felt a continuing and increasing concern to maintain a continuing view. The Department, of course, is the lead agency in the Federal Government dealing with wildlife matters.

When Assistant Secretary Reed came to the Department in the spring of last year he brought with him plans for reassessment of the predator control program and, shortly thereafter, with logic rare in Government, the Department and the Council agreed to conduct a study jointly. In choosing the committee members, we sought and obtained integrity, scientific capability, and a balance of knowledge of ecology, management, and policies involving wildlife, predators, public range and forest lands and livestock. We believe we were fortunate in obtaining an outstanding and effective group for this purpose.

The Committee consisted of Dr. Stanley A. Cain, Chairman, Dr. Durward L. Allen, Dr. Richard Cooley, Dr. Maurice Hornocker, Dr. John A. Kadlec, Dr. A. Starker Leopold and Dr. Frederic H. Wagner. We charged this Advisory Committee on Predator Control with the responsibility of studying intensively and evaluating the entire predator control situation in the nation. They were to examine the status and control of predators to review and analyze predator control and associated animal control programs and policies, evaluating their direct and indirect effects, including environmental impacts and effects on the livestock industry, and examining alternatives to the present practices. They were to cover federal, state, private and local practices. Their report was made for the advice and counsel of the chairman of the CEQ and the Secretary of the Interior. However, when we received the report in draft form, we believed that the committee had done such a fine job and that the report was so important that it should be made public. Accordingly, upon request, the committee prepared the report in final form, arranged for the printing, and even handled the galley and page proofs. Clearly this was an independent report without government interference.

When we received the Committee's recommendations, we set up inter-agency committees under the chairmanship of the Department of the Interior to study and prepare recommendations of government response. Findings of these deliberations were that the evidence presented by the Advisory Committee was compelling and the recommendations well-taken. The President decided that this subject was of such national importance that he would take action himself, announcing it in his environmental message presented to the Congress and the public on the 8th of February. Dr. Cain and Dr. Leopold will discuss the report and its recommendations, and Secretary Reed will discuss the government implementation.

The Committee's report in its final form was ready to go to the printers in mid-December. It was subsequently printed and released by the chairman of the Council and the Secretary of the Interior on February 8 immediately following the President's announcement. The report includes 15 recommendations, 13 addressed to the Federal Government. The Government has acted to implement in whole or in part all 13. I want to emphasize that the reception given this Committee's report and the prompt and comprehensive implementation given to its recommendations including direct action by the President are an indication of the high regard in which Government holds the work of this Committee and of the high importance it attaches to management of wildlife and our public lands. Now, I would like to introduce the chairman of this Committee, Dr. Stanley A. Cain.

REPORT OF THE COMMITTEE CHAIRMAN

STANLEY A. CAIN

Chairman, Advisory Committee on Predator Control; Professor, School of Natural Resources, University of Michigan, Ann Arbor

Ladies and gentlemen: I want to tell you briefly how the committee operated. Its work didn't get under way until the 22nd or 23rd of July, 1971, with a meeting in Washington, D.C. Being busy people, most of us were heavily committed in many ways prior to that date.

We met again in Denver, Colorado, about a month later on August 26 through 28. Another meeting was held in Logan, Utah from the 22nd to the 24th of September and a fourth in Santa Cruz, California, on the 16th through 19th of October.

We were working under a contract written by the Council on Environmental Quality for itself and the Department of the Interior, which required a report by October 30. At the urging of Dr. Talbot, however, we placed the introduction, Parts I and II with the 15 recommendations, and about a full page of supporting material for each in their hands a full week in advance of the deadline. Part III, the longest part, consisting largely of chapters in support of the recommendations, by different committee members, was presented by November 1. The final draft was completed by mid-December and delivered and published early this year. As published, the report contains 207 pages, about 100 of which are appendix materials that we gathered and which we hope will be informative to people using the report, and another 100 pages of supporting essays, documents, and chapters on special subjects.

I should say that we first considered public hearings. We decided, however, that there simply was not enough time to hold public hearings, to gather testimony, and to digest it because of the slowness of the hearing process.

But this does not mean that we did not make many contacts. We employed investigators who contacted all appropriate agencies and all interested private associations. There were about 190 contacts with organizations and more than 300 with individuals. We let it be known that we welcomed comment and we received much correspondence from individuals. We examined all of the predator control reports from the states that are made to the federal Division of Wildlife Services. There were, in fact, five full filing drawers of background material. While we could not digest it all, we did search out and found much substantiating material. I think this will be helpful to the readers in evaluating the positions we took.

I would like now to introduce Dr. A. Starker Leopold, who will carry on from this point.

REMARKS OF A. STARKER LEOPOLD

Professor, University of California, Berkeley; Member, Advisory Committee on Predator Control to the President's Council on Environmental Quality and the Secretary of the Interior

First let me state that it was distinctly a pleasure and a privilege to serve on the Advisory Committee on Predator Control, under the chairmanship of Professor Stanley Cain. For some years I have concerned myself with the problem of regulating and restricting the killing of our predatory animals, but until recently the public conscience has not been troubled enough to force much change in the widespread practice of overkill. Now rather abruptly the government and the public have awakened to the point that the President and members of his Cabinet are taking positive action to bring a degree of restraint in control programs. The recent Executive Order of President Nixon precluding the use of poison on public lands and calling for other modifications in control programs represents a positive and gratifying advance in our national philosophy toward carnivorous animals. We face now the problem of implementation of the President's Order.

The long-established format of predator control, administered through Wildlife Services in the Bureau of Sport Fisheries and Wildlife, is about to be phased out. What types of programs will take its place? It is implicit that cases of predator damage will occur and localized control will be undertaken. By whom? A new format is called for to meet these situations. State governments and the livestock operators themselves will have to assume much more responsibility for predator management in the future, as the Federal Government divests itself of this function.

Yet the Federal Government will impose restrictions on method and extent of control, such as the President's order that no poison be used on federal lands. The question arises—who will enforce these regulations? In the case of the National Forests perhaps it can be assumed that the rangers and their field staffs will undertake enforcement. But on the public domain lands, the Bureau of Land Management, with a very low level of staffing, will need help to police the rules. It seems clear that a period of substantial adjustment lies ahead, in which patience and perseverance are much needed. The livestock industry and state agencies, as well as the federal bureaus, will need time to devise a workable system of predator regulation that meets the new objectives of public interest, as set forth by the President.

Both state and federal agencies likewise will need funding to administer these new concepts of predator management. BLM in particular requires manpower for general management, predators being only one facet of need. The state fish and game departments will require funding too, insofar as they become implicated in predator management. Their activity should not in any way draw substantially on hunters' license fees, which are set aside for purposes other than protecting the livestock industry.

Lastly, the conservation organizations, who may look upon the Executive Order as a great victory for protection of predators, should realize that many important organizational steps must follow that will require public support and understanding. Control of the use of poisons by action of the President, the Secretary of Interior, and the Environmental Protection Agency means that other control procedures must be allowed to deal with damage situations that inevitably will arise.

An aspect of animal control that will continue to plague administrators is the periodic outbreak of rabies in wild animal populations. Appearance of rabid skunks or coyotes in a neighborhood leads to instant demand for governmental killing programs, despite the fact that repeated studies fail to support the contention that the disease is controlled by such an approach. Generally speaking, a rabies outbreak will disappear naturally before effective control can be generated. Much research on the epidemiology of rabies is still needed, and this is a function that should be served by the Bureau of Sport Fisheries and Wildlife. But government agencies, state and federal alike, are going to have to be prepared for an onslaught of public demand for action each time an outbreak of rabies occurs.

In summary, there are some major adjustments called for in dealing properly and intelligently with the management of predatory animals. Governmental agencies, conservation organizations, the livestock industry, and the public at large will all be called upon to exercise patience and judgment in arriving at a new and sensible program of predator management.

Now lastly we will hear from Assistant Secretary of Interior, Nathaniel P. Reed.

VIEWS OF THE DEPARTMENT OF THE INTERIOR

NATHANIEL P. REED

Assistant Secretary for Fish and Wildlife and Parks, U.S. Department of the Interior, Washington, D.C.

On February 8 of this year, President Nixon issued Executive Order No. 11643, prohibiting the use of poisons for killing predators on public lands of the United States.

After a moment of stunned silence, there were reactions on both sides of the environmental fence. Certain western sheep growers let out a howl . . . "They had been betrayed; even now, packs of slavering coyotes were gathering in the hills and within a few moments after the ban went into effect, these vampires would swoop down and destroy their only means of livelihood."

On the other side, certain protectionists first exulted and then said: "But that isn't anywhere near enough; now we must stop all trapping, all shooting, all killing," and they girded their loins for another charge at the Administration.

But by and large, the reaction we have heard most often and which seems to represent the general public feeling on this matter is: "Good for President Nixon—it's about time the poisoning was stopped." This has been reflected in numerous editorials throughout the country, from widely differing viewpoints ranging from the *New York Times* to the *Salt Lake Tribune.*

At the same time that the poison ban was announced in the President's Environmental Message, the report of the joint Interior/Council on Environmental Quality Predator Control Advisory Committee was released and our proposed legislation on the predator control program was sent to the Hill. The legislation has been introduced as H.R. 13153.

The Advisory Committee Report has been printed and is available from the Director, Bureau of Sport Fisheries and Wildlife, Washington, D.C. If you do not presently have copies of both the legislation and the report, I would urge you to obtain them as rapidly as possible.

As with any bold action taken by the government, this action to drastically change the 57-year-old Federal predator program has met with its share of criticism—most of it uninformed. A prominent western sheep grower condemned the Advisory Committee Report out of hand in public because he saw the name of his state's leading environmentalist among those contacted by the Committee. When it was pointed out to him that the President of his own wool growers association had also been contacted, he paused for only a moment and said: "Yeah, but when the report got to Washington, all his stuff was thrown out." The point is, he didn't read the report and didn't intend to. His mind was made up. Ignorance may be bliss, but it is not the way to run a country.

This is unfortunate. I am sure there are a great many people who, as the new bill moves through the legislative process, will be commenting on it. I hope they will do so from a sound basis of fact which includes *reading* the Cain Report. In the process of changing the law and the program, I am sure that this report will show its great value under intense public scrutiny from all sides.

The evidence in the Advisory Committee Report was overwhelming in its condemnation of poisons for predator control uses. So much so, in fact, that we were not hesitant about recommending to the Council on Environmental Quality, the Office of Management and Budget, and the White House that the use of poisons be restricted for predator control purposes on federal lands.

Following the environmental message, the Bureau of Sport Fisheries and Wildlife took immediate action to modify its program in accordance with President Nixon's order. Field personnel set to work to retrieve all of the poison baits that were put out last fall to control predators on rangelands this winter and spring. As the weather permits, all coyote-getters and 1080 and strychnine bait stations will be deactivated and the poison destroyed.

We feel that it is no longer in the national interest for the Federal Government to be conducting an operational program which largely focuses on the killing of resident animals for the benefit of private and commercial interests.

In lieu of the Predator Control Act of 1931, we propose legislation that will permit the Department to conduct an expanded research program to learn more about predator/prey relationships; develop better, more selective, humane control methods; and get a better idea of what the actual predator-caused losses of livestock really are. We have been able to spend only a minimal amount of funds on predator control research for several years, yet there have been some promising developments.

Currently, we are conducting research on non-lethal control methods, coyote behavior, and predatory animal ecology. We are spending about $125,000 per year on these studies. We have plans, when fund and personnel limitations permit, to conduct extensive research on nonlethal control methods using sound and light, tranquilizers, aversive agents or repellents, and reproductive inhibitors. We want also to conduct research to document actual predator-caused livestock losses and learn more about predator/prey relationships.

We propose, in addition to research, to provide an extension program to each state that desires help, to teach state personnel what we know about animal damage control, and recommend new control methods based on research findings. We also propose a 3-year, sliding scale, phase-in type of grant-in-aid program to assist those states which need predator control programs to develop them. During the first year, funds would be granted to the states on a 75 federal/25 state matching basis; the second year our financial assistance program would be on a 50/50 matching basis; and the third year the rate would be 25 percent federal to 75 percent state.

We anticipate that the states will develop programs of predatory animal control using a variety of techniques. We expect their efforts will largely focus on specific troublesome or offending animals. Some states will utilize professional trappers; others will develop aerial hunting techniques, possibly with aircraft that can land and take off in short distances or even helicopters. It is possible that some states will find a beneficial use for snowmobiles in predator control. Another approach may be to place the coyote on the game animal list to encourage a greater harvest by hunters.

The Department of the Interior will continue to conduct animal damage control where necessary to protect endangered species and where migratory birds are involved. Here, there is an overriding national concern and existing but separate statutory authority for the Secretary of the Interior to conduct programs to protect, conserve, propagate and preserve these species.

Other federal agencies and bureaus are also taking action to implement the President's order. The Bureau of Land Management has issued proposed regulations which would subject grazing permitees on the public lands to the loss of their permit if they misuse poisons. The Environmental Protection Agency has cancelled the registration of poisons that are used to kill predators. Now—what are the implications of the Executive Order and the Legislation?

The Executive Order took the Department of the Interior, and the

Bureau of Sport Fisheries and Wildlife in particular, out of the business of using poisons to control predators. The Executive Order did not stop all federal predator control activities, however. Until the Act of March 2, 1931, is repealed, the Bureau of Sport Fisheries and Wildlife will continue to control predatory animals. They will not use poisons. Some of our critics scoff at the idea that livestock losses to predators can be reduced to tolerable levels by shooting, trapping and denning. We believe it can be done by focusing control efforts on offending animals. Heretofore, the approach of the Bureau has been to try to depress entire predator populations in a given area on the theory that the abundance of predators had a direct bearing on the incidence of predation. In the future, the Bureau's approach will be to conduct a more selective control program directing their efforts only at offending animals.

To the livestock owners and other private and commercial interests who have been benefiting for 57 years from this subsidy-type operation, the action of the President means that they must reassess their program and devise ways and means to cope with the problem without the use of poison. I would expect some to feel a sense of frustration and insecurity, while others will take the action in stride. I doubt that the action of the President has taken many livestock owners by surprise. I feel certain that many hate to see poison used to kill animals. Livestock owners who graze animals on federal lands will be forced to control any predator losses they may sustain by shooting, trapping and denning. Any increase in the livestock loss rate on federal lands as a result of the ban on poisons will be a part of the price that private and commercial interests must pay to utilize resources that are of value to all the people and are public-owned.

To the states, the action that has been taken by the Department opens the door for including predatory animals on the game animal list and encourages the development of state programs that would be responsible for controlling any predator losses that individual livestock owners could not tolerate.

While some states may not be eager to assume responsibility for predator control, predators for the most part are resident species and come under the purview of state government. Most states have traditionally claimed their right to manage, protect, preserve and propagate resident species. This right extends to those species which are unpopular, *i.e.*, the coyote, as well as to the popular species. We invite them to step forward and accept the responsibility which they have been claiming. We intend to offer extension services and financial assistance on a matching basis to help them get their programs off the ground.

In conclusion, let me say that as a society, we have matured to a level and have reached a point in our history beyond which we can no longer afford to kill predatory and depredating animals without first considering all of the consequences of our actions. It is inconceivable to me that the Federal Government, a state government, or any local governing body would undertake the destruction of animals on a widespread, operational basis without first assessing all of the consequences. Even if the control of large numbers of coyotes and other predatory animals is necessary to our way of life and the preservation of our environment, which I seriously doubt, we should have proof that this is so before embarking on an operational control program.

We must also have proof that the methods we use to control animals are as safe, selective, and humane as man can make them. In my judgment, the use of poisons to control predators is not warranted on any lands.

When predator control is necessary, I feel strongly that only offending animals should be destroyed. I disagree with the practice of depressing entire predator populations as a means of reducing predation on livestock. I think it is quite evident that all wildlife species have value, even those which are predators. These values have increased considerably in recent years as we have become more aware of the needs of our environment.

While I do not feel that the Federal Government should be involved in the control of resident species on state and private lands, I do think we have a responsibility to conduct predator control research. With adequate research, I am confident that the predator control issue can be resolved to the satisfaction of all concerned.

It takes courage to initiate an action or endorse an action that will bring about change, even for the betterment of the environment; especially if it is going to affect the livelihood and the pocketbooks of people. The Department of the Interior has demonstrated courage in trying to bring about change. President Nixon has taken unprecedented action to restrict the use of poisons for predator control purposes. If these actions and others like them are to succeed all of us will have to join together in a cooperative effort to make them work.

PANEL-AUDIENCE DISCUSSION

MR. URBAN NELSON (Alaska): I submit that predator control is a subsidy. This must certainly be a first consideration. I question the Secretary as to what extent the Department is trying to convince the livestock industry that their number in terms of percentage of human population is decreasing. They must necessarily accept, at least in part, recommendations of the Committee. It seems to me that the agencies of the Department of Agriculture have started to commit themselves, and have cancelled some permits. It would be similarly true that, by simple administrative action, the FAA would have equal authority to cancel the pilot license when a man uses his plane illegally.

My concern is in relation to the polar bear. I would like to see action taken immediately through the FAA to see that when a pilot violates the terms of his license, it should be cancelled.

I would like to say that when rabies runs through a native village it moves like a tornado, and once it is gone, you can do nothing about it. We must give this great importance. We must have control, because of the danger to humans, but, also because of the presence of large numbers of dogs. We have dangers in Alaska that are not imminent in most areas. I'm not suggesting that we need to use poison, but if you have a comment I would like to hear your remarks. Lastly, for the benefit of those who are interested in wolves, we in Alaska have limited the bounty on wolves to a very small area in southeast Alaska. I'm hoping in another year we'll have no bounty.

ASSISTANT SECRETARY REED: Thank you sir. If I could answer the part that was addressed to me about how well we have elicited the support of the livestock interests: this may come as a shock to many of the western game commissioners and certainly the Woolgrowers' Association. Among the many telegrams that we received decrying the President's actions were hundreds of letters from cattleman and from woolgrowers saying "right on." I will expect and look forward to the close-working association of the cattlemen and woolgrowers with the Department of the Interior and with the affected states. I am not looking for trouble. I am looking for a period of intense cooperation, especially on the subject of shooting from planes, because of the passing of the law on the 24th of December 1971, a law cancelling licenses of pilots who break state or federal regulations.

PATRICIA CARPIO WHITING (Tigard, Oregon): My question has just been answered, but I wish to make one statement: If just 50% of the people in this room when you return home, write just one short letter to the President and to this Commission stating your concern about the predator it would help. As Dr. Leopold pointed out, our fight is just beginning. I come from a state where there are great cattle and sheep interests and industry, and we in the State of Oregon are faced with a dilemma—people's livelihood versus the protection of wildlife. But is it true? I look forward to the support of the Commission's recommendations regarding the new predator law and the development of educational awareness regarding the total environment.

DR. CAIN: I would like to answer Pete Nelson's question concerning rabies. I fully understand the psychology of a rabies outbreak. Nevertheless let's not kid ourselves that you are controlling an epizootic by going out and shooting animals, I quote—if you will look at your report on page 106—a report of the Committee appointed in 1971 by the National Academy of Science on the subject of rabies. It recommends abolishing persistent trapping or poisoning campaigns for the purpose of rabies control. No evidence exists that these costly and politically attractive programs produce either a reduction in wildlife or a decrease in rabies.

MR. VERN VIVION (National Woolgrowers Association): I would like to comment that the problem is not as great as you may have heard. Ranchers are going to cooperate. I think that probably the only thing that you should understand is that our interest is real. But I want the people here to recognize the fact that the Association, prior to my time, had gone to Congress over ten years ago, seeking research funds. The members of these organizations should combine for a pool for this type of thing. We are not going to try to destroy any wildlife. But you must realize that our people are individuals, just as you are, and you will have some individuals who will break the law. I cannot speak for every last individual, and I am sure that you recognize this, that there could very well be some violations of this order, but almost 99.9% of the ranchers will not violate these recommendations. They feel that if the regulations are not completely realistic, in future legislation they hope to have the help of some people to correct them.

You should recognize the fact that the rancher has been a true conservationist. I can point to the normal balance of wildlife in my own State of Wyoming. I think you people know this, and the people of Wyoming are proud of it. All this has taken place during a time of predator control and of technological advance in range management. Our range has, in fact, prospered. I hope people realize that the ranching business has done a great deal for the propagation of wildlife.

Just one example: the population of antelope in Wyoming in about 1915 was 5,000 roughly, and in 1970 the game and fish estimate of antelope population was over 200,000. We are proud of this gain and we intend to sustain it and we think with good ranch management we can do that. I know we have a lot of experts on the Cain Committee, but the fact is that all their figures are not completely indisputable. We're proud, frankly, of this great achievement we had in Wyoming.

I would like to say that the general count showed that there were 10,000 eagles in the whole U.S., and the recent count by the Game and Fish people was 12,000 just in the State of Wyoming. Their projection count was up to 16,000. I'm telling you this because you do not have to be concerned—our people generally are known to do the thing that is right and live by the mandates of the President and the Interior Department. And I want you to know that we are concerned.

ROBERT JANTZEN (Director, Arizona Game and Fish Department): I have a question for Secretary Reed. Mr. Secretary, we were advised of the establishment of this Committee on July 9th, in a speech given by Secretary Morton. At that time, Secretary Morton said that he absolutely guaranteed an opportunity for full review and comment by the affected people and, I would like to ask: Could you explain to the people here primarily in State Government why the by-laws were changed so that there could not be a review or comment before implementation? I ask you, Mr. Secretary, who made that decision?

ASSISTANT SECRETARY REED: I would be delighted to give you the answer. I think it is about time that it came right out onto the surface and everybody knew. We all understand the political truths of life. The President received the recommendation sent by the chairman of the Committee to the Secretary of the Interior, and said: "It's about time I got a recommendation like that and I intend to act upon it. However, I think that it is of such national interest that I reserve it as my right to give it in the Environmental Message which is scheduled for February 8th. There will be no disclosure of the report nor your recommendations to me until that time."

MR. JANTZEN: Mr. Secretary, now we know whom to talk to. My second question is: They have had the strength to step forward and take the responsibility for predator control. We also invite them to step forward and take the responsibility for rodent control. Many of these animals are also harmful to wildlife. We would be delighted to work with you on this subject of rodent control which has been a problem and we will be revising our regulations on it in the very near future. As you know, the Bureau immediately suspended use of certain poisons for rodent control, waiting for the proclamation. We now know clearly what the regulations are. We will be reissuing these regulations and rules on which rodent control can be continued.

ASSISTANT SECRETARY REED: I have no problems, Bob, and if you want to take over rodent control in Arizona, why fine with me. Chief Cliff is here and I am sure on the national forests he would be glad to have you help out there, too. I look upon these controls probably as split between the Federal Government and the State Government, but if you would like it all in Arizona, that could be arranged. I would like to speak on the International Game Commissioners' Report because it is a first-class report and it is also included in the Cain Committee's Report. It was thought so highly of that it is part of that report.

MR. W. W. ROBINSON (Vice Chairman, Game and Fish Commission, Colorado): Colorado has stopped the use of poison as far as the Commission is concerned, simply by cutting the thing off at the pocketbook about nine months ago and not contributing to the cost where poisons were used. We also are dealing with so-called predators, including the bear, the lion, and other species. Two things that we did I think you should know. One was to make up a list of professional hunters who are willing to go on call and hunt down bears or lions that are causing damage with dogs. The professional hunters, in turn, offer special rates to sportsmen who hunt this way. That is still in effect in Colorado.

Also we encourage the use of professional dogs and by professional dogs I mean the big Pyrennian, Turkish, and Iranian sheep dogs. In Mesopotamia and in the Pyrenees they have had these problems for centuries, and they bred a special kind of dog to protect their sheep. They'll take care of the coyote in good shape, and even take care of some of the wolves. If you want additional information, we can get this from the sheepmen in Colorado. And if you have any information in addition to this, then we would like you to present it at this meeting because these are two things that are constructive.

CHARLES CALLISON (National Audubon Society): I would like to put on record the estimate of the population of eagles in the State of Wyoming. The last estimate cannot be substantiated. We couldn't count either 16,000 or 12,000 eagles in the State of Wyoming, nor were we successful in counting every migrant that crossed through the State.

RUSSELL STUART (Director, North Dakota Game and Fish Department): I concur with the Cain Report. As a matter offact I've been very much the critic of the use of poison for a very long time. However, I think I have a practical question to ask the Secretary and that is: for 57 years, personnel of federal agencies have conditioned a small segment of our agricultural community to feel they were entitled to do this and that any methods were perfectly satisfactory. Now I understand this bill—this entire problem—may be turned over to the states within three years. Can we settle it in that time?

ASSISTANT SECRETARY REED: Yes, I think so, and if you feel that three years isn't adequate, then you should let your constituency know that it will take longer. Just because we proposed this bill doesn't mean that Congress is going to act upon every single word we send them. I tend to think three years is enough, but I would welcome you to come to Washington to testify on that part of the bill. I think it is a question that has to be asked, and I think it depends a great deal upon the success we have this summer and what problems we run into this summer. I think it is a legitimate question and one that is worthwhile debating.

MR. ROBERT A. HODGINS (Director, South Dakota Department of Game, Fish and Parks): I am being asked back home why it is that the Indian trust lands are exempted. I ask Secretary Reed to answer.

ASSISTANT SECRETARY REED: I am new in Indian affairs and you will have to excuse me, but I think you will find that Indian trust lands are managed by the Indians through the DIA and through the regional corporation of the tribal hierarchy. This does not give permission to the Indian to use 1080 where a rancher cannot. It is suspended for use by him as well as to anyone else.

MR. ROBERT SMITH (Bureau of Land Management, Washington, D.C.): I would like to speak very briefly on the part of the Report, specifically dealing with predator prey relationship, the relationship between coyotes and rodents, and this is documented in another report at another research lecture. We know that the primary sources of food for coyotes are lapin rodents. We know that high rodent populations are, at least to a degree, the result of a bad range management.

Public lands are associated with and administered by the Bureau of Land Management and about two-thirds are in poor condition. This amounts to over 100 million acres. Unpublished research by the Bureau of Sport Fish and Wildlife in Texas has shown that chemical control methods are only effective where rodent populations are low; that is, where they are high, chemicals are not effective. This wraps it up in a pretty neat package. At least on public lands where it is a matter of maintaining abnormally high population needlessly, if we can get the kind of range management program underway that will correct this strange condition, we can reduce this population and cut down on predation. One more thing: we also have public regulations and are asking for comments by the Director of Land Management by the end of the month on those regulations relating to this ceasing of chemical controls and to permitees who break the federal and state laws.

PART IV

CLOSING GENERAL SESSION

GENERAL SESSION

Wednesday Afternoon—March 15

Chairman: JOSEPH L. FISHER
President, Resources for the Future, Inc., Washington, D. C.

Vice Chairman: THOMAS G. SCOTT
Head, Department of Fish and Game,
Oregon State University, Corvallis

INTENSIVE RESOURCE MANAGEMENT: PROBLEMS AND OPPORTUNITIES

REMARKS OF THE CHAIRMAN

JOSEPH L. FISHER

The day is fast disappearing when natural resources of any kind, including wildlands and wildlife, can be allowed to take care of themselves. In varying degrees virtually all resources now have to be managed, consciously and purposefully, if they are to be sustained over time and made to yield benefits to the people of the world. For many resources, management will have to become increasingly intensive and employ scientific and technical expertise, skilled labor, much capital, and a full assortment of government policies including regulation, tax incentives and subsidies, public investment, and education.

The transition from extensive resource management, or no management at all, to intensive resource management is proceeding rapidly in country after country. In many instances the management logically has to be on a bi-national or continental scale as with the Rio Grande valley or the Caribbean fisheries or North American migratory birds; or on a world scale as with radioactive elements and certain kinds of chemical pollution that spread widely through the atmosphere or oceans. Ours is becoming a managed planet in which the ultimate irony is the application of techniques of intensive management to the preservation of "wild" resources.

The principal reasons for this intensification of management are apparent. Human population is increasing rapidly in Latin America, Asia, and Africa, tending to put more and more pressure on the resource base of land, water, minerals, and air. In Europe, Japan, the United States, and a few other places population is increasing much more slowly but economic growth in absolute amounts is very large and involves technologies that are hard on nature. The accelerating concentration of people everywhere in cities, where incomes are higher and the demands for manufactured products and sophisticated kinds of services are greater, exacerbates resource problems whether these are viewed as raw material supplies or environmental quality. The mobility of people and goods is now such that scarcely any corner of the world is hid from the prying tourist or the penetration of Coca, Pepsi, and the other colas. Fresh Mexican strawberries purchased in midwinter in the supermarkets of New York, Chicago, and Montreal have to be counted as part of the advance in living standards in those cities. None of these results has been achieved without more intensive management of resources, frequently on an international scale. It would be an illusion to see the future of the world in terms of cottage industries and back yard gardens. We have to go forward toward a humanizing of technological and economic forces, directing them in ways that will permit the poorer people of the world to improve their lot, and toward a conservation of resources worldwide without which no one's well-being can be assured for long.

Progress along these lines will require resource management more intensive even than anything we have seen so far, especially where the ecological and survival stakes are high. It will also require legal and other strategies at local, state, national, and international levels far more complex and difficult than we have yet been able to devise.

The speakers this afternoon will consider several major aspects of the matters I have been talking about. Mr. Grant will deal with new problems and solutions in soil erosion; Mr. Taylor with chemical contamination of soils and waters; Mr. Bourcier with advances and needs in the recycling of solid wastes; Mr. Anderson with providing energy and maintaining environmental quality; and finally Mr. Cameron with legal approaches in terms of precedent cases. Each speaker will present his ideas in no more than twenty minutes, I trust, and then will respond to questions and comments for ten minutes. Thomas G. Scott, Head of the Department of Fish and Game at Oregon State University, will preside over the question periods.

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SOIL EROSION: NEW PROBLEMS AND SOLUTIONS

KENNETH E. GRANT
Administrator, USDA Soil Conservation Service, Washington, D. C.

I appreciate the opportunity to discuss soil erosion with you.

We have a mutual interest in its control. Soil erosion, floods, and drought create serious problems in the production of food and fiber; damage residential and industrial property; constitute a serious health threat; and impair wildlife habitat and recreation opportunities. And most measures that reduce or prevent soil erosion, floods and drought also create substantial food, cover, and quality water for fish and wildlife.

My remarks today will relate specifically to the United States; but perhaps the principles, if not the trends themselves, will apply as well to the rest of North America.

Perhaps the most significant recent development in the field of soil-erosion control is greater public interest. In four decades, much of the time with only limited interest on the part of urban-oriented voters and legislatures, 2 million conservation district cooperators have brought soil and water conservation practices to three-fourths of a billion acres. In the process they have prevented an estimated 25 billion tons of sediment from reaching America's waterways.

Today, there is a great surge in overall environmental concern across the United States. But more specifically, there is growing awareness of the off-site impacts of the result of soil erosion—sediment. Our emphasis in the 1930's was on protecting agricultural land from damage. Now, there is concern not only for the value of a ton of soil lost by the landowner, but even more concern for the cost of having to remove that ton of eroded material from someone else's land or from estuaries, lakes, reservoirs, highways, railroads, or runways. Sediment is recognized as a major water pollutant and as a carrier of other pollutants. Chemical and pesticide residues and harmful pathogens are carried off the land absorbed on or in solution with sediment.

That recognition is giving a new sense of priority or urgency to conservation programs. It is underscoring the need to improve the environment for whole communities, beyond simply protecting the property of landowners.

Here are some major trends in soil erosion and its control on agricultural land:

The cost-price squeeze and other factors have forced many farmers and ranchers to change their operations. The average farm size has increased 27 percent in 10 years, and landowners have gone to increasingly larger equipment as an economic necessity. Big combines and multi-row harvesters are more difficult to manipulate, and can't maneuver around the old terraces, stripcropped fields, grassed waterways, and other conservation measures. Some landowners have taken them out, creating new erosion problems. Mammoth irrigation systems have been installed that in some cases have brought about new erosion problems. In some areas, livestock have been concentrated on fewer farms and ranches, and on huge feedlots. Some landowners then have less need for forage crops and less incentive for including grasses in crop rotations. They farm more intensively, and this is creating new erosion hazards.

But through research and field experience, SCS and other agencies are seeking ways to cope with these agricultural trends. Our National Inventory of Soil and Water Conservation Needs showed that more than 600 million acres of land in America is suitable for today's highly intensive farming—if appropriate erosion control measures are used.

In many areas of the nation, minimum tillage is in rapidly growing use—more than 21 million acres as of last July. There are many names and versions of minimum tillage; some form can be practiced for almost any crop. Basically it calls for planting the crop in grass sod or in the residues of previous crops. It reduces the need for successive plowing and cultivating to make a seedbed, incorporate fertilizers, reduce weeds, and provide moisture control. Because the soil is disturbed less and has year-round plant cover, minimum tillage is able to reduce soil erosion from 30 to 90 percent or more. And there is no appreciable loss in crop yields. The crop residues also provide new food and cover for wildlife.

Also in growing use in several states are new methods of terracing that can accommodate larger equipment. Parallel terraces eliminate hard-to-farm corners or "point rows." New subsurface drain outlets eliminate wet channels or grassed waterways; make machinery operation easier between terraces; permit safe discharge of excess water; and allow for natural erosion processes to gradually level the soil between terraces.

Level bench terraces on deep loess soils in Iowa not only reduced soil losses but also increased water intake rates enough to cause the streams to flow for longer durations and at lower stages, thus reducing downstream flooding and sedimentation without appreciable effect on the total amount of streamflow.

So we have available many technical solutions for agricultural erosion problems. But there are stumbling blocks. One of the major ones is economics. Many landowners are not convinced that the gains justify the investment required. Many of these are absentee landowners who have inadequate concern for conservation needs and whose short-term lease arrangements do not provide for application or maintenance of conservation practices. Many other landowners simply cannot afford conservation practices because of small holdings and smaller incomes. Improved programs of cost-sharing need to be examined. There also is a growing trend at the state and local level to search for some form of regulatory approach.

We may also need special efforts for particularly difficult problem areas. Most of you are familiar with the Great Plains where unique climatic conditions called for extra attention in conservation needs. Another area is the Palouse country of Washington and Idaho—one of the good wheat-producing areas of the nation and one of the serious recurring erosion and sediment producers. One story goes, "Some parts of the Palouse are so steep you plant both sides of the soil." Several agencies and conservation districts have been searching for answers in the Palouse for a long time. A special program of cost-sharing under long-term contracts for the needed work is now being considered by the Congress. Among the solutions being suggested are to take the steepest slopes out of cultivation; use a 5- to 10-year rotation of grass and grain; use terraces with pipe outlets or grassed waterways; use windbreaks; use a stubble mulch fallow; and use new wheat varieties that can be harvested earlier.

The program costs are estimated at $220 million over a 20-year period. But the value of land in the Palouse is estimated at nearly $2 billion, and there is a $3 billion public investment in some 13 multipurpose dams that are being damaged by sediment from Palouse country erosion.

Many people once thought that farms and ranches were responsible for all of the discharge of sediment into water supplies. They do account for half or more of the 4 billion tons of sediment produced each year. But America's 3,000 conservation districts and their 2.2 million cooperators are vigorously attacking agriculture-related sediment problems.

There are other very serious sediment sources. Highways and airports outside urban areas are taking an estimated 160,000 acres of new land each year. These major new developments are incorporating erosion-control methods for the most part. Our relationship with highway and airport authorities at the national and state levels is quite good. It is on many thousands of miles of secondary roads that roadside slopes, borrow areas, and ditches constitute a serious erosion and sediment threat. A Georgia study showed that measured soil losses from bare roadside cuts were as high as 185,000 tons per square mile per year.

For the most part, technical solutions are available to reduce these losses. We are continuing the search for better soil-holding plants and mulching materials. We are working on improved structural methods for water control. The major drawbacks have been lack of funds and lack of well-defined responsibility for roadside erosion-control work.

Soil erosion also is a problem along an estimated half-million miles of streambanks in the United States. It causes loss of valuable land and increases sediment pollution. Here, some technical solutions are available; more research is needed on the hydrology of streams and materials for streambank stabilization. Builders and communities need better understanding of the impact that land-use changes have on streams. But many landowners and citizen volunteers are working to clean up and stabilize streams.

Surface mining is the principal method for extracting coal and 40 other commodities. With the Nation's expanding needs for power sources, it likely will have even greater emphasis. It has disturbed more than 4 million acres, and the total acreage is estimated to more than double by the year 2000. Much of this mining has been done without adequate regard for restoration. Spoil banks are steep, stony, and highly acid—they almost defy revegetation, and pollute streams with sediment, acid materials, and debris. The land's capacity to support wildlife or any other use is seriously impaired.

But 28 states now have enacted legislation dealing with the problem, and the Congress is considering several bills. SCS is giving technical help in planning erosion control and restoration measures, and SCS plant materials centers are working to find plants that will grow on stripmine spoils. These areas can be restored to serve a variety of beneficial uses.

One of the greatest erosion threats today is on areas undergoing urban development. Our metropolitan areas are growing very rapidly, taking an estimated three-fourths of a million acres of farm and open land each year. Much of the growth has been haphazard and poorly planned.

The process of reshaping land for urban uses alters soils in many ways, often with drastic and sometimes irreversible effects on drainage, runoff, and streamflow. Sediment yields of urbanizing areas may be from 10 to 40,000 times as much as those of adjacent farm or ranch land.

During the relatively short construction period, sediment produced may fill up a community lake or reservoir costing millions of dollars. Stream channels below the site, in adjusting to increased flows, may develop unstable banks and scoured or muddy streambeds.

Erosion problems on most construction sites can be prevented or controlled. We have assisted a growing number of builders in making plans to disturb as little area as possible at one time; plant grass on bare areas immediately after grading; install debris basins to hold sediment on the site; and use terraces and other measures to control the flow of water across the site.

In too many cases, urban construction simply is done in the wrong place. All too often we hear—too late—of a house that has cracked because it was built on a soil that would slide or settle under the weight; of a septic tank system that failed because the soil couldn't absorb the effluent; of a little stream converted into a raging torrent during heavy rains; of important natural areas converted to problem homesites.

SCS can help local officials select suitable places for roads and structures and help design protective measures against excessive runoff, sedimentation, and property losses. These considerations need to be made before the bulldozer begins its work. In urban sediment control as in every other area of environmental concern, we need to move from corrective action to preventive action.

With modern soil surveys, we can predict many pitfalls that might confront a builder. The demand for soil surveys—and the ways in which they are used—continue to increase. We have just issued a guide to help our soil scientists and biologists develop soil interpretations and suitability ratings for wildlife habitat. Suitable soil is vital to producing desired populations of wildlife.

There is need for more precise interpretation of soil suitability for many uses, and for classifications or ratings that can be used by the layman. In Maine, SCS and several other agencies cooperated to rate the soils in that state for various uses. Under Maine's new Site Selection Act and Land Use Regulation Act, state agencies use the soil-suitability guide in reviewing applications for urban development. The proposed development must either fit the land or safeguards must be planned to adapt the site and avoid soil and water problems. These two laws have helped reduce sediment and other pollutants, and helped preserve wetlands and other unique areas.

Several other states recently have enacted legislation dealing with sediment control and broader land-use considerations. This is a most encouraging trend. Several have recognized sediment as a pollutant and authorized penalties and control programs. Some give local conservation districts authority to guide land grading and urban development. More and broader legislation is needed at all levels of government. The challenge is on all of us to help land-use changes come in an orderly manner to the right places, based on quality standards.

We need some fundamentals to guide us. Among these would be national land-use policy—in which the local-state-federal partnership concept can be fully effective. Not all lands are suitable for all purposes. Prime agricultural land, to permit continued efficient agricultural production, should be allocated to that use wherever possible. Needs for industrial and institutional sites, highways, recreation areas, residential development and the like must be considered. Unique geological formations, wetlands, and many other landforms important for wildlife or scenic values—environmental corridors—need full consideration. The desires of local people—landowners and land users and interested groups and organizations—also must be considered in the decision-making process.

This kind of planning and development can assure that land-use patterns meet the best total interest of every community—and make a major contribution to improving the environment while helping the United States grow economically.

These challenges must involve every one of you. By working together to improve mutual understanding of our respective roles, projects and plans, I am convinced that your organizations and the SCS and local conservation districts can do a better job to assure a high-quality environment for man and wildlife.

It's worth the effort.

DISCUSSION

CHAIRMAN FISHER: Dr. Grant's presentation has served to remind us that erosion is an exceedingly complex problem. The past emphasis has been placed pretty largely on land loss. Today, while this is still important, we must look beyond this and evaluate the off-site effects of erosion. The presentation is now open for questions or comments.

MR. ROLAND CLEMENT (National Audubon Society New York): I would like to express a point of view that will complement Dr. Grant's interesting presentation. I begin by reminding Dr. Grant that I got involved in the conservation movement at about the same time Hugh Bennett became Mr. Conservation. For a decade and more the U.S. Soil Conservation Service was for many of us the preeminent conservation organization, the one we looked to for the most dynamic thinking. And I say this, Dr. Grant, to put you at ease in that in a professional conservation group like this, you are among friends.

At the same time, I want to take advantage of this opportunity to call your attention to the fact that among this professional audience there are very many of us who are concerned about some of the recent directives of the Soil Conservation Service. Of course we must recognize that the crop subsidy program in our own United States has certainly spurred intensive use of land and created some of the problems that you properly complain about. And Dr. Fisher's own organization, Resources for the Future, just a few years ago, pointed out as a result of a study of the Midwest that perhaps less than 30% of the land was being properly used according to modern understanding. Your own paper, Dr. Grant, certainly suggests that although we have done much work we have not, perhaps, made nearly so much progress. And I want to particularly stress the fact that the current implementation of Public Law 566 that has to do with the channelization of streams seems to me to fly in the face of science.

First of all, we are most of us agreed that there is no effective demand for more agricultural production in the United States. Three national commissions have told us that we should not be investing federal money in bringing more land into production, and yet this is the principal objective of channelization. Recently, geographer Gilbert White reminded us that the Soil Conservation Service, despite 20 years of study of the upstream effects of small watershed projects, had really not succeeded in demonstrating that they made any difference. We know intuitively that we should prevent erosion, of course, and that's enough reason for doing so, but I am suggesting that channelization is the reversal of the good trend that the Soil Conservation Service instituted 35 years ago.

The crux of my comment is that our rationality, our scientific understanding, is still primitive. At the same time we must not let the call for more study blind us to the fact that perhaps what we need most of all is a little bit more humility in applying what we understand so poorly. And Dr. Grant, what I'd like to do is to conclude my suggestion to you that since you have the ability of having such programs reviewed at very high levels, you include the recommendations of Dr. Maurice Arnold of the Bureau of Outdoor Recreation in Denver, to the effect that instead of channelizing streams, the Soil Conservation Service should work out a program to protect the flood zones of these streams, in this way both helping the farmer and contributing to the preservation of natural ecosystems, and therefore helping to answer the call for a better balance between natural and developed ecosystems that the Odoms made so forcefuly for us in yesterday's panels. Thank you.

VICE CHAIRMAN SCOTT: Thank you Dr. Clement. There being no further questions or comments, I shall return the session to the Chairman.

CHEMICAL CONTAMINATION OF SOILS AND WATERS

A. W. TAYLOR

Research Chemist, U.S. Soils Laboratory, Soil and Water Conservation Research Division, Agricultural Research Service, U.S. Department of Agriculture, Beltsville, Md.

In examining this subject the first question that should be clarified is "what is a contaminant?" This itself can be an awkward point, and much space could be devoted to defining contaminants in relation to chemicals deliberately added to improve soil fertility for a crop, to counteract the effects of "natural" contaminants such as salts, excess free aluminum causing soil acidity, or carbonates and calcareous materials that cause alkalinity. In a broad sense predatory organisms such as insects, nematodes or fungi should be included as forms of biological contamination, particularly where their numbers increase when a host plant is activated and provides an increased food supply. Although not soil related, the infestation of the cotton-growing regions of the southeastern United States can be regarded as a contamination problem.

For the purpose of the present discussion, chemical contaminants in soils will be counted as those which are added to soils (or waters) for a deliberate purpose, but which, as they accumulate or persist, produce undesirable side effects on non-target organisms.

Although there are exceptions, such as the deposition of lead and other heavy metals as a consequence of their presence in fuels, the bulk of chemicals that enter the soil-water system are deliberately added for a specific purpose as part of a management system to improve agricultural, horticultural or forest productivity. Considered in this light, when contamination problems arise they must be considered as a part of the cost of the management for increased productivity. The central problem that now faces us, although it is often disguised in other forms, is the evaluation of this social or ecological cost, and how the basic management system in which the chemicals are used can be modified to reduce this to acceptable proportions. In doing this both benefit and cost must be weighed, difficult though this may be when it must be done in terms of social and environmental factors that are difficult to enumerate in quantitative terms. Even attempts to state the problem in terms of the effect of reduced fertilizer or pesticide use are bedeviled by the assumptions that must be made. In most of the discussions of these subjects that are presented to us the protagonists are often in basic agreement, and much of the dust and heat generated are due to the totally different assumptions that underly the attitudes which the protagonists take. When one considers the almost incredible complexity of the system of production distribution and consumption of food in a modern society, such differences in assumptions become very understandable. These complexities are rarely apparent and frequently are taken for granted until difficulties arise. When this happens, few, if any, are in a position to understand the whole picture and it is hardly surprising that many points of view are found.

Basically most environmental questions are concerned with management. This is very clear in the problems of agricultural production. The farmer, in his endeavors to create favorable conditions for the growth of carefully selected and highly specialized crops, is an environmental manager above all else. His basic mission is to maintain an ecologically unstable system that will rapidly revert to an unproductive condition if left to itself in the face of weed and insect infestation and climate.

The degree of success to which the positive side of this sector of environmental management has been raised in a modern economic community such as that of the United States is evident from the shrinkage of the agricultural base itself. Some pertinent statistics are summarized in Table 1, for the period since 1940 (U. S. Department of Agriculture, 1969). This period is of particular interest since it covers the development of a high and intensive agricultural system. Despite the increasing restraint imposed by the need to feed and clothe a population that increased by 48 percent, the demand was

TABLE 1. CHANGES IN AGRICULTURAL PRODUCTION RELATIVE TO POPULATION IN THE UNITED STATES FROM 1940 TO 1967

Year	1940	1967
Total population (millions)	132.1	195.7
Farm labor force (millions)	11.0	4.9
Persons per farmer	12.	40
Total harvested acreage (millions)	345	308
Harvested acreage (per capita)	2.61	1.57

fully met with a decrease of 11 percent in the actual land requirement, and of 55 percent in the labor force, so that one farmer now supports over 40 other people. It may be noted that this number of persons only rose from 4 to 12 over the whole century preceding 1940.

These advances are based upon three primary inputs. These are the introduction of high-yielding varieties of crops, the use of agricultural chemicals for increased fertility and the advantages offered by mechanization both in field operations, bulk handling and transport of produce. The consequences of two of these, the biological improvement of the crop and of mechanization, are not of primary importance in the impact of the farming system on the rest of the environment and will therefore not be discussed here. Their importance as part of the whole management system should not, however, be discounted. All three factors are intimately interlinked and any change in the third, chemical, factor could not be made without reducing the advantages to be gained from the other two.

The principal environmental problems associated with agricultural chemicals arise from their mobility, as with nitrate which is removed readily from almost all soils that are leached with moving water, or from their persistence. With persistent materials, of which the organochlorines are the most notorious example, their lower mobility is offset by their tendency to accumulate in non-target organisms over longer periods of time. The range of properties of the chemicals used in agriculture and the wide differences in their behavior in both the agricultural system is so wide that no generalizations are possible. The extent to which their mismanagement causes environmental problems is best considered in the light of these effects and their causes. When the causes of the problem are identified it then becomes possible to identify remedial measures for their control.

One way in which fertilizers can be distinguished from other categories of agricultural chemicals is that they are composed of materials that occur in nature. They are not "artificial" in the sense that they are exotic chemicals that were not present in natural systems before they were introduced by man. The problems associated with their use are therefore largely due to the unwanted increases in fertility of waters when the nutrient contents become too high. This is the process of eutrophication. Whether or not this is bad depends upon the use that we want to make of the water. Many marshes and wet lands, which are the natural habitat for many forms of wildlife, are prime examples of this process occurring on the natural scale. For many other purposes, including recreational use for sailing, swimming and some kinds of fishing, pure, clear and nearly barren waters may be more desired. Where this use is wanted in a lake surrounded by high fertility land, it is clear that we may have a management problem to reconcile the two systems.

In considering the phosphate problem, which has been discussed at great length as one of the basic causes of eutrophication, it is useful to consider the very small amounts of material involved. If we accept a concentration of 0.03 parts per million as the limiting concentration above which algae blooms may occur, other conditions being favorable, we find this represents 37 grams (or 1⅓ ounces) of phosphorus in a body of water covering 1 acre to a depth of 1 foot (30 cm). This corresponds to about 140 grams or 4.8 ounces of calcium phosphate, which is the active part of superphosphate fertilizer. These amounts are very small and are close to those often present in natural systems themselves. Table 2 contains data obtained at Coshocton, Ohio, comparing the quantities of phosphorus carried by two streams, one draining farmland and the other unfertilized woodland (Taylor, 1970). Although the amount removed from the farmland is definitely higher than that lost from the woodland, which has received no fertilizer or treatment since 1940, the amount lost by the woodland gives a good index of the levels that are to be expected in a natural and undisturbed ecosystem.

The most serious danger of phosphate contamination occurs when there is runoff from cultivated land, where fertilizer has been applied and still remains on the surface. The actual quantities are difficult to predict because they depend upon the intensity and duration of the runoff and rainfall and the amount and character of the fertilizer applied. Under adverse circumstances concentrations of over 1 ppm can easily be reached, so that for short periods of time the amounts may be as great as those associated with untreated sewage effluent,

TABLE 2. AMOUNTS AND CONCENTRATIONS OF PHOSPHORUS IN STREAMS DRAINING WOODLAND AND FARMLAND AT COSHOCTON, OHIO, BETWEEN 1966 AND 1969

	Average phosphorus concentration (ppm of P)	Average annual total of phosphorus removed (grams/hectare)
Farmland	0.022	56
Woodland	0.015	20

which is however a continuous process. The remedy for this situation lies in land management. Research has shown that if the fertilizer is incorporated in the upper few centimeters of the soil, either by band placement or cultivation after application, the amount lost can be reduced by over 90 percent. An equally obvious improvement is that of controlling the runoff itself. Phosphate salts are very strongly adsorbed by the mineral colloids present in all fertile soils and do not move downward in water percolating through the soil. Reduction of the amount of water moving over the soil surface will therefore go a long way towards fertilizer control.

The problem of controlling losses of nitrogen, almost always in the form of nitrate salts, is different in character. In addition to being free to move in the soil water, there is no fixed amount of nitrate present owing to the complexity of the transformations that take place between the various forms of soil nitrogen. Under native conditions, without fertilization, gaseous nitrogen was fixed by soil microorganisms and utilized by plants. The amount taken up was then returned to the soil during the decay of plant tissue. In this way a natural cycle was established with a reserve of organic forms of nitrogen in the soil, although it should be realized this was not completely closed. Oxidation of organic matter naturally leads to nitrate formation, and some would always be lost in the water passing through the system.

When such systems are brought under cultivation the depletion of the organic reserve is accelerated and nitrate production increased to produce levels greater than those demanded by the plants. Leaching of nitrate is therefore increased during this process. Estimates of the balance existing in this process made for the whole United States in 1930 (Lipman and Conybeare, 1936) indicated that 4 million tons of nitrogen were being lost annually by leaching alone. A further loss of 5 million tons were also lost by erosion. Only 0.3 million tons were replaced by fertilization. More recent estimates (Stanford *et al.*, 1970) suggest that in 1969, leaching losses amounted to 2 million tons. This, together with erosion losses of about 3 million and crop removal of 9.5 give a total estimated removal in 1969 of 14.5 million. Present nitrogen fertilization rates account for a replacement of about 6.8 million: when allowance is made for the input from natural fixation, return by animal manures and other sources, it is evident that the present situation is closer to a balanced situation than that of forty years ago despite the increased demand required to support the present population.

Broad statistics of this kind are however of little value in identifying the places were particular troubles arise. Fertilizer application rates and crop demands vary widely within the United States, and there cetainly are situations in which excess quantities of nitrogen are being used. The solution to the problem is again one of management. In the past, recommendations for the amounts of nitrogen required have been based primarily upon experience of the amount required for a given level of production. Considerable progress has, however, been made in the last few years toward improved methods for estimating fertilizer requirements. These methods are based upon calculations of the demand by the crop, which can be calculated from the amount that it is known to contain, and chemical tests that will indicate the amount that we can expect to become available from the soil reserve during the growing season. The addition of the balance, as a suitable nitrogen fertilizer, will then permit maintained productivity without overuse which leads to the accumulation of the excess unused nitrate in subsoil and groundwaters. There is also a good possibility that the further development of slow release fertilizers, which release nitrogen at a rate parallel to the crop demand, will permit further improvement. Soil management practices including the timing of fertilizer application are important. Once a crop has become established there is rarely any downward movement of water through the soil because of the crop demand for water. If, however, fertilizer is applied too early to a moist soil, soluble nitrate can be carried below the root depth and may be lost to the plant before it has time to grow, emphasizing the need for delay in fertilizer application until leaching has essentially ceased.

The problems associated with pesticide residues in soils and waters are of an entirely different character to those of excess levels of nutrients. As noted earlier, essentially all pesticides are exotic compounds that have been introduced by man. The wide variety of chemicals used to control insects, weeds, fungi, nematodes and other pests is so great that any detailed analyses of their behavior is impossible within the scope of this discussion, but some generalization can be made, based upon the type of material and the purpose for which each is used.

The most difficult environmental problems that have arisen have been those due to the organochlorine insecticides. The two features of their behavior causing these problems have been their persistence and high degree of solubility in fats which are responsible for this re-concentration in the food chain, leading to their accumulation in a number of species. The range of persistence times of these compounds in soils is rather wide, ranging from 95 percent disappearance times of 10 years or more for DDT and dieldrin to about 2 to 3 years for heptachlor and lindane. The main process of loss from soils, even with the more stable compounds, is that of a slow chemical or biochemical degradation. The fractions which move from soils to other phases of the environment—air, water, and absorbed by crops—are usually small, provided that the compounds are mixed into the body of the soil soon after application. This is usually the case where they are directly applied to soils to control soil-borne predators. Research on the fate of dieldrin cultivated into soil to control corn root worm has shown in the first year about 3 percent is lost by direct volatilization to the air. For an application of 2.2 kg/hectare (2 pounds/acre) this is a loss of about 60 grams/hectare over the growing season. After the first year the rate probably drops by an order of magnitude, to about 5 grams/hectare/year. This loss can undoubtedly be reduced considerably if the material is applied in a band application within the corn row and covered with fresh soil. Owing to their high adsorption by the organic matter the movement of organochlorines is very slow, and they show very little movement away from the site of application.

Apart from volatilization, which occurs from that fraction of the pesticide that remains close to the soil surface, the second most serious cause of environmental contamination from soil-applied materials of this kind is due to that bodily removed into a stream when erosion and soil movement take place. This is of course a much more erratic process, the amount being carried depending upon the amount of soil moved, which varies greatly from year to year. In studies continued over four successive years, the maximum removed in this way from experimental watersheds in Ohio planted to corn was 3.3 percent of that applied. In two of the three years the loss by the pathway was zero, since there was no erosion. The maximum loss took place in 1968, when the watershed was deliberately managed to give conditions favoring erosion. The use of known conservation practices could have prevented the loss completely. The ultimate fate of a persistent pesticide moved with eroding material is difficult to predict. It will of course act as a slowly available supply to the waters in the stream in which it is deposited, but the concentration reached in the water will depend upon the extent of its readsorption by other sediment material such as those derived from stream-banks which do not contain the material. Nevertheless, since the material may be re-concentrated in the tissue of fish and other aquatic organisms it will then enter natural food chains and constitute an environmental hazard. Where it may remain necessary to apply such persistent pesticides directly to soils it is clear that this should only be done in conjunction with known conservation practices that will control the erosion itself.

The third most conspicuous cause of contamination of water from pesticides applied to soil is that carried in solution in runoff. In the same studies in Ohio the amounts removed in this way were very small, amounting to less than one twentieth of one per cent of the total ($< 0.05\%$). The highest concentrations found were in the range of 10 to 20 parts per billion and always occurred in runoff produced soon after application. The concentrations, though erratic, showed a consistent decrease with time, and fell to 2 ppb or less in the second year. The actual quantities removed, as opposed to the concentrations, depended upon the amount of water flowing off the soil, and could, as with the erosion problem, be eliminated if runoff were prevented. Data indicating similar orders of magnitude for runoff losses have been found in other studies using other insecticides and herbicides.

Owing to their long persistence times, the organochlorines such as DDT and dieldrin represent an extreme example of an environmental control problem. This, coupled with their widespread and liberal use has made them conspicuous in this respect. The present trend towards the introduction of less persistent compounds, such as organophosphates and carbamates, although these in some cases have much higher acute toxicities, offers many opportunities for the better pest control without increased environmental cost. Compounds which decay more rapidly, within a period of weeks or months, and do not have the property of accumulating in fatty tissue so that they do not accumulate in food chains will clearly present much smaller hazards.

It must of course be recognized that the differences in their behavior will require the careful development of improved management techniques for their use. One of the basic advantages of persistent materials is that the timing of their application is less critical. Once present in the soil or plant system they remain active and can be applied in advance of the emergence of the pest and continue their control effects independently of its biological cycle. Less persistent materials, whose activity decays much more rapidly, require much more careful application timing to maximize their effects while pest populations remain low and most easily controlled. Considered together with the other factors in the system, such as the danger of pesticide movement by runoff and erosion, which is always present where these processes are allowed to happen, and the variations in persistence and extent to which different chemicals are retained by soils, it is clear that the management techniques required will be much more sophisticated than those in the past.

It is increasingly clear that the development of such management methods, and the generation of the basic information to support them will be the main preoccupation of our agricultural and conservation research programs for at least the next two decades. Viewed in a broad perspective, the fundamental preoccupation is one of cost—

efficient and economic food and fiber production at a minimum cost to the environment. Although the latter cost has become most evident in the more highly developed countries of the world in recent years, the problem is really worldwide. As long as populations increase and demand rises, the basic pressures on our resources must inevitably continue. This problem is illustrated by the data presented in Table 3, which are summarized from a study of the consequences that would follow the restriction of fertilizer use in the United States (Mayer and Hargrove, 1971), taking into account the projected demands on production imposed by the increase in population. In these projections the average rate of 110 lb/acre corresponds to continuing the present levels of use, 50 lb/acre a reduction by half, and zero abandonment of fertilizer use.

Aside from the impact of price increases on diet and the cost of living, the data show that increased amounts of land would have to be devoted to crops requiring cultivation and row cropping. This implies an increased conservation problem to avoid increased erosion and runoff problems. It is therefore, highly likely that restrictions in fertilizer use would lead to increased adverse effects in water quality. Although data on the consequences of pesticide restriction are not included, the consequences would follow the same trend owing to the need to use more land to make good the reduced yields.

The basic cause for the present pressure in our agricultural, forest and other land resources is the need to meet the demand imposed by an increased population. The basic lesson of the data summarized in Table 3 is that there is now no road back to the simpler management systems of an earlier time. While undue reliance has perhaps been placed upon the role of chemicals in agriculture in the past, the only path that appears open to us is to learn to bring them into place as a

TABLE 3. PREDICTED EFFECTS OF CONTROLLING FERTILIZER USE ON CROP YIELDS, ACREAGE REQUIREMENTS AND CONSUMER COSTS FOR MAJOR CROPS AND FOODS IN THE UNITED STATES

Crop or Commodity	Actual 1969 values	Estimates for projected levels of fertilization in 1980 Average fertilizer use (lb/acre) 110	50	zero
		Yields (bushels/acre)		
Corn	83.9	85.8	70.2	45.8
Soybeans	27.3	27.5	27.5	27.4
Wheat	30.7	34.8	33.0	20.7
		Acreage (millions) required		
Corn	54.6	60.7	75.9	103.0
Soybeans	40.8	44.5	44.3	24.7*
Wheat	47.6	38.9	44.3	49.7
		consumer expenditures (billion dollars)		
All food	95.3	117.0	118.7	134.0
All meats	28.5	37.1	38.3	47.2
Poultry, eggs	7.4	9.1	9.7	13.8

*Decrease due to diversion of land to other crops.

part of an overall management system where the costs, both economic and environmental are brought as low as possible consonant with the basic needs that must be met.

Agriculture, although the oldest and most basic of human environmental management activities, is only part of a wider picture. As we are all aware, the need for total resource conservation in the widest sense is the increasingly imperative need if the natural balances of the life of the earth are to be maintained in a stable equilibrium.

LITERATURE CITED

Lipman, J. C. and Conybeare, A. B.
1936. Preliminary note on the inventory and balance sheet of plant nutrients in the United States. New Jersey Agr. Exptl. Sta. Bull. 607.

Mayer, L. V. and Hargrove S. H.
1970. Food costs, farm income and crop yields with restrictions on fertilizer use. Center for Agricultural and Economic Development, Iowa State University, Ames, Iowa.

Stanford, G., England, C. B., and Taylor, A. W.
1970. Fertilizer use and water quality. Agric. Res. Service, U.S.D.A., ARS 41-168.

Taylor, A. W., Edwards, W. M., and Simpson, E. C.
1970. Nutrients in streams draining woodland and farmland near Coshocton, Ohio. Water Resources Research 7, 81-89.

United States Dept. of Agriculture.
1969. Handbook of Agricultural Charts and Statistics. U.S. Government Printing Office, Washington, D. C.

DISCUSSION

MRS. PATRICIA DEE CARPIO WHITING (Tigard, Oregon): I represent Zero Population Growth at this Conference. I, for one, do not think that because we have a predictable population increase that we should continue increasing the use of pesticides. We need to curb our use of pesticides. I will cite two references to back up my opinion. If anyone is interested, they can look into them further. The first: from *Medical Opinion,* volume 7, No. 5, May 1971, page 6. By Dr. Walter Pories. And my second reference: Clinical Applications of Zinc Metabolism, International Symposium, Case Western Reserve University Medical School, Cleveland, Ohio, October 29, 1971, Dr. Walter Mertz. Thank you.

ROLAND CLEMENTS (National Audubon Society): I was a bit surprised to hear Dr. Taylor say that current investigation suggests that the main pathway for the movement of a chemical like Dieldrin is volatization. I wonder what the role of biological migration is, Doctor. A few years ago in taking part in a symposium on this question, with specialists of the U.S. Department of Agriculture, I was quite amazed that no one had paid attention to biological migration. The point is, of course, that all soil organisms have liquids and that these organo-chloride chemicals are therefore absorbed and then that many of the soil organisms reaching the surface are probed from the soil by vertebrates, like birds for example, and taken from the plot. In other words, has USDA research taken account of possible biological migration in reaching these conclusions that you have reported, Dr. Taylor?

DR. TAYLOR: I think this is a question of scale. The pathway of biological migration, I think, is probably more direct and immediate in the reconcentration in the food chain. I suspect it is a good deal swifter as the materials go up the food chain to the creatures which suffer more seriously from them. I was rather thinking when I spoke of the mechanism of distribution on a larger scale, on a state, continental, or even global scale. I personally am convinced that the volatility of these materials is the reason why they are found in the arctic region. The amounts in the air are very small indeed. But these move directly up and out into the air, and the reconcentration occurs when they come down in low but sometimes measurable concentrations in the rainfall on a wide scale. I would say, again, that this is one of the very reasons why they spread. And the next step in this pathway is that they get into the seals and the eagles. Thank you.

DR. KENNETH BOWDEN (U.S. National Water Commission): Dr. Taylor, there are obvious implications of your talk and in experiments and their results that are now emerging, which show that agriculture must reformulate its former production functions. That is, in the old days, if you had statistical validity, you could have experiments in which nitrogen and phosphate, and potassium and a few trace elements were put into the soil and yield was measured against the amount applied, obviously without taking into account the other externalities and effects. What I now would like to know, is what is the present state of the art in terms of now reformulating and reinvestigating the so-called production functions in agriculture, probably both at the federal level and at the land-grant college level?

DR. TAYLOR: I can more easily speak for the federal level but I am pretty certain that everywhere, and I am on a day-to-day basis with the federal and with my colleagues in the land-grant colleges, these problems are beginning to bite very much into our minds. You are right—the old methods were simply based on output, and for their day and time, I think they did a wonderful job. One thing we lack—and here I have to speak a little about nitrogen—is a good soil test for the amount of nitrogen in the soil that is going to become available to a plant in the coming year. Intensive work is, to my personal knowledge, going on in this area and within the ARS we have a number of related experiments in progress which cover most of the U.S., work which is looking into all three aspects of this question, work on the nitrogen mineralizing power of soils, the yield question of how much fertilizer you use, and direct measurement in all cases of how much residual nitrogen remains in these soils. It's a considerable problem when you consider the variation that we have to look at—conditions from the Imperial Valley in California to those of the Palouse and to the Southeast. We are very conscious of this, and it does mean, that we have to rethink some of our experimental approaches. I know some of the older people would hoot me down statistically on the work which I have described because we had one set of observations in each year. This was because we cannot work on the old field plots scale in this way. You've got to go out and look at nature as she is, and nature is variable, and you've got to find out what is going on in one place, identify the causes of what's going on in that place and then learn to extrapolate to others. I know this problem and I am very conscious of it myself. I am one of those who drive people out of the laboratory, and I say go and look at what is happening under God's heavens. This is where the problem is.

* * *

RECYCLING SOLID WASTES: ADVANCES AND NEEDS

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Energy conversion and the manufacture of material goods are the two foundations upon which our civilization is built. And it has been so since primitive man first developed fire and clothed himself in an animal skin. There are, of course, many tie-ins between the two.

Natural resources such as fossil fuels are either used directly by energy conversion industries or indirectly after being converted or purified by material processing. The energy thus produced is either used directly by the economy or indirectly through the conversion of other natural resources to salable commodities. Thus, energy and goods pass to final consumption points. All along the processing line and after final consumption, these twin streams generate environmental insults or "pollutants" as unwanted residuals or discards. This concept has been graphically illustrated in the literature (Rose, 1970).

The reasons civilization has been built upon energy and material goods are complicated indeed. Yet, we can attribute major emphasis to the fact that this is really a very hostile planet for man. Imagine, if you will, the few places in the world where this "hairless ape" could survive and propagate without the use of energy or things.

Yet, by virtue of his adaptability, Man has been able to extend his domain to the far reaches of the Earth and even to outer space. He has done this, not through evolution or natural selection, but by using his intellect to create an artificial environment that is compatible with his physical well-being.

Today, we are seeing the fruits of that expansion, both in terms of vastly increased living standards and as an adjunct, a tremendous proliferation of environmental insults. Our fouled waterways and even oceans, our polluted air and our moldering refuse heaps are monuments, as it were, to Man's progress.

There are those who advocate retrenchment, a going back to simpler times, as the solution. These believe that environmental pollution is irrevocably tied to technological progress, and they make some strong points. Our known supplies of petroleum, ferrous metals, non-ferrous metals and even nuclear fuels are measured in tens or, at most, hundreds of years. They point out the truism that this is a finite planet—a spaceship if you will—that cannot logically support an ever-increasing population and technological expansion—both of which have been expanding exponentially for some time.

[1] In the absence of the author, this paper was presented by Mr. Gilbert Bourcier, Reynolds Metal Company.

But, we should also ask is such retrenchment really necessary or even possible at this time. Taking the latter first, perhaps one third of the world's population is literally starving. Even in the United States, are we going to tell our poor that their lot is never going to get any better? That our goal is to *reduce* rather than increase our general standard of living?—I think not. To some the answer is a redistribution of wealth. Some simple arithmetic shows vividly that this isn't the answer either. There simply isn't enough wealth to go around. The pat answer here is that there are too many people.

Maybe we're being too pessimistic. Maybe the answers are here. Centainly, indefinite expansion of population and technology cannot be tolerated, but, perhaps, we are not even near the limit. I submit that there is some evidence that this is the case, at least insofar as our resources are concerned.

Regarding materials, or natural resources, we have a rather interesting phenomenon. In his use of *things,* Man actually uses up very little. A modern U.S. automobile generally weighs about 4,000 pounds when it leaves the factory. After eight or ten years of use, the car still weighs just about the same. It is "worn out" in the sense that it is no longer an effective means of transportation. The same holds true for clothing, beverage containers, newspapers and almost all of the material accouterments of our modern civilization. To be sure, to reuse or recycle these items will take some energy, but often far less than replacing the used item with a new one made of virgin materials. Also, there will be losses in the remanufacturing process—the recycling industries, if you will. In my industry, aluminum, these losses can run up to 10 percent using today's technology. Even here though, we've extended the basic availability of the material by ten fold. If we can reduce our loss to one percent, we have increased the availability 100 fold.

Furthermore, when a discarded product is reused or recycled, the many so-called "environmental insults" associated with the product are reduced. At every stage in a manufacturing process there is a potential for pollution. Recycling shortcircuits the whole product manufacturing process and reintroduces the material near the end. Thus, recycled wool, for example, eliminates the real or threatened pollution associated with the animal waste from the sheep, the fertilizer used to grow the corn to feed the sheep, the pesticides used to control his ticks (and the manufacture of these pesticides), the harvesting of the wool, and degreasing it. Parallel situations can be described for almost every recycled commodity.

You will note that I've referred to reintroducing the recycled product into the manufacturing stream rather than reusing it as is—*i.e.*, a returnable product. I think it would be well here to pause and really define this word "recycle" since there is so much confusion in terminology in this whole area.

I prefer to define recycling as the reuse of a product or material *in any form whatsoever*. Certainly a *returnable* product is *recycled if* it is returned. However, returnable is but a small part of the definition of recycling. Some products can be salvaged and the basic materials reused to make new products. Others, perhaps can best be converted to totally new items or their basic energy and chemical constituents can be used.

Another pertinent definition is that of solid waste itself, which in the general senses, can be defined in the negative sense as any waste that is not air or water borne. Examples include everything from slag heaps to junk automobiles to the contents of the nation's garbage cans. The major emphasis of this discussion will be on mixed municipal refuse—the refuse generated in the households of the nation. This is a particularly critical part of the overall solid waste picture since so much is generated in relatively small geographic areas. Municipal refuse alone amounted to over 250 million tons in 1967 and probably exceeds 300 million tons annually today.

By applying known technology and the broad definition of recycling, it is possible to reduce the amount of residuals to be disposed from municipal refuse of by at least ten fold and, ultimately reduce these residuals to virtually zero.

Contrast these figures with the achievable goals of retrenchment. If one were to totally eliminate the beer and soft drink industry, for example, to get rid of their total packaging contribution to the solid waste load, the U. S. solid waste would be reduced by only 3½ percent. Solid waste is growing in the U. S. at a rate of 4 percent per year so even this extreme measure would buy only 10½ months of time. One of these industries, alone, beer, contribute about $2 billion dollars annually to the economy in direct taxes which is about *40 percent* of the bill for collecting, transporting and disposing of *all* municipal solid waste generated in the country.

If we eliminated the entire packaging industry from the scene, we would reduce municipal refuse by under 20 percent. We would also eliminate packaging's $20 to $30 billion input to the U. S. economy. It appears that while attempts to reduce solid waste at its source should be made by every effort industry can bring to bear on this problem, recycling offers a way to do the job to a far greater degree and do it in a way that will not require vast changes in American life styles and industrial productivity.

We have made great advances in the area of recycling in just the last few years. The first piece of federal legislation regarding solid wastes was passed only seven years ago in the form of the Solid Waste Disposal Act of 1965. It is indicative of the change in society's attitude that the subsequent Federal Act has been named "The Resource Recovery Act" of 1970.

While recycling of industrial scrap is nothing new and certain commodities such as waste paper and industrial scrap metals have been recycled for years, what is new is the attitude, the awareness on the part of the general public, industry and federal officials that recycling is a concept that makes sense as a way to reduce solid wastes and conserve resources at the same time. At the federal level we have The Resource Recovery Act of 1970. At the industrial level, a number of the nation's largest materials suppliers, product manufacturers, beverage industries, and retailers were responsible for the formation of The National Center for Resource Recovery, Inc., a new non-profit organization formed in 1970 exclusively to implement recovery of resources from the nation's garbage. From the youngster in grade school through organizations such as the Scouts to the ordinary citizen, recycling is now recognized as a desirable goal. Many elements of society with deep philosophical differences, such as the hippie and the businessman, are uniting in the common cause.

Nor has the movement to recycling in just the last few years been merely emotional, legislative, and devoted to the forming of new projects and organizations. Concrete progress is being made. Processes have been developed to handle that traditional symbol of solid waste—the junk automobile. Large central processing systems have been developed where entire car bodies are shredded and passed over magnetic separators to separate for recycling the ferrous metals. More recent innovations have added air classification and dense media systems to extract the copper, zinc and aluminum as well. Last year over 7 million used automobiles were recycled and, in my judgment, this problem is well on its way to a solution.

In the area of consumer products, the aluminum industry has established a broad-based network of redemption and processing centers where aluminum cans and other used aluminum consumer scrap can be redeemed for cash. These facilities now exist in virtually every geographic location where aluminum cans are generally available.

Last year, over 770 million aluminum beverage cans were recycled which is about 13 percent of the industry's total production. This, by the way, is from an operation that did not really begin on a large-scale basis until 1970! Steel can and glass bottle reclamation programs are also underway.

In the area of processing municipal refuse, a West Coast company, Los Angeles Byproducts, now has in operation in several locations a method of retrieving ferrous scrap from municipal refuse and recycling it to the copper industry for use as precipitation iron. The Black Clawson Company is operating a wet pulping process in Franklin, Ohio, where 150 tons per day of raw refuse is being processed to make reclaimed paper fibers. This facility also has the capability to retrieve ferrous and non-ferrous metals and glass.

The U. S. Bureau of Mines in its College Park, Maryland Laboratories has developed a pilot-scale incinerator ash recovery system where ferrous and non-ferrous metals and color-sorted glass cullet are being retrieved from incinerator ash.

Even composting plants in the United States which, in general, have trouble finding markets for their finished product, have still contributed substantially to the field of resource recovery in the last few years. Innovative systems for processing refuse to automatically retrieve paper and ferrous metals have been recently employed at several composting plants. These systems will have general applicability regardless of the ultimate fate of composting as a solid waste-processing scheme.

In terms of laboratory research, paper studies and pilot-scale operations, a vast expertise is being generated in the field of resource recovery in the United States. The list of government and industrial projects is known to be long and ranges from the above-mentioned programs to such exotic new concepts as hydrolysis, pyrolysis and direct-fired gas turbines as ways to retrieve a whole spectrum of organic liquids and gases and/or energy from refuse. These technical advances are particularly exciting when it is realized that they, too, are recent, with most projects being only 2 or 3 years old. A partial listing of pertinent government and/or industrial recycling activities is given in Table 1.

Yet, more needs to be done if we are to approach the solutions to the solid waste problem in a coordinated workmanlike manner.

States should be encouraged to set up regional planning districts where all aspects of the solid waste collection, transportation and disposal or recycling functions can be coordinated to take advantage of economies of scale, if for no other reason.

I believe in the area of recycling solid wastes we are at the beginning of a vast new industry—an industry that will bear striking resemblances to our present-day utilities such as gas, electricity and communications. The new utility will, like its present-day counterparts, be regional in scope, and steps should be taken now to encourage its formation.

On the technical front, I believe we must begin to move at the federal level to help set up prototype demonstrations of solid waste recycling systems. I am disappointed at the attitude of some government officials who say that "the technology exists—we must first establish markets." The technology does exist to process municipal refuse into a myriad of potentially useful products. But, the costs of

TABLE 1. PARTIAL LISTING OF GOVERNMENT AND PRIVATE RECYCLING PROJECTS[1]

Project Description	Sponsor(s)
Hydrapulping Municipal Refuse	Environmental Protection Agency Black Clawson Company Glass Container Manufacturers Institute
CPU-400 Turbine Generator	EPA Combustion Power Co.
Paper Recycling and Refuse Shredding	EPA Madison, Wisconsin
Air Classifying Shredded Refuse	EPA Stanford Research Institute
Hydrolysis	EPA University of Louisiana Denver Research Institute
Glasphalt	EPA University of Missouri Glass Container Manufacturers Institute
Incinerator Ash Recovery System	U.S. Bureau of Mines
Steam Generating Incinerator	Chicago, Illinois U.S. Navy, Norfolk, Va.
Steam Turbine Powered by Refuse Incineration	Union Electric Co. St. Louis, Mo.
Refuse Pyrolysis	U.S. Bureau of Mines
Pyrolysis of Municipal Refuse	Garrett Research Monsanto
Composting	Numerous Private and Federal Sponsored Operations
Plastic Bottle Recycling	Dow Chemical San Diego
Steel Can Recovery from Municipal Waste or Incinerator Ash	Chicago, Illinois Atlanta, Georgia Los Angeles Byproducts
Steel Can Remelting	U.S. Bureau of Mines University of Wisconsin
Steel Can Recycling Centers	National Steel Co. Continental Can American Can
Aluminum Can Recycling Centers	Reynolds Metals Co. Aluminum Company of America Kaiser Aluminum
Refuse Separation	EPA Vanderbilt University Franklin Institute

[1] The purpose of this table is to illustrate the types of projects underway. Complete surveys of on-going projects can be obtained from the U.S. Environmental Protection Agency, Office of Solid Waste Management Programs, Rockville, Maryland and The National Center for Resource Recovery, Inc., 1211 Connecticut Avenue, N.W., Suite 800, Washington, D.C. 20036.

obtaining marketable products is still an unknown. One can respond that the markets exist for aluminum, ferrous metals, heat energy, etc. obtained from municipal refuse, but the *costs* of obtaining them in marketable purities remains to be developed. I believe that this can be done *only* through large-scale demonstrations. These systems will be sufficiently large—500 tons per day or more—to develop the operating experience, equipment, cost and performance characteristics and marketability of the finished products. These prototype plants will cost from $5 million to $20 million apiece and at least three or four will be required to demonstrate possibly desirable systems. (Here one might consider incineration with waste heat and incinerator ash reclamation, pre-sorting of raw mixed waste followed by incineration of the organic fraction, pyrolysis with either pre or post resource recovery systems and a presorting system followed by totally new technology such as hydrolysis of the organic fraction to produce protein or ethyl alcohol.) It is inconceivable that such systems can be financed at the local level since local tax dollars, particularly in cities, are already scarce and certainly cannot be committed to unproved technology. Industrial capital, too, is limited and, to a large degree, is committed to industrial specialties rather than totally new fields, particularly when such new fields will require regional government cooperation and most probably, utility-type controls for their successful implementation.

It falls, therefore, in my judgement, upon the Federal Government to take the lead in providing the financial backing for this new technology much in the same way the field of atomic energy and space exploration was handled at the federal level, using the manpower and technology of private industry to implement the task.

I am confident that this new technology will come, but I think it can come now rather than a generation hence, if we are willing to spend the money to demonstrate the soundness of the approach. The myriad of on-going programs today will eventually culminate in virtually the total recycling of what we, today, consider municipal solid waste. A generation from now, however, we will have burned or buried about 10 billion tons of natural resources and our children and grandchildren may never forgive us for squandering their heritage!

LITERATURE CITED

Rose, Sanford.
1970. The economics of environmental quality, Fortune, LXXXI, No. 2 (February).

DISCUSSION

MISS CAROL J. SNOW (Library Reference Service, Denver, Colorado): I just wish to make a short comment. It's not the world's starving people who have to be told to reduce their standards of living but rather us who are not starving who have to be told to stop consuming to such an excess.

SPEAKER (Unidentified): I just want to make a comment and ask a question in answer to that comment. The recycling of solid waste is only one-half of the problem; the other half is collecting this solid waste. For example, the problem of solid waste from automobiles, particularly in small areas where it is not particularly feasible to recycle these wastes. In cities there are many junk automobiles and wastes from homes that are left to be collected in the same way as I suppose they did it in Roman times—put it on the street and wait for somebody to pick it up. I would urge industry to do some innovative thinking on ways of collecting the solid wastes and slurries from homes and factories so that we would have a means of quickly recycling solid waste through disposal plants such as we now have for sewage wastes, although here we are not too good at recycling. And I'd like to ask whether Reynolds is doing this type of thinking or planning with respect to disposal of these solid wastes.

MR. BOURCIER: The EPA has funded studies on the collection problems of solid wastes, but with solid wastes, the problem of collecting it only starts when you, the individual, get tired of these little treasures that you've laid out your money for. Before that they are valuable possessions.

Just as our population is heterogeneous, so are our possessions. Disposal does become a problem. I know no answer to the collection problem of solid wastes other than to reduce the loads. There have been many arguments in legislatures to abandon non-returnable containers, for example, but containers represent a very small fraction of solid wastes and some of them represent that noisome fraction called litter. But paper is about 50% of the solid waste load of our nation today. It represents about 60% of our litter. I seriously doubt if the 4th estate would take kindly to a prohibition reducing their portion of the solid waste load of this country. So much for that.

Now to talk about the automobile. The Bureau of Mines has an excellent group of engineers. They have established some dollar figures for shredding automobiles. They can retrieve about $55 worth of metals, ferrous and non-ferrous, from a shredded auto body. If an auto body can be delivered in one form or another to an auto shredder for less than $55, for some marginal profit plus the cost of shredding, this might be a feasible method of getting rid of these cars. Some states have very restrictive laws on the removal of abandoned automobiles with regard to their titling. Those states that have an enlightened view on title elimination are making quite a bit of progress in the problem of getting rid of junk cars. The automobile can be a profitable item if properly handled. This would then provide an incentive in itself to effect the removal of these cars from the stream of solid waste that collects around our cities.

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PROVIDING ENERGY AND MAINTAINING ENVIRONMENTAL QUALITY

ROBERT O. ANDERSON
Chairman of the Board, Atlantic Richfield Company, New York City

The chairman has assigned me a topic of rather sizable proportion. Either of these subjects is a monumental assignment—is probably the key issue of the day. The resolution of the one without compromise to the other is the key problem facing the world today. Concerning the problem and its possible resolution:

I think we can all agree that the problems that face this conference and the environmental age are the problems associated with man. Our present concern with the environment is actually our concern with man's impact on our global life support systems. Many natural disasters have occurred and will occur, but they are not truly the ones we are addressing ourselves to today.

Even primitive societies have had an impact far in excess of their numbers, largely through overgrazing, a common practice in pastoral societies. The vast wastelands of the Mediterranean basin and the Middle East are mute testimony to destructive grazing activities long before the birth of Christ. That damage, largely through erosion of the topsoils and impact on local climate, is the first evidence that *Homo sapiens* possessed a unique ability to modify or change his environment and, unfortunately, not always for the better.

The brief 57-year life span of this organization has witnessed a global revolution in terms of social institutions as well as changes in our basic way of life.

Twenty-five years ago, with a global war behind us, we were secure in the knowledge that the world ahead, together with man's intellect and ingenuity, would resolve all of our problems. The atomic age had dawned, a fourfold increase in annual income, plus more leisure time, appeared within our grasp. Above all, higher education would be available to virtually all. It was the great moment for idealism as it promised revolution of the most diverse opinions as we moved into what we saw as a "Golden Age." Our foreign policy reflected this suspect confidence in the belief that as the American way of life became available to all, they too would share in this great future—a future in which the individual could reach his own level of fulfillment.

This quarter of a century has come and gone and with it many of the vain hopes and assumptions which we still cling to rather than face the realities of global social life.

Energy has been the key to industrialization. It is as basic a component of contemporary western society as the food we eat. Indeed, without it most of us would not eat. As a major component of industrial society, energy furnishes a rather remarkable index of a nation's, or people's, contribution to the global environmental problems. Its use is projected to double within the next 15 years and re-double again by the end of the century.

In North America, and particularly the U. S. and Canada, we use much greater quantities of energy and confidently assume even higher levels of consumption for the future. This confidence springs from a historical abundance of relatively cheap energy and the assumption of its continued and unlimited availability in the future.

Neither of these assumptions is necessarily more accurate than our optimistic assumptions of a quarter of a century ago. The Stockholm conference on the human environment convenes in early June, less than three months hence. At that meeting, we will appeal to the world for solidarity and unity in facing the global environmental problems that will occur with the doubling of the global population.

Demographers vary on the exact date of such doubling but virtually all estimates fall somewhere in the 30 to 40 year range. All are in agreement, however, that such a phenomenon will happen.

In Stockholm, the United States stands as a family of 6 percent of the world community family of 100 percent. As a family of 6 we consume an estimated 40 percent of the global energy, resources and services. I suspect we may find something less than enthusiasm when we ask for global help in solving what unfortunately is viewed as *our* problem. We must ask ourselves—is it over-consumption on our part or is it under-consumption on the part of the majority of the world's people? Whatever the answer is, the two worlds are too far out of focus for complacency, and indeed the very distribution of resources may be radically altered in this period of population doubling.

Our space efforts, while still highly controversial, have assisted in the realization that man cannot escape from his planet as well as to enforce the concept of a finite life system. For the first time, man must face the realization that the dream of the last two centuries whereby man's achievements were limited only by his ingenuity and his mind, may lack validity in today's world. He could invent the future and essentially unlimited control over his destiny. For a brief moment we felt we stood on Olympus. Today, we find we are once again mere mortals, faced with gigantic problems that stubbornly refuse to go away.

This may very well be the Moment of Truth when we must start to think in terms of the future. Long-range planning is difficult in representative society, as political thinking is generally confined to the term of office or response to the immediate. The growing use of the so-called "discounted present works" yardstick also mitigates against planning more than a decade or so ahead. Overgrazing of pastural lands is probably the oldest and most classical form of discounted present works. A society must have belief in its future, together with reasonable security. Clearly the nomads had little, if any, of either.

DISCUSSION

CHAIRMAN FISHER: The paper just presented on this provocative subject is open for comments and questions.

MR. DAVID BROWER (Friends of the Earth): I have a few sentences and a question about what I believe is an essential role for industry. I think Professors Meadows and Forrester and others are telling us eloquently that there are limits to growth. We can no longer dream that there aren't any limits. Our numbers and our appetites for food and things are growing and there's no technical solution for making the planet grow accordingly. Meanwhile, our soil fertility and gene bank that are our biological capital are being put on a half-life basis. If we try to increase the consumption of energy in order to heal the wounds already inflicted on the planet by undisciplined use of energy, it seems to me that that's like trying to sober up on martinis. Since there are indeed limits to growth, should we not voluntarily, using our best judgement and skills, stop growing before growth has usurped the planet's living beauty and the quality of life we seek? Can you conceive of ways in which the oil industry, world-wide, together with other industries of this type, can join with conservation groups in urging less use of energy, showing how to use it less extravagantly than we do, far more efficiently, with fewer of the by-products entering our cells and our lungs? What more can you do to help lead industry around this turn in a battle to preserve a livable environment here and abroad that absolutely requires the administrative and organizational abilities of industry? A new corporate approach to leadership, I believe, is necessary and essential. How can we promote more using up of less?

MR. ANDERSON: Dave, you know how to ask tough questions. I would like to say that in the last year for the first time that I can recall there is a mood within the energy industry to take steps towards wiser use of energy. For many years, just as in all industries, there was a feeling that this was somebody else's problem. But I think we are in the period within the energy field when responsible people, the heads of big companies, are not only willing to talk about it, they're even beginning to endorse it. And I think it's going to be slow—we're a pretty wasteful society. There are two people involved here—one is the man who makes it and the other one is the man who uses it. I'm hopeful, and I may be atypical in my field, but I believe something can be done about it; I believe something has to be done about it. I had dinner with Jay Forrester and Dennis Meadows Monday evening, and I wish I could fault their book in such a way that I could throw it away and forget it, but I can't. It's a book I think we'll all have to learn to live with.

MRS. PATRICIA WHITING (Oregon, Zero Population Growth): Last year at the 36th Conference I asked various representatives of the oil industry for studies that they referred to regarding the development of the pipeline in Alaska. They publicly stated before the Conference assembly that they would contact me and give me such information. I did get response from Mr. Keith Hay of the American Petroleum Institute. He sent me much information but he said the corporations representing, I presume, several oil industries in Alaska, would send me studies I particularly requested. I guess I asked too many questions. I didn't receive one reply; I didn't receive one study.

Now, gentlemen, I was truly, honestly, trying to understand your point of view, and I was seeking to help so that I may understand, and we need social understanding, the individual exploration of the mind. In spite of that I'm still waiting for such studies to support your hypothesis that will lead to explore and develop the oil industry in Alaska. In my estimation, the lobbying that went on in Washington, D.C., in the last year to maintain the continuation of pipeline development in Alaska has contributed to the complete loss by the State of Alaska regarding the environment and the natives who live there, the caribou that they herd, and the cultural life that they lead.

MR. ANDERSON: I have to leave immediately after this, but I promise you you will get more information than you may wish on the subject.

DR. DURWARD L. ALLEN (Purdue University): I think that Mr. Anderson gave us some excellent statements of what some of our problems are and of some of the choices we'll have to make. For the next 35 years we will be trying to serve, in effect, a doubling population, while still retaining on this earth some of the things that will need to be used for a long time to come. This time perspective, for me, is particularly significant if we consider energy resources and what we are doing and will probably continue to do with fossil fuels.

Just for purposes of discussion, I think we might say that we are using a stock of fossil fuels that may have taken something like a hundred million years to deposit in the crust of the earth. It will perhaps be three centuries in which a few generations of men will take the great bulk of this stock of fossil fuels out of the earth, burn them up for the most part, and turn them loose in the atmosphere as CO_2. Now we don't know particularly what the results of that are going to be. We are taking chances there but we are also monitoring it and I assume that maybe there's no great difficulty in view. However, our former speaker said there were some things that future generations would not thank us for. All in all, these fossil fuels, these carbon compounds, are tremendously versatile. As manufacturing raw materials they could certainly serve man in a thousand ways, for thousands of years, if we wanted to use them that way, to use them prudently over a long time period. In the onrush of our culture in the past half-century, we haven't been able to think much beyond ten years. Now we're thinking to the year 2,000. But if we really had reason above the level of the outlook of the lemmings and the rabbits we'd be thinking in terms of centuries, and of thousands of years; and that, I believe, is the perspective in which a lot of our planning is going to have to be done. Maybe we won't do it until we get over this population hump here at the end of the century and beyond, and we don't know how we are going to come out of that, but I believe that the outlook for the fossil fuels is clear enough so that we could be doing some very constructive planning right at the present.

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LEGAL APPROACHES—PRECEDENT CASES

RODERICK A. CAMERON
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It is a pleasure being here in Mexico City for several reasons. I have always wanted to come here but have never had a chance until now. It is a lovely place and Mexico is a fascinating and colorful montage of the ancient and the modern. The other reason is because of the far-sighted wisdom displayed by the Government of Mexico in its recent act to set aside Scammon's Lagoon on Baja California as a sanctuary for the gray whale. Like so many whale species, the gray whale has been brought close to extinction by man's shortsightedness. Unlike other whale species, however, the gray whale has received effective protection and has recovered somewhat.

It is therefore all the more significant that Mexico has decided to protect these waters so crucial to the survival of the gray whale. I only hope that Mexico will extend this protection to the other important calving waters along Baja California's coast and thus protect an essential part of the habitat of this species so recently decimated by man's thoughtlessness. Such protection can be extended and made permanent with little expense or disruption now. In the future it may not be possible. Thoughtful Mexicans and Americans applaud Mexico for its wisdom and, I think, encourage this country to extend the gray whale sanctuary to the other vital calving areas along Mexico's West Coast. Some of these same areas would very appropriately be designated general wildlife refuges. They contain spectacular displays of flora and fauna.

In the nature of things society has always cared better for the rich than the poor. The legal profession, of which I am part, is no exception. The law has from the beginning of time been more an instrument to preserve the prerogatives of the rich and powerful than to protect the rights of the non-affluent. As an old anonymous English verse has it:

> The law locks up both man and woman
> Who steals the goose from off the common.
> But lets the greater felon loose
> Who steals the common from the goose."

But the legal imbalance between rich and poor was gravely accentuated about a century ago with the first major use of the corporation as a

[1] The Environmental Defense Fund is a nationwide coalition of scientists and lawyers dedicated to presentation of scientific data before courts of law and regulatory agencies dealing with environmental matters. EDF attempts to serve as a legal action arm for the environmentally concerned scientific community.

mechanism for concentrating and focusing capital for private gain. The corporation was a legal invention and has facilitated a large part of the material progress man has made in recent times.

But, like so many human inventions, the corporation, at least in its present form, is a two-edged sword. Its capacity to exploit capital for human welfare carries with it the capacity to exploit society and people for corporate welfare. And a large part of this dangerous capacity has derived from the profound distortion of the allocation of legal talent which corporate power has wrought. By 1905 that distortion had become sufficiently clear for Louis B. Brandeis, then a Boston lawyer but later to become perhaps the most distinguished jurist America has ever produced, to say:

> The Leaders of the Bar, without any preconceived intent on their part, and rather as an incident to their professional standing, have with rare exception, been ranged on the side of corporations, and the people have been represented, in the main, by men of very meager legal ability. If [our] problems are to be settled right, this condition cannot continue.

But the condition has continued and indeed worsened. In 1934 U.S. Supreme Court Justice Harlan Fiske Stone, a former Wall Street lawyer, stated:

> Steadily the best skill and capacity of the [legal] profession has been drawn into the exacting and highly specialized service of business and finance. At its best the changed system has brought to the command of the business world loyalty and a superb proficiency in legal skill. At its worst, it has made the learned profession of an earlier day the obsequious servant of business, and tainted it with the morals and manners of the market place in its most anti-social manifestations.

Last year Robert Townsend, former President of Avis Rent-a-Car, stated "It's no wonder you can't get senior partners of major law firms to work weekends. If I were doing to America what they're doing to it from ten to six Monday through Friday, I'd have to get stoned on Saturday and Sunday, too." In a less hyperbolic vein former U.S. Senator Paul H. Douglas writing three years ago described a typical Congressional scene:

> The large hearing room of the [Senate] Finance Committee seats 150 persons. When we considered a tax bill, the room was filled with prosperous lawyers, graduates of great universities and of the top ranking law schools, whom Assistant Secretary of the Treasury Stanley Surrey once referred to in a burst of

> admiration as the "best minds in the country," all working to hold what they and their clients had and to enlarge it. . . . Not more than one out of every hundred citizens actively working on a tax bill is trying to represent the general interest.

In the last decade the "general interest" or "public interest" lawyers have increased their number and effect. More and more lawyers, particularly younger ones, are devoting a substantial part of their professional lives to representing interests about which they have a genuine moral commitment. Thus civil rights, minority representation, and poverty law have become important new subjects for lawyers. Now an additional area for concerned lawyers has appeared in the form of environmental and consumer law. It is in this field that the Environmental Defense Fund works. Other groups are now forming and having an effect on public policy as well.

So now that we have the capacity—the lawyers—to utilize the legal approach, what are the tools, the statutes and precedent cases, that we can use to represent environmental interests? Until recently, there were no direct ways to plead unnecessary environmental degradation as a basis for obtaining relief in a court of law. One either had to plead direct economic injury as a result of some environmental insult, or if possible take the long and arduous course of the Scenic Hudson Preservation Conference in its battle with the Federal Power Commission and Consolidated Edison Company of New York over the proposed pumped storage facility in the Storm King Mountain area of the Hudson River Valley. That controversy raged well over half a decade and consumed impressive resources on the part of environmentalists, both financially and intellectually, just to achieve the right to have environmental and scenic considerations be part of the decision-making process of the Federal Power Commission. Although certain subtle and very important advances in the law occurred in the Storm King Mountain case, it is doubtful whether any real lasting protection of the scenic integrity of the Storm King Mountain area has been or will be guaranteed. The pumped storage facility will apparently be built. It is difficult to take comfort from the controversy.

The first big break in environmental law came with the passage of the National Environmental Policy Act by the American Federal Government in 1969. The statute compels all federal agencies to evaluate their projects with the purpose of minimizing their environmental impact. The Act directs these agencies to prepare "environmental impact statements" detailing the adverse effects as well as the beneficial ones of the project they are undertaking. It also requires rigorous and comparative analysis of the various alternatives to the project which the agency is proposing. And, of course, consideration of alternatives gets you into a discussion of consideration of alternative goals. For example, consideration of a dam to create a flat-water recreation lake may have as an alternative leaving the river free-flowing for its own recreational potential.

The National Environmental Policy Act or NEPA has wrought a profound revolution in some agencies of the Federal Government. It has done so not just by being passed but also by being rigorously, aggressively enforced by environmentalists, who have won decision after decision compelling compliance with NEPA's procedures and forcing thorough reevaluation of a project and of its alternatives with the viewpoint of minimizing environmental degradation. I can say, with some pride, that Environmental Defense Fund has been responsible for the largest portion of these cases.

The first major victory under the National Environmental Policy Act was a preliminary injunction against the Cross-Florida Barge Canal. The judge ruled that the plaintiff Environmental Defense Fund was, on the basis of evidence presented at the preliminary hearing, "likely to prevail on the merits" at full trial. He added that without temporarily halting the project until full trial could be had, the plaintiffs would be "irreparably harmed." His preliminary injunction sent shock waves through the Federal Government and five days later President Nixon ordered that construction on the Cross Florida Barge Canal, then about one-third complete, be abandoned in order to protect the unique and lovely Oklawaha River over whose course the canal was being built.

Within a month came a second and, from a legal standpoint, even more important decision. This was the case of Environmental Defense Fund vs. The Corps of Engineers over its construction of a dam on the Cossatot River in Southeast Arkansas. Again the project was well advanced in construction but nevertheless, the court granted, this time, a permanent injunction. The impact statement which the Corps thought was in compliance with NEPA was ruled to be inadequate. The project had to be redesigned to comply with NEPA.

Shortly thereafter three environmental organizations, the Wilderness Society, Friends of the Earth and, again, the Environmental Defense Fund in the most notorious of the NEPA decisions to date, obtained a preliminary injunction delaying construction of the Trans-Alaska Pipeline System. The Secretary of Interior was enjoined from issuing a permit for construction of the giant project across nearly 800 miles of federal land until he had prepared "an adequate" statement. For the past two years this impact statement has been in preparation. It is a massive task and has brought substantial hard-ship on the oil companies counting on quick access to the oil treasures of Alaska's North Slope. But those hardships are balanced in my view by the interests of the public at large in seeing this very tricky and environmentally dangerous project executed with minimal damage to the fragile, vital and astonishingly abundant wildlife of the Arctic.

Last summer came a terribly important decision in the *Calvert Cliffs* case, a nuclear power plant application for a license from the Atomic Energy Commission. The Court held that NEPA did apply to the regulatory licensing functions of the AEC, that it applied to on-going projects for which licensing proceedings were underway and that the procedures of the AEC for taking environmental factors into account were inadequate. The decision perhaps as clearly as any to date gave clear warning to all federal agencies that the National Environmental Policy Act meant business and would have to be complied with in spirit as well as in letter. It caused a new consciousness to explode through the bureaucracy of the Atomic Energy Commission and precipitated a crisis of severe proportions. In some respects it is unfortunate that nuclear power, which might well be environmentally less destructive than power generated from fossil fuels, is handicapped in its development and deployment by being required to more rigorously account for its environmental effects than fossil power.

A very recent decision, *Greene County Planning Board* vs. *The Federal Power Commission,* has made clear that NEPA applies to FPC licensing proceedings as well. But so far the federal regulatory handle on the environmentally crucial question of electrical power is uneven and discriminates against what is potentially at least the most preferable means of generation.

The last NEPA decision I will mention to you is a January 13, 1972 decision called *Natural Resources Defense Council* vs. *Secretary Morton.* In that case the Department of Interior was enjoined from selling leases for oil and gas off the coast of Louisiana. The decision went so far as to suggest that in the consideration of alternatives to the project a federal agency must in effect go far towards developing a national energy policy. That decision had a profound effect upon the Department of Interior's consideration of the Trans-Alaska Pipeline.

The National Environmental Policy Act has yet to meet its most important test. Some accuse NEPA of merely being a disclosure statute. Once a federal agency publishes in an impact statement the laundry list of environmental insults which a project will cause, and the laundry list is found to be incomplete, the question becomes whether NEPA has been satisfied. Put legally, if the procedural requirements of Section 102 are met, can environmentalists insist that a less destructive alternative to the action proposed by the Federal agency be taken? This is the ultimate question for NEPA: does it have substantive content to compel adoption of optimal solutions taking into account human and environmental welfare as well as financial considerations? The Court in the *Calvert Cliffs* decision flirted with this issue but did not resolve it. So far NEPA has been primarily a delaying device. Resolution of this substantive-procedural issue will tell whether NEPA can compel modification of federal policy to lessen environmental destruction.

There is a statute now on the books of several states which may be of even more profound importance than NEPA. It has been introduced in the U.S. Congress by Senator Hart and by Representative Udall, among others. It grants the government as well as private parties the power to sue to stop unreasonable degradation of the land and air and water resources. It has been made into law in the States of Michigan and Connecticut. Lesser versions exist in other states as well. It permits a balancing in every environmentaly significant project or action, which is challenged in court, of the human and environmental factors against the economic ones. It does not require passage of an air quality act or a water quality act or a solid waste management act or the creation of new bureaucracy and large budgets. It simply permits government agencies, corporations, and private citizens to complain about "unreasonable degradation" on the part of other government agencies or corporations or individuals. And if the plaintiff has a good case, that is if the challenged action is unreasonable, it is stopped or modified. The Act in effect creates a public trust in the environment which will prevent the forceful taking of air basins by industry smoke stacks, of streams by municipal and industrial effluent, of rivers by the Corps of Engineers, and the Bureau of Reclamation, and a host of other takings which have led us to our present state. This environmental protection act will require that destructive uses of natural assets which belong to all of us may have to be justified publicly and in an adversarial context.

There is one message I would like to emphasize and have you carry away with you. Legislation to protect the environment is always rich in rhetorical promise. But laws and statutes are only one wheel of a two-wheel vehicle. The other wheel is enforcement. A statute must be enforced if it is to have any effect at all. And it is in the area of enforcement where citizen interest and persistence and sophistication are particularly essential ingredients. Citizens must have access to the enforcement side of the equation if our laws are to have effect. Government agencies are often paralyzed by political pressures, inertia and inadequate budgets. Citizen groups must have the right to directly enforce statutes in the courts and before regulatory agencies.

Many have stated, particularly in the context of the public trust statute in effect in Michigan and Connecticut, that citizen suits would clog the courts and tie up the economy. This silly reliance on the doctrine of horrible consequences was to no avail. The statutes were passed and the courts have not been clogged up. Litigation is far too expensive a process to bring capriciously. You need organization, financial clout, legal strength, and access to scientific expertise to make a go of an environmental court case. Only strong environmental organizations are capable of mounting such campaigns. And they can only do so for a small proportion of the necessary cases.

Environmental litigation is a significant element in the overall picture but it is not so large that it can damage our economy or be more than a prodding force to make government and industry take the environment seriously.

DISCUSSION

CHAIRMAN FISHER: As citizens we have an unusual opportunity here. We have a very well-informed lawyer in the environmental field virtually on the witness stand. Are there comments or questions on this presentation?

MR. WILLIAM RAINEY (Caribbean Research Institute, Virgin Islands): It's a peripheral issue, but I would take issue with your contention that the strictures on atomic energy development are perhaps unduly rigid, because the potential short-term hazards are really great.

MR. CAMERON: I suspect they are not strict enough, but the problem is that there is virtually no regulation of other forms of power, and these other forms must be considered so that there is not this handicap for fission power, which is probably less destructive than the air pollution that goes with fossil power.

MR. KENNETH BOWDEN (American Water Resources Association): This morning we heard, from Dr. Tom Maddock that the relationships between stream alteration and biological resources in very few instances were known. Possibly you could say they were completely unknown. Now, Mr. Cameron has been dealing with phases that concern one or two impact statements in environmental protection cases as required under the Environmental Protection Act. These statements present supposedly the beneficial and adverse effects of stream alteration. I take this as one example because there are thousands of conservation projects on the books, planned and soon to be developed in the Southeast of the U.S. Now we come to the situation in which we have a Council of Environmental Quality supposedly reviewing one or two statements which are supposed to give the full effects on biological resources. This procedure, in my mind, simply neglects to take into account the primary and secondary repercussion effects of these particular water projects. Now, what suggestions do you have so that we can somehow strengthen either the CEQ or get down to the type of account that we really want, that will say whether a water project is in the national interest or not? I would like Mr. Cameron, by virtue of his experience, to give us his ideas. Should we abolish or should we revoke Public Law 566 from the books? It seems particularly relevant when we have 50 million acres and more of land in the Soil Bank, and yet here we have an area rich in wildlife habitats and we are still going along and creating more agricultural land. Thank you.

MR. CAMERON: That's a multi-part question. Attacking or applying rigorous analysis to the many stream-channelization projects is probably going to be very difficult for citizen groups because the projects are fairly small and there are so many of them. I believe methods will be found, but its not as easy as it is, say, in dealing with the Corps of Engineers where there are very large projects and it merits the time and energy necessary to challenge the project. This is true also of the Bureau of Reclamation. It's harder with SCS because there are so many projects, perhaps many of which have to be challenged. How CEQ, or perhaps the Environmental Protection Agency, can be strengthened I don't know. CEQ has relegated to itself this sort of umpire status in which it makes very few substantive statements itself. The task of reviewing impact statements, is so great that even EPA balks at it. Some have suggested that EPA set up some sort of gigantic kind of Rand-like corporation to review impact statements, a multidisciplinary group, that would be given the specific task of reviewing them. All I can say is that its a terribly difficult problem. I have no stock answers.

MR. ROLAND CLEMENT (National Audubon Society): I think I can comment intelligently on the relationships involved in the last question. What do we need to do to make our systems more effective in protecting the public interests? What every conservationist and citizen in this room and elsewhere should know about the Council for an Environmental Quality is that only one individual is available to CEQ to review all the water-related projects being proposed by all the agencies and everyone else in the U.S. So obviously if we want to make our system work, we've got to invest in the qualified personnel necessary to assess the impact statements. The alternative to doing it intelligently and professionally is constant confrontation and obstructionism. The agency people who don't like this had better get busy and help us solve these problems professionally.

CHAIRMAN FISHER: As Chairman this afternoon, I have two things yet to do. One is to introduce the final event in this Conference, but before that I want to thank the speakers this afternoon for excellent presentations, and thank those of you who made comments and asked questions. Of course these will be available in due course in the proceedings. The problems raised will be with us for some time yet, but we've made a start in this session, and in this Conference. And now I want to introduce Robert A. McCabe, Professor, Department of Wildlife Ecology, University of Wisconsin in Madison, who will present the critique of the program of this Conference.

Dr. McCabe, you have a challenging task. Good luck with it."

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INTERNATIONAL COOPERATION AND RESOURCE NEEDS

A Critique of the Program of the 37th North American Wildlife and Natural Resources Conference

ROBERT A. MCCABE
Professor, Department of Wildlife Ecology, University of Wisconsin, Madison

Chairman Fisher, Ladies and Gentlemen, personal friends, and those who couldn't afford to go to Acapulco. We are weary. The hour is late and home beckons but it is appropriate that some kind of benediction close our sessions, even if it be by devil's advocate.

I consider myself privileged to have been asked to summarize this Conference. Like others before me, I reviewed the summaries of past conferences. This was a very revealing drill, and some day it might be enlightening to offer a critique of the critiques. Clearly, every summarizer rose to the occasion, each attempting a unique or personalized approach. Some were serious paper-by-paper resumes of what Jones or Smith had to say; a few dwelled at length within the Conference theme; others were humorous, historical, analytical, or oriented to current game problems. Some had an old-shoe or cracker-barrel approach. Others were literary or almost literary—even to requiring a Roget's *Thesaurus* to comprehend. All were worthy of the assignment and all were worth reading. Apart from the texts, most summarizers lamented their inadequacy in handling the assignment or lavished more syrupy praise than candid criticism. I would not dispute the proportions or the judgments involved. Each of us sitting on the curbstone sees the passing parade from a different angle.

As a by-effort of the rereading of summarized Conferences I examined the content of each volume of the Transactions and marveled at this compendium of thinking on matters of conservation. On its pages, some now yellowing with age, are to be found the history, strife, innovation, progress and failure, vitality and the not-so-subtle politics of North American wildlife conservation. We are most likely to think of the Wildlife Management Institute only as the catalyst for this Conference that facilitates our meetings and arranges for our comfort and entertainment. Important as these arrangements are, the truly outstanding contribution of the WMI to our profession and to science in general is the publication of the Conference Transactions. Nowhere in the world is there a comparable series, now in its 37th year. Nowhere has one agency taken on so important a service role for conservation. Its reward is this paper monument, built volume by volume.

There is a dual significance in holding this Conference here in beautiful Mexico City: (1) It is an appropriate setting for reaffirming an old and venerated treaty among the three largest countries in North America to protect the migratory bird resources of this continent, and now an additional 32 families of birds are included; and (2) it serves notice that Mexico is a senior partner in the cooperative effort to conserve the natural resources of our land. If you have any doubt, read the papers contributed by our Mexican colleagues.

The worldly and gentlemanly Juan Zinser was Mexico's first representative at the North American Wildlife Conference in 1936. Even before he gave his paper he said . . . "I hope this conference will accomplish its noble purpose and will help perpetuate the friendship of the nations taking part in this conference . . ." His hopes were realized but bear repeating for this conference. In the years to follow Juan Zinser never glossed over his country's difficulties in conserving its natural resources, but each year there was the inevitable sign of progress. In 1938 he lamented without apology: ". . . that conservation work in Mexico has not as yet extended to the scientific and experimental field . . ." In those years there was great effort, if not always effective, to curtail the battery shooting of wintering waterfowl (the armadas of Lake Texcoco).

In 1947 the pragmatic and business-like Luis Macias represented Mexico at the Conference. His opening statement is classic: "Conservation of wildlife in Mexico will become an accomplished fact when the public at large is fully appraised of the value and importance of wildlife to our country." This could have been said for all countries. In 1949 he asserted himself in a forceful and positive manner when the American press implied blame onto Mexico for the reduced waterfowl populations. It was a bold defense of his country's position in which he said: ". . . I think it is time to stop pointing to Mexico as being guilty of things for which we are not responsible." After a presentation of harvest information for Mexico, he concluded, "The annual kill rate of wild ducks in Mexico must be considered very low, and Mexico cannot be blamed for the reduction of continental flocks." It was more than an adequate defense; it was a position statement respected as accurate and sincere.

Two subsequent Directors of the Mexican Department of Wildlife, Rudolfo Hernandez Corzo and Bernardo Villa R., have continued and extended the conservation program of their predecessors. Commercial duck hunting in Mexico has been effectively controlled. Refuges have been established for colonial nesting birds and for the tapir. The creation this year of a sanctuary for the calving grounds of the gray whale was a major contribution by Mexico to international conservation. More refuges are now under study. Enforcement of the national game laws is steadily improving, although the warden force is grossly undermanned.

The scholarly Enrique Beltran has made his presence felt at international meetings and at this Conference where he has been a member of the Program Committee since 1957. His country can look with pride to the fine work undertaken by the Mexican Institute of Renewable Natural Resources under his able direction.

Mexico's progress in the field of conservation is a testimonial to a small group of dedicated men who persevered in the face of political and social change and where financial support was limited.

* * *

In assessing the papers presented I am at liberty, according to the charge given me, to treat of them singly, in aggregate, or not at all. What follows will be a combination format.

This Conference had many exciting issues in all sessions. I will comment, therefore, on certain ideas that seem germane to our profession, and as to where we stand today. Many papers were concerned with problems of pollution, too many people, and habitat destruction for man and beast.

In the pollution context, these ideas were particularly pertinent:

1. A common set of environmental standards and guidelines should be accepted and vigorously enforced at the federal level and by all the states (U.S.A.) so that industries capable of polluting would find it impossible to migrate to areas of more permissible environmental standards.
2. Ecologists and field technicians can identify a problem and assess its environmental impact, but major corrective measures will doubtless lie in realigning the strictly economic and engineering approaches to insure continued functioning of ecosystems on a sustained basis.
3. The United States defiles the sea, as exemplified by 1.5 million cubic feet of trash dumped into the Atlantic by New York City each week.
4. Mexico City's air pollution is the most serious in all Latin America, encouraging such human miseries as bronchitis, emphysema, and asthma.
5. Ecology, contamination, and pollution are words in the lexicon of the Mexican citizen today because they are understood through early training in matters of conservation.

The too-many-people concept is today commonplace and recognized by all. These ideas were impressive:

1. According to one speaker what we need is a good "five cent contraceptive." In many countries of the world this would hold, but for the apparent number required in the overpopulated areas of India, Africa and some parts of Latin America the price may still be too high.
2. A population ethic was proposed including a family planning service, public medical clinics for birth-control counseling, repeal of abortion laws and population dynamics in education. Without such an ethic, living quality is lost and survival of man is threatened.
3. No paper on burgeoning human populations came to grips with the role of the Church in its encouragement of reproduction or the stand it has taken in opposition to the reduction of family size. If indeed our survival is threatened we can no longer tiptoe around confrontation with religious dogma. An inflexible church position on artificial means of birth control will, if current predictions are accurate, reduce most of its secular adherents to poverty-ridden second-class citizens of the world.

The dangers of unlimited development in Mexico City are caused by two entities, one human and the other industrial. Lying as it does in a geological basin of limited air flow, pollution from industry in Mexico City was inevitable. The appraisal of the people danger was perhaps the most significant statement of this conference. Among other alternatives the speaker said: ". . . a complete birth control (program) has to be carried out if humanity has (is) to survive." This is no astounding revelation—its importance lies in the fact that it was stated by a Mexican scientist in Mexico, in public, and for all the world to hear.

To professional wildlife people, concern for the environment is not a new idea. We studied and fought for the integrity of wild environments for wild creatures and, in so doing, were among the first, if not the first, to recognize the plight of human environments.

Continued oversell, oversimplification and overstatement will, I fear, produce the refractory stage of the "cry wolf" syndrome in a public now almost oversensitized to people and pollution rhetoric.

What we need is not more statistics or inspirational appeal in making us aware of problems of pollution and too many people, but programs that will begin to resolve the man-land disharmony.

The tenor of this Conference was also exemplified in the following positions.

The paper on a "Defense of Natural Systems" was really an airing of California's resource problems and a diatribe against hunters and wildlife administrators. Many of the other points were well-made, including a plea for more knowledge on non-game species, for a more rational approach to large predator management, and a fresh call for public awareness in matters of wildlife conservation. There were, however, some seriously disturbing statements in the potpourri of ideas presented. Time permits only one example. A statement was made that "without a game label, the wildlife is tossed into the 'varmint category' easy target for the man with a gun." The statement was in my opinion extreme and too encompassing. Many of us who dedicated our professional and private lives to wildlife conservation and who came into this field by the gunpowder route are by inference insensitive to nongame wildlife, and therefore stand idly by condoning the concept of a varmint category for easy gunning targets—not so. I suspect more hunter members of this audience belong to scientific and social societies concerned with the conservation of the total environment than hold membership in gun clubs. And if it need be known, harvest restraints on game and refuge systems to protect wildlife were more often than not suggested first by the hunters themselves. In the latter case paid for and protected by them as well.

When the charming speaker (who is certainly no little old lady in tennis shoes) and the lay public with whom she identifies learn the difference between hunting and killing, and the relationship of preservation and the role of management to ecology, then perhaps she can better shoot down anti-conservation programs with a well-aimed verbal rifle, than hip shoot with a scatter gun. If I must be labeled a chauvinist pig for disagreeing in part with the female conservationist from California, I can only reply with a loud grunt.

Thinking of the earth as a spaceship is an intriguing if not a simple idea. The basic tenets of the exercise in supposition as I saw them were: space and food energy are in a very real sense finite like the spaceship itself, and we cannot afford to do what comes naturally either in a biological or social context if we wish to maintain or improve the quality of existence. Those aspects of our Spaceship Earth which generate pleasures of the mind through the eye, whether they be natural or man-made, cannot as a rule be enjoyed by all, and a variety of inequitable schemes were proposed to share a limited resource. The key factor that limits the ability to share the amenities of the spaceship is simply *too many people*.

No demographer, no champion for population control ever presented a case for limiting numbers of people more eloquently or with greater depth of purpose that the late Bill Vogt. And what is more, he did it yesterday. He would have been pleased to read the several fine papers dealing with this thesis presented at this Conference and to know that the torch has not fallen from his hand to be snuffed out by the damp of social lethargy.

The basic objective of the paper on strengthening fish and wildlife conservation in the water resources program was almost overlooked by the rare admission of failure by at least one employee of the Bureau of Sport Fisheries and Wildlife. The initial report concerned the Cross-Florida Barge Canal. A document supporting the canal was called a "misguided Bureau report" that failed to assess the overall environmental damage. The story did not end in an alibi or apology. Instead it told of how the Bureau reversed its position, recovered its poise, and exerted its leadership, the end product of which was a strong series of recommendations to all concerned with water. Its official title is *Action Report—Conservation and Enhancement of Fish and Wildlife in the National Water Resources Program* and it contains 169 recommendations. Read the action report and scrutinize this paper; they will give you, as they gave me, an occasion to be proud of the Bureau of Sport Fisheries and Wildlife.

The six papers in the session on planning were no mean challenges for an ecologist. We use the same words but not the same language. Building a language within a language is not however peculiar to planners, for ecologists, chemists, economists, physicists and medical people, to name a few, have done the same. I suspect the ability to speak the tongue of a discipline gives one a sense of belonging, while at the same time it creates communication barriers between disciplines and among the sciences. The planner has had outstanding success in engineering, transportation, business, urban development, etc.

The planner is a recent addition to the natural resources scene. He is almost a preacher come to town, for who will dispute the need for planning—short-range, long-range, comprehensive, integrated, effective or just plain planning in resource management? Resource ecologists must not abrogate their responsibilities to just any planner, for unless the planner is himself an ecologist, his main job will be to compile inventory data and run the retrieval machinery. The resource value judgments as to what goes into the computer or model must be made by an ecologist—and the meaning of what comes out of the machine must also be interpreted by an ecologist.

On occasion the use of sophisticated hardware of the planner may be like using a micrometer when a yardstick would do the job. The planner and the resource specialist often make an excellent team for environmental impact assessments. It is not improbable that degree tracks for wildlife planners will soon be available in many universities.

No paper solicited more genuine acceptance and strenous opposition than the one concerned with solid waste recycling. The skill and methods thus far developed are encouraging. It is the attitudes expressed in the introduction that are disturbing. The writer says that man's intellect has brought us vastly increased standards of living. I agree. It is the *cost* to the natural environments on which we disagree. He regards retrenchment with disdain. If I can leave one thought on world problems with you today, it is that I regard retrenchment to a lower standard of living as *imperative*. It is not a matter of when, the time will be forced on us soon enough. It is a matter of *who* and *how* and perhaps *where* this can take place. To ask whether "we are going to tell our poor that their lot is never going to get any better" is a smoke screen. It is the affluent who must reduce standards of living, not the poor. It is patently unrealistic for affluent society to demand more of the "things" that produce higher standards of living, forcing industry into greater pollution, and then point an accusing finger at industry for the insults to the environment resulting from those demands.

I will close my remarks by referring to the fine paper on a new American Wildlife Policy. The history, needs, and a new approach were ably stated. My only caution is that we remember who we are.

An object lesson in this regard occurred in the discussion period of the first general session where an eminent plant breeder found himself caught in the quagmires of ornithology. If wildlife professionals will do the job for which they are trained, the best interests of world environments and man will be served.

Finally our first responsibility must be to the resource and not to the exploiter. This concept, in my opinion, will automatically conserve the resource and protect the equity of the resource user.

The formal critique is ended. I feel a little like a cased muskrat skin—that is, turned inside out. The choice to undertake this critique was mine and I do not merit your sympathy or acquiesence. The only person to whom I would have looked for reaction died in April, 1948. The most I can hope for is that your own assessment of the Conference may have been challenged.

Author's note:

Unfortunately the 30 minutes allowed the summarizer prevents a paper-by-paper assessment of the Conference. This, however, is exactly what I did as an initial exercise in abstracting. All papers were read and most were heard; I learned something from each. Those selected for comment were ones that, in my opinion, solicited greatest audience reaction and in no wise is an importance rating implied. Personally, I thought the papers on water in the Southwest were very good. The impact of environmental degradation will doubtless be felt most acutely by man through water and associated water uses.

This Conference contained fewer papers on game than any other that I can remember. There was not a single paper on waterfowl, for example, and that must be a record of some kind. Nonetheless each session had a very important environmental message. It is for all citizens to listen and to heed. Ours is a rapidly changing world and we must adapt without sacrificing principle to make issues of conservation part of progressive change, or lose the wild resources by the attrition of technology behind the shield of progress.

ROBERT A. MCCABE

CLOSING REMARKS

LAURENCE R. JAHN
Chairman, Program Committee, 37th North American Wildlife and Natural Resources Conference

Bob, thank you very much for that fine critique of the 37th North American Wildlife and Natural Resources Conference. It helps all of us place the knowledge gained at individual sessions in an overall perspective. Your concise statements emphasized the truly international nature of this year's meeting. We sincerely appreciate your taking time from a busy schedule to join us here and provide those fine remarks.

Many other people have contributed immensely to this successful conference, held in Mexico for the first time since 1915 when these meetings were initiated. Vice-Chairman John Rogers and Executive President Fred Evenden of The Wildlife Society, along with all other members of the Program Committee, were instrumental in helping plan and stage the many activities we have been privileged to participate in.

Here in Mexico a host of individuals helped us to resolve difficulties with languages, physical materials and facilities, and transportation. The outstanding contributions of each individual either have been or will be acknowledged personally in the near future. But two individuals from our host country merit special praise from all of us for their truly outstanding cooperation in bringing this conference to a successful conclusion. They are Enrique Beltran and Bernardo Villa. Their concerted efforts helped achieve the highly satisfactory registration of about 1,250 people. Total attendance was something larger, as quite a number of individuals, especially young people, did not register.

Many of you who have attended these conferences for the past 25 years have undoubtedly noted the absence of C. R. "Pink" Gutermuth on the official agenda. He is here, as most of you know, completing his final term, as Consultant with the Wildlife Institute. What many of you probably do not realize is that "Pink" and Bess also are on a honeymoon here in Mexico—their Golden Wedding Anniversary occurred on March 4. We deeply appreciate your dedicated efforts, Pink, in administering this important annual conservation conference for so many years. And my personal thanks for your considerate guidance during the last few transitional years.

Next year the conference will be held in Washington, D.C. on March 18-21. One of the highlights will be the report on the new proposed North American Wildlife Policy. We are pleased to announce at this time the confirmed 22 members of the important committee responsible for drafting the new policy statement. They include:

Dr. Durward L. Allen, Purdue University, Lafayette, Indiana, *Chairman.*

Mr. Daniel A. Poole, Wildlife Management Institute, Washington, D.C., *Secretary.*

Dr. Enrique Beltran, Mexico Institute of Natural Renewable Resources, Mexico, D.F.

Mr. Eugene F. Bossenmaier, Department of Mines, Resources and Environmental Management, Winnipeg, Manitoba, Canada.

Mr. James Brooks, U.S. Bureau of Sport Fisheries and Wildlife, Anchorage, Alaska.

Mr. Charles H. Callison, National Audubon Society, New York, New York.

Dr. Kenneth D. Carlander, Iowa State University, Ames, Iowa.

Dr. Archibald B. Cowan, University of Michigan, Ann Arbor, Michigan.

Mr. Henry A. Hansen, U.S. Bureau of Sport Fisheries and Wildlife, Washington, D.C.

Dr. John C. Hendee, U.S. Forest Service, Seattle, Washington.

Mr. Cyril Kabat, Department of Natural Resources, Madison, Wisconsin.

Mr. Roy Komarek, Tall Timbers Research Station, Tallahassee, Florida.

Dr. John V. Krutilla, Resources For The Future, Inc., Washington, D.C.

Dr. Daniel L. Leedy, U.S. Office of Water Resources Research, Washington, D.C.

Mr. Harvey K. Nelson, U.S. Bureau of Sport Fisheries and Wildlife, Jamestown, North Dakota.

Mrs. Margaret Owings, Big Sur, California.

Mr. Merrill L. Petoskey, Department of Natural Resources, Lansing, Michigan.

Mr. Robert L. Salter, Fish and Game Department, Boise, Idaho.

Mr. Samuel P. Shaw, U.S. Forest Service, Upper Darby, Pennsylvania.

Dr. Clarence M. Tarzwell, National Marine Water Quality Laboratory, West Kingston, Rhode Island.

Dr. James G. Teer, Texas A&M University, College Station, Texas.

Dr. Frederic H. Wagner, Utah State University, Logan Utah.

The Conference Program Committee will meet in April to begin to develop the complete agenda for the 1973 meeting. Constructive suggestions you may have for topics to highlight critical international, national, or eastern regional resource problems can be forwarded to me and will be appreciated.

On behalf of the Wildlife Management Institute, many thanks for your active participation. This has been a rewarding conference here in Mexico. Have a safe journey home.

The 37th North American Wildlife and Natural Resources Conference stands adjourned.

* * *

REGISTERED ATTENDANCE

ALABAMA

Ann L. Durham, Barry Durham, F. H. Farrar, W. L. Holland, Charles D. Kelley, Claude D. Kelley, Mrs. Claude D. Kelley, Allen M. Pearson, Daniel W. Speake, J. S. Wise, Mrs. J. S. Wise.

ALASKA

Edward A. Bellringer, Mrs. Edward A. Bellringer, A. W. Boddy, Thelma Boddy, Frederick C. Dean, Jon Klingel, Marlene Klingel, Mrs. Peter Lent, Peter Lent, Raymond D. Moody, Mrs. Raymond D. Moody, Tom K. Moody, Kenneth A. Neiland, Mrs. Ruth L. Nelson, Urban Nelson, Gordon W. Watson, Mrs. Gordon W. Watson, Kyle Watson, Leslie Watson, Robert Weeden.

ARIZONA

Mrs. Aerial Appleton, Frank Appleton, Lee Appleton, Bud Bristow, Goode P. Davis, Milton G. Evans, Joe T. Fallini, Mrs. Joe T. Fallini, Steve Gallizioli, Robert A. Jantzen, David A. King, Patricia A. King, Seymour H. Levy, John A. McComb. Robert .E Moore, DeWayne Smith, Lyle Sowls, Mrs. Lyle Sowls, Roy E. Tomlinson, N. A. Winter, Mrs. N. A. Winter.

ARKANSAS

William J. Allen, Mrs. William J. Allen, Robert E. Apple, Ralph B. Griffin, Andrew Hulsey, Bob Leonard, Mary Blanche Nelson, Rudolphus A. Nelson, Joe D. Scott, Pat Walker.

CALIFORNIA

Ray Arnett, David R. Brower, Mrs. David R. Brower, Stanley A. Cain. Maynard Cummings, Frank F. Farley, Mrs. Frank F. Farley, Seth Gordon, Mrs. Seth Gordon, Garrett Hardin, Mrs. Garrett Hardin, Carl L. Hubbs, Mrs. Carl L. Hubbs, Carl Kuford, Susanne Kuford, Bob Lantimore, Lois Latimore, A. Starker Leopold, Mrs. A. Starker Leopold, J. Michael McCloskey, Mrs. J. Michael McCloskey, H. Geoffrey Moser, John H. Oh, Margaret Owings, Penn Post, Henry Smith, Vern Smith, Richard D. Teague, Charles Vogel, Mrs. Charles Vogel.

COLORADO

Maurice D. Arnold, Pete Barrows, Adrey E. Borell, Mrs. Adrey E. Borell, Clait E. Braun, Eugene Cook, Letha Cook, Alexander T. Cringan, June C. Cringan, Joseph F. Dado, Maureen A. Dado, Eugene Decker, Richard N. Denney, Bob Evans, Trudy Evans, D. L. Gilbert, Evelyn Glover, Fred A. Glover, Bill Grave, A. F. C. Greene, Mrs. A. F. C. Greene, Jack Grieb, Retha Grieb, Jack E. Gross, Frances D. Hill, Ralph R. Hill, E. R. Kalmbach, M. A. Marston, Mrs. M. A. Marston, Rutherford Phillips, R. T. Phillips, George Post, Thomas W. Riley, Darlene Robinson, William W. Robinson, Wayne W. Sandfort, Virginia Seaman, Wayne Seaman, Carol J. Snow, Dean Suttle, Mrs. Dean Suttle, Evadene Swanson, Gus Swanson, Eric C. Thompson, Jack F. Welch, Don West, Roberta Winn, Cool Withers.

CONNECTICUT

John M. Anderson, Mrs. John M. Anderson, Philip Barske, Mrs. Philip Barske, Stephen Berwick, Roland C. Clement, Charles Dickey, Edmund S. McCawley, Jr., Warren Page, Mrs. Warren Page, Ronald T. Speers, Mrs. Ronald T. Speers, Jean D. VanVoorhies, Mrs. Jean D. VanVoorhies.

DELAWARE

Wilbert Rawley, Bette Wilder, Norman Wilder, George Wright.

DISTRICT OF COLUMBIA

Thomas S. Baskett, Jack Berryman, Warren Cheek, Louis S. Clapper, George Crossette, Libby Crossette, Frank C. Daniel, Robert K. Davis, Philip A. Douglas, Fred G. Evenden, Joseph L. Fisher, Mrs. Joseph L. Fisher, John W. Grandy IV, Mrs. John W. Grandy IV, Kenneth E. Grant, C. R. Gutermuth, Mrs. C. R. Gutermuth, Keith Hay, Dorothy Hetrick, Sydney, Howe, Michael Hudoba, Laurence R. Jahn, Mrs. Laurence R. Jahn, Robert M. Linn, Thomas Maddock, Jr., Mrs. Thomas Maddock, Jr., Richard T. Marks, Mrs. Richard T. Marks, John A. Mattoon, Cliff Morrow, Mrs. Dean A. Murville, Gene Oren, Daniel A. Poole, Mrs. Daniel A. Poole, Hamilton K. Pyles, Mrs. Hamilton K. Pyles, William L. Reavley, Estuardo Rodriguez, James B. Ruch, George C. Ruhle, T. R. Samsell, F. Victor Schmidt, F. Victor Schmidt, Elwood A. Seaman, Robert J. Smith, Spencer H. Smith, Mrs. Spencer H. Smith, Richard H. Stroud, Mrs. Richard H. Stroud, Dottie Taylor, James B. Trefethen, Mrs. James B. Trefethen, Lonnie L. Williamson, Gordon K. Zimmerman, Mrs. Gordon K. Zimmerman.

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Paul Breese, K. S. Norris.

IDAHO

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MONTANA

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