TRANSACTIONS

of the

TENTH NORTH AMERICAN WILDLIFE CONFERENCE

Originally scheduled to meet in New York City, February 26, 27 and 28, 1945, Hotel Pennsylvania. Government ban on all conventions, made effective February 1, 1945, necessitated cancellation of actual meetings. The major portion of the papers planned for this Conference are printed herewith.

Edited by Ethel M. Quee

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THE NORTH AMERICAN WILDLIFE CONFERENCES

The North American Wildlife Conferences and their predecessors, the American Game Conferences, have played a most important part in the conservation movement in North America. The American Game Conferences pointed the way. Naturally through the years many changes have come about in the manner in which the Conferences are conducted. At the present time the conduct of the meetings are, we believe, unique.

The American Wildlife Institute is the sponsor of the North American Wildlife Conferences. The Institute assumes the responsibility of making arrangements and of supervising the meeting but the Conference is the vehicle of all conservationists and their organizations.

Perhaps there is no better way of demonstrating this than to describe in some detail just how a North American Wildlife Conference is staged.

We will assume that an annual Conference has just closed and a number of important problems have been brought to light. Work is immediately begun on the next year's Conference. The Institute selects a program committee made up of representatives of national organizations, government agencies, sportsmen, the press, and others. For practical reasons these men reside in Washington, D. C., the headquarters of the Institute. This is necessary so that the group can be called together from time to time without delay.

At the first opportunity the Executive Committee of the Institute, or a duly appointed group, selects the city in which the next Conference will be held. The policy is to hold the convention in various cities and regions throughout the continent so that the representation will not become regionalized and so that the meeting will be representative of geographical interests.

When the convention city is selected a representative of the Institute ascertains the facilities available for the Conference. This involves hotel accommodations, meeting rooms, and a number of minor considerations which in one way or another affect the success of the Conference and the comfort of those attending.

The program committee then determines the over-all theme of the Conference if a theme is to be incorporated, the relative amount of time to be allocated to the different types of sessions, and in some instances selects the subject matter for some of the individual sessions, particularly those known as general sessions. In recent years there have been general sessions, technical sessions and special sessions. The general sessions have been those of broad, general interest. They have frequently dealt with administrative problems, large programs of restoration, etc. The technical sessions have been arranged by the

Wildlife Society (a technical organization) and dealt with technical problems and research developments. Special sessions are provided for those interests that are neither biologically technical nor broad enough in their interests to be classed as general sessions. In addition to these types of meetings, which are all open to the public, the Institute, in making arrangements, tries to provide facilities for business meetings of any group that so desires.

Once the subject matter is selected (this is frequently done by polls) the program committee selects a chairman for each session. These men are asked to serve in this capacity because of their intimate knowledge of the specific subject and their wide acquaintance with the men engaged in that line of work. That is the only prerequisite. The chairman is asked that both sides of any controversial question be presented. He is, for practical reasons, requested to limit the number of papers and to provide for adequate discussion time. Beyond this it is his responsibility to solicit and select papers on which to build the program of his particular session. Each chairman furnishes the Institute with the list of titles and speakers by a given time for the printed program.

In the meantime the Institute, with the cooperation of other organizations has, through the press, magazines and by direct mail, notified the public of the time and place and, as far as possible, the tentative program.

As far as the Conference itself is concerned there are no delegates, no formal organization and no registration fees. The Institute provides the necessary funds, acts as a coordinating agent and the business representative of the Conference.

It provides the stenographic reporting for the various sessions. There are usually 15 to 20 sessions. The transcripts are edited by the Institute and incorporated with the formal papers in a Transactions of the Conference. These Transactions are printed and offered to the public by the Institute at a price of less than cost as a service to the cause of conservation.

The Transactions have through the years grown to be the most complete chronological history of the growth of conservation and development of restoration methods that is available anywhere. Those who are fortunate enough to possess a complete set from the 15th American Game Conference Proceedings (1928) to the 10th North American Wildlife Conference Transactions (current) have a possession to be prized. For those that are not so fortunate or who are not historically inclined there is no better medium of keeping abreast of conservation developments than through the Transactions of the North American Wildlife Conferences.

Chairman: VICTOR SKIFF

Deputy Commissioner, New York Conservation Department, Albany, New York

LAND USE FOR PUBLIC HUNTING

PROGRESS OF THE PUBLIC GAME LANDS PROGRAM IN PENNSYLVANIA

SETH GORDON
Executive Director, Pennsylvania Game Commission, Harrisburg, Pennsylvania

The Pennsylvania Game Commission began its operations in 1896, and in the ensuing 50 years has developed into an efficient organization which employs nearly 260 regular salaried workers to perform the multiple tasks connected with game management, propagation, and administration. This paper will outline the progress made during that time, with special emphasis on the Cooperative Farm-Game Program.

The pioneer conservationists who composed the first Commission labored diligently on their own time, and without pay, to preserve what little game remained in the State. The odds against them appeared almost insurmountable, and the people of the State, unused to being told what and when to shoot, resented them and their ideals.

In 1905, after a decade of persistent struggle, the Commission established the first primary game refuge on State Forest lands, and two additional ones during the next 2 years. Opposition was bitter, at first, for the plan necessitated closing 2,000 to 3,000 acres of choice hunting ground for each unit, and some feared that these preserves were to be used by politicians as private hunting grounds. The latter objection was soon disproved, for all violators were prosecuted indiscriminately.

Four years later, in 1909, forest fires raged throughout the State, destroying much valuable timber. Fortunately, only one of the three refuges was affected, only one third of which was burned. Almost at the outset the refuges prove their value by providing sanctuary for birds and mammals, especially for the deer purchased and stocked as each new refuge was established.

In 1915 the Legislature authorized the Commission to lease lands for refuge purposes, including public hunting grounds. Four tracts of ideal game territory were immediately offered and promptly accepted. These made a total of 14 refuges on Pennsylvania soil, 4 on leased lands, and 10 on State Forest land. All were surrounded by a single strand of wire, trails were brushed out in order to facilitate forest fire protection and general administration, and trespass notices were posted liberally around the areas.

Four years later, in 1919, the Commission had 30 sanctuaries, 24 of which were primary refuges and 6 were auxiliary projects located on leased lands. The Commission paid the taxes, in return for their use as game preserves, which at first constituted only a nominal rental but soon increased to such an amount that the Commission saw no reason in paying the additional charges. When the leases expired the hunting rights on these lands would revert to the owner and the Commission would be without either the money or control of the land.

Consequently that same year, the Legislature passed a law authorizing the Game Commission to buy suitable areas to be known as State Game Lands, for use as game refuges and public hunting grounds. Under this system, which is still in effect, the sportsmen pay for their own land. The major portion of State Forest areas are also used as public hunting grounds, with many Game Commission managed refuges on them.

As the new purchase program got under way a new problem was encountered, namely, the development and maintenance of the newly-purchased areas. Although of equal importance, this problem was not recognized at first. It seemed enough to furnish the land for both the protection and hunting of game, for surely Nature would take care of the rest. But the Commission soon realized that this was not so; if it expected an increase in wildlife it had to provide more than just a home without furniture.

After the conclusion of World War I, the Commission began to plant trees, shrubs, and grains such as hickories, walnuts, elderberries, haws, grapevines, buckwheat, kafir corn, millet, sunflowers, etc., that would produce food for birds and mammals. They built new fire protection roads, improved old ones, made the homes of the refuge keepers more comfortable, and established many new refuges.

During the 1922-24 biennium, the growing tendency of individuals and hunting clubs to purchase lands for private hunting grounds resulted in the Commission's decision to greatly expand its land purchase program, lest the hunting clubs monopolize the better hunting territory and crowd out the general public. By 1934 the Commission owned 32 refuges, comprising 72,850 acres of land, and an additional 28,950 acres open to public hunting. They also possessed some heavy equipment for development and road maintenance on the State Game Lands.

The 1920's were years of progress. The work done by the Commission during this period was suggestive of paving a road after the foundation had been laid. Now that lands had been bought and refuges established there remained the improvement of roads and trails for protection against fire, winter game feeding, predator control, reforestation, game food planting, and general administration.

In 1927 the hunter's license fee was increased from $1.25 to $2.00 at the request of the sportsmen themselves. With the additional revenue of 75 cents per hunter, the Commission expanded its land purchase and management programs.

In 1930 the Auxiliary Refuge program was somewhat curtailed. These refuges had been established on almost any type of land, usually within easy reach of heavily-populated districts, and were used mainly for small game. The refuges and hunting lands were popular with the city dweller who was often unable to get very far from home to do his hunting.

During the following 2 years, land purchases exceeded all previous records—146,590.37 acres were acquired, making a total of 320,141.77 acres, valued at $1,359,749.25.

The fiscal year 1933-34 saw six Civilian Conservation Corps camps of about 225 men each set up on the larger blocks of State Game Lands. These men made themselves useful by building new roads and fire trails, opening the more inaccessible areas of forest, and fighting forest fires. With the opening of new roads through the mountains which had before been inaccessible to the general public the necessity to establish more refuges became apparent.

For a number of years the Commission had been looking for a suitable site on which to establish a refuge for migratory birds. Many ponds and lakes in the western and northwestern parts of the State were considered, but few of them were suitable for ducks, geese, swans, etc., because they lacked proper food, and many of the lakes were too deep to grow wild rice and other plants on which the birds could feed.

It was not until 1935, however, that a Migratory Bird Refuge was finally established on the Pymatuning Reservoir. This territory was the Pymatuning Swamp, on which the Water and Power Resources Board of the Department of Forests and Waters had erected a huge dam in which to impound flood waters. Of the 25,000 acres of water, marsh and land, 3,670 acres were allotted to the Game Commission to be set apart as a refuge. In this part of the reservoir 21 low islands, varying in size up to several acres, and densely covered with vines and marsh plants, provided ideal food, cover and nesting areas for waterfowl.

On April 9, 1936 a new plan was approved for the management of the various upland game refuges. This provided for the grouping together of all Game Lands and Refuge units within a specified territory and placing a game protector in charge for protection, development and management of each group; 44 groups were set up. This new plan was far more effective than the old system.

During the first 16 years of the land acquisition program, i.e., from 1920 to 1936, a little more than 60 per cent of funds earmarked for refuges and lands was spent in the purchase of lands, and slightly less than 40 per cent for their development, administration and general maintenance. Approximately a half million acres of State Game Lands were acquired during that period, and it became apparent that some changes in policy should be made. It was decided that the land purchase program should be gradually curtailed and more time, effort and money expended to make these lands provide more desirable living quarters for their wild tenants. It was also resolved to reduce the size of some of the larger refuges (2,000 to 3,000 acres each) and establish many new, small ones especially for wild turkeys, ruffed grouse, and certain other small game, and to exert every effort to improve small game hunting in agricultural territory within easy reach of cities and towns; also to purchase Game Lands in such locations whenever possible.

The program continued to be expanded and improved. During the late 1930's, the C.C.C., the N.Y.A. and the W.P.A. did much toward the betterment of Game Lands by clearing fire trails, building roads, helping to fight forest fires, constructing fences, and planting shrubs and vines along these fences to produce food and cover for wildlife. In addition to numerous release cuttings to remove competitive growth from around clumps of crabapple, hawthorn, wild grape, dogwood, blackberry, birch, and other game food producing plants, timber sales on Game Lands netted $39,263.04 during the biennium 1941-42.

On December 31, 1944, Pennsylvania had 778,736.78 acres of State Game Lands with approximately 38,230 acres additional under contract for purchase.

At this writing 207 Primary State Game Refuges, consisting of 59,371 acres, are maintained on State Game Lands, leaving more than 740,500 acres open to public hunting.

Within the 1,655,821 acres of Pennsylvania State Forests and 447,156 acres of Allegheny National Forest, the Game Commission operates 83 Primary Refuges totaling 56,878 acres. Practically all of the balance of these state and national forests, aggregating 2,103,000 acres, except special park areas, are open to public hunting.

There are 51 Auxiliary Refuge Projects on 44,414 acres of privately-owned land from which the Commission leases the hunting rights. Fifty-six refuges on these lands total 11,379 acres, leaving 33,035 acres open to public hunting.

The determination to improve hunting conditions for farm-game species, especially near populous centers, accounts for the adoption in 1936 of the Cooperative Farm-Game Program. By this plan, agreements are negotiated with landowners for the hunting rights on their properties, in return for which they receive protection, one of the basic features of the plan.

The most important provisions of the Cooperative Farm-Game Program are outlined below:

PROJECT DEFINED. A project is a contiguous group of cultivated farms, for which the owners and tenants sign agreements vesting the hunting rights in the Game Commission for 5 years or more, without curtailment of their customary activities. No rental is paid for these privileges.

ACREAGE REQUIRED. A minimum of 1,000 acres are required for any one project, at least two thirds of which must remain open to public hunting.

RIGHT OF ENTRY. Representatives of the Commission, in connection with their official duties, are granted the right at any and all times to go upon the various farms.

SAFETY ZONES. The Game Law prohibits hunting or trapping for wild birds or animals, or the discharge of firearms, within 150 yards of occupied buildings, except by specific permission of the owner or tenant, and imposes a fine of $25.00 for violation of this provision. Safety zone signs warning hunters of this are provided and posted by the Commission around the safety zone area in accordance with the occupant's wishes.

GAME REFUGES. Small-sized refuges, generally 3 to 15 acres, but averaging about 8 acres, are established within each project area, wherein hunting or other disturbance of wildlife by any person is unlawful.

The boundary line around each refuge is conspicuously marked, usually by a single strand of No. 9 wire where there is no fence, and posted with appropriate State signs.

PUBLIC HUNTING. Hunting for game and trapping fur-bearing animals in season by the public is legal on all portions of a project area not set apart for refuges or safety zones. The landowner is permitted to hunt wthout a license upon his own and adjoining farms, except within refuges.

SPECIAL PROTECTION. Cooperating farmers and farm property are provided special protection from thoughtless, careless, or otherwise destructive hunters, especially during open seasons, usually through patrolling by deputy game protectors.

Signs warning hunters that certain acts are unlawful, and citing others which either should or should not be done, are posted within project areas. The distribution of signs is made in accordance with the wishes of the farmer.

The Game Law provides a heavy penalty for resisting an officer when attempting to make an arrest for destroying property or livestock on lands where the hunting rights are controlled by the Commission.

GAME STOCKING. Project areas are given special attention with respect to the release of game for stocking purposes. All such areas are suitable for cottontail rabbits, and a majority of them for ringneck pheasants and bob-white quail.

RAISING RINGNECKS. Cooperating farmers, their families, or employees, if they so desire, are paid for raising ringnecks from eggs or day-old chicks furnished by the Commission.

PREDATOR CONTROL. Predatory animals and birds are kept under control in so far as possible by the Commission's representatives or by responsible persons acceptable to the cooperator.

NATURAL FOOD AND COVER. Efforts are made to provide as much natural food and cover as the potential game crop warrants. Farmers are asked to avoid cutting shrubs, vines and weeds along fences, or from untillable areas, such as brier thickets, ravines, spots where erosion is taking place, wood lots, etc. In many instances game food producing shrubs and vines are planted on so-called waste spots, as eroded gullies, ditch banks, or rocky areas, without harm to agriculture, but greatly to the benefit of wildlife.

Small refuges or retreats are usually installed on areas having the greatest quantities of natural food and cover to insure survival of sufficient breeding stock.

GRAINS. Wherever possible, strips of grain near coverts are purchased from farmers at an agreed price. Similar strips or plots are planted, subject to the farmer's permission, either by the Commission, sportsmen, or the farmer. Seed for such plots or strips is generally furnished by the Commission, while plowing and seeding are usually done by the cooperating farmer, but paid for by the Commission.

Grain plots purchased or planted shall not be cut but must be left standing for game's use during fall and winter months.

CANCELLATION OF AGREEMENT. An agreement may be cancelled by the Executive Director of the Commission upon request when a good reason is offered.

During the eight years this plan has been in existence the great majority of the cooperators have been fully satisfied with the plan, and the manner in which it operates. However, the Commission is not convinced that it has the final answer to this problem and is constantly endeavoring to improve the program.

A study of hunting statistics in Pennsylvania reveals that at least 75 per cent of all game killed is taken from farm lands. Therefore, the Commission believes that more of its funds should be spent in enlarging and developing the Farm-Game Program. As an experiment, with this in view it recently appointed an experienced deputy game protector to devote himself to the development and expansion of the seven Farm-Game Projects in Montgomery County, containing 15,700 acres, and comprising 324 farms. As part of his duties he will perform a public relations job among the cooperators, control predators, and oversee the protection of the projects during the hunting season.

Provided the experimental results justify, this program will be greatly expanded and developed through the employment of capable men to specialize in this phase of the work, and to aid the cooperating farmers with their planning problems, especially from the soil conservation standpoint. Also to cooperate with County Farm Agents and other public or private agencies necessary to aid the program.

Food and cover planting programs as determined by technicians will be undertaken on each farm wherever the landowner can be persuaded to permit it, preferably with his active participation. The Commission will furnish the planting stock required.

On the basis of anticipated hunting pressure, the Commission feels justified in planning an expansion of this program to an area comparable in size to its present land holdings. Ultimately it may be found desirable to maintain twice as much Farm-Game acreage as forest game lands. The Commission may also desire to extend the program to other counties which are not included in the present setup. If properly managed, Farm-Game Projects should not only produce a self-sustaining game crop but also supply a considerable number of rabbits and other game for transfer and stocking purposes.

Every effort will be made to provide sufficient deputy help so that portions of the projects may be visited at least once daily during the hunting season. As a rule, the regular officers are unable to devote any considerable amount of time other than supervisory to these projects, at that season.

The first Cooperative Farm-Game Project was established prior to the hunting season of 1936. Additional projects were established during subsequent years, and for the hunting season of 1944 a total of 72 project areas were in operation, comprising 1,913 farms, totaling 153,208 acres. Of this 5,738 acres are used for refuges, and 36,076 acres for safety zones, or 41,814 acres are closed and 111,394 acres open to public hunting.

An indication of the popularity of the program is evident from the fact that 50,495 hunters used the projects during the hunting season of 1943, and secured a total of 78,523 pieces of game from the areas, comprising 153,729 acres, as follows:

Cottontail rabbits	43,588	Ring-neck pheasants	16,727
Gray squirrels	15,922	Bob-white quail	1,444
Raccoons	637	Ruffed grouse	192
Deer	13		

The cost of such a venture as the Cooperative Farm-Game Program to the Game Commission should not be overlooked. During the period of 8½ years since the program has been in operation, the Commission expended a total of $200,000.00 for the creation, establishment, protection, development, and maintenance of the projects, or an average of about $23,500.00 a year. In addition to this, during the year 1943, approximately $27,641.80 worth of rabbits, ringnecks, quail, etc., were planted on the project areas, and $3,000.94 was paid to farmers for raising ringnecks. Consequently, the cost to the Commission, paid from the sportsmen's license fund, amounted to approximately $54,142.74 for the year 1943, as against $112,818.40 which is the estimated value of the game killed by sportsmen on the various project areas that year.

As of January 1, 1945 the Pennsylvania Game Commission had under its control for wildlife purposes a total of 1,063,708 acres, of which 199,910 acres were closed and 863,798 acres were open to public hunting.

The Pennsylvania Game Commission has been giving the management of its game land holdings intensive study during the past year in an effort to agree upon a practical management program that will assure maximum annual wildlife crops. The Commission is of the opinion that it will not be wise to expand its land purchases indefinitely, and that from the standpoint of hunter pressure it will be much more desirable to develop and enlarge satisfactory cooperative programs with the farmers. The gun pressure in Pennsylvania today definitely justifies placing our major wildlife management emphasis upon our better farming areas, where the heaviest crops of ring-neck pheasants, cottontail rabbits, and other farm game species are found.

EVALUATION OF THE NEW YORK STATE EXPERIMENTAL COOPERATIVE LANDOWNER-SPORTSMAN CONTROLLED PUBLIC HUNTING GROUNDS PROGRAM, 1939-1943

A. W. BROMLEY

New York State Conservation Department, Albany, New York

One of the most pressing conservation problems in New York and other states in recent years has been how to preserve what has come to be known as the American heritage of free public hunting. The greatest difficulty in arriving at a satisfactory solution has been, and is, the paradoxical status of wild game in the United States. Fish and game are recognized as a natural resource belonging to all the people of the state. But the lands and waters from which the wildlife crop must be harvested are, for the most part, in private ownership. With this as a background and spurred by increased hunting pressure, the New York State Conservation Department inaugurated, in 1939, its experimental public hunting plan known as the Cooperative Landowner-Sportsman Program. During the ensuing 5 years the Department spent approximately $185,000 on this experimental program. This expenditure involved the leasing of approximately 122,000 acres of land from 1,204 individual owners for the establishment and maintenance of areas in 14 counties. A total of 58,272 hunting permits were issued and 40,678 head of game, mostly pheasants and rabbits, were taken.

ESSENTIALS OF A LANDOWNER-SPORTSMAN PLAN

Before initiating the Landowner-Sportsman Plan in New York State, records of farmer-sportsman plans as attempted or in operation in other states were studied. Scores of various arrangements on the same theme had been tried, for the conditions which prompted New York to study ways and means were by no means unique in this State. Many of these plans had failed dismally; others were still in operation.

Through this study it was possible to establish several cardinal rules which, it was hoped, could be erected as guide posts in assuring the success of such a venture. These rules seemed then and, after 5 years of operation, still seem valid. They are:

1. The plan must be simple, i.e., easily understood by the landowner, the sportsman and other cooperating individuals or agencies. Also it must be easy to manage.
2. The plan must be financially feasible and economical.
3. The landowner's rights must be protected and the landowner

must receive remuneration in some form for his share in producing a crop of game on his land.

4. The sportsman must be assured of a place to hunt where he would feel welcome.

5. A sufficient head of game must be maintained to guarantee the sportsman's interest and make him feel well paid for his day afield.

OUTLINE OF PROGRAM AS ADOPTED AND OPERATIONAL PROCEDURE

The plan was launched during the summer of 1939 with the selection of sites in Ulster and Seneca Counties. With the cooperation of sportsmen's federations and groups, representatives of the State Grange, Farm Bureau and others interested, the Conservation Department leased the hunting rights on the lands from the owners at the rate of 10 cents per acre per year for a period of 5 years. As a basis for just payment, the records of deeds were relied upon as a guide to actual ownership and acreage. The agreement form was carefully worked out to protect both the interests of the landowners and the State. The text of the agreement is:

NEW YORK STATE CONSERVATION DEPARTMENT
DIVISION OF FISH AND GAME
Bureau of Game
AGREEMENT
between

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and

THE NEW YORK STATE AND CONSERVATION DEPARTMENT

THIS AGREEMENT made this .... day of .... 19......, by and between ...., residing at ...., his successors and assigns, hereinafter called the Lessor, and the Conservation Department of the State of New York, hereinafter called the Lessee.

In consideration of the conditions herein set forth and the further consideration of $...................., the receipt of which is hereby acknowledged, the Lessor does hereby Lease to the Lessee for a period of .... years from the date of this agreement all the hunting, fishing and trapping rights in, to and upon all that tract of land situated in the Township of ...., County of ...., State of New York, containing .... acres, more or less, and bounded and described as indicated on the reverse side of this page, or as indicated on the map or description attached hereto and make a part hereof.

IT IS MUTUALLY AGREED:

1. That the Lessee, or any party by it authorized, shall have the right of ingress and egress upon the said private lands of the Lessor, at any and all times, for the purposes of protecting, propagating, and managing the wildlife resources thereon, and for other purposes connected therewith.

2. That the Lessee may establish (a) seed stock refuge(s) for game on such part of the lands of the Lessor as may be mutually agreed upon, and that such refuge(s) may be posted by the Lessee against all hunting, fishing, and trapping. Such seed stock refuge(s) may be wired by the Lessee to delineate the area and/or to protect the game food, and cover thereon, and burning practices shall not be carried on within the limits of such refuge(s) excepting as agreed upon in writing between the Lessor and the Lessee. Nothing contained in this item shall prevent or hinder the Lessor from carrying out regular activities on such refuge area(s) excepting those activities which would be detrimental to the value of the area(s) as a game refuge.

3. That the Lessee, or any party by it authorized, may make such changes in the vegetative cover of said refuge(s) and may erect such signs and/or other devices as may be agreed upon between the Lessor and the Lessee to be in keeping with the purposes aforesaid.

4. That the Lessor shall make prompt reports to a Game Protector, or his associates, of all violations of the Conservation Laws which may come to the attention of the Lessor, or his agents and employees.

5. That the Lessee shall establish restricted hunting (farmstead) zones about building and service areas by posting, but such posting shall not prevent the owner or tenant, or employee of such owner or tenant, from using firearms or hunting, fishing, or trapping thereon after having in other respects complied with the Conservation Law.

6. That all parts of said lands not excepted above shall remain open to hunting, fishing and trapping at the discretion of the Lessee; and that notices shall be erected by the Lessee designating this property as (a part of) a Cooperative Game Management Area.

7. That the Lessee shall furnish reasonable protection, through its law enforcement agencies, to the leased area(s) in accordance with the provisions of the Conservation Law.

8. That the Lessor, his successors or assigns, may terminate this agreement upon sixty (60) days' written notice to the Lessee and by repayment by the Lessor to the Lessee, at such termination, of a sum at the rate of ____________ per acre per year for the unexpended balance of the term of this lease, provided that the Lessee is satisfied the principal object of such termination is not to convert to private use the hunting, trapping or fishing rights made more valuable through

the use of such property as a cooperative game management area. If so cancelled, the Lessee shall have an additional ninety (90) days in which to remove wire, fences, signs, etc.

9. That no liability shall be incurred by the State under the terms of this Agreement beyond the money available to the Conservation Department for the purpose of establishing such public hunting, fishing, and trapping areas in various parts of the State, or if, in the opinion of the Lessee, the hunting, fishing and trapping rights on sufficient additional lands cannot be obtained on adjoining properties to justify proper control of hunters, fishermen and/or trappers.

IN WITNESS WHEREOF, the said Lessor, and the Lessee, have hereunto set their hands to be effective on the day and year above written.

Lessor

STATE OF NEW YORK
COUNTY OF
CITY OF
} *ss.:*

On this .... day of .... 19........., before me duly appeared ...., to me known and known to me to be the same person(s) described in and who executed the foregoing Agreement and he (she or they) duly (and if more than one, severally) acknowledged to me that he (she or they) executed the same.

Notary

Certificate on file in ....(County)

NEW YORK STATE CONSERVATION DEPARTMENT

Lessee

By ....

Consent and Waiver by Mortagee

Signed: ....

Approved ...., 19 ....
State Comptroller
State Comptroller's No. ....

A fully executed copy of this Agreement was mailed to the Lessor on ...., 19.....

Signed: ....

After securing the hunting rights, as above outlined, on contiguous properties on sufficiently large blocks to permit minimum unit cost of operation (later shown to be not less than 10,000 acres), the Department proceeded with establishment as follows:

1. Posting, within the Conservation Law, with three principal types of signs:

a. Public Hunting Ground posters. These stated that sportsmen might hunt upon the Landowner-Sportsman area by securing a permit so to do and abiding by the regulations pertaining thereto.

b. Farmstead Zone posters. These were set up to delineate the farmsteads, service and similar areas on each farm within which it was deemed hunting would be dangerous or deleterious to property rights.

c. Seed Stock Area posters. Established around natural escape cover areas to assure a carry over of adequate breeding stock.

Other posters used included parking area signs and directional arrows.

2. An area permit quota was then established as a control measure against excessive hunter concentration. This was based, at first, on four hunters per hundred acres and later reduced to not to exceed three hunters per hundred acres. No more than that number of permits were issued at any one time.

3. A centrally located station of Adirondack "lean-to" style was established as area headquarters for the issuance of permits. Areas of heaviest hunting pressure were serviced by two such stations.

4. Permit station operators were employed throughout the pheasant season on all areas and were continued on duty on some heavily hunted areas after the pheasant season. Upon closing the regular permit station, permits were made available locally for each area.

5. Sportsmen hunting the area were required to secure a permit (Figure 1) at the station and were supplied with sketch maps (Figure 2) to help guide their hunt. Rules and regulations pertaining to the operation of the area appeared on the maps as well as on the permit. Cooperating landowners, members of their families and employees working and living upon the landowner's property were eligible for seasonal permits. Regulations governing the use of seasonal permits were the same as for daily permits, except that the seasonal permittee did not report his game take until the end of the hunting season.

6. Permittees were required to park vehicles in designated parking areas, each limited to certain number of cars. Hunting pressure was thereby spread in the interests of safety.

7. Other simple rules of conduct, as listed on the permits and maps, were enforced. Permittees were required to check out at the permit station after hunting. Thus an accurate game tally, or inventory of take, was made possible.

8. To assure protection of landowners' rights and property, as well as enforcement of Conservation Laws and Landowner-Sportsman reg-

NEW YORK STATE CONSERVATION DEPARTMENT
PROJECT GAME TALLY M2A

This tally is necessary in order to provide your Conservation Department with the basic information necessary in order to administer this area effectively. The success of this project depends upon your whole hearted cooperation.

ALL DATA FOR THIS AREA ONLY

Hours Hunted____________ **Other Permit Nos. in party**

Number in hunting party________ 1________ 2________

SPECIES	TAKEN	SEEN (By party and not killed)
	To be filled out by each hunter	To be filled out by one hunter only for the party
Pheasants		Hens- Cocks-
Rabbits		
Grouse		
Woodcock		
Deer		

Complete This Tally and Leave in Box at Permit Station
Fold Along This Line (Do Not Detach)

LANDOWNER - SPORTSMAN COOPERATIVE GAME RESTORATION PROJECT

DAILY HUNTING PERMIT

Date____________ **Hunting License No.**________

Address (Home)____________________
Town Street State

Signature____________________

Auto License No.____________

The above licensed sportsman having read and hereby agreeing to abide by the rules and regulations printed on the back of this permit, as well as other provisions of the Conservation Law, is hereby authorized to hunt on the____________ County Game Management Area on the date above written.

NEW YORK STATE CONSERVATION DEPARTMENT
BUREAU OF GAME, ALBANY, N. Y.

No. 38589 Per____________

Figure 1.

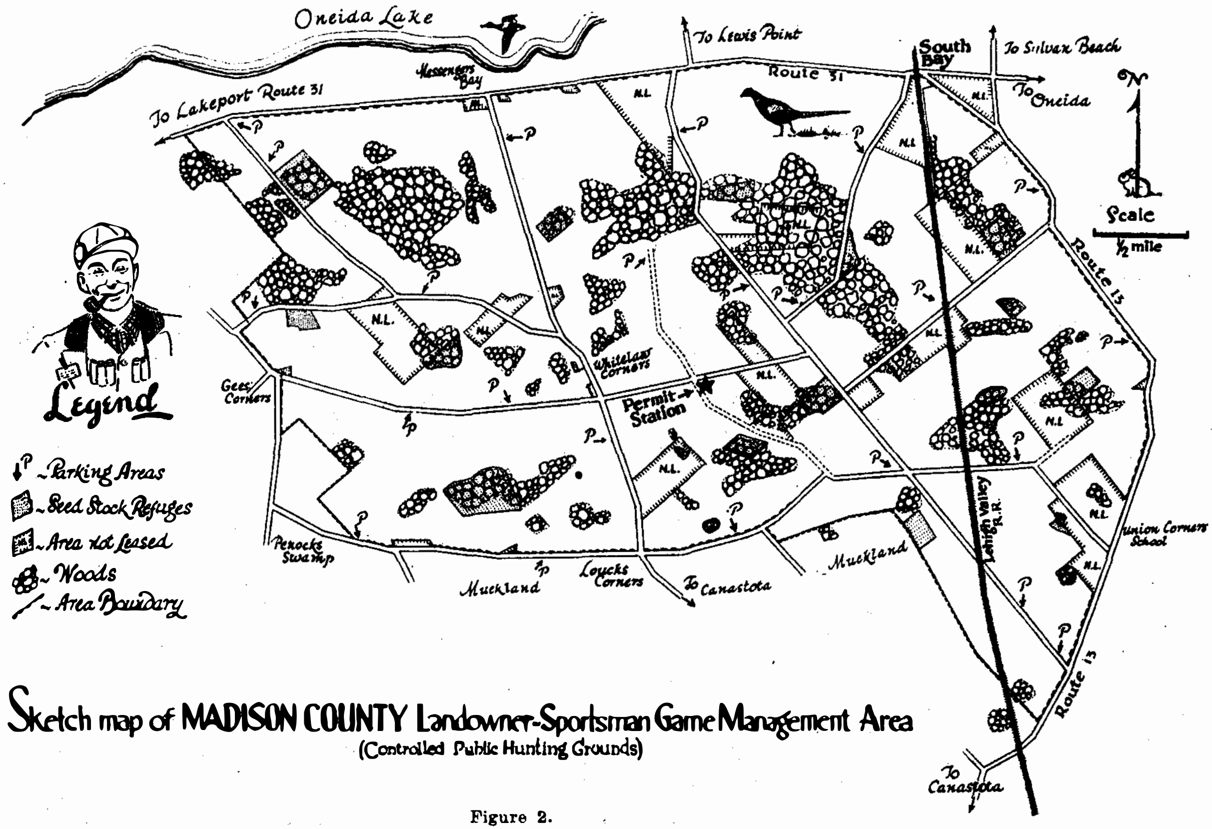
ulations, special game protectors were employed to serve on each area. Term of service was dependent upon the hunting pressure demand.

The above briefly outlines the establishment and operation of the Landowner-Sportsman Plan. It was the pattern followed on 11 of the 14 areas established. However, there was evolved a variation from this original plan called "Type B" in contrast with the original or basic "Type A." Three areas were established under Type B, located in Livingston, Cayuga and Jefferson Counties. A clarification of the differences in these two types of areas follows:

The "Type A" area might be called the standard form as it was the original plan used in the establishment of the first two areas in Ulster and Seneca Counties. Under this plan the Conservation Department did all the original field work, including the contacting of landowners, securing of lease signatures, etc. Furthermore, the State compensated the cooperating landowners at the rate of 50 cents per acre for the 5-year term of lease.

Of the 14 Landowner-Sportsman Areas, 3 are of the "Type B" pattern. Two of these, the Cayuga and Livingston Areas, were established in 1941, while the third, the Jefferson County Area, was set up a year later. The major difference in establishment under the "Type B" form was that, in each of the three above listed areas, strong sportsmen's groups, rather than the Conservation Department, were the sponsoring agencies. In each instance these sportsmen's groups, assisted, it is true, by the Department's District Field Managers, did the original contact work among the landowners and followed up by securing the signed leases. The sportsmen's organization paid each landowner the minimum legal consideration of $1.00 per farm, irrespective of acreage involved. These leases were then signed over to the Conservation Department by the sportsmen's organizations. From that point the Department carried on with the operation of the area just as in the case of the "Type A" plan. The major saving to the Conservation Department under the "Type B" plan is, of course, under acquisition. Some additional savings under the "Type B" plan may also be realized by the Conservation Department through continued assistance from the sportsmen's groups in posting of the area but, in general, the cost to the Department after acquisition is the same under the "Type B" plan as under the "Type A" plan.

It would appear, from cursory observation and in consideration of the respectable savings realized in cost of acquisition, that the "Type B" area should be the pattern to be followed in any future Landowner-Sportsman operation. However, experience in the operation of both types of areas has indicated that a generalized statement to that



Sketch map of MADISON COUNTY Landowner-Sportsman Game Management Area
(Controlled Public Hunting Grounds)

Figure 2.

The rules governing this CONTROLLED PUBLIC HUNTING GROUND are simple. There is a definite reason, of course, behind each. When you read over the following you will realize clearly just why your fullest cooperation is necessary if the plan is to succeed ~ ~

The RULES *(condensed)*

1. First obtain permit *(from designated permit station)*, fill out and carry it while hunting. On return, fill out the "GAME TALLY" and deposit at permit station. Permits good only on day issued.
   Reason *Regulates number of hunters to size of areas and to harvestable amount of the game crop.* GAME TALLY *of very great value in regulating game seed stock to be left for next year and to guide game management plans* — **So please be accurate.**
2. Park cars and enter area only at points designated by BLUE signs. The number of cars which may be parked at one time will be indicated on these blue signs.
   Reason *Guards against undesirable "over-running" of land and permits easier patrol.*
3. Don't hunt on Seed Stock Refuges.
   Reason *To conserve a breeding stock of game.*
4. Don't hunt on Farmstead Zones.
   Reason *These occur about buildings, pastures, fields or orchards where the normal activity of the farm makes hunting inadvisable. Good sportsmen wouldn't hunt there anyway.*
5. Don't smoke around buildings or scatter litter.
6. Don't hunt in groups of more than three.
   Reason *Gives the game a break. Helps prevent too much "driving".*
7. Keep dogs out of Seedstock Refuges and Farmstead Zones.
   Don't train dogs on the area during the two weeks preceding the opening of the pheasant season.
   Reason *Helps prevent the driving of game from the area.*
8. Don't take or molest produce, stock or other farm property.
9. Shut gates; be careful of fences and keep out of Fall planting.
10. Don't use rifles except under special permit. (-A safety factor).

For complete legal wording of Rules, see reverse of permit

Remember-*You are a* GUEST *of the Landowner*

Value the Farmer's hospitality

Figure 2.

effect would be unsound. There are several qualifying factors to be considered in conjunction with the "Type B" operation. As a basis, the Department must be on the closest cooperative terms with a large, well-organized sportsmen's organization which can be counted upon to carry the project through the stage of acquisition. Such well-knit sportsmen's groups are not the general rule throughout the State and even where they exist they may not be in a position or may not care to handle the Landowner-Sportsman project. Also to be considered is the fact that any sportsmen's group is generally "sparked" by one or two exceptionally capable and enthusiastic leaders who enjoy a wide acquaintanceship and prestige among the potential cooperating landowners. This "personality factor" assures success in selling the plan. However, in 5 years' time there is the probability of changes in personnel within the sportsmen's organization. The successors in charge may not be so enthusiastic in the continuance of the plan or they may lack the favorable contact with the cooperating landowners.

Even more important, perhaps, is the matter of remuneration to the cooperating landowners. As noted above, the original contact and leasing are carried out by the sportsmen's organization; the landowner receiving from the club representative one dollar, in cash or in value received, to make the contract legally binding. The contracts are then signed over to the Conservation Department by the legal representative of the sportsmen's group and the Department thus becomes the party of the second part. The Department, while legally empowered to proceed with the operation of the area, has had little or no previous contact with the cooperating landowners while the landowners, although guaranteed protection of their property rights under the plan, have received no remuneration from the Department for the hunting rights on their farms. This is a weak and artificial form of operation. Its limitations have already become apparent in dealings with several individual landowners on "Type B" areas. Their attitude tends to be: "Why should I restrict my actions and that of my family and help on my own land when I am not receiving any money for so doing?" This, it should be noted, is not the general reaction encountered but it does indicate a potential handicap in the continued operation under the "Type B" plan.

One final consideration regarding restrictions in application of the "Type B" plan is worth mention. While it has proved possible, under particularly favorable circumstances, to establish three "B" type areas in the State, they are all located in sections of relatively low hunting pressure. According to a posted land survey carried out by the Bureau of Law Enforcement for the year of 1940-1941, Livingston County was 21 per cent posted, Cayuga County 2.7 per cent posted and Jefferson County only 1.8 per cent posted. Thus with the possible exception of Livingston, none of these areas had felt any appreciable degree of outside or metropolitan hunting pressure. The opposite situation occurs in such counties as Putnam (44.09 per cent posted) and Orange (52.62 per cent posted) which are subjected to very heavy outside or metropolitan hunting pressure. In such counties the reputation of sportsmen has suffered somewhat through the irresponsible actions of the unthinking few to the extent that, as a group, the sportsmen have acquired a "nuisance value." From the Field Managers' contacts with hundreds of landowners in these sections, it seems clear that it would be wishful thinking to believe the "B" or lease-free type of area could be established or maintained under such circumstances.

EVALUATION OF PROGRAM

A. Cost Analysis:

The cost of the program to the close of 1943 was $184,945.11. This cost, as applying to each area, is divided into three main divisions as follows:

I. Acquisition and Leasing
II. Establishment
III. Maintenance and Operation

These principal categories are, in turn, further broken down to their smallest applicable components.

In completing this cost analysis it was immediately apparent where the great majority of costs should be applied. However, there was a considerable "line-item" cost involved in acquisition, establishment and operation. This was represented, for the most part, by District Field Managers' salaries and expenses.

The District Field Managers, while assigned to many other duties in addition to Landowner-Sportsman, found it necessary to devote a considerable share of their time to this project. To arrive at a fair means of applying this "line-item" charge, each District Field Manager determined from his individual records what percentage of his total time and travel applied to Landowner-Sportsman. This percentage was then prorated over the number of areas in his district for the year involved.

Explanation of cost sheets and graphs.—Cost analysis forms were drawn up from the collected accounts and work sheets (see Figure 3 for typical cost analysis breakdown for one area). All areas were handled in exactly the same manner by a breakdown, as indicated above, into three principal categories: (1) Acquisition and Leasing, (2) Establishment and (3) Maintenance and Operation.

ULSTER COUNTY COOPERATIVE LANDOWNER-SPORTSMAN AREA
COST ANALYSIS FOR 5 YEARS OPERATION

INVESTMENT

Total and Pro-rated Acquisition and Establishment Costs

Items	Totals	1939	1940	1941	1942	1943
1939 Acquis.	4,097.42	819.50	819.48	819.48	819.48	819.48
1940 "	1,486.51		371.63	371.63	371.63	371.62
1941 "	66.00			33.00	33.00	
1943 "	38.00					38.00
Tot. Acquis.	5,687.93	819.50	1,191.11	1,233.11	1,233.11	1,229.10
1939 Estab.	1,404.54	280.91	280.91	280.91	280.91	280.90
1940 "	532.04		133.01	133.01	133.01	133.01
Tot. Estab.	1,936.58	280.91	413.92	413.92	413.92	413.91
Tot.Acq.& Estab.	7,624.51	1,100.41	1,605.03	1,638.03	1,638.03	1,643.01

Maintenance and Operation Costs

Items	Totals	1939	1940	1941	1942	1943
Pers. Serv.	5,500.74	696.15	1,405.82	1,246.98	1,363.08	788.71
Rent.& Of. Ov'hd.	101.67		14.26	40.14	35.27	12.00
Travel	2,404.86	409.24	543.79	645.38	578.08	228.37
Truck. & Ship.	73.19	18.71	29.73	11.40	13.00	.35
Communication	108.25	5.40	23.97	27.05	34.54	17.29
Mater. & Reprs.	79.60			38.32	36.03	5.25
Fuel	37.50			10.00	15.00	12.50
Equipment	35.63			19.89	15.74	
Printing	92.23		25.31	32.90	26.82	7.20
General	26.97		2.66	11.79	11.02	1.50
Stock Liberated	3,454.00	1,080.00	1,202.50	421.50	691.00	59.00
Food Patches	577.50		187.50	210.00	180.00	
Tot. M. & O.	12,491.14	2,209.50	3,435.54	2,715.35	2,999.58	1,132.17
Tot.Acq.& Estab. & M. & O.	20,116.65	3,309.91	5,040.57	4,353.38	4,637.61	2,775.18

RETURNS

Hunting Pressure and Game Tallies

Items	Totals	1939	1940	1941	1942	1943
Acreage		5,293	5,293	5,293	5,293	5,293
Tot.Permits Iss.	5,782	1,047	1,654	1,447	1,043	591
Tot. Hrs. Hunted	21,997	3,769	6,297	5,374	4,128	2,429
Av. Hrs. Hunted	3.8	3.6	3.8	3.7	4.0	4.1
Tot.Pheas.Kill	845	190	257	225	115	58
Tot.Rabbit Kill	1,766	208	415	357	604	182
Tot.Hd.Game Kill	3,547	509	826	704	1,090	418

APPLIED COST TABLE

Items	Average	1939	1940	1941	1942	1943
Cost Per Acre	.760	.625	.952	.822	.876	.524
Cost Per Permit Is.	3.427	3.161	3.048	3.009	4.446	4.696
Cost Per Hd. Game	5.671	6.50	6.10	6.18	4.26	6.639

Figure 3.

These costs are shown under the major heading "Investment" (Figure 3).

The totals spent under each heading are shown in the left-hand column under "Acquisition" and under "Establishment." These totals are then prorated or spread over the full term for which the area was leased (5 years in all instances). Prorating of "Acquisition" and "Establishment" costs in this manner is essential in achieving an equitable basis upon which to compare an area in operation for 5 years against an area in operation for a lesser span of years. Even apart from this reason it would be illogical to load the whole burden of acquisition and establishment cost on the first year's operation of an area leased for a 5-year period.

To the prorated Acquisition and Establishment Costs are added the current or annual maintenance and operation charges, thus establishing an equitable basis upon which to compare one area to another, irrespective of varying terms of operation. Working from these basic costs certain tangible analyses were evident. These are illustrated by the accompanying bar graphs (Figure 4):

Chart A—Average Cost Per Acre
Chart B—Average Cost Per Permit
Chart C—Average Cost Per Head of Game

Of course, following this same pattern, additional analyses can be made. It is possible, for instance, to determine costs on the basis of pheasant take, rabbit take, etc. Likewise, cost per permit issued might be reduced to a cost per hour hunted. However, in the last instance, there is little to be gained by such reduction due to the fact that the average hours hunted, as reported at the permit stations, did not vary significantly one area to another for any particular year. Also, there is much to be desired from the standpoint of accuracy in the sportsman's estimate of the time actually spent in hunting while on the area. For these reasons the "permit issued" basis is used.

B. Values Received From Landowner-Sportsman:

With the above discussion of "Costs" in mind, it is now possible to turn to the other side of the ledger for an analysis of values received to date from the experimental Landowner-Sportsman Program (see under "Returns" Figure 3).

Certain of the more evident values received were essential in deriving the average costs of the prime factors: Cost Per Acre, Cost Per Permit Issued and Cost Per Head of Game.

For a summarization of what are here called tangible returns see Table 1.

As significant as may be the fact that in 5 years more than 58,000 hunters utilized the Landowner-Sportsman Areas and harvested, dur-

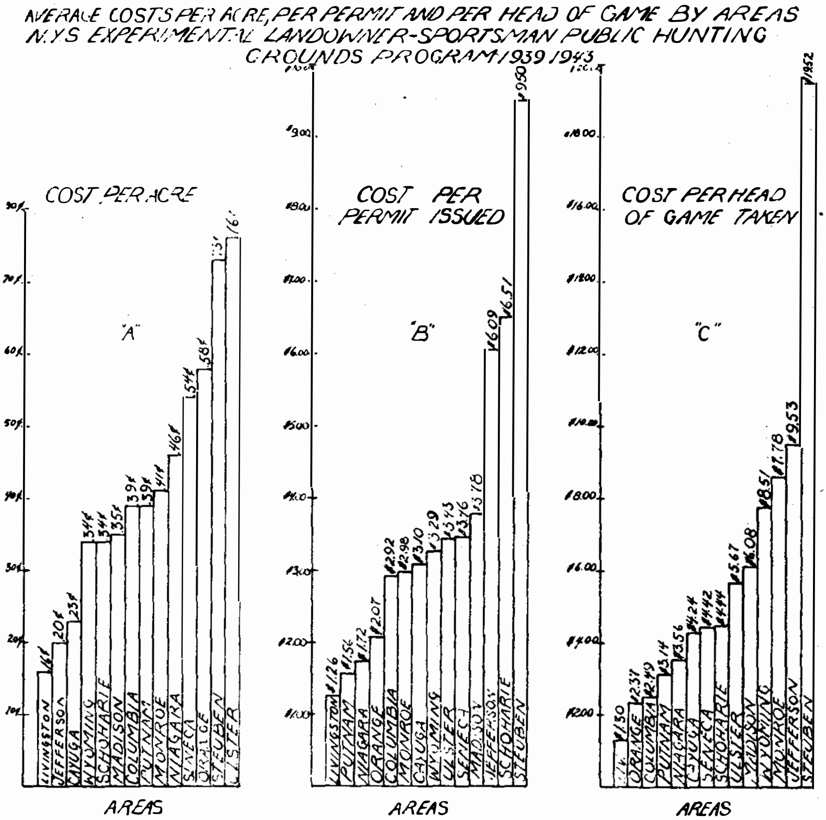


Figure 4.

ing that period, 40,678 head of game, it does not tell the whole story. To be added to the credit side of the ledger are many values received which, as mentioned earlier, do not lend themselves to reduction on a dollar and cents basis. A brief discussion of these values follows:

1. *Measurement of game productivity of land for farm game species.*—The mechanics of Landowner-Sportsman operation, inclusive of the check-in and check-out permit station system, automatically made possible a means of inventory of the game productivity of the land in many sections of the State. So closely have these areas been controlled that it is believed the records of game take are better than 90 per cent accurate. This accurate check on the game productivity of known units of land in relation to known hunting pressures for successive years would seem to have most important possibilities in forwarding our knowledge in game management. It is doubtful that

TABLE 1. RETURNS FROM LANDOWNER-SPORTSMAN PROGRAM

YEARS	*1939*	*1940*	*1941*	*1942*	*1943*	*TOTAL*
Areas established	2 areas operated	6 areas operated	13 areas operated	14 areas operated	13 areas operated	
ACREAGE[1]	8,005	30,605	98,688	121,975	120,498	121,975
Number of cooperating landowners[1]	88	315	1,022	1,204	1,183	1,204
Number of permits issued	1,604	7,811	20,277	15,945[2]	12,635[2]	58,272
TOTAL HOURS HUNTED	5,607	29,446	76,828	76,241	58,315	246,437
NUMBER PHEASANTS TAKEN	401	1,531	3,497	4,288	3,343	13,060
NUMBER RABBITS TAKEN	245	2,239	5,270	6,793	5,310	19,857
TOTAL HEAD OF GAME TAKEN	767	4,469	10,608	13,959	10,875	40,678

[1]Figures shown for acreage and number of cooperating landowners are cumulative.
[2]Drop in hunting pressure due to wartime restrictions, principally in auto travel.

there exists elsewhere so much potentially useful and accurate information bearing on this one phase of the game productivity of the land.

Thus far it has not been possible to analyze this data to determine how it can be utilized practically, but certain conclusions seem evident. As an example, the Orange County Area produced 1,321 cottontail rabbits during the 1940 season, 1,336 during the 1941 season and 1,679 during the 1942 season with the acreage and hunting pressure remaining about constant. This high productivity was entirely sustained by natural reproduction. One practical use for such data would be as a guide to the State in any program of purchase and release of imported cottontails. Obviously the rabbits prospered on this and similar regions and hardly needed the dubious impetus of imported releases.

2. *Proving ground for game research and game management techniques.*—a. Collection of Research Material.

The permit stations, operated as an integral part of the Landowner-Sportsman Areas, served as excellent depots for the collection of much material for game research purposes. The Pittman-Robertson projects in Food Habits, Pheasants, Cottontail Rabbits, and Diseases and Parasites Research all profited through the collection of quantities of material from widely diversified sections of the State through the medium of the permit station check-out system. At the same time many sportsmen who cooperated in this effort were introduced to the research work being carried on by the Department.

b. Winter Feeding.

Much attention has been devoted in the field of game research and management to the possibilities of holding and carrying through the winter months greater numbers of pheasants by means of supplementing their normal cold weather diet with so-called "winter food patches." The possibilities of this management technique were explored on the Landowner-Sportsman Areas. Seed grains, mostly sweet corn and buckwheat, were supplied by the District Field Managers to cooperating landowners. These landowners were, in addition, paid a nominal sum to recompense them for their effort and land use involved in planting this grain in one or two acre "food patches" adjacent to good winter cover. These patches remained unharvested and, theoretically, provided a source of winter food during the critical time of the year.

Basically this practice seems sound and yet practical application on the Landowner-Sportsman Areas has not, in the opinion of the Field Managers, paid dividends in the form of greater native population carry over commensurate with the cost involved.

The poor results obtained from this project do not necessarily condemn the practice of emergency winter feeding in New York State, but rather are an indication of the limitations of achieving satisfactory returns under the lease status of the Landowner-Sportsman Program. Without direct control of environmental factors through actual ownership of the land it has been found impossible to achieve the desired ends.

c. Comparative Survival of Brooder-Reared vs. Range-Reared Pheasants of Different Ages.

The location of the Landowner-Sportsman Areas on agricultural lands in various sections combined with the accurate check on the hunter harvest of game fitted in perfectly with the requirements of the Pittman-Robertson Pheasant Research Project (1-R). Research experiments conducted on the survival value of different age and differently reared pheasants were carried on through the utilization of certain Landowner-Sportsman Areas. It is doubtful, since answers were dependent upon securing data from actual field conditions, whether as conclusive results could ever have been obtained by any other means.

PHEASANT REARING BY COOPERATORS ON LANDOWNER-SPORTSMAN AREAS

From the inception of the Landowner-Sportsman Program intensive effort was made to incorporate with the management plans on each area the rearing of young pheasants by children on a cooperative basis. As a part of this plan the cooperation of 4-H Club leaders and agricultural teachers in centralized schools was solicited. Pheasant eggs were furnished to boys and girls of cooperating landowners by the District Wildlife Field Managers. The Field Managers followed through by continued supervision, giving advice and help in hatching under hens and subsequent rearing of the pheasants to 6 weeks of age. The Department then paid the children 50 cents each for the birds so reared. The young birds were allowed to wander off of their own accord on the area.

Although much effort was exerted to make this plan work, the results were uniformly poor. It was difficult to find a boy or girl able to carry through the approximate 9-week project with the necessary painstaking care involved. An approximate 35 per cent survival to 6 weeks of age was about the over-all average success for all areas.

A variation of the above plan was evolved on certain of the areas in the last year or two. This was a centralization of rearing effort, either by a group or, in some cases, a single individual. Results were considerably better. On the Orange County Area, for example, approximately 500 birds were reared to 6 weeks of age. Most of these resulted from the production of one individual using the incubator-brooder system. The survival of his pheasants to 6 weeks of age was 72 per cent.

LANDOWNER-SPORTSMAN AS A SOLUTION TO METROPOLITAN HUNTING PRESSURE

As outlined in the introductory portion of this discussion, a primary objective of the New York State Experimental Landowner-Sportsman Program was to achieve a solution to the posted land problem, both existing and potential, in certain sections of the State.

There is some evidence to support the feasibility of strategically-located Landowner-Sportsman Areas as an answer to metropolitan hunting pressure demands. Examination of the origin of hunting pressure on two of the most heavily-hunted areas in the Lower Hudson District supports this assertion. These records are shown in Table 2.

TABLE 2. ORIGIN OF HUNTING PRESSURE
1940-1942

Orange County Cooperative Landowner-Sportsman Area

	1940		1941		1942	
Daily permits issued to	Number	Per cent	Number	Per cent	Number	Per cent
In-county residents	1,430	63.6	1,362	52	1,114	50.2
Out-of-county residents[1]	234	10.4	367	14	200	9.0
New York City and vicinity residents	478	21.2	695	27	590	26.6
Ont-of-state residents	107	4.8	186	7	316	14.2
Total	2,249	100	2,610	100	2,220	100.0

[1]Other than those classed under New York City and vicinity.

Putnam County Cooperative Landowner-Sportsman Area[1]

	1941		1942	
Daily permits issued to	Number	Per cent	Number	Per cent
In-county residents	342	9.4	287	10.5
Out-of-county residents[2]	30	0.8	225	8.2
New York City and vicinity residents	3,265	89.2	2,185	79.8
Out-of-state residents	25	0.6	41	1.5
Total	3,662	100.0	2,738	100.0

[1]Putnam County first opened in season of 1941.
[2]Other than those classed under New York City and vicinity.
Note: 1943 hunting pressure so reduced by war as to make figures for that year invalid in measuring origin pressure.

The degree of utilization of these areas, particularly the Putnam Area, by hunters from the metropolitan zone of New York City is convincing evidence of the demand for hunting opportunity in these heavily-posted counties. Much the same picture, although not so pronounced, can be shown for areas situated adjacent to other large cities, such as Buffalo, Rochester, and Syracuse.

Although the existence of a Landowner-Sportsman Area in a heavily-posted county has not, as previously noted, reduced the degree of posting in the surrounding countryside, certain trends worthy of mention have occurred. Following the 1941 hunting season in Putnam County, for instance, landowners in many sections of the County remarked upon the noticeable decrease in the numbers of hunters afield as compared to the previous year. Considering the fact that there were no restrictions in travel in that year it seems logical to believe, for this small county, that the role of the Putnam County Area in playing host to a total of 3,662 hunters that season had a decided bearing upon this landowner reaction. Paradoxically the cooperating landowners on the Putnam County Area reported at the close of the season that they had experienced less trouble from hunters than in previous years. Since it is certain, with the Area as a magnet, that this block of 12,000 acres carried more hunting pressure than ever before, we have no alternative but to concede that the various control features of handling the hunting pressure were effective in managing heavy hunting concentrations. This is verified by the remarkable record of the whole Landowner-Sportsman Program which, from 1939 to 1943, is credited with absolutely no serious accidents nor damage done to landowners' property. During this period 58,272 sportsmen secured permits and hunted upon 121,975 Landowner-Sportsman acres, representative of over 1,200 cooperating landowners.

PUBLIC RELATIONS

One of the most difficult returns to measure from the Landowner-Sportsman Program in New York State is the value derived by the Conservation Department through its association with sportsmen's groups, schools, county officials, agricultural organizations and individual landowners and their families by reason of this program.

Individual sportsmen's clubs, federation groups and representatives to the annual Conservation Council meetings have known, either directly or indirectly, of the Landowner-Sportsman Program since its inception and have followed its progress with interest.

Schools, particularly the central schools in regions of the areas, cooperated with the pheasant-rearing program.

County supervisors and other town and county officials assisted in the establishment and maintenance of many of the areas. In Putnam

County, for instance, the Board of Supervisors approved an annual appropriation averaging $600 as the County's share in the support of the area. This money paid the salary and expenses of a special game protector who worked on the area under our supervision.

Agricultural representatives and organizations, such as the State Grange, County Agricultural Agents, 4-H leaders, and agriculture teachers in rural schools cooperated in nearly every county where an area has been established.

And not least have been the friendly relationships established between the Conservation Department and the many hundreds of landowners who, with their families, cooperated in the establishment of the areas. Important, also, in this landowner relationship has been the previously described pheasant-rearing plan offered to the children of the cooperating landowners.

CONCLUSIONS

As outlined in the introductory portion of this analysis, the original purpose of New York's experimental Landowner-Sportsman Program was to solve the posted-land problem, existing or potential, by furnishing satisfactory shooting on controlled public hunting grounds so managed by seed-stock refuges, food patches, regulated hunting effort and other management devices as to produce an annual crop of game on a sustained yield basis. It is apparent now that this goal has not been achieved. The following basic considerations are applicable and interdependent:

1. Operational costs per area do not vary significantly irrespective of area location.

2. The common denominator of value-received from any area may be expressed in hunting pressure, i.e., number of permits issued.

3. Only 4 or 5 of the 14 Landowner-Sportsman Areas were so strategically located within the sphere of metropolitan influence as to realize consistently heavy hunting pressure.

4. Cost per permit issued on all but the most favorably located areas was prohibitive; on the better located areas the cost was high.

5. The necessity for reducing unit operational costs to a minimum is dependent upon sustained hunting pressure at area capacity. This, in turn, is incompatible with the original theory that a sustained annual crop of game to meet such pressure could be produced by management practices.

6. Thus, it is obviously necessary to abandon the original thesis of "Game Management Areas" and view them in their actual role of "Public Shooting Grounds."

Realization of the necessity for this departure from the originally outlined goals for the Landowner-Sportsman Program, and acceptance of the fact that only four or five areas, so located as to attract very heavy hunting pressure and thus more or less qualified as public shooting grounds, can be considered for possible justification on a cost-value basis, clears the way for further consideration.

Because the Putnam County Area typifies the public shooting ground role so well it is used here in amplification of the following conclusions which, it is believed, must apply to future successful operation:

1. To reduce the unit cost per permit to its lowest point, the daily hunter quota of 300 must be realized every day of the pheasant season.

2. A hunter-success ratio of 1 bird to 5 permittees represents the turning or balance point in satisfaction. If the success ratio runs lower, complaint of unfavorable hunting conditions outweighs satisfaction. To operate the area efficiently, a success ratio of 1 bird to 3 permittees should be maintained.

3. Natural reproduction, even as augmented by such management practices as can be carried on, cannot be counted on to supply more than a small percentage of this large demand.

4. To assure this 1 to 3 success ratio, the area must be stocked with artificially-reared adult cock birds and these birds must be released just prior to and periodically through the open season. (The percentage return from the release of half-grown birds on the areas of 2 months before the season is too low to overcome the differential in cost involved.)

5. The number of adults necessary for stocking and the cost can be calculated.

a.	Number of permittees per day	300
b.	Number of birds brought to bag per day	100
c.	Number of hunting days of the pheasant season	12
d.	Number of birds brought to bag for season	1,200
e.	Approximate percentage return on adult stocking done immediately prior to and during season	50[1]
f.	Number adults necessary to stock for season (Area records indicate approximately 400 of this requisite number can be produced by natural reproduction each year.)	2,400
g.	Number adults necessary to stock each year minus natural reproduction on area	2,000
h.	Average cost per adult bird stocked	$1.75[2]
i.	Annual cost of stocking	$3,500

[1]Percentage return given here verified by release of adult branded stock on this area.
[2]Calculated on basis of prewar production costs on State game farms.

6. This stocking cost, necessary for any successful future operation of the Putnam County Area, can now be integrated with other basic operational charges to give a complete picture.

a. Average annual over-all cost of area (not including stocking charge)	$3,500
b. Annual calculated stocking cost	$3,500
c. Total annual cost	$7,000
d. Probable number permits issued per season (pheasant season 3,600; remainder of season 2,000)	5,600
e. Calculated average cost per permit	$1.25

7. Continued operation of the Putnam County Area or any of the other few areas considered in its category must be visualized along the above outlined plan or it is believed hunter dissatisfaction and complaint will far outweigh good will.

With the completion of the full 5-year period of experimental operation of the Cooperative Landowner-Sportsman Program on two areas and from three to four years operation on all but one of the remaining twelve, enough data has been secured, it is believed, to fully justify the conclusions as set forth above. It has been shown that even those most strategically-located areas operating at lowest unit cost were more expensive than the State could justify on an economical basis. On the Putnam County Area, it cost the State $1.56 to issue one permit per man per day, or more than the revenue derived from the sale of his license. The average permit cost on all areas was $2.67, or nearly two times the revenue realized from the sale of a hunting license.

However, in writing "finis" to this experimental program as originally conceived and operated over the past 5 years, it should be clearly seen that, while we have been on the wrong track in regard to fulfilling the original ideals and intent, we have, at the same time, realized returns of the utmost importance in the fields of game research and management. It has been recognized from the start that these areas, set up and controlled as they have been, were ideal testing grounds for game research and management techniques. In no other way could such accurate data be gathered bearing upon stocking methods, rate and degree of spread, cover or habitat value and survival ability. Answers to these and other equally basic questions have a direct bearing upon the annual expenditure in New York State of approximately $187,000 for propagation and management purposes.

Furthermore, it is felt that our experience to date, in the operation of the experimental Cooperative Landowner-Sportsman Program in New York State, will be invaluable as a background from which to approach any future public hunting program as may be necessitated by postwar demand in this and other states.

Chairman: KARL T. FREDERICK

Chairman of the Board of New York State Conservation Council, New York, New York

WATERFOWL

BASIC CONCEPTS OF WATERFOWL MANAGEMENT

IRA N. GABRIELSON
Director, Fish and Wildlife Service, Washington, D. C.

America is approaching the end of the era of waterfowl restoration and entering one where its greatest concern will be the management of existing resources rather than further restoration in numbers. Despite many statements that have been made to the contrary, we have not yet reached the climax of the restoration program. Some species of ducks, such as the mallard, pintail, and widgeon, are approaching the maximum numbers that can be maintained on this continent under present conditions. But other species still need to be increased in numbers unless we are to turn largely or wholly to these three species and neglect others. That, I am sure, no one wants to do. Therefore, for the present, we still have the job of increasing our populations of practically all other species of wildfowl and, in some areas, even of the three species mentioned above. It is particularly desirable that the populations that use the Atlantic Coast Flyway be materially increased above their present numbers. Accordingly, for the next few years we will undoubtedly be passing through a period in which we will attempt a mixed program of restoration and management. This may conceivably stretch out for many years depending, of course, upon the many factors that affect waterfowl populations. It is entirely possible that one or two years of drought in major breeding areas could throw us back entirely into a restoration type of program. Naturally we all hope that a setback will not occur and that we can go ahead in developing new ideas and testing new practices for a management program.

There are many factors that need to be considered in connection with such a program. In a short paper for presentation in this forum only a few of the more important ones can be discussed. First, we have the desire for greater hunting privileges, which is expressed continuously. The memories of duck hunters are notoriously short and those who clamor now for greater privileges never think to turn their thoughts back to '35 and '36 and compare the hunting opportunities they now enjoy with those they did not have during the bad years. Second, and associated directly with the first factor, is the problem of obtaining a better distribution of hunting privileges. Much of the agitation for one change or another in the regulations is based on the desire of the community or locality involved to get a larger quantity of the total number of birds that are taken. From their viewpoint this is a perfectly simple procedure. From the viewpoint of an over-all administrative agency, however, it is necessary to look at the national picture and try to make regulations that will provide as nearly as possible an equality of hunting opportunity. Obviously, equality is impossible of perfect achievement since we are dealing with a group of migratory birds which respond readily to local vagaries of weather, availability of food, and seasonal water conditions. Up to the present, the basic philosophy has been to relax the regulations as rapidly as the increase in the birds justified, but to do it in the way that would increase the hunting opportunity for the greatest number of sportsmen. This is still and probably will always remain a good basic concept. It does imply, however, the contrary idea that, when populations decline and it becomes necessary to reduce hunting pressure, the reduction should affect the greatest number of hunters and thus accomplish the desired result in the shortest possible time.

A third factor that contributes to our present puzzlement and to the necessity of looking ahead is the concentrated damage to agricultural crops in certain areas, particularly in the arid and semi-arid sections of the country. Such damage seldom occurs in better watered districts and, except under special conditions, cannot be expected to occur in the same intensity as it does where water is scarce. Under arid conditions, watered areas act as a magnet to concentrate the birds to a far greater degree than occurs elsewhere. This crop damage problem has been accentuated by labor shortages, by intensive cultivation efforts, and other factors. Any effort to increase further the waterfowl populations or to attempt to maintain a maximum population, is certain to make crop damage a continuing problem that will vary in intensity from year to year. During the war the situation has been complicated locally by shortages of shotgun shells, by limited supplies of gasoline for transportation, and by the limited time available to indulge in hunting. In many localities these war conditions have resulted in a reduction of hunting pressure greater than would have been necessary from a strictly management standpoint. It has also contributed to the confused thinking of many people on the over-all waterfowl problem.

The fourth problem which faces us today, and one which must be considered by all wildlife administrators, is the possible increase in hunting pressures which may arise after the end of the war. Without exception, as far as I know, every administrator who has attempted to forecast the magnitude of these pressures has concluded that there will be an increase of 3 per cent or more in the number of licenses sold, which is the most accurate index that can be obtained of the anticipated increased hunting demand. These conclusions are based partly upon a study of developments following the last war and partly upon studies of correspondence emanating from servicemen throughout the world.

The foregoing are only a few of the major problems that confront every wildlife administrator who is attempting to decide what the regulations for the coming season should be for migratory game birds and, to some extent, for all forms of resident game.

What should responsible wildlife administrators do to meet these problems on a long-time basis? I have devoted much effort in attempting to rationalize my own thinking, and I have discussed the issues at every opportunity with my colleagues, as well as with sportsmen and state conservation officials. So far as I can put ideas into words at this time, it seems to me that the making of regulations for the next year or two, or until the end of the war, should be based upon the following philosophy:

1. That it is legitimate and reasonable to provide a wider hunting opportunity as long as the anticipated demand created by that opportunity allows a continuous building up of wildlife stocks to provide for the expected increased take. Certainly this is not the logical time to make a radical change in basic regulations that would provide for an enormously increased hunting opportunity. Obviously, the approach should be conservative, particularly where there is no factor of crop damage involved. In view of the liberal increase that has been made during the past few years in the length of the waterfowl hunting season and in the relaxation of other regulations, such a philosophy will not impose any serious hardship upon those who indulge in this form of sport.

2. The fact should be faced squarely that more thought be given to management and less to restoration. To do this honestly less thought must be given to those specific regulations which sometimes become fetishes to those who favor them, and more consideration be accorded to the effect of such regulations on the wildlife population. The question as to how far our regulations should go in attempting to effect a more even distribution of hunting opportunity between different classes of hunters must also be considered. The arguments, for example, concerning the question of live decoys or baiting are only par-

tially a problem of management. They include also a large element of distributing hunting opportunity. Omitting any other contentions regarding these practices, it must be admitted that there is some logic in the argument used by the average gunner when he states that the restoration of either of these hunting devices is largely regulation for a minority. Use of such devices, however, will, by and large, increase the hunting opportunity of those fortunate individuals who own or control waterfowl shooting areas, and no corresponding advantage will accrue to those who must find their shooting on the limited areas of public land or water that are open to them, or who must find hunting opportunities where they may on privately-owned land. Another variant of this same one-sided idea is found in the constant arguments presented in support of recommendations which attempt to meet, by special regulations, the seasonal vagaries of waterfowl flights. As stated before, the memories of duck hunters are notoriously short and if attempts were made to change the regulations from season to season, basing such action only upon sportsmen's recollections of the preceding season, it is quite certain that over a 5-year period the result would be less instead of more shooting in the areas concerned. In the past waterfowl regulations have been based upon a concept of a limited number of zones which, as nearly as possible, have been comparable in seasonal temperatures and which have been correlated as well with the average mass movement of the birds. After these zones were established, efforts have been made to provide in each a hunting season that is long enough and so adjusted to the flight of the birds that it will insure a certain amount of shooting in every part of the zone. Naturally, the results can never attain perfection and dissatisfaction has been voiced by some of the duck hunters, particularly those who are most enthusiastic about their privileges and least mindful of the welfare of the birds. No sooner is a season set than this type of hunter begins to resent the fact that the season does not coincide entirely with the times of greatest abundance of birds in the area where he does his shooting, and he immediately clamors for a change in the season in order to accomplish this, for him, very desirable result. Were all these wishes met, it would undoubtedly penalize many other communities and many other duck hunters.

3. The zonal concept has further involved the idea of uniform basic regulations, an idea which has not been violated appreciably during recent years. It has been a good philosophy. It has accomplished the desired results. Consequently, there is good reason to believe that it can be used as a tool for management as satisfactorily as it has been used for restoration. It should not, however, preclude thinking about still other methods which might be applied with more precision and

greater flexibility. In speaking before the North American Wildlife Conference in Chicago a year ago, I outlined the possibility of a change from the zonal to a flyway concept. This was only a suggestion and it will be discussed in another paper to be presented in these *Transactions.* Fundamentally it would involve the idea of getting away from uniformity of regulation and the application of regulations by flyway populations rather than by the continental population. Biologically it is sound, but administratively there would be many difficulties connected with it. Not the least of these would be the necessity of changing completely the average sportsman's point of view regarding the regulations. Until they can understand that in some years it would be good management to have larger bag limits and longer seasons in one section of the country than in another, dependent upon the supply of birds in the respective flyways, it would be difficult if not impossible to put such an idea into actual practice. The Fish and Wildlife Service is studying the flyway concept and other suggestions with the thought that, after mature consideration and wide public discussion, they may be useful for improving the present regulations.

4. The final concept, which is certain to govern our actions until the end of the war, is that we must be sufficiently conservative in making the regulations so that it will not be necessary to reduce hunting privileges during the first year, at least, after the close of the war. Obviously, it would be unfair to the many hundreds of thousands of sportsmen, who are now pursuing other kinds of game in foreign lands, to give wide open privileges to those who have remained behind and then be obliged to reduce drastically the hunting privileges in the season in which they will have their first opportunity to enjoy their favorite sport at home. Not only would it be unfair but it also would be poor psychology for the Fish and Wildlife Service, or for any state game department managing resident game resources, to get in a position that such action would be required. Furthermore, it would be exceedingly poor management from a long-time viewpoint to allow regulations to swing so widely as to require drastic curtailment in any one season. An unexpected catastrophe in late summer, after the regulations have been issued, might justify such action. Taking chances with the waterfowl resources to please the vociferous minority of hunters cannot be regarded as a valid excuse for such a mistake.

THOUGHTS OF A DUCK HUNTER

RAY P. HOLLAND
Scarsdale, New York

The few words I have been asked to write will be written from the standpoint of a duck hunter. They will be written in behalf of the duck hunter, for after all, he is, and always has been, the man most interested in wildfowl. In fact, most of the men who have really accomplished worth-while things in game conservation have been dyed-in-the-wool duck shooters. Old friends of mine like George Shiras III, Geo. Bird Grinnell, John B. Burnham, John C. Phillips, John M. Phillips and many others went out and did things for the ducks. Look at the record! These men were all confirmed duck hunters. They knew ducks and the needs of ducks.

Today the duck hunters chip in a dollar each, once a year, to insure their sport. Public servants charged with wildfowl protection may have at times forgotten the duck shooters' interest. Originally, under the Migratory Bird Law and the Treaty Act which followed, there was an Advisory Board of duck shooters and state game officials, which met with the federal administrators of this legislation. About the time bureaucracy started to run rampant in this country, the Advisory Board was dropped. This is deplorable!

When wildfowl first showed need of protection, the duck hunters passed a law stopping spring shooting of ducks and geese. Later, they led the fight that outlawed the sale of migratory game throughout the nation. Then came the campaign to purchase ducking areas and establish refuges, originated by duck hunters, and the law finally passed by duck hunters, which assessed each member of the fraternity $1.00 a year for the privilege of shooting ducks, in order that the legislation would be adequately financed.

No man, in the many who worked for and passed this legislation, ever thought that the Federal Government would clutter up the law with a lot of minor regulations that couldn't be obeyed, let alone enforced. Rather, the federal law was to be a broad measure enforced by a munificent and paternal government and the states were to do the dirty work. No one ever dreamed that the Federal Government would ask a duck hunter to tell the difference between a hen scaup and a hen redhead, as the birds flew by at 60 miles an hour. Regulations impossible to observe make honest duck hunters violate the Criminal Code of the United States of America.

The thought behind the Game Refuge Bill was that the duck hunters would furnish the money to buy up large tracts of ducking grounds, and thereby prevent their drainage on the pretense of more land for agriculture. These areas were to be saved for the ducks—and the duck hunters. Small areas were to be set aside as inviolate refuges, so the ducks would have a haven, and the balance of the area was to remain open for shooting, as the whole area had been at the time of purchase.

A certain lobby killed the public shooting ground feature of the original bill, claiming that it would result in slaughter. The measure passed the Senate and was beaten in the House by a very few votes when brought up by the opposition, while many of its friends were away over a holiday. I should know about all this as I helped write the bill and took it to Washington and lived with it during its struggles to become law. The emasculated bill became law in 1929.

Today, the government is still buying land and water areas and they are set aside as inviolate refuges—great tracts where birds gather in immense flocks and stay until they move on to another refuge. I am told that when the natural food is eaten and the birds stay on, that the government feeds them corn. Many of the very best ducking areas in the country have already been taken from the duck hunter. It is not hard to believe that in time, as the money keeps rolling in, that all of the duck shooting marshes will be refuges. It may be necessary to amend this law!

My acquaintance with duck shooters over the country is large. They write me from every state. When they have had a good season, they like to tell a friend. When the shooting hasn't been up to par, they want to talk about it. This past season there have been more complaints than usual. This in spite of the fact that our government officials, the Canadian game authorities, Ducks Unlimited and others in a position to know, claim an overabundance of birds.

A number of letters have stated that the shooting hasn't been so good, "since the government established" a certain refuge nearby. If ducks were at low ebb, that would be fine, but with the birds damaging crops in certain areas and Canada claiming the greatest crop in years, it is not so good. A duck hunter in the Middle West, who needs a lot of luck to kill a few birds, must feel pretty bad when he hears that in other sections the bars are down and hunters are allowed to shoot without regard to season or bag, in order to save the crops.

I don't know that it is true that grain-growers have been given the privilege of unlimited shooting. I have heard so from several sources. I wrote to the Federal Government asking enlightenment. The rumor persists. If it is not true, it should be denied. If it is true, it is high time that the game be managed looking toward a better distribution.

Waterfowl constitute a crop. That crop should be harvested with care that the breeding stock is not encroached upon. The ideal situation would be a distribution even enough, to give as many gunners as possible a little sport and a little meat. The duck hunter in Podunk Center is just as much entitled to his sport as the man who owns a thousand acres along Currituck.

John C. Phillips once told me that he feared the feeding of ducks in refuges, and keeping them there for long periods free from molestation by man, would be detrimental to the birds. When any game loses its wildness, it is doomed. Scientists have already proved that a physical change takes place in wild turkeys that are raised in captivity, and that they are no longer capable of becoming wild. When liberated to shift for themselves they can't make a go of it. Lets not make bums out of the ducks by keeping a free lunch table handy in a refuge.

If the government must feed wildfowl, why not use that grain to get a wider distribution of birds? It takes a lot of duck food to care for the millions of birds in the flight. Oil and other pollution has played havoc with much of the natural duck food in this country and there never was too much. In the old days of spring shooting, the birds going north were always poor in flesh. Many of them had hardly enough meat on them to bring them down when shot. Certainly, they couldn't do a first rate job of reproduction.

I have often thought that the government should have required every duck hunter to feed, instead of placing a ban on artificial feeding by the hunter. What a job that would have done, if every man who killed a duck had been required to put out grain where other ducks could reach it, no grain within a hundred yards of a blind. Those ducks would never have become tame while getting that grain, for someone would always be after them, but they would find it and they wouldn't get hurt, if the feeding was a hundred yards away from a shooting blind. In fact, excess killing was rare in the days when everyone on the East Coast fed bushels of grain right in front of his blind, because ducks are smart and feed as much at night as they do in the day time.

A number of years ago when the duck total was way down, due to a drought in the breeding areas, many nuisance prohibitions were laid on the doorstep of the duck hunter. Canvasbacks, redheads, buffleheads and ruddy ducks were particularly hard hit by the drought. None of these ducks ever looked at a live decoy, so the regulation forbidding the use of live ducks as decoys, which was promptly slapped on, didn't help them much.

Mallards and pintails are the ducks that came most readily to live stool. They are the species that are doing the most damage to the crops today, but the prohibition against live decoys still holds. It is said the use of live stool would help the wealthy hunter. That is unadulterated piffle. The wealthy have always looked out for themselves. The ducking areas they control don't need live decoys, but the boys throughout the country, who must kill their ducks on little potholes could use a couple of live ducks to advantage. Wooden stool on big water, where there is a breeze or a slight current, look like live fowl to passing birds. The same decoys on a flat, still pond look like what they are—blocks of wood. One live duck tied with them will keep the water stirred up and help business.

I like the man who gets his sport facing a sleet storm. Duck hunters, by and large, are swell folks. I am proud to belong to the fraternity. I think they need a break. It would be well if the old Advisory Board were revived, even if it had no power to act. A dozen wildfowlers could sit-in with the makers of regulations to the advantage of all, including the ducks. The framers of our Constitution never intended to give dictatorial power to a few federal employees. Grant that these men are honest and doing the best job they can do, as they see it. Still, the duck hunters are entitled to a word in court. The Advisory Board should be again put to work. A little advice might prevent mistakes and keep some fellow from being classed as a criminal, because he shot a redhead out of a flock of scaup.

MIGRATORY WATERFOWL CONDITIONS IN SASKATCHEWAN

C. L. BERTRAND
Provincial President, Saskatchewan Fish and Game League, Regina, Sask., Canada

To Dr. Ira N. Gabrielson, Director of the Fish and Wildlife Service, Washington, may I extend a hearty thank you for your recent article, which gave a true picture of who is responsible for the lion's share of the work that is being done to restore the duck population for the sportsmen of the North American Continent.

To compare what any other organization has done for the restoring of water in the Province of Saskatchewan, the largest breeding grounds in the world, with that of the P.F.R.A., would be like the writer throwing a bucket of water in the Pacific Ocean with a view to overflowing it. There is no comparison and never was.

To substantiate my personal thanks, the following is an exact copy of an official statement of the P.F.R.A. which appeared in our leading newspaper, *The Leader Post,* Regina, Saskatchewan, dated February 22, 1945.

"Water Saving Schemes Would Make Good Lake

"Not only has the work of the P.F.R.A. helped Saskatchewan farmers by improving land facilities, but it has also helped the duck and wild game of the province, both by increasing the water supply and by using community pastures as wild game preserves.

"By official estimate, enough water has been collected by the larger water projects alone to cover 120 sections of land with six feet of water, or else it would make a lake six feet deep and three miles wide stretching from Regina to Moose Jaw.

"The water harnessed by the *small projects* would cover 80 square miles of land to a depth of six feet.

"Although the purpose of these projects has been to improve conditions for the farmer, their effect on wildlife has not been overlooked. By using the community pastures for the auxiliary purposes of game preserves, the deer population of southern Saskatchewan has increased.

"Until 15 years ago, deer were rarely seen as far south as Regina. Now according to J. W. Fairley, of the P.F.R.A., reports of deer in rural areas are increasingly frequent. From these reports, it would seem that the deer are particularly numerous around McLean (23 miles east of Regina). (In fact 3 deer were killed on the streets of Regina by accidents and taxis in 1940.)

"The ducks also are benefiting from the increased water supply in Mr. Fairley's estimate, their numbers are increasing steadily. . . ."

Commenting on the above article, this magnificent job has cost the Canadian public over 6 million dollars and according to the latest dispatches, the Canadian government's program for water restoration in the three Prairie Provinces calls for an additional expenditure of 100 million dollars.

Dr. Gabrielson has from time to time been severely criticized for his public statement, even going so far as to ask: "Why, we wonder, did the good Dr. Gabrielson in speaking of the government of Canada as the (so-called) saviour of the ducks, issue a lengthy release on the subject without mentioning Ducks Unlimited? Not so long ago, he lauded the achievements of that most worthy organization as the miracle of the century?"

Why did Dr. Gabrielson make this release? No doubt because he, like many more, has at last seen daylight, and no doubt he was the only one who had sufficient power to secure the publicity. I know I have been blocked repeatedly. Too many have fallen a victim to publicity (dictated), and trash that have appeared in various publications in Canada and the United States, not to mention the moving pictures (it would be interesting to know how and where they originated). I admire Dr. Gabrielson for this fortitude in changing his attitude after he had found out the true facts of the case. Good luck to you, Dr. Gabrielson!

Working hand in hand with the P.F.R.A. and taking advantage of what they are doing is the Saskatchewan Fish and Game League. The only organization of its kind in the Province and the only one that is recognized by our governments. We handle all matters and questions pertaining to the wildlife of our Province, whether migratory waterfowl or otherwise, publications and press dispatches. That other organizations from outside Canada are working shoulder to shoulder is absolutely false. It has been tried and all offers have been turned down flatly, due to the manner in which they have tried to work. We will not tolerate any organization trying to monopolize the wildlife of our Province, especially our fur-bearing animals, such as has been the case since 1938; nor will we tolerate other schemes to commercialize and expand at the expense of our natural resources. We in Saskatchewan will cooperate with anyone, but it must be done fair and above board. The wildlife of this Province belongs to no man—it belongs to everyone, share and share alike—and it is our intention to keep it that way.

The American sportsmen have for a number of years been spending hundreds of thousands of dollars to increase the duck population, but to what avail? Time after time you read press dispatches that the predators of the north take a toll amounting to 80 per cent of our hatch and higher in some localities. (This is one dispatch that is not stretched.) But what has been done with this American money to cut down this drastic loss? Out of $140,000 donated to duck restoration, not $5,000 a year has been utilized for predator control, and what has been done in this respect (*outside of the money our league has collected*) has been utilized for a crow egg gathering contest amongst the schools of Saskatchewan. Is this getting at the root of the trouble? Certainly not. Its the *adult* birds that wreck havoc, and we know this from actual experience. But try as we can, every effort to raise money for this important work has been blocked in the United States.

We have only a small number of hunters in a Province so large that we could stand the British Isles in one corner and never know it was there. In 1943 we did not have 8,000 hunters in the Province. Can 8,000 satisfied sportsmen, who can go out to their favorite hunting grounds and secure their bags any day, be approached to secure financial aid? Certainly not. We must rely on the hundreds of thousands of our American friends to the south of us to support the work that is being done. We have been receiving wonderful support from those whom we have contacted, that is, the ones who at one time or another have visited Saskatchewan to do a little hunting or fishing. The largest number in any one year to take advantage of this opportunity numbered 672. I myself have taken the liberty to canvass them and last year I received 202 replies from 670 letters (old addresses in many cases). This amounted to $202.00 in membership dues and $620.95 for predator control. Many letters are received with these contributions, all with praise for the work we are doing. Why do we get this praise? Simply because they have been to Saskatchewan and know what we are trying to do for them. They know our organization is in the hands of men who do this work for a hobby or the love of it, and not for gain or publicity. We have branches all over the Province, just raring to go, but lack of funds keeps us at a certain level. With the P.F.R.A. behind us, all the engineers we require (free), and the best naturalists (free), we don't have to pay 75 or 80 per cent of the funds collected for salaries, rents, moving pictures. That is not our work, we are out to raise game birds. The money we spend for incidental expenses comes from the percentage on the membership money we receive from the branches and the profit from the publication of our year book.

To further substantiate our standing with our governments and contrary to dictated publicity that we do not carry on a predator campaign, here is an exact agreement that the writer made with the government, which speaks for itself and also for the 1943 campaign:

THE WARTIME PRICES AND TRADE BOARD

Ration Administration
Regina, Sask.
Feb. 8, 1945

Mr. C. L. Bertrand
President, Sask. Fish & Game League
Regina, Sask.

Predatory Campaign—1945

Dear Mr. Bertrand:

The writer forwarded to Headquarters your complaint that much time, rubber and gasoline were expended in the last campaign by applicants for ammunition, because they were forced to go to their nearest local Ration Board to obtain approval of the RB-202.[1]

Their reply was to the effect that last year's campaign in Saskatchewan was very well conducted and rigidly controlled, and in view of this, and if the same routine is adopted for the campaign this year, they are agreeable to authorizing you to sign RB-202's on behalf of the Ration Administration. They are also agreeable to using only one copy instead of three.

This means that the routine to be adopted this year is as follows:

(1) RB 202's especially marked for use in the Predatory Campaign will be supplied from this office to you only.

(2) One copy of RB 202, must be properly completed by the applicant with his signature and gun registration, and the square must be completed and signed by you showing whether it is an initial stock or an additional supply, and must also be signed by you on behalf of the RATION ADMINISTRATION, in the space where local ration Secretaries usually signed.

(3) The RB 202 properly signed completed as above may then be presented to any retailer of ammunition.

(4) As there will now be no need to break up the allotment of ammunition into separate quotas for local ration boards, it will be necessary for you to be in a position to notify this office daily of the amount of ammunition you approve.

The method in which you will obtain the gun registration and signature of the applicant on each RB-202 is left entirely to you. If you wish to send any of the blank forms to your different branches so that these two items may be completed before they come in to you for approval, we would advise that you keep a record of the number you send to each branch, so that you can determine at any time exactly how many blanks should be returned to you.

Signed: A. G. Rusconi,
Regional Supt. of Rationing.

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[1]Form RB-202 and poster used in predatory control campaign supplied upon request to author.

With this set-up, and every branch ready, and organizing further every day with 3,000 posters distributed throughout the Province, hundreds of schools taking part in a separate campaign, you be the judge, the golden opportunity the sportsmen are missing by not knowing the truth has retarded the proper increase in the duck population for years.

We have the ammunition at our disposal, and *any one* in the Province will be given a supply, either shotgun shells or .22's and we will duplicate the permits to anyone as long as they bring in the predator's feet to show the results of the initial border, and at the same time secure the bounty of five cents a pair. This campaign will be kept going until our funds are exhausted.

In conclusion, support an organization that knows how to increase the duck population. We will not show you moving pictures of large concentration of ducks in a selected area, we will not send paid orators out—we have no money for this. But we will send proof to you *by the wing.*

THE PERMANENT VALUE OF REFUGES IN WATERFOWL MANAGEMENT

J. CLARK SALYER II
Fish and Wildlife Service, Chicago, Illinois

Since the dark days of the early 30's when the continental waterfowl population, through a combination of adverse factors, was so seriously threatened that duck hunting appeared to be relegated to the "now I can remember when" status, conditions have so improved that some raise the question: "Are waterfowl refuges necessary?" The answer is not hard to find. Waterfowl refuges, and for that matter refuges for other forms of wildlife, are a necessity. The continued expansion of intensive land utilization in the United States forces maintenance of the wildlife refuge program as a sort of life insurance policy for the nation's wildlife resources. The national wildlife refuge program provides the most concrete and lasting safeguard against possible depletion of the waterfowl population. Without the refuges, and with less successful management, it is certain that the present liberal hunting regulations would not have been possible.

The most outstandingly successful programs for wildlife conservation have been based in part upon refuges. The original purpose of the national waterfowl refuge program was sound, namely to restore as much breeding ground as was possible under existing land and land-use conditions. Those conditions vary, hence some of the lands that are necessary from a long-time conservation viewpoint are not restorable now but may be in the future.

The second purpose of the program was to provide suitable areas at intervals along the four great flyways where the birds could find rest and food, and the third was to preserve or restore as much of the wintering ground as possible. The birds can be substantially benefited only when provisions are made for their welfare at all seasons.

An important form of insurance provided by the refuge program is the preservation of habitat against the deterioration or complete destruction that so often follows intensive land-use development. Individually such developments may not affect large acreages of waterfowl habitat but collectively they have a far-reaching effect by decreasing below the essential minimum the area necessary to furnish adequate nesting, feeding, and resting habitat for these birds—an important national resource. Industrialization along the Atlantic seaboard during the past few decades, together with the drainage of marshes for resort development and mosquito control have eliminated more than 7 million acres of wintering grounds formerly available to the waterfowl of the Atlantic Flyway. Forty years ago the public would have scoffed at the idea that the drainage of coastal marsh lands could have such a far-reaching effect on the waterfowl population. We have profited, in a measure, from the mistakes of past exploitation but nonetheless, continued vigilance is necessary to protect the remaining waterfowl habitat. Flood control, irrigation and power projects, and ill-advised drainage projects now directly menace vast acreages of the remaining waterfowl territory in the United States. These continued threats emphasize the necessity of permanent wildlife refuges.

Providing refuges for wildlife is not a new activity. That the principle is sound is demonstrated by the general practice by gunning clubs for many years of alternating shooting periods with intervals during which there is no gunning on actual hunting lands, and of protecting a reasonable proportion of the total acreage controlled by the club against all shooting. The logic behind the refuge program is not that of locking up wildlife and attempting to protect it absolutely and forever; rather, refuges should be considered as reservoirs that assure a sustained annual yield from a renewable resource. Many sportsmen, one time generally opposed to the waterfowl refuge idea, have learned by experience that these closed areas have permanent value in creating better shooting locally. Thus, instead of the birds being "burned out" of a district during the early part of the hunting season, their movements along the migration route are more leisurely because of the presence of resting areas protected from shooting. They filter out gradually from such rest areas and feeding grounds and provide a more uniform and longer shooting season than would prevail if the refuges were not available.

The preservation of the residual brood stock necessary to populate the nesting grounds is far more important than is generally recognized by gunners who have an opportunity to make observations on only isolated sections of the waterfowl habitat. Destruction of waterfowl resorts through industrial and other land-use developments results in the concentration of waterfowl on remaining areas, these giving to the local observers an impression of plenty. Right now we are faced with a real possibility of having too few feeding grounds to accommodate the waterfowl raised in Canada and Alaska, but which must depend to a large extent on the United States as a winter resort. Waterfowl must eat 12 months out of the year and unless they are properly cared for and well fed during the winter months they cannot fully populate the breeding grounds the succeeding season. Controlled water levels, management practices which have been developed and put into effect on the refuges, permit the production of more waterfowl food per acre than is possible on lands not so intensively managed. While a good job is being done with what we have, the refuges cannot provide all the feed necessary for the continental population of waterfowl; they do, however, feed a sufficient number to guarantee a reasonable annual crop of young birds. In districts where vast acreages of waterfowl habitat have been converted to agricultural use, restriction of natural feeding grounds has led to destruction of crops. Concentrated production of food on refuge lands has acted as a buffer, however, has minimized depredations, and helped to prevent the serious losses of grain and other crops that would have resulted in the absence of such a program.

The principle of multiple use applies fully to the Service's national wildlife refuges. While the majority of the refuge areas were acquired and developed primarily for waterfowl, their contribution to the protection and increase of other wildlife is sometimes equally important and in many instances of greater importance locally. The lakes and marshes developed for waterfowl are highly productive of fish and fur animals. The annual yield of muskrats from some of our refuges constitutes an important economic contribution to the community. Sport and commercial fishing has developed locally on a large scale where nonexistent before. To date more than 40,000 pheasants have been made available from waterfowl refuges for restocking under the direction of state conservation departments. More than 5,000 deer have been supplied from refuge properties for stocking by state conservation officers.

From the beginning of the national emergency the federal refuge properties have contributed substantially to the growing of war food crops and the grazing of livestock. Economic use of refuge lands is a part of our basic management program. The regulated grazing of pasture lands contained within refuges promoted recovery of forage to the extent that the additional grazing required for expansion of beef production was available locally. It is significant that even though many of our national waterfowl refuges were restoration projects in the fullest sense of the word, many having been developed on land once classed as submarginal, the yields from cropland upon them which has been devoted to food production compare favorably with those of the best land in the vicinity. The same is true of the range land. Thus, the refuge acreages are not closed to economic or recreational use, but are utilized to the extent consistent with primary management of the properties for waterfowl and other wildlife. The harvesting of timber from refuges has yielded a large volume of high grade lumber now urgently needed by war industries. Thus, the national wildlife refuges not only have a permanent value to local economy but in an hour of need have provided resources of vital national importance.

A permanent value of refuge properties that is frequently overlooked is their function as field laboratories wherein experimentation is constantly carried on to determine the most efficient and most practical means of managing wildlife populations and wildlife habitat.

Their most fundamental value, of course, is that they provide homes for the birds. We have a considerable part of the breeding population of some of the most important waterfowl species in the United States and for at least half of each year we must feed an overwhelming percentage of the waterfowl of North America, not only those which breed in the United States, but also in Canada, Alaska, and Greenland. Practically all of the geese winter in the United States and their fate depends upon our treatment of them.

The waterfowl refuges always give us a necessary margin of safety in continental conservation, hence it's just as good business to keep them as it is to keep life insurance. They supply the margin of safety which makes possible sound management of a commodity so unpredictable as a wildlife population. So far as I can see we are always going to need the national refuge program.

To summarize:

1. The national waterfowl refuge system preserves waterfowl habitat, thus providing a place for the birds over large areas where suitable habitat has practically disappeared.

2. The waterfowl refuges are necessary to save the breeding stock essential for repopulating the nesting grounds each year.

3. The waterfowl refuges have proved themselves to be one of the

important tools of waterfowl management, spreading the birds with fair uniformity over the entire country, extending the length of the shooting period locally, and making shooting opportunities more democratic.

4. The waterfowl refuges provide a habitat for many interesting and important nongame species of wildlife, some of which, as the fur bearers, are of great economic importance.

5. The refuges have become very important to the economic life and success of surrounding communities and are making a very appreciable contribution to the war effort in foodstuffs, furs, lumber, and fibers.

CALIFORNIA'S WILDFOWL CONDITIONS

H. R. BASFORD
Member of the Sportsmen's Committee, California Duck Hunters Association, San Francisco, California

We in California present the following fundamental facts pertaining to wildfowl in our State according to attached sheet.

We believe that the practice of the Fish and Wildlife Service of making uniform regulations for wildfowl for the entire country is bad game management.

We believe that wherever special conditions are present over any general territory that thorough study should be carried on, following which regulations for such sections be made accordingly that will result in a well-rounded picture for the benefit of the farmer, the wildfowl, and the hunter.

We also stipulate that our contentions are made upon the supposition of our adequate usable surplus of birds, and that we earnestly desire and have spent our money and time to help increase the population. Further, that the Fish and Wildlife Service very properly have it in their power and will regulate seasons and bag limits according to what in their best judgment is the safe take by sportsmen. If through overshooting, disease, or a bad breeding season there occurs a decline, they can make regulations accordingly.

We further maintain that conditions no longer exist that necessitated drastic rules against feeding, live decoys, etc.

We maintain that it is just as much the responsibility of the Fish and Wildlife Service to work with private and state interests; to see that the birds have sustenance on their wintering grounds as to aid in recreating their population.

It is inconsistent to the last degree for them to create great refuges all over the country and to feed them, drawing birds away from shooting areas while at the same time forbidding those who are willing to spend their money in a manner that will aid in true conservation, to feed them and to thereby secure their fair share of the usable surplus.

It was claimed that the cause of the duck decline was almost wholly due to the overshooting. While that played a part, the real cause was the drying up of the feeding grounds in the northern tier of the states and Canada.

The studies made by More Game Birds Foundation, over a period of 4 years, proved this beyond question.

While the Service has done some good work south of the Canadian border, it is the work of recreating the breeding grounds in Canada by Ducks Unlimited aided by Canadian authorities that has, in the largest measure, caused the present great increase of wildfowl.

Therefore, for the reasons stated, we in California feel we are entitled to feed birds under reasonable federal supervision.

Sportsmen's Committee,

Dr. John Graves, Chairman	Harvey Sorenson
R. F. Jose	W. P. Caubu
Dr. H. C. Veatch	H. R. Basford
Dr. A. W. Ward	

FUNDAMENTAL FACTS PERTAINING TO MIGRATING WILDFOWL IN CALIFORNIA

1. California is a wintering ground for wildfowl.
2. Except for rice, congested in three areas, there is little natural feed for the millions of fowl migrating here.
3. There are a few natural marsh areas to form a habitat for them.
4. Wildfowl have greatly increased in numbers.
5. They must be given sustenance on their natural wintering grounds.
6. There is just as great responsibility to feed them in winter as to raise them on their natural breeding grounds in summer.
7. The public is entitled to take the usable surplus now amply above necessary breeding stocks.
8. There are already seven refuges in California. More refuge areas are a waste of money, taking lands out of taxation.
9. Under reasonable regulation, widespread feeding by those already supplying ample water areas will hold the birds in this their natural wintering grounds and at no public cost. The State is also acquiring large acreage for public shooting grounds which will add to the total. Arrangements will be made to reimburse the counties for taxes.

10. The practice of making similar regulations for the whole country defeats the purpose of proper game management.

The government is seeking 90,000 more acres for refuges. There is no need for them. The State may open these lands to public shooting after planted crops are eaten, if the duck stamp law, which declares such refuges inviolate, is changed or appropriation from the general fund can be secured.

It is inconsistent for them to state these true needs, permit feeding on public shooting grounds, and forbid private owners to do likewise.

There are many thousands of acres of artificial marsh-water areas from the Oregon line to San Diego supplied by private ownership and some by public state shooting grounds. They (provided there is a surplus of fowls to be taken) are the best refuges because they are watched against trespass and are shot over not more than 50 hours a month during season. At all other times no shooting is allowed and on off season they are inviolate. They cost the government nothing, provide proper feeding grounds, and also on private properties at no public cost.

The attitude of federal authorities seems to be that duck clubs are a menace to wildfowl. That their areas will not serve the purpose for the harboring of the species, and that to furnish habitat they must own vast acreage of artificial marsh, assuming that the hundreds of thousands of acres already supplied by private owners at no public cost, should be penalized and fowl drawn away to areas of sanctuary, thereby decreasing the opportunity of taking the surplus to which the public is entitled either by direct take or by gift from others. Lack of feed is losing us the flight so far as fowl coming to rest and remaining here is concerned.

Widespread feeding under reasonable regulations on off-shooting days throughout the entire areas of private ownership and public shooting grounds, will save our sport, and in great measure remove depredation on rice areas.

CALIFORNIA DUCK HUNTERS ASSOCIATION

By the Committee:

Dr. John Graves, Surgeon
R. J. Jose, Head of "Quail Preferred"
Harvey Sorenson, United Grocers
W. P. Caubu, Attorney-at-Law
H. R. Basford, Wholesale Distributor
Dr. A. W. Ward, Dentist
John Greenlaw, Retired
Dr. H. C. Veatch, Dentist

FLYWAY REGULATIONS

FREDERICK C. LINCOLN
Biologist in Charge, Distribution and Migration of Birds, Fish and Wildlife Service, Washington, D. C.

Management of our migratory waterfowl according to flyways is a sound biological concept. The idea, however, is heavily weighted with administrative problems.

In this brief forum discussion it is important first to explain our meaning of the term "flyway." Basically, the four recognized flyways are geographical regions rather than mere airways of avian travel. Each flyway has extensive breeding grounds in the North, with a complex system of migration routes connecting it with more or less restricted wintering grounds in the South. Overlapping of the breeding grounds occurs in all four, and is extensive in the Atlantic, Mississippi, and Central Flyways. Wintering grounds of the Atlantic and Mississippi Flyways are chiefly within the United States, while important parts of the Central and Pacific winter areas are in Mexico.

Of outstanding importance, nevertheless, is the fact that each flyway has its own population of migratory waterfowl, and probably also, of other birds. This has been clearly demonstrated by the recovery records of thousands of ducks and geese that have been marked with numbered bands. In other words these data demonstrate that within the United States there is very little interchange of individual ducks and geese between the flyways, even of those species that have a more or less continental distribution. It should be remembered that mating begins on the wintering grounds, is continued as the birds travel northward in the spring, and is consummated by the time the pairs arrive at the nesting grounds. This fact largely prevents "flyway crossbreeding" and since it is generally accepted that general knowledge of ancestral migration routes is hereditary, it means that the progeny of each pair of birds are likely to return to the same general region where their parents wintered during the previous season. On some parts of the Canadian breeding grounds nesting pairs of mallards, pintails, scaups, and other species, belonging to all four flyways, may occupy the same piece of marshland, but when the migration urge comes upon them, each family group follows its traditional route back to its ancestral wintering ground.

The foregoing are the salient facts as shown by the banding data, although among tens of thousands of records, are many of individual birds that have not remained within their respective flyways. These atypical migrants are easily explained in many ways but probably best by the mere fact that no form of life is so mobile as the bird which is able to travel when and where it pleases, unhampered by the barriers that rigorously control the movements of terrestrial and aquatic animals.

The outstanding feature of this continental panorama is that each flyway population is a separate unit, each of which may be subject to controls that do not affect the others. In other words, it is possible for the members of a species in one flyway to be so reduced in numbers, that complete protection is necessary while the same time, the same species in an adjacent flyway may be sufficiently abundant to warrant the granting of special shooting privileges. During the years of the Great Drought when the national waterfowl regulations were the most restrictive in history, many sportsmen who shot along the North Atlantic Coast urged that they be granted more liberal seasons, bag limits, etc., on the grounds that many of their birds (chiefly black ducks) were not affected by the shortage of water in the Great Plains Region. Contrariwise, enlargement of the 1944-45 bag limit to include five additional mallards, pintails, and widgeons, was due, not to a general increase of all three of these species in all four of the flyways, but to the increase of mallards in the Central Flyway and to the increase of pintails and widgeons in the Pacific Flyway. It would have been biologically sound management if this privilege had been restricted to those particular flyways.

This brings us up sharply against the chief objection to different sets of regulations for each flyway, namely, interstate jealousy. It requires no imagination to visualize what would have happened if the special bag limit of five extra birds had been granted only to the states of the Central and Pacific Flyways. Regulations according to the flyways would sometimes have other very real and apparently discriminatory inequalities in shooting privileges, but the result would be intelligent management. As the army of American hunters continues to multiply, administration of the national wildlife resources becomes increasingly difficult. Despite the present abundance of most game species, the supply is not inexhaustible and if the American system of free shooting is to be preserved, sound management based upon the results of scientific research must be the watchword of every administrator.

A FEW COMMENTS ON WILDFOWLING

FREDERICK K. BARBOUR
New York, New York

I feel strongly we should revert to the use of live decoys. I am convinced that a majority of our crippled birds is due to the fact that birds are not very confiding when stooling to block decoys. It can be argued that poor presentations should be passed up. If, however, your opportunities to shoot are largely confined to suspicious birds, what is the gunner going to do? In my opinion, it would be far better to bring the birds in well over the decoys, whereby one would be enabled to kill cleanly the allotted number and body-shot birds thus be held to an irreducible minimum.

There is another aspect of live decoys apart from the utilitarian. To me, particularly on a bluebird day, it was a great pleasure to watch these decoys, with their alert movements, and to listen to their conversation. The wheezy, peevish "crate call" was to me an intriguing signal that the day's sport was drawing to a close.

I am open-minded in regard to the question of baiting. I think, in years gone by, when baiting was an accepted practice, the ratio of killed birds to crippled birds was better than it is today. I am not greatly impressed with the argument that we should not return to baiting because this practice is a resource of the wealthy. I think this observation irrelevant. If it had merit, then we all should use single barrel shotguns of the mail order variety—my first shotgun, by the way. I do not see that any guilt attaches to the purchase of a high grade gun made by an outstanding manufacturer, in spite of the fact that it be offered for a fancy price.

Just one more observation in conclusion. When I started out, I had the conviction that No. 4 shot was the size to use. In recent seasons, I find that I seem to do better using No. 6's in the early season and No. 5's toward the close.

Chairman: C. B. Lister

Secretary, National Rifle Association, Washington, D. C.

IN THE WAKE OF WAR

This session arranged by the National Rifle Association

RETRAINING THE RETURNED G.I. TO SHOOT SAFELY

George O. Van Orden
Colonel, U. S. Marine Corps, Klamath Falls, Oregon

Safety with firearms is born of technical knowledge and skill.

Do the returned veterans have sufficient knowledge and skill to be safe with sporting arms?

The greater the number of G.I.s who go into the shooting game, the more important the problem.

How many will go in for shooting and what can we do about safety?

Before we may judge what should be done to retrain the G.I. to shoot safely, we must discover what we are to work with—what are the G.I.'s aptitudes and attitudes in small arms, and how do they fit in with the requirements of safe field and target shooting? What is the extent of his technical knowledge, and is it adequate to carry him unaided, yet safely, from the military rifle on the battlefield to the sporting arm in the field or the target arm on the range?

There is only one way to find out the answers—go to the G.I. and try him out. This we have done. We have been in a position to observe approximately 5,000 returned veterans during a period of 6 months, and we have been able to get a fairly clear picture of what they want, what they think about, and how they feel about a number of things—sport with firearms among them.

The group we have tested are the marines at the Marine Barracks, Klamath Falls, Oregon, men who have been returned to the United States from overseas and who are being reconditioned, after bouts with malaria and filariasis, for further service. During the 3 to 6 months of a training program which restores 97 per cent of the men to a full duty status, considerable attention is paid to familiarizing the lads with adult recreational activities, particularly those having therapeutic value through body-building. These activities, occupying a considerable proportion of the weekly schedule, range from bowling to horsemanship to—yes, shooting.

We believe that the group represents the average returned veteran, and that, in the matter of our present inquiry, it is not unusual in any particular.

The weapons training background of these marines is similar to that prescribed for all infantrymen. The Principles of Marksmanship right out of F.M. 21-5; demonstrations, perhaps, by the superb training films of the Infantry on marksmanship, and the usual 2 to 3 weeks of target practice during recruit training. There are evidences, of course, of the greatest variations in efficiency and quality of basic instruction, just as in any outfit in war, but, full-and-by, from what we have observed in the field, there is little difference today in weapons qualifications between the average marine rifleman and the average G.I. rifleman. In any case, we can safely judge the one and be fairly certain that the results will not be far off in the judging of the other.

So, let us examine the Klamath Falls marines *before* they have received instruction in ''sporting arms'' (a 12-hour introduction to organized sports with firearms and field shooting) and see what they know and how they feel about firearms and sport.

This will, of course, throw us into a number of statistics, but the figures *are* interesting, and they *do* give us the answers we want to know. And to get a true picture, we need hit but a few high spots.

For example—to start off—65.6 per cent say they *will* hunt game with a rifle of some type after the war. Eighteen and six tenths per cent say ''maybe'' they will, and 15.8 per cent say definitely they will not.

How about bird hunters? Sixty per cent say they *will* hunt birds with a shotgun after the war (but only 23.6 per cent will go in for trapshooting, and 19.1 per cent for skeet).

Very few of these men hunted before the war. So, there are a lot of new hunters coming up—if they can get the equipment and a place to hunt.

We find that 81.3 per cent want to go into some form of organized competitive shooting (73.7 per cent of this group want to hunt birds and game in addition to the target sports). Thirty-eight and four tenths per cent of all men examined are interested in and intend to get into smallbore rifle shooting, and 35.3 per cent into service rifle shooting. Thirty-five and four tenths per cent say they'd like to shoot sporting rifles in matches, and about one half of that group say they're not interested in the service rifle for match shooting. Most of the sporting rifle enthusiasts also checked smallbore rifle as a sport in which they intended to participate. About one half of the men interested in service rifle competitions indicated no interest in any other shooting sport.

Twenty-three and six tenths per cent say they are going into trap-shooting, and 19.1 per cent, all included in the trap group, will shoot skeet. (But, remember, 60 per cent of all men examined will go bird hunting with shotguns.)

Three and two tenths per cent are interested in muzzle-loading rifles. But only about that percentage know anything at all about that sport.

The biggest attraction of all in numbers interested is pistol and revolver: *46.4 per cent* want to get into that man-trap.

And, finally, 18.7 per cent are not interested in any form of target practice; 34.4 are not interested in any form of hunting.

These figures mean a lot to any one experienced in target-practice promotion. They mean that hundreds of thousands, even millions, of men *want* to become shooters or hunters—be it with rifle, pistol, or shotgun. Whether they *do* actually become shooters and hunters, depends on the availability of equipment, the accessibility of safe, clean, and attractive shooting grounds, economics, and little else.

Supposing that conditions exist after the war that do permit and attract the G.I. to become a target shooter or a hunter. What about his present technical knowledge of firearms? Is it adequate to permit him to take up a sporting arm and safely go on the range or into the field without further instruction?

Let's select a few representative questions, and see from the answers given what situation exists. For example, every man in the examined group has handled caliber .22 long rifle cartridges in boxes and fired this ammunition in preparatory training. But only 74.4 per cent said the .22 l.r. is dangerous up to a mile. About the same number remember the "Caution—Dangerous within one mile," printed on the flaps of the cartridge boxes, but one man said the .22 l.r. was dangerous up to 100 yards, and another said 6 miles . . . but the majority who were in error said, 2 miles. So, if there is any consolation in this ignorance, it is that the error, in most cases, is on the side of caution—and safety.

Nearly all the men examined were initially trained and armed with the U. S. Rifle, Cal. .30, M1903. Yet, when asked the caliber of the "U. S. Rifle, M1903 (commonly called the Springfield)," 55.4 per cent said, "30," and 44.6 per cent said, "30-30." The sins of the fathers, etc., plus the shades of '18! However, they don't make that mistake with the M1 rifle—that one *is* '30"—Dad never told 'em different.

Are they technically ready to go hunting? Thirty-six and three tenths per cent say the Carbine would be an efficient deer rifle—but 56 per cent say definitely, "No," and 7.7 per cent are undecided. Thus, if it is any consolation to the deer to be shot in days to come, Mr. Deer, without further public education on the subject, can figure on a two out of three chance of getting shot dead quickly by a proper weapon and cartridge instead of being crippled or otherwise painfully fouled up by ones not suited to the job.

How about the degree of familiarity with the principles of marksmanship of this great number of men who propose to take to the ranges and woods, gun in hand, looking for a day of sport?

Many have had fundamental training with the pistol, but, in general, their skill is so poor that they would not stand up to the class of Marksmen in the N.R.A. classification system. Promoters should be prepared to start from scratch with that 46.4 per cent who will go to the pistol ranges.

Comparatively few have ever fired or even handled a shotgun, so those old-timers who go into the fields or on the trap and skeet ranges with the new shooters had better be prepared to hold a basic training class before they start—or else.

But the rifle picture is somewhat different. All the men examined had fired the rifle for qualification over a standard course. However, 19 per cent said they did not remember whether they were Experts, Sharpshooters, Marksmen, or Unqualified. Of the 81 per cent who said they did remember, half of them were wrong. The 81 per cent said they qualified 93.2 per cent—actually they qualified but 65 per cent. Forty-one per cent of all men examined rated themselves higher than the correct ratings shown in their Service Record Books. Some Unqualified men say they are Experts.

Even this means something: it brings out a frailty of man's nature he usually thinks he's better than he really is. "A little knowledge is a dangerous thing. . . ." To the rangemaster and the woodsman, this frame of mind is a danger signal; it means that there are tens of thousands of men going out to shoot who are so convinced they are Davy Crocketts that it will be hard to get them to take advice from anyone. Give people such as these five minutes with a loaded gun, and they may kill some innocent bystander in the next county.

The actual collective skill of the group examined is shown by the solid line on the graph (Figure 1). The graph shows the scores of 824 returned veterans who fired at 200 yards slow fire in four positions on the Klamath Falls Range. The scores were recorded during the second firing of the course and following 3 hours of preparatory exercises. For comparison with these scores, we prepared an "expectancy curve," or what we "expected" to get in score during the test, from our records of the scores of over one thousand men firing similar courses at Quantico during 1940: the lowest score of the Quantico Group was 65 per cent; the highest 97 per cent; and the average is shown by the dotted line on the graph. From the difference between the prewar average and present-day scores, rifle promoters will see that there has been a considerable drop in the collective skill of military marksmen on the target range. Therefore, from among the new shooters we may expect mostly Marksmen, and but few Sharpshooters, according to N.R.A. registered competition standards, and the promoters should point their tournaments to interest the type of shooter who a few years ago was called a dub. Interest them, however, and hold them—and in a short time the Experts and Masters will blossom forth in a satisfactory profusion.

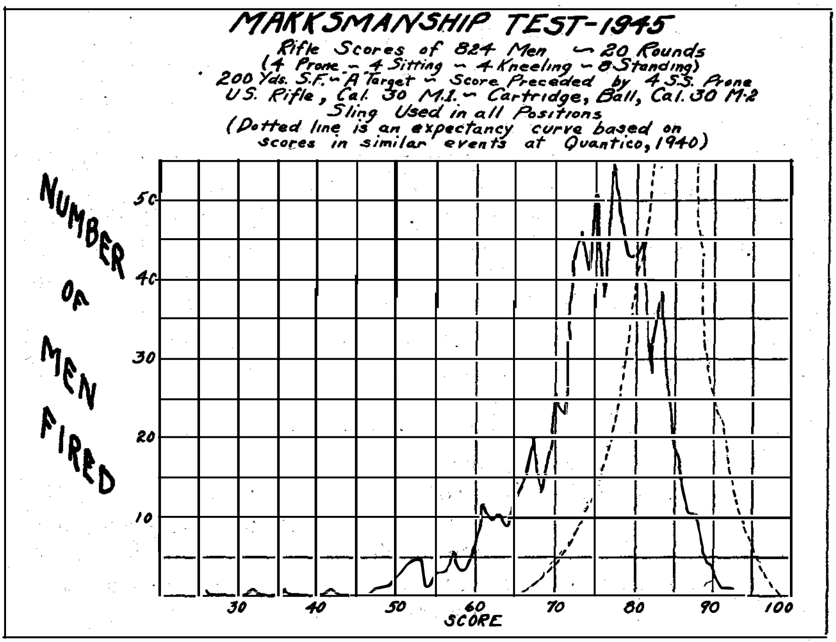

Figure 1.

In review, from what we have determined through our tests of the returned veteran, there is little doubt that target and field sports stand on the threshold of a great expansion, a many-fold increase in the number of sportsmen on the ranges and in the fields.

These new men who will fill the ranks are fine fellows, enthusiastic and intelligent about the things they do. But, in general, while their military background prepares them, to some extent, for sports with firearms, *their technical knowledge of weapons and their skill is not* *adequate for them to safely go out shooting with target and other sporting arms without further instruction.*

It appears that the scope of training definitely required includes a course in the mechanics of the new firearm the G.I. will acquire, a refresher in the fundamentals of marksmanship, sufficient target practice on the range to insure development of an adequate skill, and an introduction to the game and conservation laws that will affect his activities.

Will the returned veteran be receptive to any sort of training program? The answer is definitely "yes," if the program is presented in an attractive and practical way. In the first place, most veterans are *very* safety conscious. Secondly, the majority of them are well aware of their shortcomings and are willing to learn anything that will help them to do better the things they are interested in. They are well aware of the necessity for restrictive controls in the use of firearms, and will abide by the laws—if they are told what they are. They are aware that shooting organizations exist, and are willing to support them. (For example, when asked what the initials, "N.R.A." stand for in connection with rifle and pistol shooting, 81 per cent answered, "National Rifle Association," although practically none had ever belonged to this organization.)

Because of this attitude on the part of the returned veteran, the picture is most encouraging, and, to our way of thinking, there is a practical way of correcting the bad spots in it.

We do not believe the retraining problem can be solved while the G.I. is in the service. The system of retraining which is proving successful at Klamath Falls is probably impractical at any other facility for the handling of returned veterans, there being no other such place where men of this category are assembled for a definite period of time under the conditions which exist at Klamath Falls. The problem must be handled after the G.I. has returned to civilian life.

We believe the problem can be successfully solved through the cooperation of the arms manufacturers, the national shooting organizations, the tournament promoters (or shall we say the local club officials) and the local dealers. These are the agencies who can provide the instruction the G.I. needs to shoot safely, and this instruction can be accomplished if the situation we shall hereafter describe is brought about through the mutual efforts of these agencies.

Whenever a sporting arm (which includes target and hunting rifles, shotguns, and most revolvers and pistols) is sold, let there be found in the box with the arm, a set of colorful, well-prepared "home study" pamphlets.

The first, prepared by the arms manufacturer, will describe by word, picture, and drawing, the mechanics of the weapon, so that the owner will be able to really learn the functioning of his weapon and how to properly strip, clean, and assemble it. Let there be clear, sharp pictures of how to load and unload, and how to set the safety—no matter how simple these operations may be. Let there be a section on the ammunition for this firearm: the suitable types of cartridges for it; the bullet and powder weights; the trajectories, in simple, graphical, and tabular form; the *ranges up to which the ammunition is dangerous;* the shock and penetrative powers, and a statement of the type of game, if any, which may be humanely and safely hunted with the cartridges under discussion. All of this data is *essential knowledge* to a *safe* shooter! In addition to this, let there be a section with pictures on "sighting," with the sights provided with the firearm, together with a discussion of sight-setting, and how to correct for range and deflection. Even fixed-sights require detailed explanation. Following in order, let there be sections which by word, picture, and cartoon, cover special features or characteristics of the firearm which may affect the application of other fundamentals of shooting, such as positions or trigger squeeze. For example, in the case of a straight-stock, prone-position target rifle, the text should explain the ramifications of shooting offhand with such a rifle—and why. And, finally, let there be a section on *safe firing procedures* on the range and in the fields with *that* particular firearm.

We place the responsibility for the production of this pamphlet, even though it includes special notes on marksmanship, on the arms manufacturer, because, in the interest of safety, we do not consider the generalities of a general text on marksmanship adequate to cover all the peculiarities of different firearms. What we desire is a special text for each type of arm—leaving nothing to chance or possible misunderstanding.

We do not want this pamphlet to be so technical and involved that the new owner will take a look and say, "My God, what do they want me to do—take a postgraduate course?"—and then chuck the book in the wastebasket. What we would like is a gay, colorful pamphlet full of good pictures and good dope—and with just enough detail to present the fundamentals clearly. There should be Sad-Sack cartoons here and there throughout the pamphlet, driving home warnings of the silly things people do with guns. The whole thing must be attractive enough to entice even the Davy Crocketts into reading it.

This is the type of training publication that has taken the G.I. by storm—and the returned veteran *will* read such a pamphlet when he finds it enclosed in the box with his new gun. Having read even this one pamphlet, and even if he does not read the others we will enclose in the box, *his* Safety Factor will go up many a point—at least, he now will have the technical knowledge necessary for him to be able to *handle* his new firearm safely, and he will know where, how, and under what conditions he may safely shoot it.

The second pamphlet to be found in the box is a complete outline of the fundamentals of marksmanship, prepared by the national shooting organization concerned with the type of shooting done with the firearm in the box. For example, with every shotgun there will be complete information on how to shoot it accurately on the trap and skeet ranges and in the field. Again, this pamphlet must not be so complex and long that it will scare away its intended reader.

The third pamphlet enclosed presents the advantages of organized shooting, and the fun that is at hand for the new gun owner. This pamphlet also is prepared by the national shooting organization concerned with that particular type of firearm. For example, with every small-bore target rifle sold there should be a pamphlet by the National Rifle Association extolling the virtues of registered competitions, describing in detail how tournaments are conducted, and showing how easy it is to be a participant in the sport. We presume, of course, that the day is nearly at hand when there will be competitive opportunities for every type of firearm, and that the .32-20 and the .250-3000 shooters will have suitable matches set up for them in sporting rifle tournaments—if only for the purpose of getting *every* gun owner into organized, competitive target practice—paper targets, clay pigeons, or what have you.

Why the pressure to get *every* gun owner into organized, competitive shooting? Because it is through organized, competitive target practice that skill is developed, the skill which, coupled with technical knowledge, produces *safety.*

With this pamphlet attracting every new owner to the target ranges, be it for target or hunting rifle matches, or for trap or skeet, or for a crack at the dancing bull's-eyes of the pistol course, the stage is now set for the returned G.I. to *teach himself* to shoot safely.

Our bet is that the G.I. will read everyone of these pamphlets (if they have been prepared properly) and, having done so, will have taken the first step toward *safe* shooting by having prepared himself mentally.

It is now up to the promoters to do the rest—by providing opportunities for practice—practice through tournaments. Matches that are fun, and fired on accessible, clean, safe, and attractive ranges; matches that are a test for the Masters, yet not a torment to the Marksmen; matches based on slow, precise shooting, so that a newcomer can truly develop basic skill.

The finishing touch to all this is provided by the local dealer, who, with the sale of every firearm that conceivably might be used for hunting, puts in the box with the other pamphlets a copy of the State Game Laws, and other notes on the "local ground rules" for field shooting. In addition to this, in the case of any firearm that he sells, it is also up to the dealer to place a card in the box inviting the attention of the buyer to the addresses of the local shooting organizations concerned with the type of firearm he has just bought.

With all this accomplished, and no less, we may expect the G.I. to shoot safely.

All this has been done before? No—not in a manner and to the extent we suggest. There is much to be accomplished in the production of satisfactory pamphlets and in the cooperation of the several interested agencies.

All this costs money! Yes—and a great deal of money. But it is money spent to make money—better yet, it is money *guaranteed* to to make money through the creation of good will and through the maintenance of good will because of a degree of safety built up among the new shooters that will prevent the expansion of shooting from being killed aborning by stupid accidents on the ranges and in the fields.

Make the "home study" training pamphlets as much a part of every gun that is sold as the sights and the trigger; make the pamphlets as attractive as a polished-walnut stock, and so clear and simple that anyone who *can* read *will* read and understand them; give the gun owner the will and the chance to practice on the range to develop his skill, and, finally, send him to the woods and fields with a working knowledge of the game laws fresh in his mind—and we will have retrained the G.I. to shoot safely.

HUNTING ACCIDENTS

C. B. LISTER
Secretary, National Rifle Association, Washington, D. C.

The public hears a great deal about hunting accidents. Some state game commissions become greatly exercised over the subject, some try to dismiss it with the airy comment: "We do not have any big game hunting so we do not have any hunting-accident problem."

Just how serious *is* the hunting accident problem? What is the ratio of hunting accidents to hunters afield at any given time? What are the principal causes of hunting accidents? Accident research in other fields has established the fact that the major portion of accidents involve "repeaters." Do these people carry their accident-causing habits into the hunting field? Is excessive drinking a contributing factor? Is the accident tendency greater among urban than among rural citizens? Does Boy Scout training, target range training, general athletic training affect the accident rate for the hunter? Are autoloading weapons involved in more accidents, proportionate to their use, than manually operated arms?

Certainly all those questions, and many others, need answering before we can determine (a) the seriousness of the situation or (b) how to correct it. Do you know any of the answers? Does your state game commission know? The answer is "No!" No one knows because there is no uniform system for collecting, compiling and disseminating data on hunting accidents. Michigan, Minnesota, Pennsylvania and New York each have good systems for collecting data but no two of them seek the *same* information. Most of the other states depend for hunting accident data on vital statistics, newspaper reports or just skip the whole thing. With a probable increase of three and a half to four million new hunters crowding into postwar hunting fields, many of which were already overcrowded before the war, we had better begin now to get *facts* on a nation-wide scale. We need facts to protect us from a rash of anti-gun, anti-hunting laws which will be proposed by the gun-shy element of our population and we need facts to protect us from our own well intentioned but poorly informed hunters who have a variety of panaceas to offer to solve the hunting accident problem.

The most time-honored example of the hunter's need for protection from his own clan is the shotgun deer hunting law. "Take the danger out of deer hunting by taking the rifle out of the deer hunter's possession" is a patent medicine cure that has been legalized in numerous states where no hunting accident statistics were available before the laws were enacted. As a matter of fact in states where statistics are available the shotgun invariably shows up as being just as deadly, often more deadly, than the rifle!

Another suggestion, heard now with increasing frequency, is that hunters should be required to "take a test" before being issued a hunting license. The automobile drivers' license test is the criterion most often mentioned in this connection. Certainly the idea merits careful study. But what *kind* of a test should be given the rabbit hunter, the duck hunter, the deer hunter, the elk or goat hunter? One test for all? Absurd, of course! But what *kind* of a test, where, how, by whom? For *what* should we test? Vision? Reaction time? Marksmanship? Woodcraft? Neurosis? Knowledge of game laws? Knowledge of ballistics? I don't know! Neither do you! Neither does any state game commission. Why do we waste time talking about license tests, restrictive legislation, safety campaigns, when we do not know where, when, how or why most hunting accidents occur? Why don't we start right now to collect *facts?*

The following form is suggested as a Uniform Report for Hunting Accidents. It is borrowed almost intact from the form designed and used by the Michigan Department of Conservation. The Michigan form has, however, been broadened to include previous accident history and other information considered important in getting to the bottom of the hunting accident problem. To start the ball rolling, the National Rifle Association intends to recommend the adoption of a uniform report blank to all state game commissions. Constructive criticism of this suggested form will therefore be appreciated. The active cooperation of sportsmen within each state will be necessary because many of the state game commissions do not, at this time, gather accident statistics. Let's all get busy so that when we talk *safety* we can talk *sense!*

HUNTING ACCIDENT REPORT

State ______________________ Year (season) ______________

1. Name of Victim ______________________________
   Address ______________________________
2. Name of Shooter ______________________________
   Address ______________________________
3. Name of Witness ______________________________
   Address ______________________________
   Name of Witness ______________________________
   Address ______________________________
   Name of Witness ______________________________
   Address ______________________________
4. Date ______________________________
   Month Date Year Hour A.M. or P.M.
5. Place ______________________________
   County, Township, Name of Farm, direction and distance to nearest village
   ____
   or similar data

6. While hunting ☐ Small Game ☐ Big Game ☐ Trapping
☐ Upland Game Birds ☐ Marsh or Water Fowl
7. Type of Gun (used by shooter):

☐ Shotgun	☐ Rifle	☐ Pistol
— Gauge	— Caliber	— Caliber
☐ Single	☐ Bolt	☐ Revolver
☐ Double	☐ Lever	☐ Autoloader
☐ Pump	☐ Trombone	
☐ Autoloader	☐ Autoloader	

Make ______________ Model ______________
☐ Own Gun ☐ Borrowed Gun
8. Type of Cover:

☐ Open Meadow	☐ Brush	☐ Under Cultivation
☐ Open Woods	☐ Under-brush	☐ Slash
☐ Timbered Swamp	☐ Grassy Swamp	☐ Loose Shale
☐ In Offshore Blind	☐ In Shore Blind	☐ In Boat

If both parties involved were not in same blind or boat explain relative location of
Victim ____
Shooter ____
9. Visibility:

☐ Clear and Bright	☐ Clear, Deep Shadows
☐ Overcast, Good Visibility	☐ Dark, Poor Visibility
☐ Fog, Mist, Light Rain	☐ Heavy Rain
☐ Light Snowfall	☐ Heavy Snowfall ☐ Sleet

☐ Estimated
☐ Measured } distance gun muzzle to victim ____________ yards
10. Cause of Accident—Personal Judgment Factors:
☐ Victim stepped into line of fire without warning
☐ Victim was in line of fire unseen by shooter
☐ Victim was mistaken for game
☐ Excited shooter in following game swung gun so as to cover victim at moment of firing
☐ Didn't know it was loaded
11. Cause of Accident—Accidental Discharge:

☐ While loading	☐ Unloading
☐ Climbing fence	☐ Removing gun from car or boat
☐ Trigger caught in brush	
☐ Shooter slipped or stumbled	☐ Gun fell from insecure rest
☐ Clubbing game or cover	☐ Holding gun on foot

Other ____

12. Cause of Accident—Mechanical Conditions:
- ☐ Safety jarred off or broken
- ☐ Barrel ruptured due to obstruction
- ☐ Semi-automatic malfunctioned into full automatic
- ☐ Hang fire ☐ Wrong Ammunition
- ☐ Victim wore Red Cap ☐ Red Coat

If not, what kind of clothing? ______

______

13. Cause of Accident—Personal Physical Condition:

Victim	*Shooter*
Age ______ ☐ Male ☐ Female	Age ______ ☐ Male ☐ Female
Drinking prior to accident? ______	Drinking prior to accident? ______
______	______
Any history of serious illness or depression? ______	Any criminal record? ______
______	______
Any history of previous accidents? (Home, traffic or elsewhere) ______	Any history of previous accidents? (Home, traffic or elsewhere) ______
______	______
______	______
______	______
How much previous hunting experience? ______	How much previous hunting experience? ______
______	______
______	______
Member of Trap Shooting Club? ______	Member of Trap Shooting Club? ______
Member of Skeet Shooting Club? ______	Member of Skeet Shooting Club? ______
Member of Rifle Shooting Club? ______	Member of Rifle Shooting Club? ______
Member of Conservation Club? ______	Member of Conservation Club? ______
Served in ☐ Army ☐ Marines ☐ Navy ☐ Coast Guard ☐ National Guard	Served in ☐ Army ☐ Marines ☐ Navy ☐ Coast Guard ☐ National Guard
Branch of service ______	Branch of service ______
Actual Combat? ______	Actual Combat? ______

14. Investigator's comments: ______

______

______

______

FITNESS EXAMINATION FOR HUNTERS

W. C. SHAFFER

Chief, Division of Law Enforcement, Pennsylvania Game Commission, Harrisburg, Pennsylvania

The topic under consideration is certainly not a new one and probably has been studied as seriously and carefully as any other subject receiving the attention of game law administrators.

The discussions on how to avert hunting accidents seem to lead to but one conclusion by those who have not given study to the problem. Whenever hunting accidents are discussed somebody inevitably offers the remark: ''They ought to examine every hunter before they allow them to go into the woods.''

The problem is not so readily solved as those who jump to such conclusions would have us believe. Most of the proponents of the idea seem to think that the mere examination of a hunter to determine his knowledge of the handling of a firearm, his vision, and his knowledge of safety principles, coupled with adequate legislation, is all that is required.

The State of Pennsylvania has for many years been interested in the subject of preventing hunting accidents and has devoted a great deal of time and energy to the matter, hopeful that some solution might be found to this perennial problem, which not only takes life, maims unsuspecting victims, produces costly hospitalization, and leaves many households without a bread winner, to say nothing of the fatherless children.

No state in the country has as many laws designed primarily to assure human safety and so rigidly enforced as Pennsylvania. Despite these inhibitions and their strict enforcement, we still suffer too high an annual rate of accidents. None of the prominent sportsmen who have so loudly proclaimed the ''examination method'' as the panacea for the elimination of hunting accidents has been able to suggest any worth-while method of accomplishing this most desirable objective.

Let us consider the mechanics involved to examine 591,820 resident hunters who obtained licenses in Pennsylvania last year and add to this 13,961 nonresidents who came to Pennsylvania to hunt. It is conservatively estimated that 100,000 farmers hunt in Pennsylvania each year, on their own and adjacent property, who are not required to take out a license. The hunters to be examined run well over seven hundred thousand. Annually, thousands of youths become eligible to secure licenses, which adds mathematical complicity to the problem. The physical problem alone is immense, but could be accomplished if worth-while results were to be assured. But can they be?

Most persons who handle a firearm know that it is deadly and certainly need no demonstration to prove its potential possibilities as a lethal weapon. Examining a hunter on the component parts of a firearm would be of little value. When he appeared for examination he would be well drilled in the safe handling of a weapon, and probably could load, unload and handle it as well as the manufacturer who designed and made the weapon. Of all the tests that have been suggested, no one has, and no one apparently can, devise the ONE test that should be applied.

Man is a peculiar creature. Psychiatrists tell us that no two persons react alike to similar emotional tests. No person can tell what the other fellow is going to do under certain circumstances. Will he become frightened and shoot at random, or will he get even a mild case of "buck fever"? Will he shoot at a moving object in the firm belief that it is game, moments later to discover that he has shot another hunter in mistake? Most certainly he would not do these things while taking an examination under favorable conditions. *No examination, scale, or standard has yet been devised to measure the hunter's mental reaction under extraordinary conditions, which cannot be produced artificially,* such as he meets in the woods every day with birds flushing madly in their effort to escape, or big game cunningly negotiating a steep mountainside. Until a practical standard is devised the examination of hunters appears to be largely a waste of time, effort and money. Its only value would likely be psychological, and not commensurate even to a small degree with the effort required to produce the result.

A few years ago a hunting accident in Pennsylvania provoked a number of persons to write to the editor of a newspaper in that locality protesting that every hunter should be subjected to severe vision tests before being permitted to hunt. The offender, it seems, wore glasses to correct his vision. Strangely enough he hit his "target" on the first shot! For many weeks the community was stirred up over this accident, and frequent editorial comment appeared demanding that something along the line of vision tests be worked out before persons be permitted to hunt.

Let us consider that phase alone for a moment. First, the offending hunters seem to be hitting the bull's-eye pretty well even if it is a human being. Experience has taught us that a man who requires corrected vision is no more liable to go hunting and do something foolish than is the same man likely to go fishing and make a false step out of a boat and be drowned because of defective vision.

One sportsman, in discussing the proposal, humorously stated that he believed the optometrists were advancing the "vision test" idea with a view of creating new business. That statement, of course, was not true, and was only humorously made.

We are told that even with corrected vision frequent re-examinations are required of the eyes in order to keep pace with their rapid change. How often, if vision tests were required, should the hunter be required to submit to such an examination?

The same question applies to any type of examination that might be designed. As persons become older we are told their reflexes are retarded. Under a system of examining hunters it might be found that when persons reach a certain age they should be denied the right to hunt. Grand disputes would arise between the enforcement authorities and the individual as to the degree of competency of the hunter, and his legal right to hunt! Some cases would undoubtedly end up in bitter litigation.

The examination of automobile operators is compulsory in a great many states today. Despite comprehensive tests of vision, reflex action, driving ability, laws and safety precautions, we still have an appalling volume of automobile accidents annually, all caused by people who have been examined and approved to drive motor vehicles. Why? Simply because no means or device has been perfected to measure reactions under unforeseen circumstances, that could be simulated when the applicant was examined.

A few years ago one of our staff officers, who has been extremely interested in safety, made a relative comparison of automobile and hunting accidents. It proved to be most enlightening.

Motor vehicles are subjected, periodically, to rigid mechanical fitness inspections. Operators are required to successfully pass vision, driving ability, and tests of highway laws before being permitted to operate a motor vehicle.

A 50-mile speed limit during the period of the comparison was strictly enforced. The survey just mentioned was made during the period of the general open hunting season in Pennsylvania, November 1 to December 15, 1939, Sundays excepted, and between 7:00 a.m. and 5:00 p.m. During this period there were 34 fatal and 336 nonfatal hunting accidents.

Utilizing the same dates and hours, there were 1,268 automobile accidents, *in rural districts only,* in which 33 persons were killed, 859 injured, resulting in 463 cases of property damage. Bear in mind that light and weather conditions were exactly comparable. All of the operators of the motor vehicles involved had been subjected to the most severe vision and other tests that safety engineers have been able to devise.

A preliminary study of comparable figures at the present time seems to indicate a slightly lesser ratio in automobile accidents, which highway authorities attribute to reduction in speed limits to 35 miles per hour and less vehicular traffic because of the prohibition against nonessential use of automobiles.

There are few industries in the country today which are not, by legislative action, required to take every precaution to see that their employees are protected from all conceivable physical hazards. Accidents, both major and minor, are still reported daily.

Until those who are struggling with this tremendous problem can devise some means of examining the applicant under conditions that he will constantly meet while afield, it appears we must content ourselves to increase our efforts towards training present and prospective shooters in safety methods through every possible channel. The youth of our country must be trained to respect firearms and handle them safely and efficiently—whether intended for use in hunting, general recreational pursuits, or in self-defense.

To sum up the writer's observations during a period of 20 or more years, in his opinion the two primary causes of hunting accidents are *greed* and *carelessness.*

When these elements are removed the solution to the problem will have been found. Examining hunters will not gain the objective of diminishing or removing the two primary causes. Intensive training and safety education, especially among the youngsters, seems to be the only sound remedy currently available.

COMMENTS

MR. SETH GORDON (Pennsylvania): The author of the foregoing paper is exceptionally well qualified to discuss the value of fitness examinations for hunters as a principal medium for the elimination of hunting accidents. During the past 9 years, as the designated hearing referee, he has personally conducted hearings in more than 600 cases, involving both fatal and nonfatal accidents. His conclusions have been presented to the Pennsylvania Game Commission for consideration in connection with the revocation of hunting and trapping privileges. He has, therefore, had an exceptional opportunity to analyze the causes of such accidents in Pennsylvania.

Every person who causes an injury to a human being by gunfire or with a bow and arrow while hunting or trapping, or who injures himself by such means, must render a report to the Pennsylvania Game Commission on forms provided within 72 hours. If such person is physically incapable of making the required report, it becomes the duty of the individual causing the accident to designate an agent to file it for him. These reports are then analyzed by the Chief of the Division of Law Enforcement and hearings scheduled in every case where it is apparent, or appears questionable, that carelessness or negligence caused the accident.

The Pennsylvania Game Law contains a number of safety provisions, the most severe of which imposes heavy penalties upon persons who shoot at human beings in mistake for wild creatures. These cases are brought before the local courts, which in turn impose cash penalties, prison sentences, and revoke hunting privileges from 1 to 10 years.

Among the other safety provisions are requirements that (1) hunters must see their game clearly before shooting; (2) no hunter may fire at game while it is on a public highway or across a public highway at an angle that might injure the users thereof; (3) not more than five may hunt in one party for small game; and (4) no shooting may be done within 150 yards of occupied dwellings and outbuildings connected therewith.

These provisions of the Game Law are enforced rigidly because the Pennsylvania Game Commission feels that it owes it to the hunting public to make the fields and forests as safe as humanly possible for the users thereof.

In addition to the enforcement of the law, a very intensive safety educational program has been conducted during the past 10 years. As a result of these combined efforts the annual number of hunting fatalities in Pennsylvania has been greatly reduced. During the past four seasons these fatalities have been running less than two-thirds of the 10-year average. For some unaccountable reason 41 per cent of the total fatalities during the past decade were self-inflicted, a serious situation which examinations alone would never correct.

This is a subject which all conservationists, and especially conservation officials, organized sportsmen's groups, junior rifle clubs, and others concerned, must give their determined and continuing attention in an effort to bring about drastic reductions in hunting accidents. It is not something "that one can blandly sweep under the kitchen sink and forget."

THE SEMI-AUTOMATIC AS A SPORTER

THURMAN RANDLE
Commander, USNR, President, National Rifle Association, Washington, D. C.

The semi-auto has enjoyed but mild popularity as a sporter in the past. But in the anticipated increase in postwar hunting the popularity of the auto-loader is likewise expected to soar to new heights. The reason for this is that many of the men who make up the increased roster of hunters will be men who have become used to the semi-automatic and full-automatic weapons of the Army. Most of them knew nothing about guns when they went into the service. Their military tutelage has been with semi-automatics and full automatics almost to the exclusion of other types. They have learned to rely on them in battle, and it seems reasonable to expect that many of them will want them with them in their forays into the hunting fields of peacetime.

Well, what about the semi-auto as a sporter? Is it, or ain't it?

Perhaps it should be explained at the outset that the so-called "automatics" which have been manufactured for sporting use in the past are all semi-automatics. They really are not full automatic in action. The full-automatic weapon continues to load, fire, and eject as long as the trigger of the weapon is held down and there are cartridges in the magazine. This is a military or police action and should be, and is, practically restricted to these two uses by federal law. The semi-auto is in reality only a self-loading weapon which fires but one shot when the trigger is pulled. It then utilizes the power of that shot to operate the action, eject the fired case, and load a new cartridge from the magazine into the chamber. That is as far as it goes. It requires another trigger pull to fire another shot.

It is with this weapon that we are concerned here. We have no "truck" with the full-automatic weapons in this respect. They have no place in the field of sport shooting either for target work or for field use in hunting. It is unfortunate that the semi-automatic action, the self-loader, ever acquired the name "automatic," because that tag is a liability and has been a disadvantage from the very start.

There is little doubt but that this very misnomer has had its effect in the many states and in the Dominion of Canada which have banned the use of this arm for hunting. Even Pennsylvania, probably the greatest game state in the Union, has legislated this action from its hunting coverts.

But there is another problem with this weapon that is not so psychological. This is the dangerous manner in which the semi-automatic arm has too often been used in the field. In itself the semi-automatic action is a harmless piece of machinery. It takes the asinine cooperation of a damphool to make it lethal. While actually it won't kill an animal any deader than an old single-shot muzzle loader, its potentialities for deadliness in improper hands are considerably greater. This, too, has been a liability.

The problem here arises from the fact that this action, by its very nature, encourages volume of fire rather than more deliberate, accurate, safe shooting. Loaded with a hatful of cartridges the inevitable tendency is to "burn 'em up." The accurate placement of those shots too often becomes a matter of secondary importance. The rip and snort of a fast-firing weapon is a thrill to the hearts of many people, but to the heart of the hunter on the next ridge, carelessly and mistakenly identified as a buck deer in the rut, it strikes cold terror.

The real problem with the semi-auto as a sporter, then, is the misuse by irresponsible hunters of its faculty for quick loading. But this doesn't necessarily have to be so. It is possible to pull the fangs of this action so that it may be quite safely used as a sporter by the run-of-the-mill hunters afield. It was done in the case of the repeating shotgun in the hands of the waterfowl hunter when the Federal Government decreed that these guns must be throttled down to three shots. This same simple expedient of limiting the magazine to three-shot capacity will completely remove the curse from the semi-auto as a sporter. By taking away his hatful of cartridges, the hunter with the semi-automatic will be forced to slow down to more deliberate action.

He will be required to use as much care in the placement of that first shot as the man with the bolt gun or any other manually-operated repeater.

A limitation to three-shot magazine capacity will be no handicap to any hunter. It will be far less of a handicap to the deer hunter than it was to the wildfowler. There is rarely time to get in three shots at effective range. Except in cases of very ragged shooting, it is extremely rare that more than three shots will be required to bring any American game to bag. Such a limitation will, of course, require that the hunter exert more careful judgment of range and all other factors involved in good hunting and good shooting practice, but this is a move in the right direction. It will be imperative that the first shot is properly placed. This done, there will be far less need for the remaining cartridges in the clip. But, in case of necessity, there is still a second and even a third available for the coup de grace.

No, the three-shot limit will be no handicap. It still provides all that is necessary and offers a great deal more that is desirable. It should be a boon to the whole shooting fraternity, and paradoxically it should be a conservation measure. Less unfavorable publicity will be the result of more careful handling of these weapons and the whole family of shooters will benefit from that. And more careful shooting will waste less game. The fact that a second aimed shot can be delivered more quickly with the auto-loader than with other rifles will mean the loss of less wounded game.

The availability of popular new sporting arms of the semi-automatic type after the war is still a matter of uncertainty. What the manufacturers have in mind has not yet been revealed, but it seems reasonable to expect that new types of semi-automatic sporting arms will be offered to the trade. It is unlikely that the government policy with surplus weapons will be so generous as to release the Garand and the M1 Carbine from our war reserve.

The M1 Garand is a fine military weapon but its possibilities as a sporting arm are decidedly limited. The very nature of its mechanism will prohibit the use of the conventional sporter stock in remodeling to sporter style. And this same mechanism makes it quite improbable that its weight can be reduced to sporter dimensions. It certainly cannot be brought below eight and one-half pounds with iron hunting sights and not this low with the hunting telescope sight. Its M2 .30-'06 cartridge has ample power and accuracy for any American big game. But the M1 Garand was designed for this M2 cartridge, which is loaded with the 150-grain full patched bullet to a velocity of about 2,700 f.s. Under present loadings this develops a breech pressure of about 38,000 pounds per square inch. At this pressure the weapon functions well, but it must be remembered that breech pressure is the one really important limiting factor in the design of an arm of this type. Sporting ammunition in .30-'06 caliber is often more heavily loaded and, while the action of the Garand may be perfectly strong enough to withstand the increased pressures of this ammo, there is quite apt to be considerable trouble with extraction. Smooth functioning of the arm with such ammunition probably cannot be expected. After all, the Garand was designed for military, not sporting, purposes.

The M1 Carbine is a cute little job that has deluded a great many people into thinking they would like to use it in the deer woods postwar. It is a nice, light-handling little piece that has been a bone of contention ever since it was born. Everything about it, including its very purpose in life (i.e. replacing the pistol, which it never did successfully) has been criticized. It has an irritating habit of jamming entirely too frequently at exactly the wrong time, and the whole magazine is likely to fall out when you least expect it. But these little quirks can probably be remedied in time. All new weapons have such bugs that have to be worked out. Even the now dependable Garand originally had plenty of them.

But the important point here is the cartridge. The little carbine cartridge is not a deer cartridge. Someone recently dubbed it a "jackrabbit cartridge, period," and he very nearly hit the nail on the head. It is, in fact, the old familiar .32-20 H.S. in a new package. The sovereign states of Maryland and Washington do not consider this a deer rifle. Maryland requires deer rifles to have a muzzle energy of at least 1,200 foot-pounds. The little carbine cartridge isn't in that class and is consequently outlawed immediately. While the State of Washington does not specifically prohibit the use of the carbine cartridge in hunting deer (because the gun is still a strictly military arm), the list of cartridges taboo there does include the .38-40 and the .44-40. Both of these are more powerful than the .30 carbine cartridge, and it is reasonable to expect that the latter would meet with little favor by the authorities of that far western state.

Make no mistake about it, the carbine can kill deer. But so will the .22 Long Rifle—if it hits 'em right. That doesn't make the carbine any more a deer rifle than it does the .22. Fortunately the Winchester Repeating Arms Company, designers and manufacturers of the carbine, have recognized its shortcomings in this respect. They have publicly stated that it will not be made available as a commercial job with its present cartridge after the war.

The full-automatic feature of the more recently designed "M2" Carbine eliminates it from all consideration as a sporting weapon.

The Reising Models 50 and 55, adopted and issued for a short time by the Marine Corps, are .45 caliber weapons of the Tommy-gun class and as such have already been disposed of. They are not sporting arms. But the Reising Model 60 is something else again. Its action is semi-automatic and it has a barrel eighteen and one-quarter inches in length which just lets it under the fence from the standpoint of the federal firearms laws. It is chambered for the .45 Automatic Colt Pistol cartridge and utilizes a clip accommodating either twelve or twenty of these cartridges. The Reising catalogue claims that "Because of the increased velocity incident to the longer barrel of the Semi-Automatic Rifle, the maximum effective range of this Model (against personnel) is extended to 400 yards." It goes on to say that "Accuracy is high within the stated maximum effective range for this type of weapon since when the gun is loaded and ready to fire, the round to be fired is chambered, the bolt is in the locked position, and the action is at rest during the period of sighting and aiming the weapon; depressing the trigger results only in the motion of the hammer and the firing pin." That is OK. It simply means that this model fires from a closed bolt unlike other Tommy guns which usually fire from an open bolt.

But the design of this weapon does not increase the inherent accuracy of the .45 Automatic Colt Pistol cartridge which at the extreme range given above is practically nil. The .45 ACP cartridge is still a pistol cartridge in spite of the eighteen and one-quarter inch barrel. It certainly is not a game cartridge. The idea of this being a 400-yard weapon is fantastic. The .45 ACP cartridge is a man-killer designed for close work only. If offered to a gullible public for hunting, this weapon will be the best argument for anti-firearms legislation that could be conceived by or for the fanatics.

Is the semi-automatic action a sporting proposition? After all, it's a matter of how it is designed and how we use it. If it handles a properly designed sporting cartridge of adequate power; if it is accurate at sporting ranges; if its action is dependable, it will be just as sporting a proposition as the guy in whose hands it finds itself. If he's a sportsman and a straight shooter, the gun will likewise be sporting and straight shooting. But in the hands of a chiseler any gun can be anything.

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PRODUCTION AND MARKETING OF FUR

THE PROBLEM OF UNDERTRAPPING IN MUSKRAT MANAGEMENT

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Many marsh managers are cautious to avoid overtrapping, but give little thought to the dangers of undertrapping. Both are relative terms, but are easily defined when it is agreed that the object of muskrat marsh management is the production of the maximum amount of fur without jeopardizing future crops. Undertrapping occurs when the trapper could have taken more fur without hurting the breeding stock. Overtrapping occurs when the breeding stock is reduced so much that a capacity population cannot be produced for the next trapping season.

My experience has been limited to the coastal marshes of Louisiana and Texas; therefore my remarks may not apply at all elsewhere. Some of the pertinent local aspects of muskrat ecology are: more or less year-round breeding, little or no ice, and great areas of the preferred brackish marsh type within a continuous region of coastal marshes.

Spring dispersal movements are evident throughout the region beginning in January. During this period muskrats are killed along all highways in the region. This movement obviously prevents any local muskrat extermination such as might occur through overtrapping in an isolated prairie kettle-hole marsh.

An example of one of the most productive sections of marsh in Texas is a tract of less than 1,000 acres between High Island and the intracoastal canal. Each autumn muskrat beds or houses can be seen from the highway in numbers approaching those of rice shocks in the nearby grain fields. This tract has probably produced during the past 5 years as much fur as any area of comparable size in Texas.

This area, though consistently much better than average, is not managed at all. The ownership pattern of many small and irregular parcels of land results in the area being subject to heavy public trapping by the local residents of the town of High Island, from which no part of the area is more than 2 miles.

The area is a "natural" for muskrats with the dominant marsh plant being *Scirpus olneyi* with some *Spartina patens.* Brackish water is furnished by high tides. I am confident that under the management practiced by owners of similar land elsewhere this area would have produced far less revenue from undertrapping. If trapping such as this were widespread so that migration from outside was checked, it might reduce the population for lack of restocking during the spring movement; but most areas can stand more trapping than we generally recognize.

Sometimes marsh destruction has resulted due to "eatouts" of 5 to 100 acres where peak populations were not sufficiently trapped. This is the end result of undertrapping.

Usually undertrapping does not result in "eatouts" but in excessive losses from intraspecific strife, droughts, drifting, and increased predation. Food is never a limiting factor. By comparison with the food habits of northern muskrats during critical periods it is obvious that any of the numerous marsh or marsh-edge plants not ordinarily used in the South would be welcomed by a starving muskrat. There are large expanses of fresh-water marshes with few muskrats. The only apparent explanation is that the muskrats prefer the nearby brackish marsh communities and do not have to subsist on second-choice plants such as *Eleocharis quadrangulata, Scirpus californicus,* or even *Typha.*

Intraspecific strife (muskrats fighting among themselves) causes more than one third of the pelt damage on well-stocked marshes and is more important than any other among the damage causes. Any muskrat caught, but not killed by the trap, apparently is attacked by the first muskrat that passes. Many trapped animals show scars of former battles. Except for the extremes of intermittent factors (such as drought and hurricane) intolerance of crowding probably is the limiting factor in most well-stocked marshes. When this factor is operative it may be expected that losses will result from fewer young being reared as well as from strife among subadults and adults. Information on this point is difficult to obtain, but Errington's (1937, 1940) descriptions of losses of young through drowning and destruction by crowded adults in Iowa are doubtless true of southern marshes as well. Much of the movement of muskrats is a result of intraspecific strife. On cold nights on levees already closely trapped, a large portion of the catch consisted of subadults evidently looking for new territories. When younger litters appear in their lodges the parents doubtless force out the subadults.

The object of the muskrat trapping program is, of course, to harvest the crop, remove the surplus and substitute trapping for the natural limiting factors in the removal of the annual increment. The problem is to determine when to stop trapping. The usual practice is to stop when the catches fall off, or when warmer weather causes sharp increases in breeding and sharp declines in fur grades. Trappers often unnecessarily guard against overtrapping by obtaining control of more acreage than they can trap closely, trapping only the periphery of it, and leave a central area of 50 to 100 acres untouched. Many marsh operators fail to use enough trappers to completely cover their marshes with trap lines. Trappers in the region under consideration like to use from 125 to 300 traps. To set this many requires 2 to 5 miles of trap-line space and room to move traps every week or so. Few operators make preseason censuses or estimates with any accuracy. No easy method is available, although observations made from airplanes in conjunction with limited work on the ground enables a quick survey. Also, the lay of the land often determines the division of trapping lots on the basis of geography, making it difficult to apportion the area among trappers according to muskrats present.

In Iowa the breeding rate (Errington, 1940) is 4 to 17 per female per year and 1 to 2 breeding pairs per acre is considered sufficient to produce a full crop of furs. The rate of increase for the region herein described has not been determined, but the breeding season is so much longer than in the North that the smaller litter (4 instead of 6.5 in Iowa) does not make it improbable that one or two breeding pairs in southern marshes would be sufficient breeding stock. Presumably the preseason muskrat population can be safely reduced by trapping to two pairs of adults per acre.

As described elsewhere (Lay, 1945) two muskrats per bed is considered conservative in predicting catches from marshes where all muskrats live in beds. A catch of 2.8 muskrats per bed (and more than 20 per acre) was made on a test area of 31.6 acres and there was abundant sign to indicate the presence of a satisfactory breeding stock at the end of the season.

The James B. Jackson marsh of 4,300 acres produced only 5.1 muskrats per acre in 1943-44 when the count of live beds showed 7.8 beds to the acre. Each of the trappers had from 300 to 500 acres. Mr. Jackson made every effort to obtain the services of additional trappers without success. The following summer drought caused the loss of many thousands of muskrats which should have been harvested by trapping the previous winter.

Other marsh operators use twice as many trappers and still suffer from undertrapping. The home range of muskrats that are well situated and not crowded is small. Trappers who are not diligent in moving traps are inclined to expect muskrat traveling to make up for this neglect. Therefore, the allotment of small territories does not insure against undertrapping; but it is a necessary prerequisite.

Operators should insist that traps be worked continuously. The trap line that is not moved produces larger percentages of kitts, mice and females, and a lower percentage of adults. Pelt measurements can quickly produce statistics on age groups, which in the light of various local factors can be interpreted with reference to the question of when to stop trapping. (Lay, 1945.)

Muskrat managers instead of being too much concerned about overtrapping should keep in mind the near-impossibility of eliminating the species in places where it is not wanted, such as in some of the irrigation systems of the West and in Europe. The average trapper in the average southern marsh will leave the minimum required breeding stock of two pairs to the acre, without any precautions against overtrapping. Many marshes include spots or large areas of "floating" marsh where the animals live in holes and are practically impossible to trap out. Marshes with shallow water and peat formation can be trapped more closely and the manager who wishes to insure against overtrapping can do so by not trapping the population on 10 per cent or less of his area in well-distributed spots of perhaps 50 to 100 acres each. The balance of the area can be trapped until the diminishing returns force the trappers to quit.

There is no point in managing water levels, constructing levees, eliminating cattle, properly burning and in other ways managing a muskrat marsh unless the increased production due to the favorable environment is utilized promptly through proper trapping.

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CAPACITY OF ILLINOIS LAND TYPES TO PRODUCE FURS

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This paper deals with fur production for 1931-44 on the six most important Illinois land types. The catch for each type has been reduced to animals taken by species per acre per year, and income computed on the basis of the price received for raw furs by the producer.

These values were obtained by applying the raw fur price averages for 1941-42 (Brown and Yeager, 1943) Table 1, rather than using prices for the entire period. This selection of a year in which prices were average avoids pronounced market fluctuations due to the highs of the late 20's and 1943-44 and the depression lows of 1931-39.

TABLE 1. AVERAGE PER PELT PRICE OF ILLINOIS RAW FURS, 1941-42.

Species	Price	Species	Price
Muskrat	$1.40	Gray fox	$2.00
Mink	8.25	Skunk	1.50
Raccoon	4.50	Red fox	4.00
Opossum	0.50	Weasel	0.30

In the pages that follow it will be noted that fur production is herewith considered from the point of view of specific land types. This is different from the usual concept of production in relation to land survey divisions such as counties, townships, or square miles. Thus, a square mile crossed by a ditch may show a value of $11.59 per acre for the ditch area alone, instead of 7 cents per acre for the entire 640 acres. Catch is given by species on the same basis. For all types, the surrounding lands, most often cultivated fields, are used by fur animals and contribute in varying degrees to their support. Yet, the uncultivated area provides the basic habitat, without which most animals so situated would scarcely be able to exist. The great bulk of Illinois furs are taken from the six types here included.

This viewpoint emphasizes the productivity of various noncultivated types, such as marshes or ditches, which are often referred to as waste lands; and it gives dollars and cents reasons for managing these valuable areas as intelligently as possible.

A brief description of each type follows, and a summary of the sample for each is given in Table 2.

River marsh.—Characterized by cattails (*Typha latifolia*), river bulrush (*Scirpus fluviatilis*), and marsh smartwood (*Polygonum muhlenbergii*); commonly bordered by buttonbush (*Cephalanthus occi-*

TABLE 2. LOCATION AND SIZE OF SAMPLE AREAS, AND PERIODS COVERED BY DATA.

Land type	*Sample*				Remarks
	County	Area	Acres[1]	Period	
River marsh	Fulton	Rice Lake	924	1935-43	1,034 acres of marsh and water on Illinois River.
	Mason	Lake Chautauqua		1940-43	630 acres of marsh, levee margin and woods fringe.
Glacial marsh	Lake	County-wide	2,350	1938-40	46 marshes and lakes in sample; open water on large lakes (200-300 acres up) not counted.
Ditches	Champaign	County-wide	257	1938-40	132.5 linear miles of ditches in sample; 67 miles in 1938-39, 65.5 miles in 1939-40.
Wooded river bottom	Calhoun	Pere Marquette	1,542	1940-41	2,175 acres in Illinois-Mississippi bottoms.
	Franklin	Big Muddy River		1938-40	1,225 acres along a 20-mile segment of river.
Wooded upland	Jo Daviess	County-wide	2,120	1938-40	1,000 acres, mainly in western half of county.
	Jasper	County-wide		1938-40	1,120 acres, widely scattered.
Strip mines	Fulton Henry Vermilion	Somers	272	1939-41	A total of 960 acres of land and 680 acres of water involved in sample, mainly in Vermilion County. Illinois strip mines run 20 per cent or less of total area in water.
		Atkinson		1940-41	
		Four "Pollywog" areas		1927-41	

[1]Average annual number of acres trapped on type.

dentalis) and willows (*Salix spp.*); water level usually fluctuating in nature. Individual marsh areas may vary from a few to several thousand acres. Type is most common along the Illinois and Mississippi rivers.

Glacial marsh.—Cattails and various bulrushes are the principal cover species; marsh smartweed generally lacking; commonly bordered by grasslands, fields, and open water too deep for the growth of emergent vegetation. Individual marsh areas may vary from a few to several thousand acres, but small areas are most frequent. Water levels are relatively permanent. This type centers in Lake and McHenry Counties, northwest of Chicago.

Ditches.—Drainage ditches average about 12 feet in width, with an additional 10 feet on each side used for turning machinery. The total width of 32 feet, in straight ditches, amounts to 3.88 acres per mile. Smartweeds and sedges (*Carex*) of various species, and occasionally cattails, grow in ditches; ragweeds (*Ambrosia trifida*), wild parsnips (*Pastinaca sativa*) and many other weeds, in addition to various clovers, grow well on the banks and berms. Corn and soybean fields closely border most ditches. The banks and tile outlets provide denning sites for all fur animals present, including raccoons. There is about one mile of ditch for each 2.5 square miles of black prairie land (Yeager, 1943, p. 294).

Wooded river bottom.—Stands of silver maple (*Acer saccharinum*), white elm (*Ulmus americana*) and white ash (*Fraxinus americana*), with mixtures of other flood-plain species, are still fairly extensive in Illinois. The type is usually bordered by medium-sized to very large, fluctuating rivers and more or less steep terrain along the landward borders. Cutting, burning and pasturing have severely lowered the quality of most river-bottom woodlands as game range. Scarcity of den trees is felt acutely in this type because flooding and high water table, preclude extensive ground denning. Water is generally ample, but because of its unstable nature and the absence of aquatic plants, is of low quality for muskrats. For other species both water and food are generally satisfactory (Yeager and Rennels, 1943).

Wooded upland.—Upland stands of oaks and oak-hickory, with mixtures of many other species, are still extensive in Illinois. The type has been severely cut, burned and pastured. Water is more lacking here than in river bottoms, being mainly in the form of small streams suitable for minks and some other species, but of low value for muskrats. Many of the streams are intermittent, especially in central and southern Illinois. Bluffs and sinkholes tend to take the place of den trees in wooded northwestern and southern parts of the state. Ground denning is possible throughout the type, and food supplies for all species are generally ample.

Strip mines.—This new land type, scattered through 20 counties, does not exceed 30,000 acres in Illinois. Prior to revegetation, the type is not attractive to any fur species, but after weeds and shrubs appear, or after being planted to white sweet clover (*Melilotus alba*), strip mines provide fair foraging, and excellent denning grounds for skunks, foxes, opossums and weasels. After the water areas, which average 20 per cent or less of the total area, become cattail bordered, they are suitable for muskrats, and later minks (Yeager, 1942). The type becomes more attractive with age to both land and water animals.

The importance of muskrats in determining the fur value of all types is clearly indicated in Table 3. It is significant that in both the number of muskrats taken and in value per acre this species ranks first in all aquatic types. Ditches, glacial marshes, and river marshes, in this order, showed the highest per acre values, of which muskrats contributed 98, 75 and 86 per cent, respectively. Minks contributed to the catch 0.7, 22 and 9 per cent, respectively. The great variation in the number of minks taken is due in part to inadequate trapping on the river marsh sample, whereas glacial lake trappers made special efforts to take minks.

The data in Table 3 show to some degree the habitat preferences of Illinois fur animals. Other than for ditches and river marsh, the various types showed populations in about the proportion that would be expected. Thus, wooded river bottom contained the highest raccoon and gray fox densities; wooded upland contained the highest red fox numbers and, except for ditches, the heaviest populations of skunks and opossums. It seems highly significant that maximum densities in five of eight species, including both muskrats and mink, should occur on the ditch type.

The sample includes Rice Lake, one of the better marshes in the Illinois Valley, but this is balanced by the average quality of Lake Chautauqua (Bellrose, unpublished). Only muskrats were trapped systematically on these two areas. A few minks and raccoons were taken incidentally on the former and about 60 raccoons were removed under permit from the latter. No other species were taken, although opossums, skunks, foxes, and others were present on both. The river marsh sample, therefore, does not include all species. The aggregate value of opossums, skunks, foxes, and weasels on the glacial marsh, which is in many ways comparable to river marsh, was about 12 cents per acre. At least a fraction of this amount could properly be added to the annual per acre value of the river marsh type. The superiority

TABLE 3. ANNUAL PER ACRE CATCH AND VALUE OF FURS ON VARIOUS LAND TYPES IN ILLINOIS.

Land type	*Average annual catch per acre*								Average annual value[1] per acre
	Muskrat	Mink	Raccoon	Opossum	Skunk	Red fox	Gray fox	Weasel	
River marsh[1]	1.658	0.002	0.009	....	....	....	....	....	$ 2.38
Glacial marsh	2.370	0.117	0.008	0.062	0.037	0.008	0.001	0.033	4.45
Ditches	7.142	0.134	0.016	0.200	0.165	0.010	....	0.080	11.59
Wooded river bottom	0.112	0.041	0.040	0.138	0.005	0.007	0.006	0.002	0.79
Wooded upland	0.036	0.032	0.028	0.163	0.082	0.012	0.004	0.022	0.71
Strip mines	0.405	0.020	0.007	0.009	0.011	0.005	....	0.003	0.81

[1]Other species listed were present but were not trapped on sample area.

of glacial over river marsh as a muskrat habitat is undoubtedly due to the more stabilized condition of the water level.

Strip mines owe their rating as a fur animal habitat almost entirely to the attractiveness of the water area to muskrats and minks. The type provides unlimited sites for bank dens, as well as a limited amount of shallow water suitable for muskrat houses. Food, basically white sweet clover, cattails and wild parsnips, is usually sufficient, and the water level is the most stable of any Illinois habitat. Raccoons are scarce on mine areas, but to some extent in the "spoil" banks. The oldest mines are in Vermilion County, where much of the sample was taken. The value per acre, due to this circumstance, is probably high, Table 3, as an average for the entire type, but nevertheless represents a reasonable average that may ultimately be expected.

Ditches offer several environmental advantages over other types. Denning sites are abundant and good food resources are available throughout the year. During floods, which occur almost yearly, high ground is seldom more than a few rods distant; and other refuge, used particularly by muskrats, is found in willows and debris (Errington, 1937a, p. 416; Bellrose and Low, 1943). During periods of drought, water holes often remain beneath bridges, below headwalls, and at tile outlets. Finally, ditches are probably the easiest of all types to trap, making the harvest comparatively easy. Cultivation, of course, forces all species to find habitation along this combined land-water type, and makes possible the high return of $11.59 per acre per year.

The difference in productivity in ditches, glacial marshes, and river marshes, reflects their difference in quality as muskrat habitat. The chief difference in the two marsh types is that of water level, being relatively stable in glacial marshes and widely fluctuating in river marshes. In both marsh types food is usually ample; and the contingencies of flood and storm would seem to be more disastrous on both than on ditches. Errington (1937b) found storms and resultant wave action destructive to muskrats, particularly the young, on two Iowa marshes.

In regard to the comparative productivity of habitats in Iowa, Errington (1940, p. 183), says, ". . . we can expect moderate breeding populations to raise the equivalent of a full litter per adult female on marshes as at Round Lake; . . . a litter and a half on small natural streams of central Iowa; and . . . perhaps two litters in the better ditch habitats." Concerning streams, he states (1937a, p. 411), ". . . . a small shallow creek crossing through a closely grazed pasture is almost at the bottom of the scale of [muskrat] habitability in Iowa." The difference in productivity between the average of Illinois marsh types and Illinois black prairie ditches, expressed in terms of catch, is, respectively, about one muskrat to three.

It is of special interest that the highest annual per acre value should come from land most directly associated with farming. A gross return of $11.59 per acre per year was obtained on ditch banks from furs. Allowing one half of this amount for trapping and marketing expenses, a net return exceeding the usual rental charge for pasturage remains. Moreover, it offers increased incentive to practice good ditch management, since closely-grazed ditches not only fill more rapidly, but fall far short of ungrazed ditches in fur production. On the Urbana Township Wildlife Area in Champaign County, 0.7 mile of ungrazed ditch produced in 1944-45 a total of 70 muskrats and 3 minks, while on an adjoining mile of heavily-grazed ditch produced only 10 muskrats. In value, on the basis of income actually received, the comparison is $62.78 to $5.54 per acre. These figures are derived from muskrat pelt prices approximately 54 per cent higher than those for 1941-42, but comparison on the lower basis is $43.45 to $3.61 per acre. The yield is considered normal, since the same ditch area produced 75 muskrats in 1942-43; it was not trapped in 1943-44.

The advantages of good ditch management from the agricultural standpoint were given by Yeager and Yeatter (1944); and the advantages in regard to wildlife production were discussed in both the foregoing paper and by Yeager (1943). On all of the six land types the fur crop represents only part of the wildlife yield, for much of the upland and other game is produced there. The development of more suitable cover on these lands would increase the present yields of both fur and game, thus insuring a multiple wildlife return that supports, instead of penalizes, modern agriculture.

SUMMARY

The annual per acre fur income on the six most important Illinois land types varied from $11.59 for ditches to $0.71 for wooded upland. Glacial marsh and river marsh, with annual incomes of $4.45 and $2.38 per acre, respectively, ranked second and third. Quantitatively, income on all types was directly proportional to the muskrat harvest, which, in turn, reflected the quality of the types as muskrat habitat. Ditches provided the best muskrat habitat, and showed the greatest catch density in four of seven additional species, due mainly to the concentrating effect of cultivation on fur animals along this land-water type. Ungrazed ditches indicated a per acre income approximately 11 times greater than grazed ditches. Furs represent only a part of the wildlife yield on uncultivated lands, since most of the upland and other game is produced on the same areas. Management that insures

the production of this multiple wildlife crop involves no practice adverse to progressive agriculture.

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PELTING EQUIPMENT AND HOW TO SKIN, FLESH, STRETCH, AND DRY PELTS

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Hundreds of thousands of dollars are lost to trappers annually because pelts are improperly skinned, fleshed, stretched, and dried. This is a great economic loss, not only to the trapping fraternity but to the raw fur trade and can be prevented if trappers would exercise greater care in selecting equipment and would learn the correct technique of skinning and preparing pelts.

Wilderness trappers usually whip off the pelts of captured fur bearers on the trap line, or on the spot, so to speak. The pelts are rolled or wrapped and carried back to camp for the finishing touches.

Trappers in settled areas usually maintain comparatively short trapping lines and travel back and forth, either by foot, horseback, canoe or automobile. These trappers sometimes bring the animal carcass back home for skinning.

In either event most trappers maintain a headquarters camp and can procure or make proper pelting and finishing equipment.

Pelt drying boards.—First in importance is an ample supply of properly made drying boards. Too much emphasis cannot be placed on the vital need for providing the proper sizes and shapes of pelt drying boards, or, as they are commonly called, stretching boards. Unfortunately the word "stretching" is too often taken literally by trappers and stretching boards are s-t-r-e-t-c-h-i-n-g boards in fact. Boards that are out of proportion or skins that are stretched out of proportion always result in misshapen pelts. These are an eyesore and are materially disqualified by the raw fur buyer. Your goods are on display when you show them to the buyer and otherwise good pelts are certainly shown at a disadvantage if improperly dried. They not only lack trimness but if overstretched invariably show up natural thin spots that should be pinched and covered with underfur and guard fur.

Most trappers prefer to make their own drying boards and here is where the skill and workmanship of the individual trapper comes into play. Drying boards should be smooth and as finished as possible. It is just as easy to make a thing right as it is to make it in a slipshod fashion and this axiom certainly applies to trapper's equipment. Many trappers use formed wire or cut steel stretchers. Good results can be obtained by proper care both in selecting the proper size and keeping the edges free from corrosion or rust. If this is not watched carefully damaged pelts will result. Fine furs, such as mink, fox, etc., should be handled only on wood drying boards.

Skinning knives and appliances.—The trapper's prime requisite for the actual work of pelting is a good trapper's knife. The right kind of knife is equipped with a slitting blade, a skinning blade, and a small blade for general use. Each blade should be kept keen and sharp. A dull blade will cause more damage to pelts than a sharp blade that does its work smoothly and without friction.

Small, medium and large fleshing boards should be provided. These are best made of 2 by 8-inch material, 4 feet long and tapering from 8 inches at the upper end to 2 inches. Smaller sizes can be provided for animals smaller than a fox. The upper side should be slightly rounded to fit the curve in the fleshing knife.

The fleshing knife has a large, curved knife edge with a handle on each side. The edge should be dull so as not to cut the pelt. If preferred a complete set of fleshing instruments can be made or secured of wood.

Another appliance that comes in handy is a tall slit guide. The manufactured guides are metal troughs tapered to fit the tail. An old umbrella rib also makes a good tail slit guide. A tablespoon is also handy for scraping and removing excess fat.

In addition the trapper should also provide himself with a tack hammer and tacks and split sticks for removing tail bones, a pair of nippers for cutting toes, and plenty of clean hardwood sawdust to absorb fat and dirt and give a good gripping surface on the pelt.

The stretched open or open-handled method is used almost universally for beaver, badger, raccoon, bear and wild cat, although some fur buyers prefer to have the full furred northern type of coon cased. Open skins are taken off by cutting the skin straight down the belly, from the lower jaw to the vent, then slitting the front and hind legs to the body cut, after which the skin is carefully removed from carcass.

The case-handled method is used for such furs as wolf, fox, coyote, martin, fisher, mink, otter, lynx, skunk, opossum, muskrat, ermine, and civet cat. Cased skins are taken off by cutting down the back of the hind legs to the vent and then peeling the skin off carefully toward the head.

Care must be taken to keep the skin as free from flesh as possible. Use a sharp knife but guard against cutting into the skin. Peel the skin from the front legs, cut the ears close to the head and use great care in skinning around the eyes, nose, and mouth.

Feet and tails.—It is the customary practice to cut the tails off the muskrat, beaver, and opossum. The feet should be cut off the following animals: muskrat, beaver, opossum, skunk, raccoon, badger, civet cat, and coyote. The feet of the other animals should be left on and properly skinned and dried.

Fleshing.—There are certain mineral elements in fresh blood that tend to stain fur so it is advisable to wipe blood from the pelt as soon as possible after skinning.

Fleshing is one of the most important operations in preparing the pelt. It is not only essential that all surplus flesh be removed but as much fat as possible. The layers of fat and muscle can be worked loose with the thumbnail and sawdust.

Place the pelt over the fleshing board and work down with the knife, using plenty of sawdust. Be careful not to scrape too hard. Overscraping will result in cutting the hair roots and cause the hair to fall out. Work the fat off carefully around the ears. If this is not done the fat will very likely burn the fur and cause it to slip. Every trapper should accumulate a supply of hardwood sawdust. Use this freely when scraping off the fat.

Sawdust not only absorbs fat and grease but makes it possible to keep a firm grip on the slippery pelt. Sawdust can also be rubbed into the fur and then shaken out. By this means much of the dirt and grease can be eliminated from the fur and gives it a fresh, sparkling appearance. Never use salt or alum on fur pelts.

Placing the pelt on the drying board.—Select a proper sized board for each pelt. Your supply should include appropriate sizes to accommodate various sized pelts. When fitting the pelt to the board be sure the belly is on one side of the board and the back on the other. Slip the pelt onto the board gently and don't stretch it but pull it down to full length and tack. A pelt that shrinks a little on the board is better than one that is stretched a little. Fleshed pelts dry quickly so it is important that they be placed on drying boards as quickly as possible. Just before hanging the board straighten out the ears, tail, and legs.

Drying the pelt.—Drying is also an important process in the preparation of the pelt. Pelts should not be allowed to freeze nor should they be hung in a heated room. They should never hang where exposed to the sun. Pick a dry, dark space, keep flies away, and, if possible, provide for a circulation of air.

A small number of skins can be hung from nails in rafters or ceiling. If a large number of skins are to be dried a frame can be made of 2 by 4's or small, split logs. This frame slanted against a wall and studded with nails will hold a large number of skins. It is advisable to inspect the legs of pelts occasionally and make sure that they are drying properly. If tails and legs are not hanging straight they should be pinned down. Pelts of foxes and other animals that are to be shipped "fur out" should be dried leather side out in a comparatively warm place for 24 hours then the pelt should be turned fur side out.

After drying, pelts should be removed from the boards and be given a final cleaning. Wipe the grease off pelts leather side out and if fur side out proceed as follows: Lay the pelt out on a clean table or bench and rub the fur full of clean hardwood sawdust. Be sure and rub sawdust in gently otherwise the guard hairs will be damaged.

Rub the fur until the grease is cleaned out. Shake the pelt out well and hang in a well-ventilated place. Skins should never be washed, nor should alum, salt or other preparations be used.

Packing and shipping.—Many dollars are lost to trappers annually because of improper packing. Green furs or furs that have not been stretched and dried should never be shipped. Skins should be properly packed in cloth or burlap and they should be laid leather side against leather side or fur side against fur side. Fine furs should be wrapped individually in absorbent paper or cloth before being packed into the bundle. Do not wrap in newspaper or any printed paper. The ink is apt to color pelts.

Pack the skins flat and sew bundles tight. Make the package big enough so the skins can be laid out, otherwise they will come out of the bundle all rolled up and creased and their full beauty will be lost. Your pelts will look much more valuable to the fur grader if they come out of the bundle flat and free from creases or rolling.

If you are selling your furs to the local buyer, take them to him or show them to him unpacked, as it is almost impossible to pack furs in a bundle and have them come out after shipping in as good an appearance as they were before being packed. In shipping furs, be sure to have your name and address both on the inside and outside of the package.

PROCESSING HUDSON SEAL

DAVID L. LEVIN
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Many women know that Hudson seal is seal dyed muskrat, but few are aware of the manifold and painstaking processes employed in bringing this transformation about. The reader may be interested to know that it requires over 70 operations and I shall attempt to explain in a general way the steps necessary to convert the muskrat into the Hudson seal as it appears on the market today.

The muskrat is an American fur-bearing animal, found in marshy localities in various sections in the United States and Canada. Its soft, deep, dense peltage is much like that of the true or Alaska seal.

The natural color of the muskrat is dark ombre brown. Millions of them are trapped annually to supply the demand for the ever-increasing number of fur garments made from Hudson seal.

In order to get some idea of how processing converts muskrat into Hudson seal, let us take an imaginary trip through the plant of A. Hollander & Son in Newark, New Jersey. It is by their secret processes that cannot be discussed in this paper and the skillful efforts of their craftsmen that the muskrat is converted into the fine dependable Hudson seal that we so greatly admire.

We first enter a large room where the muskrat pelts are received in their raw state. To each lot an individual identification number is assigned and perforated in the skins for the purpose of distinguishing one shipper's merchandise from another's. The skins are then ready for dressing. Dressing is a term used in the fur industry to indicate the treatment preparatory to the dyeing process. A great part of the value of the finished product depends on the manner and craftsmanship in which the skin is dressed. Great care must be exercised and constant supervision must be given to this operation in order to produce the pliable chamoise-like leather that is desired. The skin is first immersed into a solution of salt water to open the pores of the leather, thereby making it more permeable to the grease applied to the skin for the leather softening.

The skins are then put into a mechanical kicking machine which kicks the grease into the pelt and begins to give the pliability a skin must have in order to bring about the soft drapable effect one looks for in the finished garment.

Following this operation the skins are thrown into a huge revolving drum containing a special sawdust which absorbs the surplus grease and thoroughly cleans the skin, which completes the dressing operation. The skin is now ready for preparatory treatment before dyeing.

The skins are then given to skilled workers who mend all rips and tears—a precautionary operation which eliminates all possibilities of later tearing. The skins are then examined for quality and those lacking the fullness of fur necessary for Hudson seal are rejected and in most instances are used as natural muskrat for garments and other purposes.

The next step is the plucking of guard hairs. This operation removes from the pelt the stiff hairs and leaves the underbed of soft, silky underfur.

Then comes shearing—another mechanical operation which cuts down the hair on the backs of the muskrat to bring the fur to an even level. The skins are now ready for the initial application of dye, and are put into huge vats and immersed in a chemical solution known technically as ground dye. This dye is lighter in hue than those used subsequently, the purpose being to make possible the variance of shade as the numerous black top dyes are applied, for the desired depth of lustrous black.

The surplus dye is then extracted in a high speed of a centrifugal machine. After this treatment the skins are dry enough to be transferred to a heated room and kept at an even temperature until they are thoroughly dry. They are then put into a drum, containing a fine sawdust which absorbs all foreign matter that may have accumulated in the fur. From this point on the drumming operation is repeated after each process, thereby removing any grit or foreign matter that may have remained in the skin.

After this procedure, a series of black dye coatings are applied by hand and machine, and the applications continued until the desired depth of lustrous black is attained. They are then taken to what is known as the fleshing department, where highly skilled mechanics remove a thin layer of leather and all surplus flesh, thereby bringing the leather side of the skin to a flesh tone commonly designated in the trade as white leather.

Once again the skins are drummed and dried. The skins then go through what is known as an unhairing process—a mechanical operation that removes all the stiff, wild hair which has not absorbed the dye. The operation is repeated to make sure that all uneven hair which did not come out in the first treatment is removed.

After a full hand stretching job, the skins are sent to the shipping room for final inspection prior to packing for shipment. The inspection completed, the skins are laid back to back, placed in corrugated boxes and shipped to the respective furriers for whom the processing was done. This in brief is the processing procedure that A. Hollander & Son uses in converting brown muskrat fur to lustrous, long-wearing Hudson seal.

RESEARCH AN IMPORTANT FACTOR IN FUR SEAL MANAGEMENT

ROBERT K. ENDERS
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No more clear-cut problem of wildlife management can be imagined than that offered by the Pribilof fur seal. While clear-cut, its ramifications are far-reaching. If unrestricted pelagic sealing had been continued it would have resulted in the extermination of a unique mammal. It would have affected the livelihood of native Aleuts in an intimate, stark manner, and destroyed a valuable trade and a source of revenue to our national government. By outlawing pelagic sealing and managing the animals on their breeding grounds these losses have been prevented, but in so doing new problems have been created, some of them international in character. Most management problems deal with comparable situations but not in such a direct and simple manner. With the seal herd, however, the factors are under direct control by those responsible for its administration and management.

From the earliest attempts to save the fur seal, federal authorities have been aware of the need for adequate biological information. It was on the basis of biological data that the extreme wastefulness of pelagic sealing was demonstrated. This paved the way for treaties with Russia and Japan in accordance with which the resource has been administered to the mutual advantage of all concerned.

Among the biologists who have studied the herd at first hand include men of great intellectual stature from several generations of field naturalists. Henry W. Elliott was the first naturalist to study the fur seals after the acquisition of Alaska; his work extended from 1872 to 1890. Two years later a group which included C. Hart Merriam visited the seal islands. Since that time David Starr Jordan, Leonhard Stejneger, Frederich Lucas, Chas. Townsend, D'Arcy Thompson and other outstanding scientists have devoted attention to the problems of the maintenance of the seals. A famous group of scientists who studied the fur seals before the organization of the Fish and Wildlife Service included W. H. Osgood, Edward Preble, and George H. Parker. Their report was published in 1915. Since then other scientists have continued the work.

The widening field of knowledge concerning wildlife has led to a certain degree of specialization. The problem of fur seal management is no exception. Experts trained in several branches must cooperate if the maximum information is to be obtained for properly managing the herd.

It has been our privilege to participate in this cooperative venture, and we have received for study from the Fish and Wildlife Service over a period of several years the reproductive tracts taken from about 500 fur seals. These tracts were collected between June 25 and November 7 and no information is available on the condition during other months of the year. Some of these tracts were from animals that had been branded as pups, thus the age was definitely known.

As far as management goes our studies have supported, and in some cases verified for the first time, some of the assumptions upon which protective measures have been based. In arguing against pelagic sealing the statement was frequently made that each female slaughtered represented a double loss, for all adult pelagic females were either pregnant or nursing. Breeding in the fur seal follows parturition, which takes places shortly after the females "haul out" on the breeding grounds. The assumption that females become pregnant following copulation in the rookery was correct, in spite of the fact that they are not visibly pregnant until months later, for we have recovered resting blastocysts from the uteri of females killed after copulation. So, if pelagic sealing were permitted during the nursing period, each adult female killed would represent a potential loss of three, the lactating mother, the nursing pup, and the fertilized egg within the female.

Through the marking of thousands of pups it is now becoming possible to determine beyond doubt at what age the male and female reach sexual maturity. If marking is continued on a large scale it will be possible to determine mortality rates as to age and sex as well as to determine the length of reproductive activity.

From our present material we can conclude that females usually breed for the first time shortly after their second birthday and bear their pup the following summer. Males do not mature so rapidly, for the specimen from the youngest branded male in our collections showed that spermogenesis was from a 4-year old. All material examined indicates that but one pup is born at a time, that ova are matured in alternate years in each ovary, that the blastocyst does not migrate out of the horn into which it passes from the oviduct, and that transuterine migration is anatomically difficult or impossible. Thus the horns of the uterus as well as the ovaries are active only in alternate years. The mechanisms involved in alternate activity in the uterine horns is clearer than the factors controlling ovulation from alternate ovaries.

Possibly the next problem that should be attacked to aid in management is the physiology of the harem bull. This involves a study of reproductive physiology as well as a study of behavior, of population, and sex ratios. Enough has been done to support the soundness of the present management practices but some principles might be understood better with further research.

This brief report on the role of research on one aspect of the life history of the fur seal indicates the practical as well as the scientific value of continuing research to guide the management of this valuable resource.

ECONOMICS OF THE FUR TRADE[1]

ALEXANDER T. MACLEOD
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When I agreed to prepare a paper on the economics of the fur trade, with particular stress on costs of production, processing, manufacture, and distribution, I did not realize what I was undertaking. We, in the fur industry, are faced with greater difficulties than those in other industries. We can have no control over the supply or demand. We do not know the supply from year to year, and on many fur items, we have no idea as to what the demand for them will be at the time when we have to lay in our supply of raw skins.

Our product is not produced by humans and fur-bearing animals know nothing about the law of supply and demand. We have no control over the annual crop of foreign furs, although we do have, in normal times, statistics as to the annual imports of such furs. We have no accurate figures as to the annual catch of furs in the United States because many states do not require the licensing of trappers and the filing of reports as to their annual catch.

So much for the supply problem. You just have to guess; and, unfortunately, the raw fur buying season always opens up with reports of "a short catch this year." If we had reliable statistics, we could have a true picture and help to offset speculative buying based on false

[1]Based upon normal conditions, this article does not take into consideration the present abnormal situation due to war years, and the influence of O.P.A. ceilings on the industry.

rumors. Speculative buying is one of the factors that forces prices higher than conditions warrant.

On the demand side, fashion plays a great part and, from year to year, different furs get the call and bring higher prices until they reach such levels that the consumer rebels and then the furs go begging. Not having the supply under control, and in many cases not knowing what the demand will be on most items when the dealing trade has to do their buying, we must always estimate general economic conditions of the country before we can estimate the public's demand for furs. In fact, that is about the only basis that we can work on. Being a seasonable business, handicapped by lack of supply data and the fashion influence on the consumer's demand, it would appear that we are faced with an insurmountable problem. Added to this, are the difficult problems that confront you when you make a study of the costs of production, processing, manufacturing, and distribution in the industry. With the exception of ranched furs, it is impossible to estimate the "cost of production" of our raw product, i.e., the raw skin. Our production supply is dependent upon the number of animals trapped, and a number of factors such as man-power shortage, droughts, severe winters, etc., which influence the total catch.

The next stage is the dressing or dressing and dyeing of a skin, which we will call the processing stage. The cost of this processing is more or less stable as far as a particular skin is concerned. The biggest item, of course, is labor, and the dresser prepares a schedule of charges for the different types of skins which he dresses. Even here, there is no fixed ratio of the dressing charges to the cost per skin because the same charge will be applied to the same type of skin whether its value is $10.00 or $20.00. In the case of the dyer, while labor is also a large item, there is also an extra charge for the dye process which changes the nature of the skin.

In the case of a manufacturer, it is almost impossible to set up an accurate cost system that will show him the cost of each coat manufactured because no two lots of skins that he buys will produce an equal number of coats. This is due to the difference in quality and sizes of the skins, and the ability of his cutters to produce the maximum number of coats out of a given number of skins.

When it comes to regulating all steps in the industry, you cannot set down specific rules or ratios as to costs that would govern any branch of the industry, except possibly the retailer, provided he buys his coats ready-made. Also, it is very difficult to lay down specific rules as to what the markup should be for any one branch of the industry. At the manufacturing level, the markup would depend greatly upon whether it is a less expensive fur with a considerable turnover or an expensive fur with a much less rate of turnover.

The more you delve into the matter, the more you come to the conclusion that each type of fur has its own particular problems all along the line, from production to ultimate sale.

In spite of the many difficult problems with which we are faced, the reason the fur trade does not operate more profitably during normal times is the fault of the industry itself. Each branch and each individual is interested in his own immediate profits and the other fellow's losses if he also happens to be losing money. The over-all picture means nothing to him. He will create a "Frankenstein," if in so doing, he is making immediate profits. The fact that he is laying the groundwork to ruin his future business does not occur to him. He lives in the present, never refers to the past, or looks to the future. Today, instead of the trade leaving the purchasing of furs from primary sources (by primary sources I refer to trappers, collection houses, brokers and auction houses) to the dealers, who could lay in the trade's supply at reasonable prices, everyone, including manufacturers and retailers, even those with limited capitals, compete in the primary markets and force prices out of line at the first level of purchase. Financing by the factors in our market has made the small man a competitor of the medium and large size firm. Some factors encourage firms, irrespective of their size or type of business (dealers, manufacturers, and even retailers), to buy at primary sources by financing such purchases for them. This in itself may not sound bad, but it is harmful to the entire trade, and particularly to the small man. The small man cannot buy all his requirements at the primary sources, but he forces prices up on the purchase of the trade's requirements. Consequently, he has to pay considerably more for the greater part of his year's requirements, when he makes purchases later in the year. Had he stayed out of the primary markets, he could have purchased his year's requirements, on the average, at a much lower cost to him.

Let the dealers, within their means, do all the buying at the primary sources. Let the smaller dealers buy from these houses and have the furs processed and graded and sold to the manufacturers, manufacturing retailers or custom furriers. The manufacturers would make up the coats and sell them to jobbers or department stores and retailers, who sell to the ultimate consumer.

In this way, the original dealers would own the raw furs at reasonable prices. The intermediate dealer would process the furs and the manufacturer could buy them for immediate use. In this way, the manufacturer does not have to gamble on how the skins will come out of the dye or overbuy because it takes so long to get the goods back from the dressers and dyers. He knows the cost of his skins immediately when he makes his purchase. This orderly marketing of the furs will prevent prices from getting out of line.

Fashion plays the most important part in the sale of furs. Furs out of fashion can be brought back into demand if the price is sufficiently low to encourage retail buying. Unfortunately, as soon as a fur is offered to the consumer at a reasonable price and a demand is created, the trade immediately permits the price to rise to such a point that in relation to other supposedly more expensive furs, the public rebels.

I do not have sufficient time to go into this subject in more detail, but from the brief outline above, you can readily see that you cannot stabilize supply and demand so as to insure a profit for each operation.

However, you can go a long way in stabilizing general conditions in the industry and, being a credit man, I have to work credit into the picture.

Credit, in our market, is very cheap. When firms who are not entitled to credit receive it, they operate to the detriment of the entire market. They create unfair competition and take profits out of the industry. Sooner or later, they have to fail, and in the meantime, they sacrifice merchandise to meet maturing obligations. This depresses the market and makes it difficult for the trade as a whole to sell profitably.

The American Fur Merchants' Association, Inc. has a credit system in operation under which all members report sales, which are recorded on the sales cards of the members' debtors. If every dealer were a member of the Association and reported sales, we could control the credit situation at its source (purchases in the primary markets are not made on credit). By controlling the credit structure, you indirectly control prices, and the trade can establish a sound merchandising policy. After having spent over 10 years in the trade, I am fully convinced that this ideal condition is impossible of attainment because of the individualistic attitude of the trade. This method of control could be made effective if the trade had foresight and wanted to improve general conditions. I don't say that it would be a cure-all, but it is the only hope of attempting to overcome our many difficult problems.

COMMENTS ON THE PAPERS ON THE FUR INDUSTRY PROGRAM

SAMUEL A. GRAHAM

Unfortunately cancellation of the Tenth North American Wildlife Conference has made verbal discussion of the papers impossible. Therefore it seems appropriate to comment in writing on the program and the significance of the various papers concerned with furs.

Most of us, when we think of furs, are inclined to consider chiefly that branch of the fur business with which each of us is chiefly concerned. The conservation officer or the manager of wild lands thinks chiefly of protection or production of a trapable population of animals, and his interest usually becomes lukewarm when the animals are converted into mere articles of commerce.

The trapper is a rugged individualist who must "make hay while the sun shines," and concentrates on converting the greatest possible number of living animals in the shortest possible time into salable pelts. In so doing he seldom considers either market conditions on the one hand or the proper treatment of breeding stock on the other.

Likewise, the fur buyer and the jobber operate in such a restricted sphere that they fail to appreciate the effects of their trading methods on the whole industry, upon which they depend for their livelihood. And so on up the line, through the processor, the manufacturer of the finished product, and the consumer, each group is woefully deficient in knowledge of and sympathy for the others. Each fails to appreciate how dependent he and his business are upon each of the other links of the chain that is the fur industry.

Each stage from the field to the retailer is essential, and any policy or practice that hurts one group is felt from end to end of the chain. Unwise competitive buying may, as Mr. Macleod points out, force prices up to artificially high levels. This is inevitably followed by a corresponding drop that is sure to leave someone holding the bag of bankruptcy. But it is not only the trader who is affected. Excessively high prices often stimulate overtrapping, with the result that normal breeding populations are reduced to a point where insufficient animals are left to produce future crops. This sort of an economic setup has been an important contributing cause leading to the local extirpation of some splendid fur-bearing animals: the martin, the fisher, the otter, and formerly the beaver.

Low prices on the other hand, by making trapping unprofitable, may result in undertrapping and a waste of valuable products. Overprotection or undertrapping may lead to conditions where excessive numbers of animals actually eat themselves "out of house and home," and damage their habitat to a point where its productiveness is at least temporarily destroyed. Mr. Lay's reference to "eatouts" is an illustration of this, but even more striking cases might be cited where beaver populations, under excessive protection, have consumed all available winter food, and thus eliminated themselves from areas where moderate numbers might have been maintained indefinitely.

Mr. Macleod speaks of the inadequacy of advance information on the available supply of trapable animals each year. This is an unfortunate situation that forces buyers to set prices blindly, and often leads to cutthroat competition in an uncertain market. But this situation is unnecessary. It would be far easier to arrive at an acceptable estimate of the potential muskrat or beaver crop than it is for the Department of Agriculture to forecast wheat or corn production for any year. The only trouble is that no one has gone to the trouble of doing it. The papers of both Mr. Lay and Mr. Yeager indicate some of the basic information, either now available or easily obtained, that would serve as a basis for intelligent advance estimates of the probable crop of furs.

Mr. VanCleve has shown how the trapper, by proper methods of skinning and handling the raw pelts, can get the most from the animals that he takes, and add much to his own income and to the value of the fur crop. Greater care on the part of the trapper would simplify some of the problems of the buyers, jobbers, and processors by offering them a more uniform product of generally higher quality.

The processing of furs has become such a specialized art, as indicated by Mr. Levin's description of the conversion of muskrat to Hudson seal, that it has almost become a separate industry. But nevertheless the success of the processor is closely tied in with both the production and utilization aspects of the whole fur industry. Perhaps he can do less to improve conditions than other links in the chain, but even he could operate more efficiently if he could know in advance approximately what demands would be made for his services.

This series of papers, on the one hand, brings before us the fact that the fur industry is composed of units with greatly diversified interests and viewpoints, each unit operating very much alone. On the other hand, the advantages of closer cooperation and coordination of the entire industry become evident. But before coordination and cooperation can be attained there must be developed a broader interest than now exists on the part of individuals engaged in the various branches of the industry. They must be willing to pass up some immediate profits to avoid killing or at least crippling the "goose that lays the golden egg." Each link in the chain must come to realize that it is only a link, and not an independent industry, and that its security depends directly upon the security of the other branches.

The picture is clear, but the cure for an admittedly undesirable situation is decidedly obscure. Many feel pessimistic about conditions and have little hope of improvement. No one can say what the future holds, but certainly no improvement can be expected without effort.

Mr. Macleod has suggested a specific action that would be helpful to the financial structure. Means must be found to present such suggestions as his, and other constructive ideas, to the industry for consideration. Once accepted by the majority as being sound, means can be found to bring the recalcitrant minority into line, but without general acceptance, no proposal can "get to first base."

The need for reliable, unbiased information is apparent when we consider the various problems of the fur industry. Dr. Enders, in his discussion of the fur seal management, presents some facts on the reproduction of this king of all fur bearers that substantiate less conclusive observations of previous workers in support of management practices now in force. He has too modestly refrained from emphasizing the importance of his researches as a contribution to better management of the herd. But when we realize that much of the success attained thus far in increasing the production of fur seals is due directly to eliminating surplus bulls from the harems we realize how important is a thorough knowledge of the reproductive habits of the seals. Dr. Enders has demonstrated, what earlier workers suspected, that the development of the ova in the uterus of the cow seal is retarded, and that fertilization of the ova that will produce the next year's pups actually occurs while the current year's pups are very young.

Thus the management of the herd bulls becomes especially important, and a thorough understanding of the physiology of the male reproductive tract promises to disclose how management practices may be further improved. Dr. Enders only hints at this aspect of his work and we look forward expectantly for further information. This work is an excellent illustration of how fundamental research may be turned to practical use.

Thus we must conclude that the fur industry would benefit if each part were better acquainted with the other links in the chain.

Therefore, it is important that provision be made for improved opportunity for exchange of ideas within the industry as a whole through meetings, conferences, and the trade journals. The cancelled North American Wildlife Conference might have been a beginning of such contacts.

Through discussions a sympathetic understanding of the complex interrelationships within the industry may be gained by those participating.

Undesirable practices and policies cannot flourish in the light and many will disappear as a result of open discussion, others may require group action.

When men confer with their feet under the same table they inevitably are drawn closer together in their thinking. If they do their thinking in separate cubicles they drift apart. Therefore let us find a way to bring the fur industry together to consider common problems with confidence that such contacts would lead eventually to greater stability and correspondingly greater profits in an industry that is now most individualistic and unstable.

Chairman: N. W. Hosley
University of Connecticut, Storrs, Connecticut

FOREST LANDS AND WILDLIFE

This session arranged by the Wildlife Society

INTRODUCTORY REMARKS

N. W. Hosley

Since time immemorial game animals of certain kinds have been thought of as living in woods. However, it is only in quite recent times that we have come to realize that some kinds of woods or combinations of kinds are best for particular animals. Leopold in his *Game Management* described the interspersion of types, the edge effect, cruising radius and many other useful concepts. We had reached the point at which we began to decide what *kind* of a situation favored a given animal.

Now we are starting to think somewhat in quantitative terms. We are beginning to determine *how much* game it is possible to produce in a given area of a forest. This is, in part, due to characteristics of the species and, in part, to the available food and cover. Granted that we may know the maximum population density which can be maintained by a species, we must provide the amount and kinds of food which will support this population. We must also provide the types of cover in the amounts needed. At present we can only guess what constitutes ideal ruffed grouse range in these respects. Do we need 2 yellow birch trees to 10 acres or 10? Is a quarter acre patch of conifers enough for 10 acres or how many are needed? We have made progress in evaluating some foods in the nutrition of wild animal species but the greatest part of the job still remains to be done. Then, in many cases we know that a plant is very valuable, but how can we get it to grow? A forest is a complex environment compared with a field and, with the exception of the trees, little is known about the plants. And even with the trees we know little about the wildlife producing abilities of the different ages and densities of stocking in just the more simply managed, pure stands. Based on the study of young, dense stands of planted trees, we have built up the conception that coniferous stands are a "desert" as far as wildlife is concerned. This totally neglects the fact that, with increasing age, coniferous stands may be some of our best food producers and furnish cover also. Thinnings and cuttings can speed up and intensify this trend.

One has only to try finding any ecological information on almost any herbaceous forest plant to realize how complete the lack of information on producing it really is. The botanists have ordinarily been interested only in describing the plant and telling where it is likely to be found. Usually the description does not include time or quantity of fruiting and anything on the reproduction or requirements for growth are very rare.

We know openings are necessary for most forest game but how many do we need per unit area and what should be their size and shape? When we make an opening of a given size in a particular stand how well can we predict what plants will appear and how long can we expect them to remain?

Edges between types are favorable areas for game but is this because the two types are easily accessible or because the edges have characteristics not found in either type?

Forest game must be produced mainly as one of the multiple-use products of our woodlands. The favorableness of the environments for game must depend on the correlations of silviculture and wildlife management. We now know in many cases what environmental conditions we want, but, in order to produce maximum game crops and avoid unnecessary expense in doing it, we must know how much of particular types we need and how the needed plants can be gotten and maintained in them.

FOREST WILDLIFE AND NATIONAL FOREST LAND MANAGEMENT PRACTICES

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National forest areas of the United States occupy approximately 10 per cent of the country's land area. These vast reservoirs of game and fish habitat are equivalent to more than 20 acres for each of our 8½ million licensed hunters. Because of increased public interest in sport hunting and fishing and the tendency to impose restrictions against use of private lands and water, national forests are assuming increased importance as public hunting and fishing grounds. It is the purpose of this paper to describe some of the practices now being used in the national forests to maintain and improve environmental conditions for game and to suggest land management techniques that may lead to further improvement in the management of wildlife resources on national forest areas.

This paper is based primarily on experience in the Eastern Region of the Forest Service, which extends from Maine to Kentucky. More than one third of the country's population lives within this Region, and approximately 27 per cent of the country's hunting licenses are sold here. Even in this densely-populated area, national forests provide approximately 2 acres of public land for each licensed sportsman of the states represented.

Shantz (1941) has pointed out that "Control of the environment and control of the harvest are the implements of management." The Forest Service is primarily concerned with the environmental phases of wildlife management, although it is obvious that rational harvesting of game surpluses is a prerequisite to the maintenance of satisfactory food and cover for game. Mutual understanding between states and the national forests of the duties and responsibilities of each agency is a necessary prelude to any successful action program in the field of national forest wildlife improvement.

Maintenance of satisfactory habitats for game and fish in national forests must be correlated with other objectives if the Forest Service is to redeem its responsibility to the public as a land management agency. Timber production, water management, grazing, and various forms of recreation share with game and fish in dependence upon properly-maintained forest environment. The requirements of sound wildlife management and maintenance of favorable wildlife habitat are not considered incompatible with these closely-related spheres of land use. The same road which serves for hauling fuel wood, cross ties, and saw timber out of the forest may also contribute to the accessibility of hunting and fishing. The same forest clearing that provides edge effect and introduces desirable variation in wildlife habitat may also serve periodically as a location for the portable sawmill which makes possible selective cutting in adjacent timber stands. The same forest cover that protects a watershed against damage from erosion may also stabilize the runoff for many miles of trout stream. Integrated land management on the national forests is beginning to demonstrate its capacity to pay dividends in the form of better hunting and fishing, though the field has been barely touched at this time. On the other hand, progressive wildlife management programs on the national forests have been the means of winning increased public support for fire protection and other desirable land management objectives.

Food habits studies of some of the Region's game species (deer, grouse, and wild turkey) clearly demonstrate the need for open areas in maintenance of environmental requirements. Forest areas in which the canopy shades out ground plants and shrubs provide little browse for deer. The long list of vines and shrubs that provide food for grouse are, generally speaking, intolerant of shade. Mosby and Handley (1943) comment that "the turkey is a typical forest type of bird, but its general life history shows that openings are extensively used. A large portion of its food is derived from plants growing in or around the edges of openings; its nesting sites are generally located close to cleared areas and many of its other activities are centered around cleared areas." Climatic and other factors in the eastern states are such that open land, left untended, quickly reverts to forest type. It is obvious that one of the prime requirements of forest land management, where game production is important, must be the maintenance of some growing sites favorable to production of game foods.

Commercial timber sales provide a valuable tool for use by forest land managers in maintaining desirable interspersion of vegetative cover, an essential factor in the maintenance of satisfactory carrying capacity for many game species. Frequency and distribution of forest timber cutting operations can be a factor of major importance in maintaining the distribution of timber by age classes in selectively-cut forest areas. The sustained-yield principle, widely applied to national forest timber harvesting in the Eastern Region, is designed to provide a continuous growing stock which ranges from seedlings to mature trees, and from browse to mast, thus imparting stability to wildlife environment. Rangers and their assistants engaged in marking national forest timber for cutting, now reserve den trees for game animals and retain forest cover on the banks of fishing streams. Rotation cutting in small units, as low as 30 to 50 acres, offers a means for maintaining variety in wildlife habitat, thus favorably influencing carrying capacity for game. In densely-populated areas where hunting pressure is great, timber cuts somewhat heavier than normally dictated by silvicultural standards may be warranted in order to maintain wildlife carrying capacity at a high level. There is a growing tendency to favor wildlife needs by retaining trees and shrubs that contribute food and cover for wildlife.

Cultural operations such as thinning and weeding in young hardwood stands were commonly utilized on eastern national forests prior to the war for the purpose of removing competition from crop trees and improving the quality of growing stock. More recently, wartime demands for pulp and chemical wood have made possible commercial harvesting and utilization of much timber of small size and poor quality. Opportunities for continuing this type of forest utilization, with its consequent benefits to game habitat, hinge largely on continued demand for large volumes of low-grade timber. To be economically defensible, wildlife habitat manipulation on national forests should, to a large degree, be accomplished through commercial timber sales, with a high proportion of harvested material going into channels of trade and industry.

The stimulus exerted by selective cutting operations is readily apparent in many eastern hardwood stands in the Appalachian area, where 10 to 20 cords of pulp and chemical wood per acre have been removed by wartime cuttings. By permitting more light to reach the forest floor, reproduction is encouraged. In addition, first-year sprouts of maple (*Acer* spp.), oak (*Quercus* spp.), tuliptree (*Liriodendron tulipfera*) and other species cut on these areas have been browsed with great relish by deer. Woods work is commonly carried on during the winter months in this area, littering the snow-covered forest floor with tree branches and tops. Field examinations made during critical midwinter periods have shown that deer follow woodcutters, consuming during the night palatable browse that was cut the preceding day.

Logging operations create many openings in the forest cover in necessary operations incident to this work. Log-loading platforms, skid roads, turnarounds, and connecting woods roads afford numerous opportunities to create habitat improvements for game, and some of these openings can be retained as permanent clearings if seeded to grass. By retaining such openings as permanent fixtures in the environment, it is possible that future timber operations may utilize the same areas, thus avoiding the creation of new scars with each timber sale.

Much of the land acquired by the Forest Service in the Eastern States includes abandoned farms with cleared fields and pasture areas, old orchards, fields growing up in pines, and old roadways that have grown up naturally in a variety of food-producing shrubs. From the standpoint of maintaining a high level of carrying capacity for game, it is important that steps be taken to perpetuate these desirable adjuncts to wildlife environment. Cost of stabilizing desirable existing features in this type of cover will obviously be much lower than the cost of creating new developments. Experience with a program of wildlife habitat management on forests in the southern Appalachian area of Region 7 has led to the establishment of an objective calling for permanent clearings of one half to 1 acre at intervals of one-quarter to one-half mile on certain high-priority wildlife areas, in order to provide a checkerboard of openings within normal travel range of indigenous game species. These areas are not intended to take the place of integrated forest management which weighs the needs of wildlife, but rather to provide a minimum of desirable wildlife habitat to safeguard against growing periods when forest areas may not adequately provide for game needs. Existing open areas are utilized to the fullest extent possible in arriving at this acreage and distribution of clearings.

Bailey, Clarke and Nelson (1938), in their study of early winter foods of ruffed grouse on the George Washington National Forest in Virginia, observed that "Old orchards within forest areas are a favorite habitat of ruffed grouse."

Thousands of apple trees are found on eastern national forests, and the annual crop of fruit is an item of importance to game animals and birds. Systematic efforts have been made to prune and release these trees to extend their life and productivity.

Improvement of orchards is done during the dormant season, preferably in the very early spring. In the case of large orchards, the best acre is usually selected for pruning, releasing and maintenance. The remaining area may be planted to conifers to improve wildlife shelter, or portions of it may be seeded to grass. Fruit trees growing in isolated sections of the national forests are likely to be damaged by bears climbing in search of fruit, and pruning of these trees should favor strong branches that will survive this use.

The invasion of abandoned fields by pines (principally *Pinus virginiana*) has resulted in the creation of much excellent escape cover for deer and other game. These dense stands of pine are deficient in game food and environmental conditions for game have been improved by planting food-producing shrubs on adjacent open areas.

Many abandoned agricultural clearings have been seeded to orchard grass (*Dactylis glomerata*) thus adding an important element to game habitat in the form of green food. Frequently, old fields in the national forests front on roads that are being currently used for automobile travel, and in this case it has been found advantageous to screen clearings by planting several rows of conifers along the roadside. Open fields adjacent to automobile roads may encourage jack-lighting of deer, creating a difficult protection problem.

Forest road and trail systems can contribute to the value of national forest land for wildlife by providing additional forest edges for the growth of food-producing shrubs and vines. Forest land managers are currently displaying much interest in the development of a network of "utilization roads," low-standard truck trails that will facilitate the removal of forest products, particularly by small operators. Some of these roads may eventually be maintained in permanent sod, thereby providing additional food for game animals and birds.

In addition to utilization roads of the type described above, low-standard footpaths have been constructed between forest clearings on some national forest wildlife areas. These footpaths are used by wildlife protection officers and by workers engaged in the maintenance and development of wildlife habitat. Game animals often use the same travel routes, and it is believed that hunters may be induced to follow these backwoods paths in the national forests. Where important food-producing trees or shrubs are found adjacent to trails, small bays are cleared around them to create "micro-habitats." By encouraging hunters to spread out and hunt all of the forest area, wildlife can be more uniformly harvested and managed. From actual experience on eastern forests it has been observed that the average hunter will not ordinarily go more than a few hundred yards from a well-defined road or trail in search of game.

Logging operations have resulted in the creation of numerous openings in the forest cover for use as sawmill locations. On many of these areas, a high level of fertility exists due to feeding and bedding of teams engaged in skidding operations, and it is frequently found that duff and humus have been mixed with the mineral soil on these sites to form a good natural seed bed. Some of these areas now support excellent stands of grass. In cases where the seed bed is not satisfactory for planting of grasses, food-producing vines and shrubs such as wild grape (*Vitis* spp.), persimmon (*Diospyrus virginiana*), holly (*Ilex verticillata*), wild plum (*Prunus americana*), hawthorns (*Crataegus* spp.), or wild raisin (*Viburnum cassinoides*) are planted. Where the adjacent cover is made up of hardwoods, it has been found desirable to make clump plantings of evergreens for the purpose of improving shelter. Native species are favored in preference to introduced plants and shrubs.

Natural glades, meadows, and parks are found on many forest areas, and these areas usually provide soil of high fertility. Often these areas support a luxuriant stand of nutritious grasses. Openings of this type should be preserved as permanent features in the wildlife environment, and it may be advisable to remove trees that are shading such areas unless they are important as food-producing species.

It is recognized that land management for the benefit of wildlife should be combined with normal cultural and utilization practices as far as this is practicable. However, areas of heavy use by hunters and fishermen may justify special treatments for the exclusive purpose of enhancing wildlife habitat. This is particularly true in the densely populated Eastern States. Two projects of this type have been under way for several years on the Jefferson and George Washington National Forests in Virginia, being handled partially as Pittman-Robertson projects under the joint supervision of the State of Virginia, U. S. Fish and Wildlife Service, and the U. S. Forest Service. Among the special treatments used on these areas are the following:

1. Planting of wildlife food-producing shrubs and vines such as hawthorns (*Crataegus* spp.), persimmon (*Diospyrus virginiana*), wild grapes (*Vitis* spp.), etc.
2. Planting of evergreens to form small shelter plantations where shelter is lacking in the environment.
3. Construction and maintenance of clearings to provide additional forest edges and to provide open grassy areas and sprout growth.
4. Development of connecting trails between cleared areas for use as travel routes and for additional forest edge effect.
5. Pruning and releasing trees and shrubs for increased wildlife food production.

Just how far national forest management can go in maintaining artificial features for wildlife habitat is a question as yet unanswered. Meanwhile it is being demonstrated that wildlife populations will respond to planned improvement of environmental conditions on wild forest land.

Experience gained through work on the Virginia national forests indicates that clearings for game should be roughly rectangular in shape and at least one half to 1 acre in area, preferably situated to receive maximum sunlight. Areas containing any considerable amount of standing timber or stumps cannot be properly prepared for grass seed without undue cost, and for this reason development of sod clearings has generally been restricted to abandoned fields, pastures, and garden plots.

Successful development of sod clearings in newly-made forest openings usually necessitates plowing, liming, and seeding to a green manure crop, such as cow peas, for at least one year. A review of past efforts to establish sod on wildlife clearings in the southern Appalachian area indicates that orchard grass (*Dactylis glomerata*) gives the most satisfactory results.

Numerous requests are being received from national forest rangers for special planting stock to be used in wildlife habitat improvement operations. Conifers are in demand for wildlife shelter plantations, and there is a growing demand for wildlife food-producing shrubs such as viburnums, persimmon, hawthorn, and holly. The Regional Forest Nursery is now producing seedlings of wildlife food and shelter species for use in this program. Rangers and wildlife workers have been active in observing food preferences of deer and other game animals and collecting seeds of high-preference plants and shrubs. The Regional Nursery is now experimenting with seeds from a number of these species, with the view of extending their range through wildlife planting programs. Bringing together of state game wardens and Forest Service land unit managers in a cooperative approach to the wildlife problem has done much to stimulate thinking of these workers along lines of environmental requirements for wildlife.

Ultimate success in the coordinated program of wildlife management on national forests hinges largely upon the availability of skilled wildlife workers who have sound basic knowledge of the relationship between wildlife and its environment and a keen appreciation for the problems confronting state game departments and land management agencies. Such men can go far toward solving the problems that have impeded maximum utilization of forest land for wildlife production. Tolerance and mutual understanding between all parties concerned is a required condition for weaving wildlife needs into the over-all pattern of forest land management.

Ultimately it is believed that most of the national forests in the Eastern Region should have a wildlife specialist permanently assigned to the staff of each forest supervisor. A technician can be provided on the average national forest at an annual cost of less than one-half cent per acre. It is believed that benefits accruing to sportsmen from sound integration of game management principles with management of forest land will pay rich dividends on such an investment. Experience of the past 5 years indicates a special need for men with some training in forestry as well as wildlife management, for a large part of the national forest wildlife job must inevitably consist of practicing forestry with a wildlife slant.

SUMMARY

National forest areas of the United States occupy approximately 10 per cent of the country's land area. These lands, administered under a multiple-use policy, provide vast reservoirs of game and fish habitat. Wildlife needs on the eastern forests are now being partially met through manipulation of vegetative cover to provide interspersion. Commercial timber sales are the most effective implement in obtaining interspersion of cover. Preservation of den trees, stream bank cover and wildlife food-producing species is being practiced on a growing scale.

The program of wildlife management initiated on the Virginia national forests, employs special techniques for improvement of game habitat, including development of food and shelter plantations, permanent open areas in the forest cover for increased edge effect and pruning and releasing of wildlife food-producing trees and shrubs. Resident wildlife managers have been made available to carry on this work along with law enforcement and restocking operations through a cooperative program with the Virginia Commission of Game and Inland Fisheries. The program is popular with sportsmen and local people. The Regional Nursery and other Forest Service facilities have been drawn into the program. Wholehearted cooperation has been extended by the State of Virginia in this venture.

Preliminary conclusions indicate a promising field for integrated wildlife management on national forest areas, with intensity of development varied to meet public needs. Skilled leadership of well-trained wildlife managers serving as staff assistants to forest supervisors is believed to be the keystone of successful operations.

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PROPOSED MANAGEMENT OF FORESTED GAME LANDS IN PENNSYLVANIA

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Game land management and forestry have been approached, for the most part, from entirely different viewpoints. Few persons have taken either the time or the trouble to correlate them, resulting in one being stressed to the detriment of the other. However, the Pennsylvania Game Commission has repeatedly demonstrated that both can function successfully on the same tract. This paper will outline briefly accomplishments to date, and state in some detail the proposed management program for forest areas.

The Pennsylvania Game Commission came into existence in 1895. The first refuge was established in 1905, and the program continued to expand rapidly until it soon became internationally famous. Many other states and countries adopted it as the best system of its kind. At the present time it owns nearly 780,000 acres of land, and controls 285,000 additional acres, for the most part in forested areas.

Before each refuge was established the boundary line had to be cut out, wire strung, and the proper signs and posters placed conspicuously. Yearly maintenance of such areas was required, and other activities, such as forest fire control and trapping of predators became important and were subsequently increased.

As the program expanded it soon became apparent that development work would also be necessary. The homes for wildlife had been provided when the land was acquired, but these were of no value without food and cover to attract and hold it.

One of the first developments was planting seedlings for food and cover. This increased so rapidly that it was soon necessary for the Commission to raise its own game food seedlings in order to be certain of the varieties and numbers required.

During the winter of 1933-34 relief help became available to the Commission through the Civilian Works Administration and the Civilian Conservation Corps. Still other programs such as the Works Progress Administration, the National Youth Administration, etc., succeeded them with the result that nearly a decade of such help was provided.

With this assistance the Commission was able to repair and build a system of roads and fire trails needed for proper administration and forest fire protection; make forest cuttings and thinnings to furnish wildlife with adequate food and cover; plant and transplant more seedlings; clear, prepare, and maintain food plots to supplement natural food and cover conditions; and accomplish other miscellaneous items too numerous to mention.

Following the outbreak of the present World War, public relief programs were terminated rapidly. This, plus the loss of many Commission employees to the Armed Forces, and the inability to obtain certain necessary supplies, materials, and equipment, greatly curtailed the management work. However, the Commission realized that proper planning for future development work could be done during the interim. Therefore, on March 8, 1944, for the first time in the history of the Commonwealth, a conference was held in Harrisburg to enlist the best thinking of the state and federal agencies on the Commission's land-management program as related to long-term planning and research. This resulted in many suggestions, some of which were adopted in the Commission's future land-management program, which briefly summarized it as follows:

The Commission's general policy on land management had been developed without following any predetermined course or uniform pattern. Until recent years this general policy consisted primarily of protection against forest fires, maintenance of boundary lines, refuges and hunting grounds, and the control of predators. Lands were purchased but no detailed plans made for their utilization and development. The Commission proceeded on the general theory that lands acquired in forest areas should be operated on much the same basis as state forests, and that as timber crops became available for harvesting, selective cutting programs would automatically bring about needed improvements in wildlife habitats.

As the Commission realized the need for growing maximum annual game crops on State Game Lands, various management techniques were tried on an experimental basis. The entire land program has now reached a stage where new long-term practices must be applied, based on sound planning. Therefore it decided as a future fixed policy to manage the State Game Lands primarily to produce game crops rather than commercial timber products, and to develop a progressive long-term management program.

A. BASIC INFORMATION AND PLANNING

1. *Survey of soils, cover, food, waters, topography and wildlife populations.*

As rapidly as trained help becomes available, it is planned to initiate and complete fundamental surveys and maps for all State Game Lands. In the future, such studies will be made before lands are recommended for purchase, except in the case of interior holdings and tracts needed to straighten boundaries.

2. *Plans for long-term use.*

A long-term plan of development and use will be worked out for each tract. In such plans it will be decided which species of game shall be given primary consideration so that management plans may be devised accordingly.

3. *Research.*

Much larger Federal Aid appropriations are anticipated after the war which will enable the Commission to undertake a comprehensive Land Management-Research Program and continue such studies over a sufficient period to obtain conclusive results. Such research work is a vital part of sound management, and will be maintained even though the entire cost must be paid from the Game Fund. Information is badly needed on plant successions and food producing values of various trees, shrubs, and plants for wildlife; how best to increase those which are most desirable and to improve their annual fruit crops. (Fertilization studies have been initiated to obtain the latter information.)

B. MANAGEMENT.

The first requisite of a management program for each tract of State Game Lands is a plan of development as determined from factual surveys, and dependent upon the particular purposes for which it is to be used. With such a plan the steps necessary for the protection, expansion, and administration can then be executed in their proper order. All the items suggested below will not necessarily apply to every tract, but are recommended as general outlines to be followed as needed.

1. *Development.*

(a) *Fire protection and boundary lines.*—Paint and tag but refrain from brushing out boundary lines unless they are to be used as fire trails. Where growth is too sparse to mark boundaries well, a cut trail with suitable markers at regular intervals is essential.

(b) *Timber management and cuttings.*—Work out a definite schedule for each block of land after subdividing it into units of suitable size, so that the timber may be removed and improvement cuttings made in accordance with a fixed rotation plan. Expand release cuttings to increase production of grapes and other food-producing plants. Also provide forest openings, food plots, etc.

At the present time most timber sales must be advertised before offers are taken. The high bidder is then awarded the contract.

Under this procedure the Commission does not always obtain operators who cut so as to derive the maximum benefit for wildlife. Frequently they cannot be relied upon to continue the job vigorously during the period of the entire contract. Also, many of the workers are interested in nothing but saw timber. For these, and other reasons, it is imperative that the Commission work out a definite method of making wood sales. To begin with, probably not more than 25 per cent of the land owned by the Commission will economically grow trees to saw timber size. This is not a detriment as far as game is concerned, but it does mean that on the remaining 75 per cent of the land the Commission must endeavor to harvest products having a much shorter life cycle than saw timber. In Pennsylvania mine timber, lagging, pulpwood, and chemical wood are especially desirable. Therefore, these are the products which will be utilized.

It will also be necessary to find a method by which the Commission can choose a suitable operator and permit him to work on a certain tract continuously as long as the cuttings he makes and the price he pays are suitable.

If this cannot be done, the Commission will be forced to work out a method whereby it will supervise the cuttings, using per diem help to fell and skid the material to an accessible point. It can then be sold to the highest bidder.

Naturally, a program which will utilize trees with a short life cycle will keep forest lands more suitable for wildlife habitat, a condition which cannot be obtained when saw timber is the main objective. When the latter product is the goal there is a long period during which the trees are in the sapling and pole stages. Consequently all undergrowth is shaded out, with the result that little food and cover remains for any forest game species.

(c) *Erosion control and soil fertility.*—As rapidly as fundamental information becomes available, practical erosion control and soil fertility programs will be developed. Known soil erosion control measures and especially contour farming will be applied in connection with all food plot and share cropping programs.

(d) *Food plots and share cropping.*—Food plots have been extensively developed, and share cropping has been utilized where possible. Farming large areas of agricultural land by Commission employees to grow grain for winter feeding has been discouraged. Untilled fields rapidly revert to brush and forests, and soon lose their value for farm-game species.

Persons interested in planting food plots are encouraged to use grains which have proved successful in their locality. Studies of available grasses may suggest better ways to use some cultivated plots, and will be tried out immediately on a rather extensive scale to supply food and cover, and to prevent such lands from reverting to forests.

The share-cropping program on all tillable lands will be expanded as necessary to maintain proper small game habitats, and soil fertility. Numerous food and grass plots will be developed as justified by detailed surveys.

(e) *Seedlings.*—In the past large annual seedling-planting programs have been conducted, mostly with trees obtained from the state forest nurseries. Most of the latter have been used to improve the game cover, but generally the same species and planting methods were used as those adopted by foresters to provide future timber crops. Food-bearing shrubs and trees, grapevine cuttings, etc., have been planted or transferred in large quantities. Much of this planting has been done without predetermined schedules, and the results in the main have been unsatisfactory.

Extensive plantings will be discontinued, at least for the duration, the only exception being such transfer work as regular employees can handle in conjunction with other duties.

Investigations may indicate that in many areas the desirable food-bearing shrubs and plants will volunteer if proper forest openings are made, either through release cuttings or lumbering operations. Future nursery stock distribution will be based upon actual needs on each tract of land, and in accordance with a predetermined program.

Food-bearing and dense-cover species will be planted rather than the conifers commonly used for commercial timber crops. These are obtainable by transfer or from reliable commercial growers.

(f) *Refuges.*—Due to changed conditions, many of the remaining original game refuges have outlived their usefulness and will be abandoned, materially reduced in size, or shifted to more suitable territory nearby. Maintenance of refuges containing 2,000 or more acres is not justified except where needed to protect bears. In recent years progress has been made in the directions above indicated but the entire refuge program will be restudied and revamped as rapidly as man power becomes available.

Since refuges as a game-management medium in forest country have served their major usefulness in so far as deer are concerned, none will be established in such localities in the future except where they will benefit small game. Cover and food improvement work will be intensified within all refuges.

Auxiliary Refuges on private lands, other than on Farm-Game Projects, will be discontinued as current agreements expire, unless they are actually serving a useful public purpose. Where it is essential to the Commission's program to continue protected areas now classed as Auxiliary Refuges many of them will be changed to State Game Propagation Areas, provided the annual protective production of game for distribution purposes will justify.

(g) *Impounded waters and stream improvement.*—In only a few instances has the Commission undertaken any water impoundments. These were done with relief labor. The Commission has undertaken no stream improvement, but permission was granted various public agencies to do such work with relief labor. Much of it was of questionable value.

Necessary engineering and ecological studies are planned to determine where water impoundments are feasible on State Game Lands to benefit waterfowl and fur bearers. These studies are essential to the development of a future program.

No stream improvement work will be permitted on State Game Lands (other than those we initiate to benefit waterfowl and fur bearers), unless the Fish Commission, under proper cooperative agreements, sponsors and supervises the work.

Water impoundments which studies indicate will definitely benefit wildlife, especially waterfowl and fur bearers, will be made an important phase of the Commission's future program. Many of them may probably be so designed that they will also aid in the flood control and fishery programs.

(h) *Roads and trails.*—To date, roads and fire trails on State Game Lands have been constructed primarily to facilitate administration and forest fire protection.

Roads through forest areas provide openings the edges of which supply food, and they are used extensively as dusting places by grouse and other game and can be maintained more easily to serve these purposes than detached scattered openings throughout the forest.

Basic surveys will indicate the number and location of roads and fire trails needed for the purposes indicated. Roads and trails are also needed for the removal of forest products.

On larger tracts roads into the heart of the area will be opened for the convenience of the hunting public. Trails leading from such main trunk roads will be established for the use of the hunters to make interior portions of the lands accessible. All roads, other than those designated as trunk roads on the larger tracts, will continue to be closed to vehicular traffic.

As part of the future land-management program, an extensive system of foot trails, adequately marked, is needed not only for fire protection but also to make all portions of the land usable and assure a better distribution of hunting pressure.

2. *Maintenance.*

The current maintenance practices will be largely continued except as previously noted.

Remote land-management headquarters have been abandoned and officers better located to superintend their respective groups of lands.

Much upkeep work, especially on roads and trails, has accumulated and awaits availability of labor, supplies, and equipment.

An important phase of maintenance work which has been more or less neglected, namely, the control of predators, was re-established during the past winter.

The economic and recreational values of such a program will be stressed in order to obtain the assistance of the general public.

A complete game lands rehabilitation program is being developed to be executed when man power, supplies, and equipment can be secured.

3. *Annual inventory.*

An annual inventory is made of all property (buildings, equipment, etc.) and statistical records of accomplishments have been maintained. Within the past 2 years a uniform system of recording management work was devised, and permanent improvements and lumbering operations were recorded on maps of the respective State Game Lands.

Since in the future all management work is to be based on preliminary surveys and planning, annual inventories of accomplishments must be made in order that the progress of each management activity may be shown in chronological sequence. This will be invaluable both as a record of work done and an aid to further planning.

With a well-planned program such as this the Commission hopes to keep Pennsylvania the foremost hunting state in the country.

OBSERVATIONS ON THE INCOMPATABILITY OF WOOD AND GAME PRODUCTION

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The Forestry Department of Michigan State College has more than academic interest in wildlife management. The Department maintains two forest nurseries producing stock for private planting in Michigan and has jurisdiction over a number of forest properties in various sections of the state. What species of trees, shrubs, and other plants should be grown for sale to planters desiring to increase the food, shelter, and wildlife producing capacity of their land for specific types of wildlife? What species favorable to specific forms of wildlife should be planted on nonagricultural lands under the Department's administration?

The nursery production schedules have had to be based upon several factors that cannot be measured accurately. The decisions as to the species to be offered depend upon very incomplete data in reference to value for wildlife and other purposes, on their suitability for specific sites in the several parts of the state and on the planting and nursery techniques to produce a given quantity of plants. Then after such technological decisions have been arrived at with much misgiving, there are economic problems to be considered relative to the production costs and probable demand for each species. Finally, there are the questions involving public relations. Regardless of its value, red cedar must not be considered for planting in the fruit belt, nor currants or gooseberries in the pine belt. Rose, crataegus, bittersweet and Japanese barberry are obviously of some value but are they important enough to warrant their inclusion, if it antagonizes the nursery industry which sees in the cheap public distribution of these ornamental species a threat to their business and profits?

While the nursery problems pose many difficult questions, they are not so difficult as those arising in the proper management of our forest properties. Such properties used as a demonstration for private owners to follow usually must be managed quite differently from those managed from the public viewpoint. If the primary or sole purpose of forest management by a private owner is wood production, the preparation of a management plan is comparatively simple. Those species will be favored which produce the largest quantity of wood of the desired quality. The rotation, cutting cycle, and method of cutting will be governed entirely by wood producing objectives. Any wildlife and scenic values produced will be incidental.

It is believed despite the widespread general interest in wildlife that on a large percentage of the forest property in private ownership wood production will continue to be the primary objective of ownership. However, there will probably also be a large percentage of private landowners whose purpose of management will include to varying degrees wood production, and wildlife production, or other recreational activities. Among these will be owners whose only recreational interest is to preserve the scenic beauty adjacent to a summer cottage, and others who desire, in addition, to produce grouse or deer, or both, but still insist that the wood produced pay all the taxes and other expenses. Finally there are those who are primarily interested in the production of the maximum game that the property will produce regardless of wood production or scenic values.

The management of public forest properties in Michigan will probably attempt to achieve a true multiple use management, possibly with emphasis upon the intangible social values derived from hunting, fishing, and other recreational activities. Where erosion is a problem its control will generally be considered a paramount objective to be achieved on private land by public regulation where necessary. It is open to question whether a similar exercise of police or other constitutional powers of government will soon be adopted forcing a private landowner to manage his forest so as to produce wildlife. The present tendency in forest regulation is to insist upon management practices which are aimed primarily to produce wood, not wildlife.

This failure to include wildlife production in the specific provisions for the management of private forests probably is based partly upon the rather common concept that good forest-management practices which will produce wood will also produce game in quantity. This is certainly not always, and perhaps not usually, the case, and is well known to wildlife authorities (Bump, 1932; Hosley, 1935 and 1938; Morton, 1938). The average farm woodland in the central hardwood belt if managed to produce the maximum quantity of wood of value to the farmer will usually produce very little game. If the species present include oak, maple, beech, yellow poplar, or any of the nut species, there will be squirrels; if some of the adjacent fields are used to grow corn, there will be more squirrels.

To produce desirable timber in such a farm woodland, the rotation will usually be close to 100 years and the cutting cycle often will be only 1 to 5 years. As these woodlands average less than 20 acres, the cut in any cutting cycle will consist of a few trees. Using the usually recommended selection system, the number of trees cut at any one point will be very few and, hence, the opening produced will not only be small but it will disappear rapidly. Under such a system, food plants and shelter for ground birds and animals will never be adequate to provide a suitable habitat for such wildlife.

The edge of such a farm woodland also will consist of desirable wood producing trees of the same age class distribution as will be found throughout the woodland and the same harvest cutting methods will be used. The only difference will be that the trees on the very edge will have live branches almost to the ground. These limbs will allow the entrance of a small amount of side light that will permit the growth of more young trees of tolerant species and the growth of tolerant species of shrubs and herbaceous plants. If the woodland is carefully managed this fringe of undergrowth will not be more than 10 to 20 feet wide. Obviously it will furnish some shelter and such food as may be obtained from the succulent bark of young trees and from the shrubs and herbaceous vegetation. However, the amount and character of the food material is such that this fringe alone would be unable to sustain an appreciable amount of wildlife. The greatest value of the fringe will be to furnish shelter to wildlife subsisting largely on material found in the adjacent fields and to supplement a spare diet during the winter months.

The value of the fringe for wildlife production is therefore dependent largely upon the character of the adjacent fields. A well-managed farm woodland bordered by a full-utilized pasture or by clean tillage fields will produce the minimum wildlife. If the woodland is also pastured, which is not good forestry for any use, the wildlife as well as the timber productivity will be negligible. However, if the farmer permits the field border, 10 to 20 feet wide, that is shaded by the overhanging tree branches to remain in weeds and shrubs, a permanent fringe will result furnishing much shelter and food. Such a strip should be cut clean once in 10 to 20 years, removing thereby the invading tree species and older heavy-barked shrubs. Where the farmer is reluctant to give this space to wildlife and is anxious to obtain the maximum farm crop production, he should cut off the overhanging side branches of the trees along the edge of the woodland. This will increase the width of the wildlife fringe habitat in the woodland and reduce the wood producing capacity only slightly while improving wildlife conditions.

Leaving den and potential den trees, 1 for each 3 to 5 acres, as suggested by Allan (1944) cannot be recommended either when the forest management is primarily for wood or for multiple use. This practice would usually decrease the wood production capacity of the woodland at least 2 per cent and may be the source of a large quantity of seed from undesirable parent trees. Artificial dens for fur bearers, as suggested by the same author, attached to trees of value for wood production would serve the purpose without affecting the wood production. Insectivorous birds also can be attracted in the same way by the erection of cheap houses fashioned out of tree trunks removed in thinning operations. Over 300 such houses were placed upon the forest properties administered by this Department. Such artificial structures will require maintenance at least once every 2 to 4 years.

It is believed that if the farm woodlands in the central hardwood region are to add materially to the production of ground birds and mammals, they must be managed quite differently from the present method usually recommended. This Department applied the clear cutting method to over an acre of an all-aged farm woodland. This area thereafter for a period of 10 years consisted of a dense stand of young trees, shrubs, and herbaceous vegetation, supplying both considerable food and cover for wildlife. At the end of that time the tree species began to crowd out shrubs and other ground vegetation. Today the stand is too dense and a cleaning under ordinary circumstances would be desirable. However, as we have had one experience in which most of the trees in a dense stand of 8- to 12-year-old seedling sugar maple were completely, or nearly, girdled by mice and rabbits, the cleaning will be deferred until the bark at the base of the trees is less susceptible to this injury. By deferring this operation timber production will be retarded somewhat but it will supply food for rabbits during critical winters for a longer period and it will permit the selection of final crop trees from among those showing least basal damage. As Pearce (1940) found that after the trees were over 1.5 feet D.B.H. the percentage gnawed was very low, so damage subsequent to a cleaning after the trees have reached that size is not to be expected.

The Department plans to experiment with a farm woodland using a rotation of 90 years and clear cutting 1 acre out of every 9 once in 10 years. Intermediate improvement cuttings, which will be made whenever necessary, should provide the firewood and smaller sizes that usually are required annually on a farm. After the entire woodland has once been cut over and brought to normality for that rotation and cutting system, the total wood production should approach that of a selection forest, but the species distribution may have changed considerably. However, the amount of wildlife, particularly rabbits and small birds, should increase, as over 10 per cent of the area, in addition to the woodland fringe, now supplies food and shelter. This method of management is not recommended on sites subject to erosion.

In the grouse, deer, and beaver habitats of northern Michigan the forest-management problem is naturally different. Beaver activities, for example, must be controlled or their work may result in severe losses. All are familiar with extensive damage to timber where beaver have been permitted to build dams of any height they find to their advantage. Such damage has embarrassed this Department where the dam was located on the property of a neighbor who enjoyed their presence and wasn't interested in the loss of timber or winter yarding area for deer. Aldous (1938) brings out the fact that in the utilization of aspen the beaver is more wasteful of his own food supply as the diameter of the tree increases. Previously the Department was not too concerned when beaver cut aspen and Balm of Gilead stands of 10 inches D.B.H. or over, because the wood had little stumpage value. Present trends, however, indicate that this promiscuous cutting will have to be curtailed in the future unless the private landowner has assurance that he will be able to harvest the beaver crop. We find that with the value of beaver pelts what they are, trappers pay little attention to "no trespass" signs.

The Department has not had a serious deer problem because only a few deer have used our properties for summer range, and in the winter they have gone to deer yards on adjacent property to there retard the production of cedar posts and poles. Pearce (1937) substantiates local observations that, if they become plentiful, deer may influence materially the composition and growth of forests. One area in northern Michigan planted to white pine upon recommendation of this Department has been abandoned as a timber producing demonstration because the constant depredations of deer have stunted the growth of the trees. Grouse, too, have not as yet appeared in our plantations in numbers at the most critical time, i.e., between the period when the leaders are above the snow and still within the reach of the birds. Later visitations in a red pine plantation resulted in the debudding of all the laterals within reach, but this feeding resulted in no ill effect on the subsequent growth of the stand, because the terminal buds were already out of reach. Nevertheless, it is clear that a severe winter with a large concentration of grouse in young plantations of a certain height may result in serious loss.

However, we have sustained serious losses in plantations from snowshoe hare, rabbits, and mice. The snowshoe hare and rabbits have been guilty of clipping off the tops of small trees without any visible sign of eating any part of the top so cut off. In the case of the hare this damage was confined to areas within 50 feet of dense cover. All such damage from rodents can be reduced materially if plantations on brushy sites are plowed before planting. In some cases this costly procedure is absolutely necessary if successful plantations are to be obtained. Some of our severest losses from this cause have resulted on hardwood sites in hardwood plantations, whereas, evergreens planted there have been damaged to a much lesser extent.

Similar losses to the wood producing capacity of natural stands also occur, but because such stands are usually of mixed species and of varying aged trees, the losses at any one time or on any one area are not so severe. Wildlife in its quest for food not only may reduce the timber producing value of a stand but tends to reduce the percentage in the stand of the species upon which it is most dependent for its own perpetuation. Squirrels, for example, have been observed feeding on the bark and flowers of maple, the pistillate buds of spruce, as well as the seed of these species. Small wonder that insufficient reproduction of desired species may at times result despite careful silvicultural practices. We have a 50- and a 30-year-old white pine plantation in which small birds, squirrels, and mice are numerous and in which we have never found a single pine seedling.

When the forest landowner desires to obtain as close to the maximum production of wildlife as possible and still use the residue of the land for wood production, the problem of spatial requirements of each wildlife species is the deciding factor. Bump (1935) recommends that many small openings devoted to food species will produce the maximum of most species of wildlife rather than large continuous openings, or an area completely covered with food without sufficient shelter. Specific data on the size of such openings and the percentage of total area that need be devoted primarily to wildlife production is still a subject for much investigation. For southern Michigan the writer has suggested and planned several reforestation projects so that the total area given primarily to wildlife production is 25 per cent of the total area.

The size, shape, direction, and arrangement of areas designed primarily for wildlife production as interspersed with those for wood production depend naturally on the site. For example, part of the planting plan for the Jenison Memorial Forest was arranged around a one-fourth acre water hole with a broad food patch for grain on one side and a narrow fringe of shrubs on the other side with escape lanes and food and shelter strips running off at right angles. The wood producing species have been limited to blocks of from 1 to 2 acres. To date many minor difficulties have been encountered. Not wishing to reduce the present food and cover and also to keep down costs most of the area was not plowed. As a result we have had considerable loss from animal damage and to certain species from vegetative competition. Whether the selection of species has been the wisest and whether the food patch and width of shelter and food strips will be adequate to accomplish their purpose future observation alone will tell. At least we have avoided the large pure plantings of wood producing species which, as pointed out by Edminster (1935), and by others, became a wildlife Sahara in 20 years.

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ENVIRONMENTAL ANALYSIS OF FOREST EDGES IN RELATION TO WILDLIFE

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Environmental analysis of forest wildlife habitats should be insufficient detail to consider all of the important items and yet be so organized as to permit statistical analysis of the data for comparative purposes. All too frequently the comment on intensive surveys of this type is that they are too detailed, too long, too cumbersome, or too intricate to be of practical value. It is the opinion of the author, however, that complete and detailed investigations are in the long run of much greater value than hastily-executed, superficial surveys.

With this in mind, a study was made of forest edge vegetation on the Huntington Forest at Newcomb, N. Y. The purpose of this paper, then, is twofold: (1) to report on an investigation of type edges as forest wildlife habitats on the Huntington Forest, and (2) to demonstrate that the method of intensive and detailed environmental analysis can bring to light necessary facts and conditions not measurable by less intensive surveys. This report is purposely confined to the vegetation, for the study is but a small part of a much larger research program, covering different features of the environment.

The purpose of the study was to determine the comparative wildlife habitat values of 10 different types of forest edges. The term "forest edge" as here used refers to the edge between two forest types, rather than the edge between forest and cleared land. Much of the wildlife management now being practiced is based upon the concept of edge effect. Most of this management, however, is confined to farm game and comparatively little is being done, at least in the Northeast, in the way of managing forest game habitats. Unbroken forest areas are frequently referred to as "biological deserts," and as a result the potentialities of forest wildlife management are to some extent ignored. It is not sufficiently appreciated that forests are composed of a variety of vegetational types and that these types in turn may differ in the species composition of both major and lesser vegetation; that forested areas, too, have openings and edges, and that with a little manipulation these might possibly be greatly improved in wildlife value.

Although game managers have for a number of years recognized that edges are important to wildlife, there has been a decided lack of critical analysis to determine what the real characteristics of edges are. This study was planned to determine some of these unknown characteristics. Some of the questions it attempts to answer are: How wide is the edge? What is the characteristic composition of the edge as it refers to specific amounts of the constituent species? Is there a special edge flora or is the edge composed merely of the component species of the two adjacent types? Is there a greater abundance of any particular species along this line of juncture? Is the effective transition so wide that the various food and cover species are dispersed over too wide a range, or does the edge concentrate these various species into an area traversable by the local species of wildlife? If the existing juxtaposition and interspersion do create a favorable arrangement of food and cover, are these so composed and arranged as to be of value throughout all seasons of the year?

The data for this study were gathered by means of several series of transects. A modification of the belt transect was used in that a series of plots instead of a continuous strip was employed. In order to sample the three layers of vegetation, i.e., tree canopy, underbrush, and herbs, three different sizes of plots were used. (Figure 1.) The fact that the tree plots were just one hundred times the size of the underbrush plots, and these just four times the size of the herb plots, made it convenient to convert all the data to an equal areal basis. A

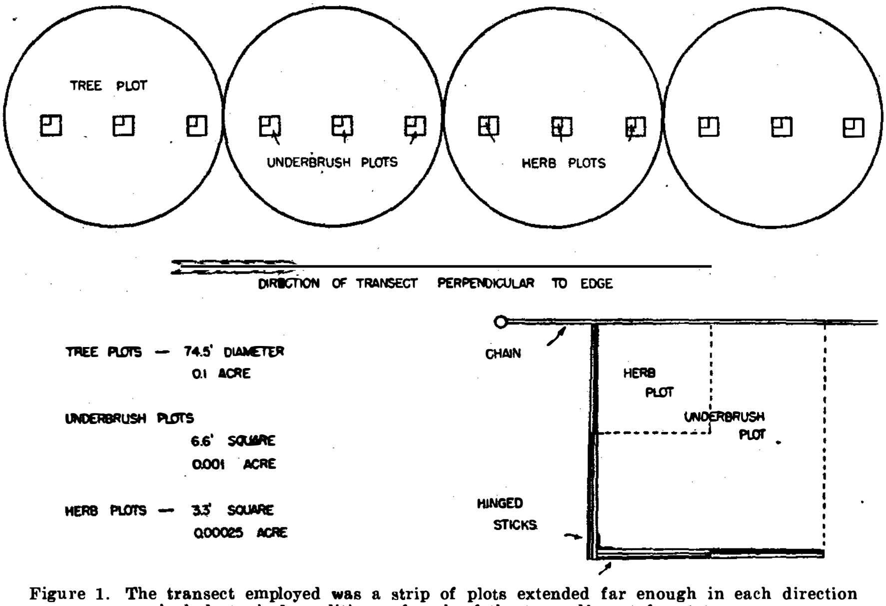

Figure 1. The transect employed was a strip of plots extended far enough in each direction to include typical conditions of each of the two adjacent forest types.

total of 126 transects were established across 10 different kinds of forest edges. These were composed of 659 tree plots, 2,028 underbrush plots, and 2,028 herb plots, making a total of 4,715 plots or 9.5 miles of transect.

On the one-tenth-acre tree plot trees were tallied by species and size. The diameter size classes used were broad enough to facilitate estimating and at the same time were so apportioned as to yield a fairly precise indication of the relative numbers of dominants, subdominants, and suppressed individuals of each species. Trees under 1 inch in diameter were classed with the underbrush and were tallied from the underbrush plot. These young trees were tallied in size classes based on height rather than diameter. The size classes used were: 0 inch to 6 inches high, 6 inches to 2 feet high, 2 feet high to 1 inch diameter. It will be noted that the number of trees in the 2 feet to 1 inch size class serves as an index to the kind and amount of arborescent winter deer browse, while the lesser reproduction could be considered potential browse for other seasons. (Figure 2.)

Since it would have been impractical to record the underbrush by

Figure 2. A sample plot of young trees, underbrush, and herbaceous vegetation. The herb plot is marked off in the near right-hand corner of the larger brush plot. On this plot witch hobble occurred with a density of three.

the tally method, a system based on the abundance and relative density of cover was adopted. An arbitrary range of 4 degrees of density was established, as described by Webb (1942). (Table 1.)

TABLE 1 – CONVERSION OF GRAPHICAL DATA TO STATISTICAL BASIS

DENSITIES		PART OF PLOT COVERED BY EACH DENSITY	RANGE OF AREA COVERED BY EACH DENSITY	AVERAGE AREA COVERED BY EACH DENSITY
UNDERBRUSH SIZE OF PLOT – 6.6' SQUARE OR 43.56 SQ. FT. (0.001 ACRE)				
•	T	0 TO 4 SQ. FT.	0 TO 4 SQ. FT.	2.0 SQ. FT.
••	1	4 SQ. FT. TO 1/3 PLOT	4 TO 14.52 SQ. FT.	9.36 SQ. FT.
•••	2	1/3 PLOT TO 2/3 PLOT	14.52 TO 29.09 SQ. FT.	21.78 SQ. FT.
••••	3	2/3 PLOT TO 3/3 PLOT	29.09 TO 43.56 SQ. FT.	36.30 SQ. FT.
HERBS SIZE OF PLOT – 3.3' SQUARE OR 10.89 SQ. FT. (0.00025) ACRE)				
DENSITIES		PART OF PLOT COVERED BY EACH DENSITY	RANGE OF AREA COVERED BY EACH DENSITY	AVERAGE AREA COVERED BY EACH DENSITY
•	T	0 TO 1 SQ. FT.	0 TO 1 SQ. FT.	0.5 SQ. FT.
••	1	1 SQ. FT. TO 1/3 PLOT	1 TO 3.63 SQ. FT.	2.32 SQ. FT.
•••	2	1/3 PLOT TO 2/3 PLOT	3.63 TO 7.26 SQ. FT.	5.45 SQ. FT.
••••	3	2/3 PLOT TO 3/3 PLOT	7.26 TO 10.89 SQ. FT.	9.08 SQ. FT.

NOTE – THE FIGURES IN THE LAST COLUMN ARE THE "FACTORS" USED IN TABLE 2

Although the mass of data secured by this detailed method of vegetation analysis may appear formidably cumbersome, a brief consideration of its organization will reveal it to be remarkably flexible and useful. It simplifies and sets upon a statistically comparative basis a type of data which has too often in the past been described in only the most general terms.

The data in reference to each transect were transcribed from the field sheets to graphical analysis forms. On the graphical analysis sheets, the tree plot on which the change from one forest type to the other was most apparent, was designated as the "center" of the transition. The data from 15 transects across the edge between spruce flat and northern hardwood are summarized in the examples illustrated in Figures 3 and 4. It will be noted that the pattern of the shaded lines is exactly the same for each species. Each shaded line

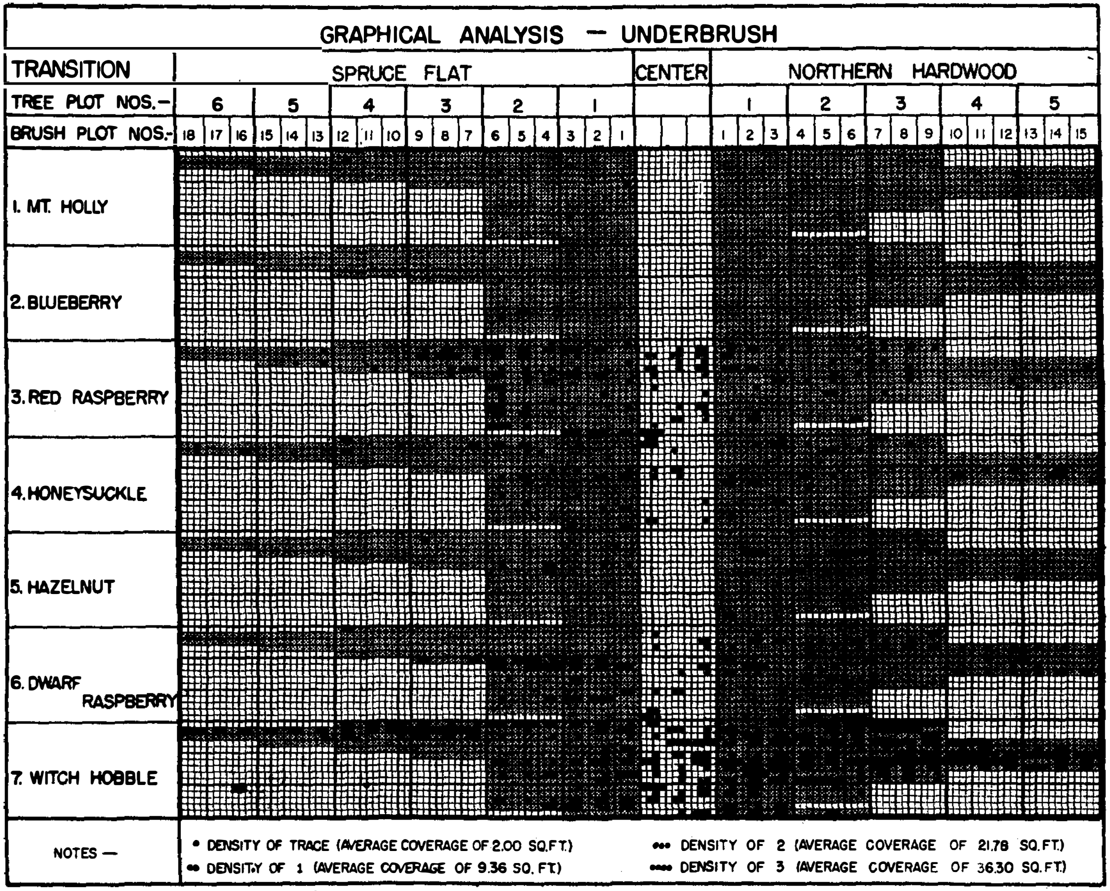

Figure 3. The "summarized" transect showing the distribution and density of some of the underbrush species that are characteristic of the edge between spruce flat and northern hardwood forest types. The data presented in this figure were collected from a series of 15 transects. The shaded zones opposite each species indicate the extent of each of these transects in each direction from the "center" of the edge. The sequence of transects is the same for each species.

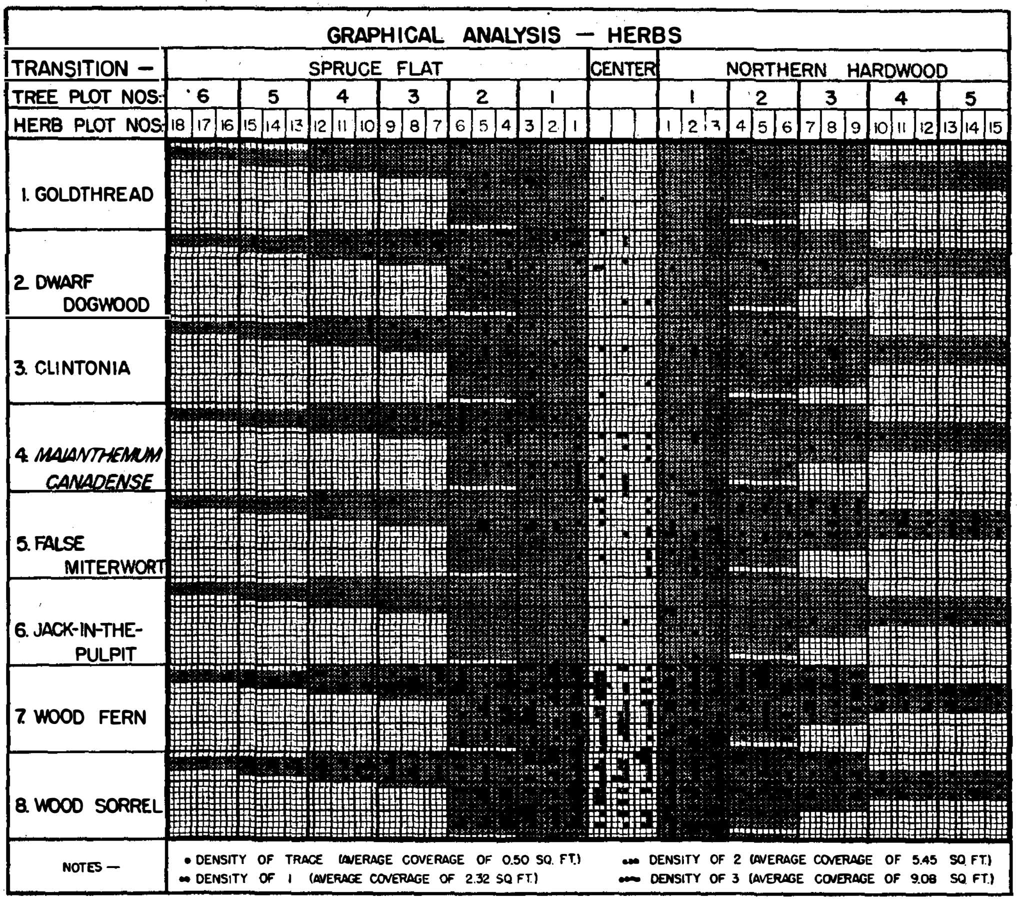

Figure 4. The "summarized" transect showing the distribution and density of herb species that are characteristic of the edge between spruce flat and northern hardwood forest types.

of squares opposite each species represents an individual transect. The first shaded line after each species represents the extent of transect number *H 1;* the second shaded line in each case is transect number *H 2,* etc. Thus, for example, the occurrence of red raspberry over each of the 15 transects is summarized in this graphical analysis. Since the transects are so arranged as to have the centers aligned, it is possible to see at a glance the relative amounts of each species across the edge between the two types. Since the species are plotted according to density of cover, it is also possible to see at a glance whether a species occurs characteristically in small scattered amounts or in large dense patches. Consulting Figure 3, it can be seen that this edge is characterized by a very sparse growth of mountain holly and blueberry on the spruce flat side. Red raspberry was found with greater frequency and density on the spruce flat side but is also abundant on the hardwood side. Honeysuckle is more uniformly scattered over the edge, as are the fewer but larger clumps of hazelnut. Dwarf raspberry has a greater frequency on the hardwood side, but occurs in larger patches on the spruce flat side; while witch hobble, abundant throughout, has its best development on the hardwood side.

By consulting Table 1, it can be seen how the data were transformed from the graphical form to a statistical basis. In the statistical analysis (Table 2), the data were divided into three parts: (1) The data from the plots at the end near type "A"; (2) the data from the plots at the end near type "B"; and (3) the data from the three plots at the center of the transition. In this manner it was possible to compare statistically the average cover value of each species in each of these three parts of the transition. As an example we may take the occurrence of witch hobble across the transition illustrated. In the first line across the top of the statistical analysis sheet are entered the names of the parts of the transition, plus the number of plots in each part. Consulting the figures in reference to witch hobble, we find that in a total of 135 plots on the spruce flat side of the transition, this species occurred 23 times with a density of "trace," 30 times with a density of "one," 7 times with a density of "two," and 6 times with a density of "three." The computed average cover values (see last column of Table 1) of each one of these densities are listed as 2.00, 9.36, 21.78, and 36.30 square feet, respectively. Then, by multiplying the frequency of occurrence of each density by the cover value of that density, and adding the products, we have the total coverage of all the witch hobble found in the 135 plots at the spruce flat side of the edge. This total of 697 square feet of witch hobble in 135 mil-acre plots means that 12 per cent of the ground surface is covered with witch hobble. By adding the cover values for each species and then dividing each by the total, we can also determine the relative percentage composition of the underbrush that each species constitutes. By consulting the frequency of occurrence in the various densities, the average area covered per plot, and the per cent of total cover, we can tell more precisely the nature of the distribution of each species in each part of the transition from one forest type to the other. We can, in brief, by this method of analysis, determine quite accurately the amount of each species of food or cover at any desired locality or type of locality.

Graphical and statistical analyses of this sort were made of each of 10 kinds of forest edges or type transitions. In this manner it was possible to determine their relative habitat values in reference to the underbrush and herbs. On this basis, for example, it was found that the edge or transition between spruce flat and northern hardwood was the widest, averaging 550 feet in width. This type of edge, moreover, provided a maximum variety of lesser vegetation, for here there were 12 species of underbrush and 36 species of herbs. (Table 2 does not list all of the species found.) The total underbrush cover averaged 14,050 square feet per acre and that of the herbs 15,560 square feet per acre. In other words, about 32 per cent of the ground surface was covered with underbrush and 36 per cent was covered with herbs. Several valuable fruit-bearing shrubs were, as a group, more abundant at this edge than at any other part of the forest. Among these were blueberry, elderberry, mountain holly, honeysuckle, and red and dwarf raspberries. There were also several species of fruit-bearing and succulent herbs, and it was found that both summer and winter cover were abundant. By referring to the summarized statistical analysis tables, it is possible to determine not only what species of plants characterize each edge, but also the relative amounts of each species at each portion of that edge. The figures are given as coverage of each density, average cover values, and as per cent of total composition.

Very often the reaction to a study of this sort takes the form of questions as to specific differences between the different types of edges examined. To answer these questions in proper detail would take far more space than is allotted in this publication.[1] Table 3, however, does attempt to compare in a very general manner some of the features of the edges studied.

As a result of this investigation, some of the general characteristics of Adirondack forest edges as represented on the Huntington Forest were found to be: (1) The change in forest type is usually reflected in changes of species composition of the lesser vegetation as well as the

[1]This work will be published in complete detail under the title "Edge Effect of Certain Adirondack Forest Types" as a bulletin of the Roosevelt Wildlife Forest Experiment Station.

TABLE 2 — STATISTICAL ANALYSIS

SPRUCE FLAT — 135†

	DENSITIES & COVERAGES — UNDERBRUSH	% OF TOTAL	NUMBER OF T'S	AREA COVERED (IN SQUARE FT.)	NUMBER OF 1'S	AREA COVERED (IN SQUARE FT.)	NUMBER OF 2'S	AREA COVERED (IN SQUARE FT.)	NUMBER OF 3'S	AREA COVERED (IN SQUARE FT.)	AVERAGE AREA COVERED PER PLOT
	FACTORS —		2.00		9.36		21.78		36.30		
1	MT. HOLLY	03	3	6.00							0.04
2	BLUEBERRY	0.9	3	6.00	1	9.36					0.11
3	RED RASPBERRY	26.3	26	52.00	15	140.40	7	152.46	2	72.60	3.09
4	HONEYSUCKLE	8.2	14	28.00	11	102.96					0.97
5	HAZELNUT	1.7	4	8.00	2	18.72					0.19
6	DWARF RASPBERRY	18.6	3	6.00	10	93.60	4	87.12	3	108.90	2.19
7	WITCH HOBBLE	44.0	23	46.00	3C	280.80	7	152.46	6	217.80	5.16
	HERBS										
	FACTORS —		0.50		2.32		5.45		9.08		
1	GOLDTHREAD	1.6	7	3.50	2	4.64					0.06
2	DWARF DOGWOOD	5.2	26	13.00	3	6.96	1	5.45			0.19
3	*MAIANTHEMUM*	4.3	43	21.50							0.16
4	CLINTONIA	2.7	28	14.00							0.10
5	CUCUMBER ROOT	1.6	15	7.50							0.06
6	SARSAPARILLA	2.2	12	6.00	2	4.64					0.08
7	STARFLOWER	1.6	17	8.50							0.06
8	VIOLET	3.3	13	6.50	4	9.28					0.12
9	FALSE VIOLET	1.6	8	4.00	2	4.64					0.06
10	FALSE MITERWORT	2.2	8	4.00	3	6.96					0.08
11	JACK-IN-THE-PULPIT										
12	WOOD FERN	37.5	47	23.50	35	81.20	5	27.25	6	54.48	1.38
13	WOOD SORREL	36.1	41	20.50	37	85.84	10	54.50	2	18.16	1.33

CENTER — 45†

	DENSITIES & COVERAGES — UNDERBRUSH	% OF TOTAL	NUMBER OF T'S	AREA COVERED (IN SQUARE FT.)	NUMBER OF 1'S	AREA COVERED (IN SQUARE FT.)	NUMBER OF 2'S	AREA COVERED (IN SQUARE FT.)	NUMBER OF 3'S	AREA COVERED (IN SQUARE FT.)	AVERAGE AREA COVERED PER PLOT
	FACTORS —		2.00		9.36		21.78		36.30		
1	MT. HOLLY										
2	BLUEBERRY										
3	RED RASPBERRY	23.8	12	24.00	9	84.24			1	36.30	3.21
4	HONEYSUCKLE	8.3	5	10.00	2	18.72	1	21.78			1.12
5	HAZELNUT										
6	DWARF RASPBERRY	11.7	6	12.00	4	37.44	1	21.78			1.58
7	WITCH HOBBLE	56.2	12	24.00	9	84.24	4	87.12	4	145.20	7.57
	HERBS										
	FACTORS —		0.50		2.32		5.45		9.08		
1	GOLDTHREAD	0.3	1	0.50							0.01
2	DWARF DOGWOOD	4.0	6	3.00	1	2.32					0.12
3	*MAIANTHEMUM*	10.6	10	5.00	4	9.28					0.32
4	CLINTONIA	1.3	4	2.00							0.04
5	CUCUMBER ROOT	2.3	6	3.00							0.07
6	SARSAPARILLA	0.3	1	0.50							0.01
7	STARFLOWER	1.0	3	1.50							0.03
8	VIOLET	4.0	6	3.00	1	2.32					0.12
9	FALSE VIOLET	0.7	2	1.00							0.02
10	FALSE MITERWORT	6.9	14	7.00	1	2.32					0.21
11	JACK-IN-THE-PULPIT	0.7	2	1.00							0.02
12	WOOD FERN	31.8	17	8.50	15	34.80			1	9.08	0.96
13	WOOD SORREL	36.1	11	5.50	14	32.48	2	10.90			1.09

NORTHERN HARDWOOD — 150†

	DENSITIES & COVERAGES — UNDERBRUSH	% OF TOTAL	NUMBER OF T'S	AREA COVERED (IN SQUARE FT.)	NUMBER OF 1'S	AREA COVERED (IN SQUARE FT.)	NUMBER OF 2'S	AREA COVERED (IN SQUARE FT.)	NUMBER OF 3'S	AREA COVERED (IN SQUARE FT.)	AVERAGE AREA COVERED PER PLOT
	FACTORS —		2.00		9.36		21.78		36.30		
1	MT. HOLLY										
2	BLUEBERRY										
3	RED RASPBERRY	6.6	27	54.00	7	65.52			1	36.30	1.04
4	HONEYSUCKLE	5.6	14	28.00	9	84.24	1	21.78	/		0.89
5	HAZELNUT	4.1	3	6.00	2	18.72			2	72.60	0.65
6	DWARF RASPBERRY	8.9	27	54.00	13	121.68			1	36.30	1.41
7	WITCH HOBBLE	74.8	23	46.00	45	421.20	15	326.70	27	980.10	11.83
	HERBS										
	FACTORS —		0.50		2.32		5.45		9.08		
1	GOLDTHREAD	0.3	2	1.00							0.01
2	DWARF DOGWOOD	0.7	2	1.00	1	2.32					0.02
3	*MAIANTHEMUM*	1.0	10	5.00							0.03
4	CLINTONIA	2.0	13	6.50	1	2.32					0.06
5	CUCUMBER ROOT	3.4	27	13.50	1	2.32					0.10
6	SARSAPARILLA	1.3	9	4.50	1	2.32					0.04
7	STARFLOWER	2.0	17	8.50							0.06
8	VIOLET	5.4	33	16.50	1	2.32	1	5.45			0.16
9	FALSE VIOLET	2.4	7	3.50	3	6.96					0.07
10	FALSE MITERWORT	11.1	57	28.50	9	20.88					0.33
11	JACK-IN-THE-PULPIT	2.4	12	6.00	2	4.64					0.07
12	WOOD FERN	41.1	45	22.50	48	111.36	9	49.05			1.22
13	WOOD SORREL	26.9	51	25.50	28	64.96	2	10.90	2	18.16	0.80

NOTES—

1. † TOTAL NUMBER OF SAMPLE PLOTS IN THIS PART OF THE "SUMMARIZED" TRANSITION.
2. "% OF TOTAL"— PER CENT OF TOTAL UNDERBRUSH COMPOSITION AT THIS PART OF THE "SUMMARIZED" TRANSITION.
3. "NUMBER OF T'S, 1'S, 2'S, & 3'S"— NUMBER OF TIMES EACH SPECIES OCCURRED WITH A DENSITY OF TRACE, 1, 2, & 3.
4. "AREA COVERED (IN SQUARE FT.)"— PRODUCT OF "FACTOR" (AT HEAD OF COLUMN) TIMES NUMBER OF OCCURRENCES OF THE CORRESPONDING DENSITY.
5. "AVERAGE AREA COVERED PER PLOT"— SUM OF "AREAS COVERED" DIVIDED BY TOTAL NUMBER OF PLOTS. THIS FIGURE, MULTIPLIED BY 1000, WILL GIVE THE AVERAGE AREA (IN SQUARE FT.) PER ACRE COVERED BY EACH SPECIES OF UNDERBRUSH. IN THE CASE OF HERBS MULTIPLY BY 4000.

TABLE 3. WIDTH OF EDGES,[2] SPECIES COMPOSITION, AND COVERAGE

Name of edge (Transition from one forest type to another)	Average length of transects (feet)	Underbrush		Herbs	
		Number of species	Average coverage (sq. ft.) per acre)	Number of species	Average coverage (sq. ft.) per acre)
1. Bracken fern to aspen	316	9	6,600	29	46,040
2. Bracken fern to 2nd growth hardwood	385	13	9,720	31	38,800
3. 2nd growth hardwood to northern hardwood (mature)	425	6	2,560	25	7,200
4. Spruce flat to mixed hardwood	450	6	12,500	29	14,920
5. Spruce flat to northern hardwood	550	12	13,000	36	15,760
6. Mixed hardwood to northern hardwood	440	6	12,940	30	12,720
7. Spruce flat to spruce swamp	390	10	9,780	32	32,960
8. Spruce flat to forest opening	410	7	19,380	36	26,120
9. Northern hardwood to forest opening	317	5	18,310	33	20,160
10. Spruce flat to open swamp	290	21	12,460	36	32,480

[2]The actual width of the edges are from 50 to 150 feet less than the length of the transects.

relative amounts of individual species. (2) The variety of species across the transition is usually greater than that at any part of the transition. (3) Most of those plant species present on all parts of the transition occur in significantly greater amounts on one of the three parts of the transition. (4) The average width of the transition is narrow enough to be traversed by animal species of low cruising radius. (5) Even with the increased amount of food and cover at the edges between the various types, there is still lacking in most cases a sufficient variety and abundance of overwintering foods for such small game species as the ruffed grouse, which is, of course, the principal upland game bird of this area. (6) The edges between forest types have the greatest potentialities for forest habitat improvement since the variety and abundance of food and cover will assist toward a maximum return from a given amount of effort.

As an additional point of interest, quite apart from the analysis of edge effect, the data in reference to the trees (not included here due to lack of time and space) revealed a game management problem which would otherwise probably have gone unnoticed. It will be recalled that the smaller trees were tallied in three size classes based on height (0 inches to 6 inches, 6 inches to 2 feet, and 2 feet to 1 inch diameter). Upon examination of this information, it was found that certain species of trees, favored as deer browse, although quite abundant in the two smallest size classes, were almost entirely absent in the size class from 2 feet high to 1 inch diameter. It will of course be noted that trees over 2 feet in height are exposed to deer browsing the entire year. The absence of such species as yellow birch, balsam, red maple, cedar, and hemlock, and the relative scarcity of striped and mountain maple in this size class indicates a growing deer pressure. Although the deer population is not large enough to cause noticeable damage to all of the potential browse on the range, it is large enough to damage at least part of the range, and an unchecked further increase would probably cause much more serious damage. The point to be emphasized, therefore, is that even to the eye of the experienced observer, the absence of a certain size class of a few species of trees would probably go unnoticed; for this reason, it is only upon detailed and intensive methods of environmental analysis that efficient management programs can be based. On the basis of specific information gained from detailed investigations, it is possible to build a management plan which will not waste time improving habitats which do not need improving, or worse yet, improving habitats by the addition of features which are already present. By means of critical and detailed analysis it is possible to find more rapidly and more exactly those limiting factors which are most detrimental to the wildlife populations being managed, and thus point the way for more efficient control of forest wildlife habitats.

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SMALL MAMMALS AND THE FOREST

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Small mammals are an important factor in forest ecology. Because they are secretive in habits and mostly nocturnal, few people know that they exist, even fewer know about their characteristics, numbers, and habits and almost no one appreciates the part they play in the life and development of our forests.

These small mammals belong to two Orders, the Rodents and the Insectivores. In the Northeast, our most widespread and common rodents are deer mice, red-backed mice, lemming mice, jumping mice, flying squirrels, and chipmunks. Of Insectivores we have hairy-tailed moles, short-tailed shrews and long-tailed shrews. Everyone is familiar with the chipmunk, which weighs about three ounces. From this size, the mammals grade down to the diminutive long-tailed shrews, which may weigh only one fourth of an ounce and are no bigger than one's little finger.

These little creatures are usually numerous and, on occasion, they fairly swarm in the woods. Populations as high as a hundred per acre often occur and twice that number are sometimes present. The numbers of all the species fluctuate greatly. Each species follows an independent pattern and timing; it is only accidentally that two or more highs or lows coincide. Seasonably, small mammals are most numerous in the autumn when the year's young have been added and fewest in the springtime, after the winter's losses and before replacement begins.

One or several species live or forages in every height zone in the forest, from the unenriched horizon in the soil to the tops of the tallest trees. The moles dig deep tunnels into the mineral soil, the red-backed and lemming mice and the short-tailed shrews make shallow burrows, while the tiny long-tailed shrews thread their way through the litter. At night they may come out of hiding, to run about on the forest floor in search of food. Chipmunks are primarily surface feeders. Deer mice and flying squirrels are accomplished climbers, often nesting or storing food in hollows 30 feet above the ground.

The chipmunk and the jumping mice are hibernators; all the others are active throughout the year. The mice and shrews, living beneath the surface litter and, in winter, under the snow, operate without much regard to season or daylight.

The effect of small mammals on the forest is tremendous. They lead fast and active lives, for they are born, grow up, and die in the span of only a year or two. All are blessed with great appetites. Their reproductive rates are high and, especially among the shrews, the breeding season is long. Life is a hectic search for food.

As a group, the small mammals have an all-embracing appetite; almost anything serves as food for one or another of them. Moles and shrews consume great quantities of insects and other invertebrates. The rodents are insectivorous, too, though to a lesser extent. All stages of insects are preyed upon whenever opportunity offers. In winter, hibernating forms are diligently sought out and consumed. During the snowless season pursuit is extended even to the treetops. The agile little deer mice are adept at climbing and readily eat caterpillars and sawfly larvae. Flying squirrels occasionally drown in maple sap buckets into which they fall while in pursuit of spring cankerworm moths.

All the rodents, and to a lesser extent the shrews, eat plant material —tubers, roots, stems, and seeds. Nuts, acorns, maple keys, and cherries, as well as the seeds of herbs and grasses, are gathered and stored. Most of them are later consumed but perhaps this is the price for the distribution of the remainder. Squirrels, chipmunks, and deer mice are the most effective agents in dispersing big seeds. Were it not for these creatures, the establishment of seedlings of heavy-fruited trees and shrubs would be slow and uncertain.

The tremendous amount of digging and burrowing done by the host of small mammals in search of prey and in making hiding places is an important factor in loosening and mixing forest soil and in providing channels for aeration and the infiltration of water. In forests having a normal mammal population, the labyrinth of permanent burrows and temporary tunnels runs through the soil and litter in all directions. Day by day, old burrows are abandoned, new ones dug, providing an ever-changing pattern of openings in the soil.

To feed the hungry horde of small mammals requires a surprising amount of food. We have estimated that the daily ration for the hundred individuals that might be found on a single acre of good forest soil would be 1¾ pounds. This amounts to more than 600 pounds of material which is ingested, digested, and subsequently returned to the soil each year. Beside this, the normal mortality produces a small additional amount of organic matter in the form of dead animals.

The smaller rodents are mainstays in the diet of many flesh-eaters, both four-footed and winged. Being both numerous and relatively easy to catch, they are important buffers, protecting bigger and more valuable, but harder-to-catch, game birds and animals. Hawks—especially the *Buteos*—capture many a mouse and chipmunk found abroad in daylight. Because most small mammals are active during the hours of darkness, the night-hunting owls are especially effective predators. Such important fur bearers as the weasel, the mink, the skunk and especially the fox depend heavily upon mice for food, particularly in winter.

The abundance and variety of small mammals is dependent upon the condition and composition of the forest and is as characteristic as is the tree, shrub, and herb composition. Dry sites with scanty litter under pioneer tree associations afford the least shelter and the poorest foraging opportunities, hence have the smallest and least varied mammal populations. Despite the heavy accumulation of needle litter, overdense, young softwood stands do not have many mammals. Timely thinnings improve the soil, alter the amount and character of the underbrush, and increase the small mammals. Older softwood stands with a dense ground cover of moss often have big mouse and shrew populations. In mixed forests on good sites, where an abundant fall of hardwood leaves and an adequate blanket of snow insure an unfrozen soil throughout the winter, the number and variety of mammals is greatest. Forest site quality and mammal populations run parallel—changes in the former are promptly reflected by the latter.

The small mammals are numerous, active, and important elements in the biology of the forest. Certain of their acts—notably the eating of tree and shrub seeds—are often considered detrimental to the forest but plants produce seed so lavishly that even a heavy loss may not be critical. In the process of digging burrows and searching for food, they stir up, mix and loosen the soil. They form a considerable portion of the food of hawks, owls and some of the fur bearers and act as buffers to protect more useful and valuable game birds and animals. They exercise a potent and ever-present check on forest insects and other invertebrates. Without small mammals, our forests would be less productive, more subject to insect epidemics, and certainly less interesting and enjoyable places.

IS THE BAG LIMIT ENOUGH?

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The bag limit is usually an expression of quantity. It commonly disregards quality in hunting and fishing. This disregard seems especially marked in recent times. Yet if more discerning sportsmen in the future demand greater quality, unspoiled areas capable of maintaining unusual species and experiences must be preserved. It seems possible to recognize relevant factors and to devise ways and means for creating effective desires for such preservation. Pertinent factors, ways, and means are herein considered.

The mind of man has always relished the division of his existence upon earth into eras or ages. These ages derive their names from equipments, philosophies, or whims characterizing different periods of civilization. Perhaps most familiar are the stone, bronze, and iron ages which indicate the materials from which man's most useful implements have been made.

Man's attitudes toward wildlife may also be expressed in terms of ages; each reflecting his equipments, philosophies, or notions during some significant period. Some of these ages, frequently mentioned, are common knowledge. They, with others more rarely considered, are useful in delineating the premises of this paper. Hence they are used.

The *age of dread,* during which man's primitive weapons were a sorry match for savage beasts, extended in some degree until the general adoption of powerful breechloading rifles. Unlike today, man had few presumptions concerning predator control. No wonder he at first sought refuge in caves! This period left its impress in tales concerning werewolves and dragons; imaginings probably conjured to keep errant children at home or to explain mysterious disappearances.

Once man possessed adequate weapons, dread vanished while game was still sufficiently plentiful to suggest an *age of inexhaustibility.* This was in part a whim. Sober realization soon replaced it with the age of *realized scarcity.* This in turn evolved into an era of almost religious fanaticism developed by some folk into an *age of preserve everything.* Here again philosophy or whim rather than facts were responsible. The literature created by devotees of this age is well known.

Current is the *age of professed plenty;* the day of enough game to fill the bag. Great unanimity marks this concept. The public gained awareness of game population increases through recurring stories of Kaibab deer, Jackson Hole elk, and Pennsylvania's white-tailed deer and doe seasons. There were also Isle Royale moose, necessary porcupine control of the early 1930's, the Sapinero deer area of Colorado, Wyoming's increasing antelope herd, lengthening open seasons, and increased annual kills. This, however, was not all.

Shantz (1937) wrote *Game to Spare* and (1943) *The Hunter, Wildlife's Best Friend.* Sparkes (1944) describes increasing game populations in *The Coming Boom of Recreation.* The Wilsons (1943) contributed *Harvesting the Game Crop.* Day (1943) associated game take with the war effort by writing *Wartime Uses of Wildlife Products.*

These articles were desirable. They broke down the opposition of some, whose minds were still in the age of preserve everything, to orderly harvests of surplus game. They proved need for ammunition releases necessary for game removal. Through them all was something else. They proved the worth of game managers from the political appointee to the most technically able.

Quite understandably, game managers have wished to prove their worth. If uninformed wildlife administrators retained for qualities other than ability can cite observable game increases, however fortuitous the reason, they can ask: "There's more game isn't there? Well, what more do you want?"

Similarly the wildlife technician desires to prove his worth. The public is not altogether convinced that he, rather than nature, is responsible for increasing benefits, although it quickly blames him for failures.

In each of these legitimate objectives, proved through professed plentiful game, quantity was accented. For these immediate ends, quantity was an effective means. Unfortunately much of the public has mistaken for the objectives of wildlife management the means here employed.

Those who have compiled statistics showing increasing populations for game considered in the aggregate, have carefully included information concerning vanishing or problem species. By comparison some interpreters have permitted the impressive figures representing species most responsive to management to obscure less numerous species capable of giving richer experience in their taking. This attitude has added to the growing assumption that numbers expressing pounds of meat or pieces of game are more important than its wildness, its development by and adaptation to its habitat, and the primitive living and travel which characterize its pursuit. One writer (Rose, 1944) has even suggested that sportsmen will appreciate quail, deer, and trout artificially bred to unusual sizes. Other pronouncements are not far from the typical query of the pothunters: "Got your meat yet?"

Writers are not alone in accenting quantity more than quality. Sportsmen have likewise chosen. Men who would irrigate western deserts state that pheasants will provide more shooting than sage grouse. Those who would dam western streams promise more fish of other species than there are now trout. In other western lands to be "developed," deer and elk can provide more shooting than present moose and sheep. Hatchery-reared trout and birds can provide more meat than will natural production.

Some, sentimentally interested in high quality natural areas, believe a limited number are sufficient to satisfy man's needs for quality in outdoor recreational resources. These assume that the national parks are adequate—realizing neither the limited areas of the national parks nor their restricted contributions to outstanding outdoor experiences. Here the attitude seems to be: "We've set aside the national parks. Now we can raise hell with everything else." Such assumptions interfere with the retention of quality in nonpark lands.

Still others believe that all wild scenes will eventually vanish before a human ant heap and think it enough to freeze within museums and zoos evidences of man's former freedom and vigorous living.

Recording quantity is much simpler than describing quality. It is easier to photograph six dead deer upon a pole than two deer grazing with heads down and in poor light. To record quantity demands little intelligence or skill. Any amateur can snap a picture of dead game upon a string but there have been few Frederick Remingtons, Philip Goodwins, or Martin Johnsons whose pictures reveal the richness of wilderness living.

It seems unnecessary to define before wildlife men the meaning of quality in respect to hunting and fishing. Leopold (1933) has eloquently asked if we are not able to keep the land pleasant to behold and desirable to live in, and has stated that recreational values of game are in proportion to the naturalness of its origin. "Ding" Darling, in public utterances exceeding even the vigor of his writings, has accented these things. Reid (1943, 1944) in his condemnation of inadequately planned dams was as much concerned with the recreational values of game as with its weight. Indeed, a vast literature written over many decades has portrayed natural values without which humanity will be mentally, physically, and spiritually impoverished. Somehow the *age of professed plenty* must be crossed into whatever lies beyond.

The demands of sportsmen form the key to the entire problem of preserving high quality outdoor experiences. Ironically this is because their satisfactions among outdoor scenes are most frequently expressed in measurable (or weighable) quantities for which they can vigorously contest. Many sportsmen are beginners enticed by easy transportation, leisure time, increasing game of some kind, and the homage civilization grants outdoorsmen. Most beginners have few standards. They are akin to the freshman girl at her first college ball—the music is divine. Every pimple-faced swain is a Lochinvar. Later she becomes more discerning. Compare the inexperienced hunter's standards of conduct with that of American or British gentlemen, of great experience, long schooled in outdoor courtesies.

Intelligence, too, affects conduct in the hunting field as well as in the drawing room. The difference is that experience and intelligence are permitted domination of social manners and standards more frequent than is true of outdoor manners. Askins (1910) and others have defined standards but perhaps some Emily Posts are needed to advise upon hunting and fishing matters.

That education and experience are needed is obvious. However, experience is something the individual must gain for himself and without education, may merely repeat past mistakes. These are not new thoughts. Wildlife literature is chock-full of recommendations for educating sportsmen. Lectures, pamphlets, motion pictures, and directors of education have all been tried. Educational mottoes to be posted along streams and at hunters' camps have been suggested.

A spontaneous self-education is needed among sportsmen; one that will banish the cobwebs of assumption and easily established standards. The better informed sportsmen will need to take leadership.

Much enjoyment in the outdoors is related to small, impromptu audiences. Standards for future performances are set among such gatherings. The pothunter needs no audiences, but the game hog cannot exist without one. The task is then to be a kindly but nevertheless questioning and constructively suggesting audience. Some have been trying this with gratifying results.

To the deer hunter who brags about having his buck back in town by noon of the first day the question is asked: "Couldn't you have stayed longer?" Comments are made about October in Colorado being the finest time of the year in the woods. There are no mosquitoes and the gold of aspens stripe mountainsides green with conifers. By hurrying back to town the chance was missed to hunt coyotes along the canyon rim while one's deer cooled in camp. The prize for the first deer brought to town, offered by a sporting goods proprietor who doesn't hunt, is often a shoddy thing, and sometimes goes to hunters who bring in deer with eyes suspiciously sunken and blood dark and dried.

He who smugly admits always killing the full limit of rabbits and pheasants is asked if he has ever experienced the thrill of killing charging game: "No? Well that's too bad. There's no thrill like facing game that wades towards you shot after shot. Of course that takes wild lands and unusual game. I was lucky enough to have experienced it a few times."

After one has done it a few times it isn't difficult and is surprisingly effective to tell the fellow who boasts of shooting protected grouse for camp meat: "I always figured that if all of us would leave them alone, they'd become numerous enough so that *all* could hunt them."

The fellow who is not an outdoorsman comfortable among primitive surroundings must hunt from cabins and cars. Camps and pack trips are not for him except under constant supervision. Naturally he shoots whatever is handy and yearns for quantity in lieu of quality unfamiliar to him. He needs to be shown the pleasures of properly equipped camps. He needs to ponder upon acquaintances who will not shoot deer from roads and who prefer hunting under the most natural conditions available.

One cannot bludgeon his way through this kind of contact. Needed is the safe-tipped foil—not the broadsword. Some people should never attempt this method. But I have seen confederates in this art change thoughtless game grabbers into outdoorsmen of the highest order.

Just as carelessly acquired individual assumptions need alteration by effective counter measures, assumptions by those active among the incompletely explored and complicated wilderness of public planning needs scrutiny if not criticism. For example, much is being said about making the finest areas available to the ill-to-do. Are those who will view rare scenes only after the way is made easy, capable of realizing much more than that the grass and trees are green, the air unburdened by smoke, and that they, too, can boast of having been to Mecca? Pearls of great price have traditionally entailed sacrifice and effort. The biblical alternative has been pearls before swine. Here no censoriousness is intended, and fortunately some methods of primitive travel are the least expensive once one has served enough apprenticeship upon lesser areas to gain the priceless ability to travel anywhere.

Marco Polo did not delay his journey to the orient until he could travel by China Clipper or Greyhound Bus. Dissenters state that more can now enjoy the Orient, diluted as it is and will be by easier travel. True, but it may not be wondered if Polo's fellow citizens of Venice did not then essay upon many little journeys highly fruitful to them and never before inspired. And still beyond them, to tempt other adventurers who could return with additional inspiration, lay an orient visited but unmodified by the man for whom *Ovis poli* was named. Within our own time Franck (1917) has adventured magnificently, on foot.

One more effective type of education could exist. Many grade-school teachers are likeable women who have not enjoyed altogether normal living. A surprising number of them live within the *age of preserve everything* in respect to game. Children, realizing that their teachers' standards concerning hunting and fishing are incorrect, reject them and evolve their own or adapt those of the nearest men they know. Perhaps more of civilization's ills than those concerning wildlife can be partially solved by the employment of more school teachers with normal concepts.

The antithesis of quantity is the combination of wildernesses and wilderness game. Those schooled in the economies of production complain that natural areas supporting the less productive creatures cannot produce as much game per acre as can more responsive species upon modified lands. If productivity overshadows all else, it should be remembered that wildlife management cannot compete with animal husbandry. Where, between the extremes of wilderness and wilderness game and shooting livestock over corral fences or catching fish directly from rearing ponds, will one draw a line separating quantity from quality? Where the line is eventually drawn must rest upon the fate of a final assumption; the assumption that more and more men will have fewer and fewer outdoor pleasures until nothing but men have no outdoor pleasures at all. Before that time someone may ask, just as folk in parts of the West are asking how many elk are desirable: "How many men do we need?" When this question is answered, the line may be drawn.

In the meantime at least four steps can be taken to prove that the bag limit is not enough and to create demand for greater quality in outdoor experience:

1. Publications giving proof of wildlife management's ability to produce increased quantities of game need *always* to be supplemented by information concerning gains and losses in the quality of outdoor pursuits.
2. Effort can be expended upon the task of rendering understandable to more sportsmen the abstractions depicting enjoyment upon perception and intellection levels.
3. A spontaneous self-education among sportsmen, coupled with other means of education designed to question restrictive assumptions, can be used to establish higher field standards of sportsman conduct.
4. Land and water modifying projects should be scrutinized as much for their effects upon quality as upon quantities of outdoor recreation affected. If maximum quality in outdoor experience is to

be retained, natural conditions must be maintained upon more areas than designated national parks, monuments, and wilderness areas.

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TIMBER AND GAME—TWIN CROPS[1]

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FOREWORD

There is increasing—and encouraging—evidence that relations between sportsmen and timbermen have been improving. It is recognized now, more than ever, that they have much in common and that their aims, far from being antagonistic, can be mutually helpful.

It was not always so. For many years it was considered legitimate for sportsmen and timbermen to engage in the pastime of mutually damning each other. It is best to acknowledge that there was provocation and, further, that there is still room for improvement.

In many cases, the logger followed methods that endangered the future of his own industry: the failure to provide the means of reproduction, and the creation of conditions which led to erosion. The sportsman far too often was responsible for starting fires in both standing and cut-over timber, and far too willing to blame the logger for the whole regrettable situation.

However, he may not have had his facts straight when he blamed forest industries for the disappearance of game. Actually, as Mr.

[1]This paper was prepared by Mr. Titus for a booklet to be published by the American Forest Products Industries, Inc. It is reproduced here with the kind permission of Mr. Titus and the American Forest Products Industries, Inc.

Titus so capably demonstrates in this publication, intelligent logging operations did and do create essential wildlife habitat and have been responsible for enormous increases in wildlife population.

Today, progressive timbermen and sportsmen alike condemn destructive logging practices. Recognition of the truths so ably set forth by Mr. Titus should go a long way toward establishing common ground on which sportsmen and timbermen can serve each other for their mutual benefit and thus contribute to the welfare of us all.

J. PAUL MILLER, *Secretary,*
American Wildlife Institute.

In these few pages we are going to look at American forests—past, present and future—with our sights particularly trained on game birds and animals naturally associated with them.

We are going to touch on a few of the mistakes man made, from the point of view of wildlife welfare, in his use of the abundant forest resources he found on the continent.

We are going to deal with the gearing in of forest product and game interests and discuss some of the practices in both fields which are already yielding fruits for the nature lover and sportsman.

And perhaps, along toward the end, we'll get our courage up to a point where we'll try to forecast what may happen if understanding of both forestry and game management continues to generate momentum as it has in the recent past.

That, then, is something in the nature of a declaration of intent.

MUST FORESTS REMAIN UNTOUCHED?

When we—especially those of us who are sportsmen—remember that our founding fathers discovered that nearly one half of what is now the United States was forested, and when we realize that much of our virgin timber has been cut, that this harvest has accelerated, even in times of peace, and that vast areas of second growth timber probably will be operated about as fast as it attains commercial size—why, we're apt to despair.

We are apt to despair because we—at least too many of us—still entertain the idea that to have abundant supplies of those birds and mammals which associate with forests, those forests must remain untouched by man.

This is one of our most popular misconceptions. Mature, dense stands of timber in large blocks make happy homes for almost none of those species of major importance. In his most noteworthy volume, "Wildlife Conservation," Ira N. Gabrielson, Director of the United States Fish and Wildlife Service, points out the utter lack of game birds and animals in many of the virgin timber stands of the Pacific Northwest and cites the paucity of game signs in old stands of hardwood timber on the other upper corner of the country. Dr. Gabrielson holds that such deep woods are much nearer the status of biological deserts than are some of our southwestern areas which geographers classify as actual desert land.

Our forefathers did not find game everywhere in the primitive forests they explored simply because most game species cannot exist, let alone thrive, in deep woods. The long record of frontiersmen with the know-how of living off the country who perished of starvation in the unspoiled wilderness attests to that. Towering trees offer no forage for browsing animals, such as deer. The fruits and nuts their high tops may produce are available only for brief periods annually and, for most species, are only items in a diet, anyhow. The shade created by a dense canopy, combined with the demands made for nutrients and moisture by their interlocking root systems, discourages the growth of low plants which might render sustenance to animals. Such forests offer but one of the many things game needs and that is shelter—shelter from extremes of weather and from enemies.

GAME SEEKS FOREST "EDGE"

Where, then, were the storied herds of deer and elk and moose located? Where did pioneers find the wild turkey and ruffed grouse and other life forms which enlivened the landscape and contributed to their food supplies? They found them just where the sportsman finds them today and no doubt always will find them: along and near the forest edge; in and about forest openings. Where outcroppings of rock made dense stands of great trees impossible and permitted ground cover to thrive. Where glaciers had put down moraines of lean soils so that forests, luxuriating on the richer plains, were interspersed by fingers of smaller and more varied growth. Where clearings created by fire started from lightning remained in grasses, scrub and shrub. Where marshes intruded on tree associations. A long list of species had to have forests to survive, mature, remain robust and multiply, yes; but those creatures had to have openings along with those forests or they faded from the picture.

Those openings make what technicians call "edge," and edge, in this sense, is something more than just a border. Wildlife authorities such as Aldo Leopold, professor of game management at the University of Wisconsin, rate the amount and type of edge as one of the great determining factors in game abundance. It isn't only food which is offered by edge. Birds and mammals, just as other life forms, cannot live by bread alone. They must have more than food and shelter to remain healthy, happy and therefore able to reproduce their kinds. Fawning time for the whitetail deer is fly time in the woods, and does and their young need relief from these pests, just as does domestic stock, so the bold ridges and open flats which give wind a chance to disperse clouds of insects are necessary. The areas on which mating rites are performed by some species have rigid specifications. Opportunity to go through those ceremonies is of first importance. As an example, recent studies of the woodcock indicate that, unless openings suitable for use as the timber doodle's singing grounds are available, populations trend rapidly downward. The list of imperative needs supplied by this condition we call edge could be expanded much further but perhaps the point is established: that openings furnish all manner of requisites which unbroken forests never can offer.

So when the white man appropriated America, consciously or unconsciously, and so long as he was in forested areas, he took the flesh he consumed by grace of forest openings. We are not here concerned with the vast herds of buffalo nor the pronghorn antelope of the Great Plains; nor are we dealing with the involved subject of waterfowl nor the upland species such as prairie chicken which thrived in extensive native grasslands. We are sticking to types of game which demand forest growth as a component of habitat.

Now, what man did by way of altering that balance of forest and opening is history. Plenty of it, in the light of today's understanding of game needs alone, was shameful; but, at the same time, some of it happened to fill so completely the needs of game that it formed rough patterns which, refined and developed, we are following currently and seem destined to follow far into the future—provided we are smart enough to learn from experience.

One of the first activities of our ancestors here was to create clearings in the forest, for home, farm and village; and wherever a clearing was made there was new and man-created edge for the birds and animals of the vicinity. Nesting sites, food supplies, mating and playing and resting places that never before existed began to dot the map, with dense woods always adjacent for shelter and escape. That was all to the good.

But when, as forest products came into greater demand, those clearings spread and multiplied and came together and over wide areas stands of thick timber became things of the past—why then our supply of forest openings became too much of a good thing. Our edge was no longer present. The shift from deep woods to choppings was complete. In county after county and state after state the game environment was completely out of balance.

Where the land thus stripped of its natural cover was suitable and needed for agriculture or any other sound social purpose there was of course justification for such a radical altering of the landscape. But where the land was neither suitable nor needed for a new and specific use, such exploitation we now agree was shortsighted and wasteful. The practice of the times was to walk off and leave the choppings and let fire run which killed off the seed trees and baked the fertility from the soil itself. The only excuse of course is that with normal pioneer enthusiasm for the opportunities of the moment and facing a continent so rich in natural resources we thought there'd be enough to last everybody forever. We just didn't know any better.

PIONEER TRADERS FOUND LITTLE GAME

No more did those pioneers realize what they were doing *for* game and forests in those few regions where deforestation was neither so rapid, complete nor permanent. The disastrous mistakes of the past have had plenty of well deserved attention. The fortuitous happenings as increasing population put most of the country to use, however, have often been neglected.

It is interesting and enlightening to study the diaries of certain old fur traders who were in many instances a century or more ahead of the loggers' axes. Michillimackinac—Mackinac Island, perhaps, to you—was one of the great fur depots before and shortly after 1800. From that headquarters on the strait between Lakes Michigan and Huron, brigades dispersed north and west and south in search of peltries. Many of those which went west proceeded up the St. Mary's river to Lake Superior and then coasted along what are now the boundaries of Michigan, Wisconsin and Minnesota.

These traders lived largely in the country, but until well toward the western extremity of this great inland sea they ate fish almost exclusively. The pineries, swamps and hardwood stands which cloaked the shore were silent places. Repeatedly in accounts of those treks we find notations of daily fish catches and then, indicating the unusual, comes the entry stating that deer or moose were seen.

An occasional moose and a stray deer, then, in that wilderness in 1800. But since the 1890's that same Lake Superior shore has been a stamping ground for thousands of deer hunters annually. Without interruption it has yielded its tons of venison each autumn, some seasons more, some less, but always enough to entice hunters back.

It was not happenstance that deer moved into this region when they did. It is happenstance, however, that they have persisted. The deer appeared when loggers made openings in those virgin timber stands and deer have continued in more or less abundance because the timber harvest followed a distinctive pattern.

The variety of forest types has been mentioned. The pineries were the first to fall, and considerably later than those to the south because they were remote from markets. As a forty or a section was logged, edge appeared where no edge had been; in time the few deer in the vicinity found those edges, established themselves and began to multiply, no doubt far faster than they had in the scattered natural openings.

Next, the great pines which grew in hardwood stands were taken. This made innumerable smaller openings, which spread the deer far in small nodules of seed stocking. Following this came need for hemlock and the number of clearings increased. Lastly, uses were found for the birch, maple and beech but it was not so steady a demand. It fluctuated with the fortunes of the industries using those woods. The pine and hemlock had built homes, barns, factories; the hardwoods went into equipment and implements, were not used in such bulk and were subject to a more variable need. An operator might cut a dozen forties one winter, twice or thrice as many the next and thereafter be down to small or no production whatever for several years. The harvest of swamp timber followed similar ups and downs.

As a result, the region was in timber production far longer than most others. It is still producing. Demand for the land for agricultural or other intensive uses was not uniform. Some of it is excellent for specialty crops but large outlets never were near, the season is short and consequently clearing for plows was spotty and relatively limited.

Because of these circumstances what, in 1900, say, was a pine chopping bordered by virgin hardwood could, if it escaped fire, be a thrifty young pinery in 1925 when the hardwood was coming down. At no time since logging began has the area been without many stands of timber sufficiently dense and extensive to afford retreat for deer and also adjacent to those openings where their other demands may be met.

Deer populations have changed and shifted as this combination of edge and forest crept from here to there. In periods, local deer abundance has dwindled but they've always been somewhere in the vicinity, with changes in numbers, true, but never so low that they failed to lure hunters.

Deer, then, followed the axe in the Lake Superior country but the story doesn't end there. Perhaps nowhere else is there an area of comparable size and with such a range of forest species where the pace of lumbering has shown so many changes. We'll be coming back to it when we get to this matter of managing forests so that yield may be perpetual, and the effects such practice can have on game supplies.

QUAIL PREFERS OPEN SPACES

It was not only big game and not mammals alone that were spread about and increased in numbers by the clearing of forests. Take the case of the biggest yielder of all our native game birds—the bobwhite quail.

Today, on the northern portions of his range, we rightly class this bird as a farm-type rather than a forest-type species. Originally, he was a woods inhabitant but the edge he required consisted of many and very definite types. Some old records seem to indicate that the more rigorous the climate, the more exacting he was about his edge specifications. So, in what are now the central and northern states, those combinations were relatively rare until white man took over. Pioneer agriculture was right up bobwhite's street to a happy home. Its grains fitted his diet list nicely. Tangles of low growth along rail fences made exactly just the hiding and nesting places he liked best. Brushy pastures with closely grazed grass plots between clumps of bushes were another made-to-order part of his environment.

So when great-grandfather hacked out his homestead near an established quail population, that population swelled because the habitat could carry more individuals. And when other settlers came to set up more farms the coveys spread over the land and the years until they seemed to be everywhere.

The change came when agriculture became more efficient and took on the first manifestations of streamlining. The rail fence gave way to wire and the broad band of rank vegetation which had bordered earlier fields shrank to a thin ribbon. Bushes were ripped from pastures so more forage plants could grow. Woodlots were eliminated or else the ground cover in them was reduced by pasturing. The grains and bugs man had brought to the wilderness were there in ever increasing quantities, but without other necessary factors quail passed the peak of their abundance in many sections and dwindled as the last square yards of neglected acres were put to man's rather than the bird's uses. There will be more to say about quail in the deep South a little farther on.

Is it clear, then, that the manner in which man handles his forests has much to do with the quantity and distribution of those game species which depend, in part, on forests? Their populations can be stepped up and given wider range if forests are managed with at least part of an eye to game values.

HARVESTS AID LIFE IN WILDS

Perhaps it is now in order to examine briefly how man can use those game resources and still anticipate a continuing supply—as we are now realizing that it is possible to use our forests and still retain them.

Just as we erred when we believed that game was all over the place when forests were untouched, so are we mistaken when we assume that if hunters were removed from the hazards to wildlife then there would be no limit to the wildlife populations.

If a forest is let alone by man and manages to escape the menaces of wind, fire, pests and disease its individual trees mature, die and fall without serving any purpose other than enhancing the landscape—important but not always paramount. A forest, then, to serve man best, must be cut. In the light of current attitudes towards natural resources it is scarcely necessary to point out that we no longer encourage or condone that type of cutting which leaves the land barren but are following programs in all publicly owned and many privately owned forests designed to make yield perpetual. Inducements to increase such practices among private owners of timberland are manifest almost everywhere.

Just as it was a mistake for society to permit a wasteful form of timber harvest by taking too much and too fast, so it was lack of foresight which, at times and in places, let us take too many birds and animals from existing stocks. What happened to the buffalo and passenger pigeon attests to that. Even today we find in the southern Appalachians far less game than the environment could carry because sufficient protection has not been given wildlife against man, his modern weapons and means of transportation.

But if game populations, *once well established,* are not in part taken either by their natural enemies or by man, a disaster more spectacular than that befalling a mature and uncut forest may be anticipated. And with predator control what it is, and no doubt will be from now on, natural enemies are nowhere, except for brief periods, of marked consequence.

So if—and, remember, we are discussing well established game stocks only—we fail to take a reasonable and regular harvest the result is either waste comparable to letting forest trees fall and rot or else a marked reduction in numbers as starvation, disease or a combination of the two overwhelm them.

Long and able study of the bobwhite quail by H. L. Stoddard has demonstrated that there are levels beyond which abundance simply cannot be crowded. Where stocking is scant an increase may be fast under favorable conditions until certain definite limits are reached. Then it stops dead. Errington and Hamerstrom, by the examination of large numbers of coveys over a period of years in Wisconsin and Iowa, have shown that a given piece of quail cover will winter just about so many individuals year after year. If hunting is banned or its success poor and an unusual number of birds go into the winter the surplus is surrendered promptly to enemies or the climate. Again and again, a specific area has wintered just so many birds and no more. If the fall population is cut down below the wintering capacity of the environment, that is one thing. But if the fall population is above the winter maximum and is not reduced, then the difference is simply lost. Your trees, in other words, have fallen down to rot.

We have turned to quail for this example because more is known about quail than any other upland game bird. Wildlife studies take time and peculiar talents. Scarcely a start has yet been made on most forest type game birds although progress is being made in understanding the needs of wild turkey and sharptail grouse. There is no reason to suppose, however, that any basic principles differing markedly from those governing quail abundance will be discovered.

GREAT MOOSE HERD PROTECTED TO DEATH

It is when we consider big game, however, that real catastrophe threatens when some influence does not offset an increase in numbers as the carrying capacity of range is approached. Here we could cite the tragic story of the Kaibab deer herd in Arizona as an example or could brief the tortuous history of Jackson Hole elk in Wyoming, but the sorry saga of the Isle Royale moose is more recent and perhaps more dramatic as well.

Isle Royale is a part of Michigan, eighteen miles off the Canadian shore near the western end of Lake Superior. It is forty-five miles long and a third as wide at some points. Until 1920 it was known only to venturesome tourists, a few commercial fishermen and its lighthouse crews. Except for scattered copper explorations many years before, it was an untouched wilderness.

How or just when the moose arrived is anybody's guess. Caribou had been present in limited numbers but had disappeared, either because the island didn't offer what they had to have or by the poaching route as no predators except a few coyotes had ever been known to live there. Obviously, moose crossed from the mainland either on ice or by swimming soon after 1900.

By 1911 sign was common. By 1915 the population was guessed at 300. By 1922 this estimate was upped to 1,000 and the Michigan Conservation Commission asked the legislature to permit limited hunting, following many years of statewide protection for moose.

The request was violently opposed by island fans. The big animals were the principal attraction for the three or four summer resorts by then established in the fiord-like harbors. It was thrilling to see as many as twenty in a wallow at one time and the argument was that if guns were kept out folks might some day see twice that many. The debate became too hot for the legislature to handle and no action was taken.

In 1929 the movement to make the island a National Park was under way and for the first time a top ranking naturalist took a look at the moose. This was Dr. Adolphe Murie. After months on the job he estimated that Isle Royale was home for a certain thousand moose and stated that an actual count, were such possible, might turn up three times that number. Anyhow, the herd was probably the world's greatest concentration of the species.

STARVED FOR LACK OF BROWSING

Murie called attention to the overbrowsed condition, which others had been doing for nearly a decade, but no action resulted. In less than ten years only a remnant of the herd was left. By 1944 estimates ranged from less than thirty to perhaps 300, with the namers of the latter figure saying it was no doubt away too high. Michigan had trapped and transported to the mainland seventy-one. Perhaps a few others had been killed by poachers. Otherwise, the animals had been unmolested. No big predators were present. No special disease was revealed by many autopsies.

That magnificent band of magnificent animals had eaten itself down to seed stock. Ground hemlock, lily roots and other staples were muttoned and today no one is venturing a guess when the vegetation will permit the herd to start rebuilding—if it ever tries. Repeatedly in nature we find when stocks of this or that reach a certain low level they are on their way out and nothing can stop them.

To stories such as these there seems to be a revolutionary moral. It is this: when game populations reach a safe level, then, to have their cake, hunters must eat it. Just as when a stand of forest trees is mature that stand must be harvested or the cords and board feet that might have served man will be lost to him, so when a population of game birds or animals reaches that point beyond which the environment will not support more, the numbers must be reduced. If they are not, and especially with the big mammals, catastrophe may be just around the corner.

PENNSYLVANIA DEER ESCAPE DISASTER

The Pennsylvania deer herd apparently missed such a catastrophe by an uncomfortably narrow margin in the early 'thirties but, because good judgment prevailed, that story has a happy ending.

From colonial times Pennsylvania had been natural range for whitetail deer. After about 1870 the range started to deteriorate. Logging and fire had done their worst, market hunting became a factor and by 1900 deer hunting was not much to brag about in the state.

In 1905 two important steps were taken. One was the setting up of the state's initial game refuge where no deer hunting was permitted; the other was the importation of fifty breeder deer. In 1907 these moves were followed by a buck law so that does had universal protection.

The condition of food and cover was due to get better shortly because all across the land men were realizing that something must be done about forest fire control. Pennsylvania made the beginnings of a real forest fire organization and areas which had been periodically scourged to a cinder began to stay green and recloak themselves with brush and trees.

By 1915 deer hunting had again become something to talk about a little here and there. Just a little. Nearly 1,300 bucks were killed that fall. In another five years the kill had doubled but that wasn't all. The pendulum had made such a rapid upswing in some counties that farmers were complaining about deer damage to crops. The Game Commission was concerned by that problem but not so deeply as over another which raised its head about the same time. This was the matter of overbrowsing. In some localities there were so many deer that they ate food faster than it could grow. And now and again a field man would report deer found dead, maybe from starvation.

Now, the quickest way to relieve troubled farmers and stocks of browse from too much pressure was to kill a few does along with the bucks in those places where aboundance had become a burden, and that is what the Commission proposed. But the suggestion plunged the body into an argument that proved both tough and protracted with plenty of trimmings in the form of restraining orders from courts of law. The revival of the state's deer supply from almost nothing to a lot was attributed by many solely to the protection of does and the doe had, in consequence, become a symbol of everything desirable. Also, the public felt that if a big herd of deer was nice to have, a still bigger one would be nicer, despite occasional crop damage and food shortages in places.

As the debate went on, starvation during winter became more general. In some areas deer perished by hundreds. Furthermore, the size of trophies went down. Once bucks had averaged 150 pounds but this level fell off, slipped to a low of 115 pounds.

Not until 1928 could an antlerless deer season of any consequence be made to stick. In the next fifteen years over 700,000 does and fawns were taken legally, along with a heavy harvest of bucks in most seasons. Winter losses from starvation lessened, the average weight of specimens began to increase and forest growth, which had been so closely browsed that grouse and hares could no longer exist in sections, started its recovery and reached a point where those species reappeared.

Before long other states and Federal agencies adopted similar measures not only to control deer herds but for elk and antelope as well. By the early 'forties from the lower Appalachians to beyond the Rockies, planned hunter harvests, based on censused game supplies and an understanding of range limitations, were in order. The permit system was inaugurated in a half dozen states. While local herds were building toward the carrying capacity of their territory, restricted kills were the pattern; where those populations had reached a point beyond which they could not go without endangering habitat, a larger take was encouraged.

This was possible because the new science of game management was getting up on its feet. While for a full century agriculture had progressed due to careful research and planning by technicians, and while forest owners had been increasingly aware of the need of direction in their operations by men trained in the basic sciences involved, game management had been almost exclusively left in the hands of generally well-intentioned but sketchily prepared administrators.

One reason was that until the early 'twenties few biologists had been trained to work in the groove of sustaining wildlife populations. Most scientists who gave their attention to wild birds and animals were chiefly concerned with classification, life histories and whatnot, all important but not going far enough. The old Bureau of Biological Survey and a very few scattered states had staff men with preparation comparable to that of agricultural experiment workers or professional foresters but the supply of technicians stopped there.

In many places by 1920 wildlife stocks were in a bad way. The general use of the automobile had both spread out and intensified gun pressure. In earlier decades, if game supplies dwindled near home there were generally happy hunting grounds farther on. But man's triumph over distance tapped these natural reservoirs of wildlife reserves. Something besides going more miles to hunt needed doing and all of a sudden game officials realized that their old cut-and-dry methods, their reliance on restrictive laws alone, had not panned out. They had been, one might say, relying on midwives to treat a serious ailment. Now they commenced yelling for a doctor.

The colleges responded and the output of augmented curricula was absorbed rapidly. Countless competent investigations were launched, experiments set up and programs laid out which pulled the management of game species from the realm of guesswork down toward sound and scientific procedure.

Techniques of censusing game populations were evolved. It was determined how much of this or that a deer or an elk must have to eat, how much of it was available and how fast it could reproduce itself, all of which made for a clear idea of range capacities. Progress was made on the important item of desirable sex ratios, the balance between summer and winter needs of animals and a long list of other important factors.

GAME-FOREST OBJECTIVES DOVETAIL

But perhaps more significant was the demonstration that game is not a thing apart from man's other interests nor its management an isolated endeavor. It ties in with most of the other uses made of land, and that throws the game specialist into a tight company composed of agriculturists, foresters, economists and so on.

In the management of forest-type game, professional and jurisdictional lines between game and forest specialists are already blurred and indistinct. The interests of the two groups overlap and the gears of their organizations naturally mesh. What is good for the objective of one is, in the broad sense, also good for the other.

The idea of sustained yield logging had been well and widely talked before game management had been reduced to definitions. Forest management on this basis calls for the following of one of two general programs. The first is rotation cutting, which means the periodic harvesting of timber on given plots, each of such a size that by the time the last has been covered the site of the first cutting will again be ready to yield merchantable timber. The second program is one of the harvesting individual trees so that the mature and cripples are being constantly removed, thereby speeding growth of the young and healthy.

But by either method edge is constantly created. If game is in the vicinity it will find and use that edge. If game is not present and the cover is of a type which will support a given species seed stock can be introduced in a hurry because the trapping and transfer of game animals has been reduced to a simple procedure. If the edge needs help by the introduction of food plants that can be done, too.

While sustained yield logging is still too new a practice to have reflected many big scale effects on game populations all one needs to do to visualize the possibilities is to remember what happened in the Lake Superior country. The procedure there roughly and just by chance followed some of the basic principles of modern forest management. There was no plan or purpose, true, but some of the results consciously desired today were achieved and the fact that they just happened to come about does not detract from the quality of the demonstration. Here we had a reasonably steady flow of new edge across many millions of acres for over half a century. In that period swamps and some uplands were scenes of cutting two and three times. The yield of forest products was not what it might have been had the original harvest been by plan but that yield, for the region, has been raggedly continuous. And the game supplies have held up, too. Now and again they have faltered in sections but at no time have they failed over wide areas. A hundred miles southward lie regions which had comparable forest types but where the harvest was fast and furious and, because of their fires, more destructive. For decades some of these sections had no deer at all and certain counties remained closed to hunters for the span of a generation. This contrast should rather well emphasize the point.

Of course, the objective advanced by early advocates of sustained forest yield was the continuing supply of wood. Almost as important, however, was the promise of permanence for economic, social and political institutions within the areas. The necessity of giving towns and their populations stability needs no argument. But the greater the diversification of commercial interests, the healthier will be the business and social life in any town. Possibilities for recreation are a distinctly valuable commercial asset to a community and nowhere is the fact better exemplified than in this same Lake Superior country. It is within easy reach of great centers of population, and while the volume of summer tourist traffic is heavy and profitable, nevertheless the annual deer season is the one big harvest time and has been for decades. For many small towns it means just the difference between folding up and staying on the map, and big towns, remember, feed on the well-being of small ones. In forested regions, then, a continuous supply of deer or grouse or any other wildlife form may be just as important to the population of a community as is the sawmill with its payroll.

The demand for forest products for the war effort brought timber operations to many established game areas. For some time cutting on a small scale had progressed on game refuges here and there for the purpose of opening canopies and increasing browse. But the war multiplied such activity. Thousands of acres have been selectively cut and technical game staffs, trained in collecting and interpreting pertinent data, may very well turn up leads for other forest managers to follow as the ultimate effects on quail, turkey and deer populations are demonstrated.

For many years fire has been a tool in quail management in southeastern states. By this means undesirable ground cover was removed and essential openings kept constant. To many a forester the deliberate setting of fire is anathema and because burning seemed to function well for the game manager's purposes there was for a time a rather definite hesitancy in some forestry circles to give game interests a whole-hearted welcome. But those fires were on the whole reasonably well controlled. Michigan experimented for years with fire as a means of pruning wild blueberry bushes and demonstrated that not only the size of burnings but their speed and intensity can be planned. So it is not unreasonable to believe that in the future fire may be used more or less extensively as a means of maintaining openings in forests where the growth has attained no commercial value and in consequence would be too costly to remove by any other method.

But with the upsurge of demand for forest products southern quail managers broadened their habitat improvement by use of the axe. In this region, as was indicated earlier, the association of quail with agriculture is neither so close nor so fixed as it is farther north. Many a tract of timber on plantations where quail production is of large economic importance was thinned during the early 'forties with a special eye to improving sites for the coveys, and the coveys put those new facilities promptly to use.

The Pacific Northwest presents its own peculiar problems. Factors wholly missing elsewhere are present. Variations of tree species, rainfall and soil types inject all manner of complications into relatively small areas. Deer, elk and the native blue and dusky grouse like the cutovers and burns, and burns must always be reckoned with so long as man is careless with fire, and lightning strikes. But in many sections tree growth is so rapid that what makes good habitat today is something else again a few years later. Dense canopies close in a surprisingly short span of time. On the other hand, certain trees reach merchantable size in from thirty to forty years, which makes possible a rotation harvest on a short cycle.

Recent studies of the blacktail deer in Oregon opened new possibilities for increasing and sustaining its populations. It was shown that in many places too heavy a kill of deer was permitted too early in their invasion of new clearings. The great Tillamook burn of 1939, when 300,000 acres of virgin timber were laid waste, gave excellent opportunity for observation and a try-out of management techniques. After two years of protection and then a program of moderate shooting the population had increased 1500 per cent by 1943. Furthermore, the condition of specimens taken was far better than it had been when openings were few and far between.

GAME IS CROP . . . LIKE TIMBER

In such a presentation as this, of course, it is only possible to generalize. Our objective has been to draw the picture in broad strokes and, indeed, had detail been desirable, many blanks would have appeared on the canvas. The science of game management is new. The surface has scarcely been scratched. Understanding the needs and responses of wild things is not as simple as is the job when domestic flocks and herds are concerned.

Still, we are on our way. Foresters, in their long-range planning, are no longer inattentive to the wants of the sportsman or the demands of the things he hunts. Game is recognized as a cash asset. More important, it is recognized as a *crop,* to be grown by tried and approved practices and to be harvested intelligently.

Just how much larger the annual yield may safely be in the future is anybody's guess. But this much seems certain: for many parts of the country we have not even approached the upper limits. With increasing emphasis on the necessity and economic feasibility of cropping not only our remaining stands of virgin timber but those millions of acres of second growth and man-planted forests which are coming along, the outlook for more and more sustained yield logging should be good if we are as far-sighted as we think we are. Once that practice is widespread and general, and once the slight modifications in standard operational procedure which make for better game habitat are recognized and heeded, the battle for more of those game types which depend on forests is largely won.

It is no longer necessary to await the slow and natural infiltration of birds and mammals to newly created habitat. A few traps in places of abundance, a few trucks, a few days and, lo, the seed stock is planted! Learning, as we are, what it takes to keep that wildlife healthy, contented and self-productive; knowing, as we are coming to know, the capacities of given ranges and what they may safely yield in given periods; aware, as we have become, of the expected growth of the hunting legions as time reels on; and appreciating, as we do, the physical and spiritual stimuli that the hunter takes home along with his bag—why, we should be well on our way to a hunting ground where the quality of happiness is secure for all time.

THIS IS A MATURE, EVEN-AGED FOREST BEING LOGGED BY BLOCK HARVESTING

In block harvesting, most of the trees are removed, but blocks of seed trees are left standing in strategic locations, to spread seed freely over the harvested areas. One parent tree may produce many thousands of seeds in one season, and the wind scatters them with a liberal hand.

AFTER HARVEST, SEED BLOCKS SPREAD A CARPET OF FAST-GROWING NEW TREES

THIS IS A FOREST OF MIXED PINE AND HARDWOOD BEFORE SELECTIVE LOGGING

In selective logging, mature trees, past the period of rapid growth, and defective or diseased trees, are usually harvested. As a result of this thinning process, the remaining young, healthy trees obtain more sunlight, more soil nourishment—and increase their rate of growth.

HARVESTED TREES ARE SHOWN IN OUTLINE AFTER THE FOREST HAS BEEN LOGGED SELECTIVELY

Chairman: WARREN W. CHASE

Chief, Regional Biology Division, Soil Conservation Service, Milwaukee, Wisconsin

CROPLANDS AND WILDLIFE

This session arranged by the Wildlife Society

INTRODUCTORY REMARKS

WARREN W. CHASE

In introducing this session on "Croplands and Wildlife," I want to point out that we have had three unusually good cropland years since we became involved in war. Wildlife production during these years has also been high. Is this an indication that we are learning how to intelligently manage land for wildlife as well as for corn, soybeans, and peanuts? Or have we had "lucky breaks" in both? I assume that there may be a difference of opinion on these points. We know, however, that agricultural crop production has been increased and maintained at high levels by taking advantage of generally excellent weather, improved varieties of plants and animals, increased incentives for great production, and a better knowledge of how to work with Nature in the management of land.

The management of land and water for wildlife is a matter of knowing how in much the same way as in agriculture and in taking advantage of very much the same conditions. The incentives are different and the subject is newer, but the principles of growth are the same. The manager of the land is interested and is learning new skills and "knacks" faster than ever before. He is willing to modify his farming practices to benefit wildlife only if this doesn't interfere with his efficient production of agricultural crops.

The papers chosen for this session present problems and solutions that are becoming more and more common to the field crop producer and the wildlife manager. Land, water, and man are also deeply involved with wildlife in what we call management. Points of view and interpretations will vary greatly as papers come from many different parts of the country. Wildlife and cropland conditions, so I have found, are different in more ways than are the people who manage the land. Papers are arranged so that the session will open with an interpretation of the subject and an indication of the direction we are taking. Technical subjects will cover the latest facts, current thinking, stimulating questions and discussions of cropland and wildlife management methods. The final paper is from the farmer's point of view—by a farmer who is managing his land for wildlife as well as for agricultural crops.

THE OUTLOOK FOR FARM WILDLIFE

ALDO LEOPOLD
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Twenty years have passed since Herbert Stoddard, in Georgia, started the first management of wildlife based on research.

During those two decades management has become a profession with expanding personnel, techniques, research service, and funds. The colored pins of management activity puncture the map of almost every state.

Behind this rosy picture of progress, however, lie three fundamental weaknesses:

1. Wildlife habitat in fertile regions is being destroyed faster than it is being rebuilt.
2. Many imported and also native species exhibit pest behavior. A general disorganization of the wildlife community seems to be taking place.
3. Private initiative in wildlife management has grown very slowly.

In this appraisal of the outlook, I deal principally with the first two items in their bearing on farm wildlife.

Gains and losses in habitat.—Wildlife in any settled country is a resultant of gains and losses in habitat. Stability, or equilibrium between gains and losses, is practically nonexistent. The weakness in the present situation may be roughly described as follows: On worn-out soils we are gaining cover but losing food, at least in the qualitative sense. On fertile soils we are losing cover, hence the food which exists is largely unavailable.

Where cover and food still occur together on fertile soils, they often represent negligence or delay, rather than design.

There is a confusing element in the situation, for habitat in the process of going out often yields well.

For example, on the fertile soils of southern Wisconsin, the strongholds of our remaining wildlife are the wood lot, the fencerow, the marsh, the creek, and the cornshock. The wood lot is in process of conversion to pasture; the fencerow is in process of abolition; the remaining marsh is in process of drainage; the creeks are getting so flashy that there is a tendency to channelize them. The cornshock has long been en route to the silo, and the corn borer is speeding up the move.

Using pheasant as an example, such a landscape often yields well while in process of passing out. The marsh, grazed, or drained or both, serves well enough for cover up to a certain point, while the manure spreader substitutes for cornshocks up to a certain point. The rapid shift in the status of plant successions may in itself stimulate productivity.

The situation is complicated further by a "transmigration" of land use. Originally uplands were plowed and lowlands pastured. Now the uplands have eroded so badly that corn yields are unsatisfactory, hence corn must move to the lowlands while pasture must move to the uplands. In order that corn may move to the lowlands, they must be either tilled, drained, or channelized. This, of course, tends to destroy the remaining marsh and natural stream.

The upshot is a good "interim" crop which has a poor future. I don't know how widely a similar situation prevails outside my own state, but I suspect that the basic pattern, with local variations, is widely prevalent.

Runaway populations.—Wildlife is never destroyed except as the soil itself is destroyed; it is simply converted from one form to another. You cannot prevent soil from growing plants, nor can you prevent plants from feeding animals. The only question is: What kind of plants? What kind of animals? How many?

Ever since the settlement of the country, there has been a tendency for certain plants and animals to get out-of-hand. These runaway populations include weeds, pests, and disease organisms. Usually these runways have been foreigners (like the carp, Norway rat, Canada thistle, chestnut blight, and white pine blister rust) but native species (like the June beetle and various range rodents) are clearly also capable of pest behavior.

Up to the time of the chestnut blight, these runaways did not threaten wildlife directly on any serious scale, but they now do, and it is now clear that the pest problem is developing several new and dangerous angles:

1. World-wide transport is carrying new "stowaways" to new habitats on an ascending scale. (Example: Anopheles gambiae to Brazil, bubonic plague to western states.)
2. Modern chemistry is developing controls which may be as dangerous as the pests themselves. (Example: DDT)
3. Additional native species, heretofore law-abiding citizens of the

flora and fauna, are exhibiting pest behavior. (Example: excess deer and elk.)

These three new angles must be considered together to appreciate their full import. Mildly dangerous pests like ordinary mosquitoes evoked control measures which severely damaged wildlife; desperately dangerous pests will evoke corresponding control measures, and when these collide with wildlife interests, our squeak of pain will not even be heard.

Moreover, wildlife itself is threatened directly by pests. Sometimes they hit so fast and hard that the funeral is over before the origin of the malady is known. Thus in Wisconsin, we have a new disease known as burn blight, the cause of which is still unknown. It threatens to destroy young Norway pine and jack pine, especially plantations. Oak wilt, the cause of which was only recently discovered, is steadily reducing red and black oaks. Our white pine is already blighted except on artificially-controlled areas. Bud-worm is in the spruce. Hickory can't grow because of a weevil which bites the terminal bud. Deer have wiped out most white cedar and hemlock reproduction. Sawfly has again raided the tamaracks. June beetles began years ago to whittle down the bur and white oaks, and continue to do so. Bag worm is moving up from the south and west and may get our red cedars. Dutch elm disease is headed west from Ohio. What kind of a wood lot or forest fauna can we support if every important tree species has to be sprayed in order to live?

Shrubs are not quite so hard hit, but the shrub flora has its troubles. On the University of Wisconsin Arboretum, an area dedicated to the rebuilding of the original native landscape, the Siberian honeysuckle is calmly usurping the understory of all woods, and threatens to engulf even the marshes.

In Wisconsin wood lots it is becoming very difficult to get oak reproduction even when we fence out the cows. The cottontails won't let a young oak get by. One can't interest the farmer in a wood lot which reproduces only weed trees.

Of the dozen pests mentioned on this page, four are imported, seven are runaway native species, and one is of unknown origin. Of the 12, 6 have become pests in the last few years.

Farm crops and livestock exhibit a parallel list of pests, of which the worst now rampant in my region is the corn borer. The corn borer can be controlled by fall plowing, but what that will do to cornbelt wildlife is something I dislike to think about.

It all makes a pattern. Runaway populations are piling up in numbers and severity. In the effort to rescue one value, we trample another. Wild plants and animals suffer worst because we can't spend much cash on controls or preventives. Everything we lose will be replaced by something else, almost invariably inferior. As Charles Elton[1] has said: "The biological cost of modern transport is high."

In short, we face not only an unfavorable balance between loss and gain in habitat, but an accelerating disorganization of those unknown controls which stabilize the flora and fauna, and which, in conjunction with stable soil and a normal regimen of water, constitute land-health.

The human background.—Behind both of these trends in the physical status of the landscape lies an unresolved contest between two opposing philosophies of farm life. I suppose these have to be labeled for handy reference, although I distrust labels:

1. *The farm is a food-factory,* and the criterion of its success is salable products.

2. *The farm is a place to live.* The criterion of success is a harmonious balance between plants, animals, and people; between the domestic and the wild; between utility and beauty.

Wildlife has no place in the food-factory farm, except as the accidental relic of pioneer days. The trend of the landscape is toward a monotype, in which only the least exacting wildlife species can exist.

On the other hand, wildlife is an integral part of the farm-as-a-place-to-live. While it must be subordinated to economic needs, there is a deliberate effort to keep as rich a flora and fauna as possible, because it is "nice to have around."

It was inevitable and no doubt desirable that the tremendous momentum of industrialization should have spread to farm life. It is clear to me, however, that it has overshot the mark, in the sense that it is generating new insecurities, economic and ecological, in place of those it was meant to abolish. In its extreme form, it is humanly desolate and economically unstable. These extremes will some day die of their own too-much, not because they are bad for wildlife, but because they are bad for farmers.

When that day comes, the farmer will be asking us how to enrich the wildlife of his community. Stranger things have happened. Meanwhile we must do the best we can on the ecological leavings.

[1]Journal of Animal Ecology, 1944, 13:1:87-88.

SOME BIOLOGIC AND ECONOMIC ASPECTS OF FIELD BORDER MANAGEMENT

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Improvement of permanent food and cover conditions for wildlife in agricultural areas is largely restricted to odd waste areas and permanent field borders. Edminster (1938) has pointed out that "considering the possibilities of remedying the deficiency in wildlife shelter, we must accept the basic premise that lands being farmed must continue to be cropped substantially as in the past. Cropping methods may be changed, as from block fields to strip cropped fields, but the crops must continue to be grown. The one big opportunity for the creation of permanent shelter areas on crop land lies in the revegetation of permanent field boundaries—the fence rows."

Action programs are already well under way to establish such vegetation along field borders in agricultural areas. Davison (1941) has reported on the establishment of *Lespedeza sericia* and shrub lespedeza borders (*L. bicolor*) in the Southeastern States. More recently, he has reported (by letter dated 7/12/44) that "more than 400 counties of the 500 now in soil conservation districts (in that region) have mature *sericia* borders in numbers exceeding ten. Borders of *bicolor* are not so far along, although there are, no doubt more than 1,000, perhaps three or four thousand." In that region, specifications have been prepared for permanent field border establishment and are being effectively used by soil conservation technicians. Region 1 of the same service has also prepared specifications for the establishment of woody vegetation in existing borders and for establishment of new borders along contour lines at strategic places for soil and water conservation. The use of "living fences" in the Midwest has recently been reviewed by Steavenson et al, (1943). State conservation departments are also furthering these efforts through educational means and in some cases by furnishing planting stock.

Despite the progress already made, widespread adoption of this practice probably will not come about until the biological and economic aspects of field border management are better understood. It is the purpose of this paper to contribute to such an understanding.

Objection to the presence of woody plants in field borders is of long standing in American agriculture. An act to compel owners of land to keep brush, briers, thistles and noxious weeds cut on their respective sides of line or partition fences was passed in Ohio on April 29, 1885 (Ohio Laws, 1885). This act was modified in 1904 (Ohio Laws, 1905) to permit the planting along line fences of vines or trees for use. The latter law is still in effect.

Farm management specialists and teachers have for years been calling attention to the amount of land made untillable by fence rows. Studies made by (Young, 1937) in Indiana and (Meyers, 1920) in New York of farm layouts present data supporting this point. Table 1 based on a survey of 53 farms reported on in the latter study was prepared to show the amount and value of land occupied by different kinds of fence. These data emphasize the obvious fact that the value of the land lost for cultivation increases with the width occupied by the border. With respect to hedge fences, Meyer (1920) states that they "are expensive to trim, but more expensive to let go. They waste much land, harbor insect pests and woodchucks, and do not turn stock satisfactorily."

TABLE 1. RELATION OF KIND OF FENCE AND CROP TO LAND OCCUPIED BY FENCES[1]

Kind of fence	*Width of land made untillable in feet one side of fence only*				Rods of of fence necessary to occupy 1 acre	Value of land occupied by each rod of fence at $100 per acre
	Hay	Small grain	Cultivated crop	Average		
Smooth wire	2.3	3.0	3.8	3.0	871	$0.115
Smooth wire and stone	6.1	7.2	7.7	7.0	377	0.265
Board fence	2.6	3.1	3.4	3.0	871	0.115
Board fence and stone	6.0	5.0	7.2	6.1	435	0.230
Woven wire	2.6	3.3	3.4	3.1	852	0.117
Woven wire and stone	5.3	6.6	7.0	6.3	419	0.239
Barbed wire	2.9	3.4	3.7	3.3	793	0.126
Barbed wire and stone	5.9	8.4	7.6	7.3	362	0.276
Straight rail	3.4	3.5	3.9	3.6	733	0.136
Straight rail and stone	5.5	7.4	9.0	7.3	362	0.276
Laid stone fence	4.4	4.8	5.5	4.9	539	0.186
Laid stone fence and stone	8.5	11.8	12.3	10.9	243	0.411
Stone pile	5.7	6.0	6.1	5.9	445	0.225
Stump	5.4	5.8	7.0	6.1	435	0.230
Woven rail	5.6	6.1	7.6	6.4	411	0.243
Woven rail and stone	8.4	8.8	11.7	9.6	274	0.365
Brush	9.4	11.7	7.0	9.4	282	0.355
Hedge	7.7	10.6	10.4	9.6	276	0.362

[1]From Meyer, 1920.

Other agricultural workers (Cox, 1925) and entomologists (Bissell, 1939; Larson and Hinman, 1931; Larson, Brindley and Hinman, 1936; and Sanderson and Peairs, 1931) have called attention to the role of vegetated field borders as sources of crop pests. McAtee (1939) on the other hand has pointed out the value of maintaining every bit of permanent cover feasible on farms in order to maintain a natural balance. Studies conducted by Fluke (1929) in Wisconsin and Ball et al. (1932) in Florida indicate that the presence of woody vegetation in field borders favors the suppression of certain insects, in these cases the pea aphid and the celery leaf-tier, respectively. It is apparent from these divergent reports that relatively little is yet known about the insect ecology and economic importance of crop field borders.

Studies by Smith (1939) and Harris (1941) in Missouri, Majure (1941) in North Carolina and the writer in Ohio were undertaken in an effort to obtain a better understanding of this problem. The objectives of the writer were to measure populations of vertebrates and invertebrates in field borders and the crop fields adjacent to them and to evaluate their ecological and economic significance.

An area of 15 square miles of intensively-farmed land in Perry Township, Montgomery County, in the southwestern part of Ohio was selected for the study. This tract of predominantly gently-rolling land of moderate fertility and soils of the Miami series is representative of much of western Ohio and northern Indiana. Corn-hog and general livestock farming is practiced by the thrifty (largely Mennonite) farmers. The general pattern of the landscape consists of moderately-sized, uniformly-shaped crop fields interspersed with narrow field borders of bluegrass, bluegrass and shrubs, solid shrubs and a few osage orange hedges and an occasional open drainage ditch. Woodlands are few, small, and usually pastured. Only 6.9 per cent of the area is in woods and only 11 per cent of the total woodland is ungrazed. Field border area in the township (241 acres) exceeds the acreage of ungrazed woods (174 acres).

The composition, distribution, and dimensions of 324 field borders in this area were studied during the summer and fall months of 1938. Aerial photographs of each section were obtained and were used as a base for mapping all of the permanent field borders in one quarter of each section. The results of this survey are presented in Table 2.

The growth form and composition of field borders in this area fits into six rather well-defined types. These in successional order are:

1. *Clean-tilled borders* represent but 3.1 per cent of the total number. They are nearly void of vegetation due to frequent cultural operations such as plowing and cultivation. Usually they are used as turn rows at the end of cultivated fields.

TABLE 2. COMPOSITION AND DIMENSIONS OF CROP FIELD BORDERS IN PERRY TOWNSHIP, MONTGOMERY COUNTY, OHIO

Border type	Per cent of borders	Average width in feet	Average length per 100-acre farm	Average area per 100-acre farm	Average area if all borders were of the same type (acres)
Clean tilled	3.1	4.0	0.09	0.04	1.5
Weedy or herbaceous	6.2	4.0	0.18	0.09	1.5
Grass sod	61.4	4.0	1.84	0.89	1.5
Grass and shrubs	22.4	6.0	0.68	0.49	2.1
Shrubs	5.9	11.0	0.18	0.24	4.0
Osage orange hedge	1.0	16.0	0.03	0.06	5.8
All types	100.0	7.5	3.0	1.81	2.7

2. *Weedy or herbaceous borders* comprise 6.2 per cent of the total number. They are areas in which clean cultivation has been discontinued for one or more growing seasons. Domestic forage plants—sweet clover (*Melilotus alba* Desv.), alfalfa (*Medicago sativa* L.), red clover (*Trifolium pratense* L.), and weeds such as giant ragweed (*Ambrosia elatior* L.), white top (*Erigeron annuus* (L.) Pers.), and green foxtail (*Chaetochloa viridis* (L.) Scribn.), predominate.

3. *Grass sod borders* comprised principally of a dense bluegrass (*Poa pratensis* L.) sod make up 61.4 per cent of the total. Other plants frequently found in sod borders are Canada bluegrass (*P. compressa* L.), timothy (*Phleum pratense* L.), orchard grass (*Dactylis glomerata* L.), and red top (*Agrostis alba* L.).

4. *Grass and shrub borders* in which low trees, shrubs or vines occupy less than half of the area comprise 22.4 per cent of the total. In these borders, sprout growth of elm (*Ulmus americana* L., *U. fulva* Mx.), hackberry (*Celtis occidentalis* L.), white ash (*Fraxinus americana* L.), white oak (*Quercus alba* L.), bur oak (*Q. macrocarpa* Mx.), wild black cherry (*Prunus virginiana* L.), grapes (*Vitis* sp.), hawthorn (*Crataegus* sp.), and elderberry (*Sambucus canadensis* L.), occur in heterogeneous mixtures.

5. *Shrub borders* representing 5.9 per cent of the total were recorded. They are composed of rather continuous stands of the sprout growth listed under 4 above.

6. *Osage orange* (*Toxylon pomiferum* Raf.) hedges comprised but 1.0 per cent of the total number of borders. At the conclusion of the study in 1942, less than one half of these hedges remained.

The minimum practical width of fenced field borders is approximately 4 feet. This is the narrowest margin (2 feet each side of the fence) that can be conveniently maintained with modern farm machinery. Additional border width in this study area would represent a loss of potential cropland under the local farming system. Land values, exclusive of buildings, average (December 4, 1940) $55.00 per acre and the tax rate $15.50 per $1,000 valuation. On this basis, the value of land lost to cultivation on a 100-acre farm with all of the field borders alike would amount to: $33.00 for grass and shrub borders, $137.50 for shrub borders, and $236.50 for osage orange hedges. The annual tax load for this land would be $0.52, $2.13 and $3.30, respectively.

The amount of land adversely affected for crop production by fence-row vegetation varies with the nature of the vegetation, the exposure, the crop grown, and probably other factors. Davison (1941) states that in the Southeastern States, "the field border problem area is rather uniformly 30 to 35 feet wide, measured from the trunks of trees of average size at the edge of the woods." That this may be generally true of fence-row vegetation is evident from observations throughout Ohio and a few measurements in the study area. Along one east and west running osage orange hedge, approximately 25 feet in height, for example (Section 19, Perry Twp.), the yield of soybeans planted in rows 36 inches apart on the south side was measurably reduced in the first 10 rows adjacent to the hedge. A three plant sample selected at random from the 5th, 8th and 11th rows from the hedge yielded 1.8 gms., 4.9 gms., and 7.9 gms., of shelled beans, respectively. Adjacent to a north and south border of shrubs and trees ranging from 6 to 25 feet in height, reduction in close drilled soybeans was evident on the west side for a width of 14 feet to 22 feet. Another shrub border (Section 11) affected appreciably the height of stalks and size of ears in the first four rows to the east of this border.

Forage and small grain crops do not appear to be so seriously affected by proximity to field borders as are corn, soybeans, and tobacco. Borders less than 6 feet in height also seem to have little or no adverse effect on the adjacent crops. Detailed measurements of crop yield reduction are needed however before the safe limits of border dimensions with respect to crop production can be established.

Collections of insects were made during the growing seasons of 1939, 1940, and 1941 by a standardized sweeping technique. Field borders representative of weedy, grass, shrub, and osage orange types and the crop fields adjacent to them were visited at 7 to 10 day intervals throughout the season. Fifty sweeps, with a specially-constructed net (Dambach, 1941) were made at random in each area. The insects collected were killed and rough sorted in the field. They later were identified with the aid of specialists and by comparison with named material in the Ohio State University collections.

Data obtained in the 1939 collections[1] are summarized in Figure 1. It is readily evident from this figure that beneficial insects subject to collection by the sweeping method are much more abundant on woody than on herbaceous plants. It is also evident that the latter plants support far greater numbers of injurious insects than do woody plants. Most of the injurious insects present on woody plants are pests of forest, shade, and fruit trees. In a section where corn-hog farming predominates, these insects are of comparatively little importance. Insects collected in meadows and on bluegrass, however, are largely common crop pests such as leafhoppers, plant bugs, and grasshoppers.

[1]A complete tabulation of all invertebrates collected is in preparation for later publication. This tabulation will include specific records for all three seasons and for overwintering forms collected in 1939 and 1941-42.

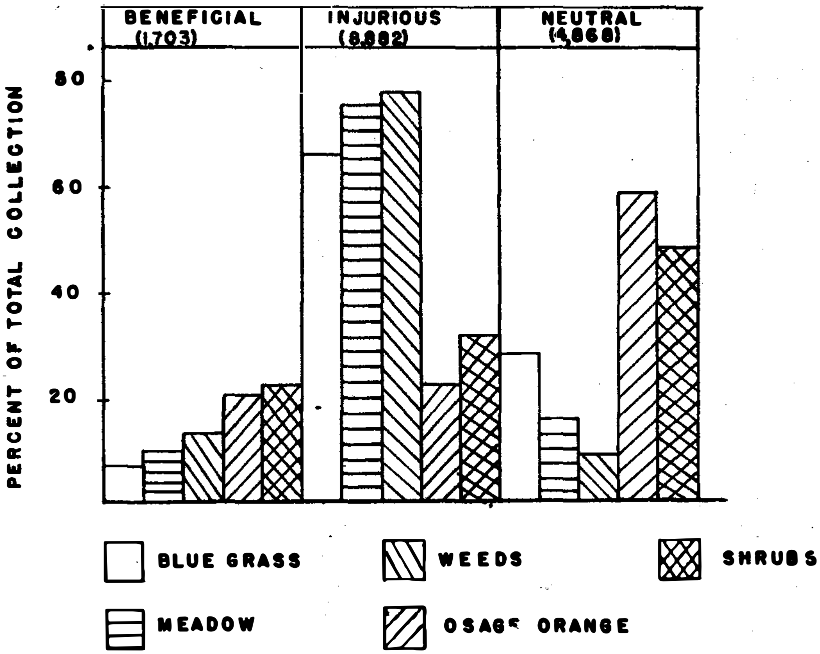

Figure 1. Relative economic value of insects collected by sweeping field borders and adjacent crop fields. Perry Township, Montgomery County, Ohio. 1939.

Burning or otherwise eliminating vegetation in crop field borders to destroy overwintering crop pests is a traditional practice in many of the Southern and Midwestern States. The widespread application of this practice probably dates to early efforts to combat, by burning, the cotton boll weevil in the South and the chinch bug in the Midwest. The ineffectiveness of the practice except under carefully-controlled conditions is now quite generally accepted by entomologists. Metcalf and Flint (1939), for example, make no reference to burning field borders for control of the boll weevil and advise that burning for chinch bug control is feasible only in areas west of the Mississippi River, and there only in bunch grasses in which the insect commonly hibernates.

In a review of control measures for 57 important midwestern crop pests which are treated at length in the revised edition of *Destructive and Useful Insects* (Metcalf and Flint, 1939), it was found that clean up of field borders is recommended as a part of the control measures for but 11 kinds of pests. The crops affected, hibernating media and recommended control measures follow.

Corn pests	*Hibernating media*	*Control in relation to borders*
Grasshoppers	Egg capsules in *sod* field borders.	Fall plowing and discing to expose eggs.
Common stalk borer	Eggs on *weeds* and *grasses* adjacent to crop fields.	Burning field margins or mowing about mid-August.
Corn aid small grain pests		
Chinch bug	Adults in field borders. Principally in *bunch grasses*, but *also in shrub* leaf *litter*.	Burn field borders (west of the Mississippi River).
Forage and legume pests		
Garden webworm	Pupal stage in soil adjacent to host plants (*grass*).	Close clipping of field borders to remove food supply.
Truck crop pests		
Flea beetles	Adults in trash in *fields* or *field margins*.	No special control measures.
Mexican bean beetle	Adults in trash in *woods* and *hedgerows*.	Clean up hibernating areas in field margins.
Striped cucumber beetle		
Spotted cucumber beetle		
Squash bug		
Thrips (onion)		
Tarnished plant bug	Adults and nymphs in litter.	Clean up of borders around fields may help.

Seven of these are truck crop pests and the remaining four are pests of grain or forage crops. The principal overwintering quarters of the latter pests is in sod or weedy borders. Population studies of invertebrates overwintering in field border and adjacent crop land litter in Montgomery County, Ohio, during the winters of 1939-1940 and 1941-1942 substantiate these observations (Figures 1 and 2). The data summarized in these two figures are based on square foot litter samples taken at random during the winter months when insects were inactive. A total of 586.4 square feet of litter was examined with the aid of a Berlese funnel. Nine thousand nine hundred and fifty invertebrates were collected. These were identified and classified according to their economic importance and the crops affected by the injurious species. These data, presented in Figures 2 and 3, indicate that the relative abundance of crop pests in the total population is much greater in crop field litter or in litter from plants closely related to crops (*bluegrass*) than in leaf litter from shrubs and trees. Orchard pests, however, are much more abundant in shrub litter than in grass and crop areas and except for samples from a field of old timothy sod, the same relationship holds for truck crop pests. Beneficial species appear to be relatively more abundant in sod and grain crop litter. In the same areas, injurious forms are approximately two times as abundant in proportion to the total population as they are in shrub and osage litter.

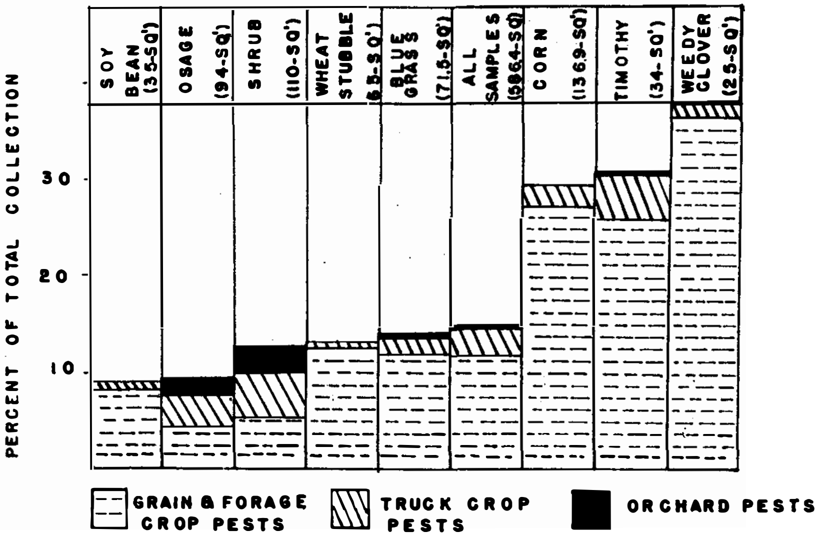

Figure 2. Relative abundance of overwintering crop pests in surface litter from field borders and adjacent crop fields. 1939.

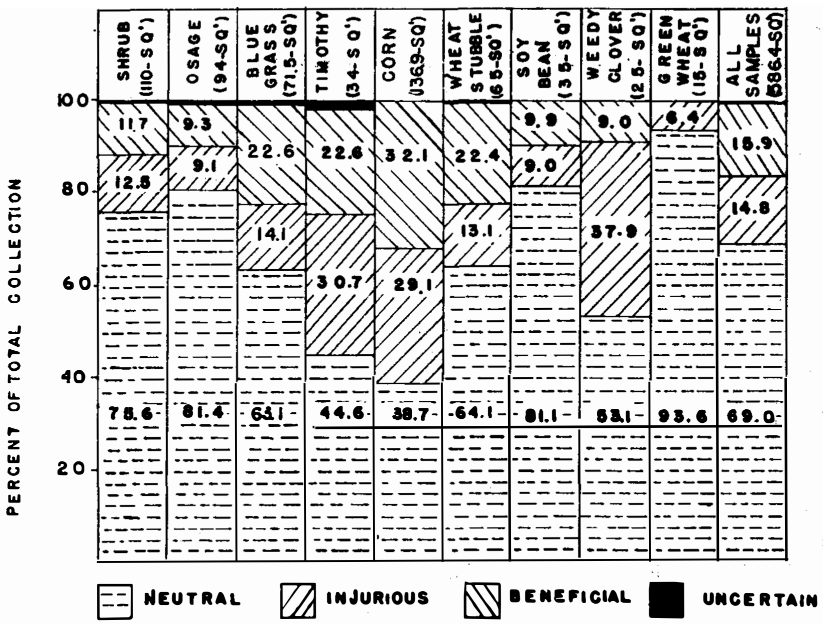

Figure 3. Relative economic importance of overwintering insects in field borders and adjacent crop fields. 1939.

Beneficial forms in the sod and crop fields were principally predaceous ground beetles and spiders. In shrub and tree litter beneficial forms were represented primarily by predaceous lady beetles and bugs which are able to fly from their overwintering quarters to summer feeding grounds. It is of considerable interest to note that in this study, injurious insects were no more abundant in proportion to the total population in field borders than in the adjacent crop fields.

The number of overwintering crop pests per unit of area, however, except in osage orange hedges, is greater in field borders. By contrast, if the total area of field borders per 100-acre farm in relation to the (Table 2) acres of crops is taken into consideration, the insect pests in crop fields would be found to greatly exceed in number those in borders. If, for example, a 4-year rotation was followed consisting of corn, small grain, and 2 years of meadow, the theoretical overwintering injurious insect population would be as follows:

Field or border	Area per 100-acre farm (estimated)	Total overwintering crop pests (Table 3)	
Corn	20 acres x 20,000 equals	400,000	Total pests in crop fields 5,800,000
Wheat stubble	20 acres x 70,000 equals	1,400,000	
Meadow (timothy)	40 acres x 100,000 equals	4,000,000	
Grass sod	1.5 acres x 210,000 equals	315,000	Average number of pests in borders 471.833
Shrubs	4.0 acres x 184,500 equals	738,000	
Osage hedge	5.8 acres x 62,500 equals	362,500	

These computations must be tempered with the knowledge that insects overwintering in crop fields are subject to control by cultural operations and that specific pests such as chinch bugs may sometimes concentrate in enormous numbers in some field borders.

Small mammal populations in field borders and adjacent crop fields were measured during the winter of 1938-1939 and 1941-1942. Ordinary snap-back mouse traps were used in both line and quadrat sets. Line sets were used in preliminary studies during the first trapping season and the quadrat method described by Boles (1939) was used during 1941 and 1942. The population data presented in Figures 4 and 5 were obtained by this method. Twelve quadrats were established

TABLE 3. NUMBER OF OVERWINTERING INVERTEBRATES IN CROP AND FIELD BORDER LITTER, PERRY TOWNSHIP, MONTGOMERY COUNTY, OHIO, 1941-1942

Litter from which samples were obtained	*Number of invertebrates per acre*				
	Neutral	Injurious	Beneficial	Uncertain	Total
Bluegrass sod border	941,000	210,000	337,000	3,000	1,491,000
Shrub border	1,116,500	184,500	172,500	4,000	1,477,500
Osage hedge	560,000	62,500	64,000	1,500	688,000
Soybean litter-crop field	484,000	54,000	59,000	....	597,000
Wheat stubble-crop field	343,000	70,000	120,000	2,000	535,000
Timothy sod-crop field	145,000	100,000	73,000	7,000	325,000
Weedy clover, crop field	164,000	117,000	28,000	....	309,000
Corn field litter-crop field	26,500	20,000	22,000	....	68,500
Green wheat-crop field	44,000	....	3,000	....	47,000

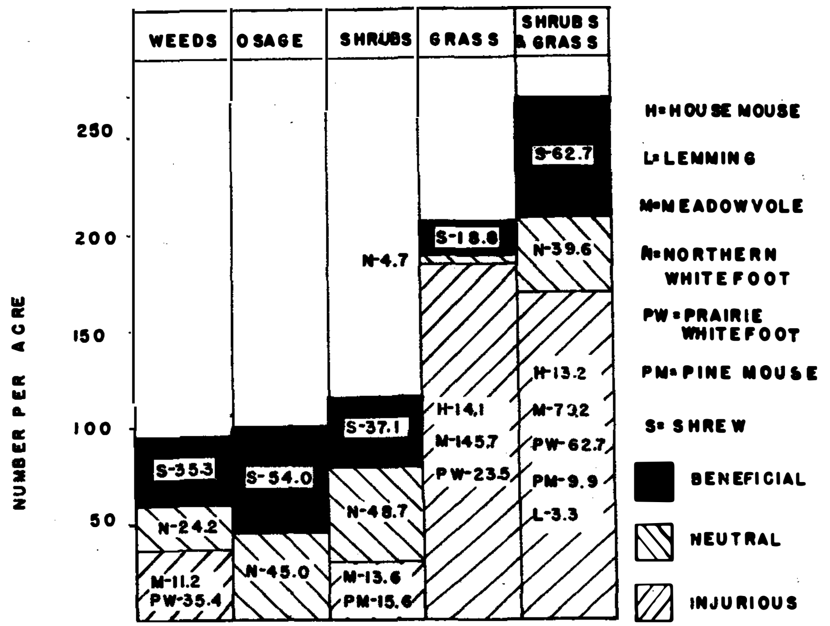

Figure 4. Winter population of small rodents and shrews in crop field borders. Perry Township, Montgomery County, Ohio. 1941-1942.

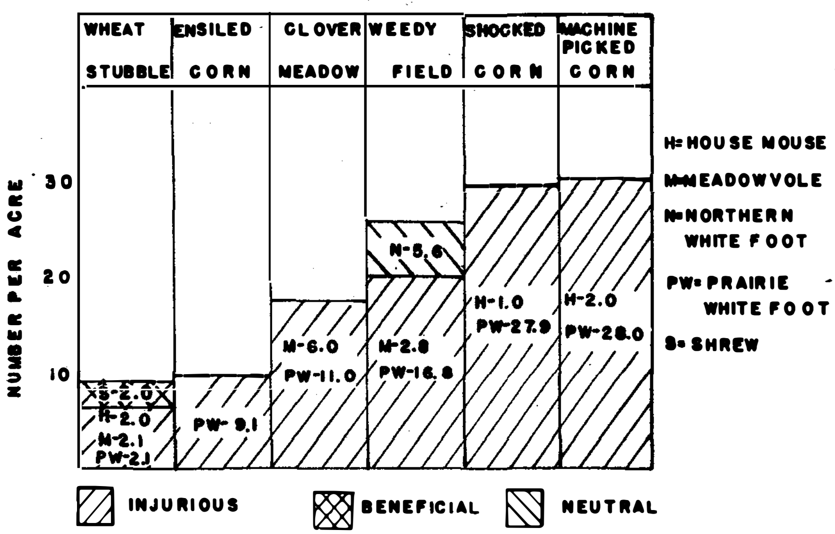

Figure 5. Winter populations of small rodents and shrews in crop fields. Perry Township, Montgomery County, Ohio. 1941-1942.

and each was operated for three consecutive trap nights. Each quadrat was bisected by a field border with crop fields on both sides. One hundred and fifty foot square quadrats were used. Traps were set in both surface and subsurface runways and were baited with dried raisins. Catches were recorded separately for the borders and the fields. The data presented are based on 6,292 trap-nights and 361 catches.

Field border small mammal populations (Figure 4) were in all cases three or more times greater per unit of area than those in the adjacent crop fields. Borders in which occasional shrubs occurred with dense bluegrass sod had populations of small mammals nine times as great as populations in machine harvested corn fields where broken corn stalks provided cover, and an estimated 5 to 10 bushels of ear corn littered the ground. In crop fields, populations ranged from 8.2 per acre in wheat stubble to 30 per acre in fields with considerable waste corn on the ground. Except for a population of 2 shrews per acre (*Blarina brevicauda* var.) in wheat stubble and 5.6 northern white-footed mice (*Peromyscus leucopus noveboracensis*) (Fischer) per acre in a fallow crop field all of the crop field mammals trapped are crop pests.

Pest species of mammals in weedy, shrub and osage orange borders made up but a small proportion of the total population. Borders consisting largely of bluegrass supported very high populations of destructive species, notably: meadow voles (*Microtus p. pennsylvanicus* (Ord.) *M. ochrogaster* var.), pine mice (*Pitymys pinetorum scalopsoides* Audubon and Bachman), lemming (*Synaptomys cooperi* var.), prairie white-footed mouse (*P. maniculatus bairdi,* Kennicott), and house mouse (*Mus. m. musculus* Linnaeus). Beneficial mammals (short-tailed shrew) occurred in greatest abundance along woody, weedy, and mixed sod and shrub borders where feeding runways of moles were numerous and where the soil was loose, friable and well covered with litter.

Although field border mammal populations appeared to be largely confined to the limits of the borders, it is quite probable that they might serve as seed stock in repopulating adjacent crop fields as food and cover conditions changed. This is particularly true of meadow voles and prairie white-footed mice in sodded borders. Borders composed largely of woody plants appear to have little importance as a source of small mammal field crop pests, but do harbor an important orchard pest, the pine mouse.

The value of brushy, field borders in providing nesting and escape cover for insectivorous and game birds has been noted by a number of authors (Edminster, 1938; Leedy, 1940; Smith, 1939; and Dambach, 1940). In the present study, an effort was made to determine the number of birds utilizing various types of borders for nesting cover. Breeding bird censuses were conducted during three consecutive years along borders where insect and mammal studies were made and along a series of borders selected at random. A combination census by singing male count and nest searching was employed. The data thus obtained are summarized in Table 4.

The low density of birds recorded in this table for 1940 is probably due to the fact that the census period beginning June 3, 1940 was preceded by unseasonably cold and wet weather. Rain fell every day from May 15 through May 25 and the ground was still soggy on June 3. The census in 1939 and again in 1941 was initiated in mid-May and continued through June at approximately weekly intervals.

It is readily evident from this tabulation that nesting birds in the area studied are many times more abundant in shrub or osage borders than they are in herbaceous types. They also are much more abundant in borders than they are in adjacent crop fields where the average population even in rich meadows is less than one pair to the acre. On the basis of the computations in this paper (Tables 2 and 4) and published crop field bird populations reported from nearby Butler County (Good and Dambach, 1943), breeding bird populations per 100-acre farm would be increased three and one half times by maintenance of all borders in woody cover.

Area of border per 100-acre farm if all borders are shrubby	4.0 acres
Average population of breeding birds per acre of shrub border	30.1 pairs
Average population of breeding birds per 100-acre farm	45.4 pairs
Potential population of birds in shrubby borders	120.4 pairs
Potential population of birds per 100-acre farm if all borders are shrubby	165.8 pairs

There is no assurance that such an increase in bird population would actually come about by the single expedient of fence-row management. It would be interesting to conduct experiments in this direction and to determine if increases in bird populations would materially alter insect pest problems.

SUMMARY AND CONCLUSIONS

A study of the ecology and economic relations of crop field borders in Perry Township, Montgomery County, Ohio, was made during the years 1938-1942. Six types of borders were recognized, namely: clean tilled, weedy or herbaceous, sod, sod and shrub, shrub and osage orange hedge. A minimum border width of 4 feet appears to be essential for operation of farm machinery. Only sod and shrub (6 feet), shrub (11 feet), and osage orange hedge (16 feet) borders exceed this width. The value of land thus made unavailable for cultivation is $33.00, $137.50 and $236.50, respectively. The annual tax load in the same

TABLE 4. BREEDING BIRD POPULATIONS IN FIELD BORDERS, PERRY TOWNSHIP, MONTGOMERY COUNTY, OHIO, 1939-1940-1941

Species	Bluegrass			Bluegrass and shrubs			Weeds			Solid shrubs			Osage orange hedge			Total		
	39	40	41	39	40	41	39	40	41	39	40	41	39	40	41	39	40	41
Eastern bob-white *Colinus v. virginianis* (L.)	7	....	....	2	....	3	....	....	....	....	3	....	3	1	....	12	4	3
Eastern mourning dove *Zenaidura macroura carolinensis* (L.)	....	....	....	2	....	....	....	....	....	....	....	....	1	1	2	3	1	2
Yellow-billed cuckoo *Coccyzus a. americanus* (L.)	....	....	....	....	....	....	....	....	....	....	....	....	....	....	1	....	....	1
Eastern vesper sparrow *Poecetes g. gramineus* (Gmelin)	11	....	7	13	1	8	....	....	....	1	1	2	....	....	....	25	2	17
Eastern grasshopper sparrow *Ammodramus savannarum, australis* (Maynard)	1	....	....	....	....	....	....	....	....	....	....	....	....	....	....	1	....	....
Eastern field sparrow *Spizella p. pusilla* (Wilson)	....	....	....	8	2	8	....	1	....	3	5	1	2	1	....	13	9	9
Mississippi song sparrow *Melospiza melodia beata* (Bangs)	1	1	1	7	2	1	....	1	....	1	1	....	2	2	1	11	7	3
Eastern cardinal *Richmondena c. cardinalis* (L.)	....	....	....	....	....	....	....	....	....	....	....	....	....	....	1	....	....	1
Indigo bunting *Passerina cyanea* (L.)	....	....	....	2	1	2	....	....	....	3	5	2	2	....	....	7	6	4
Migrant shrike *Lanius ludovicianus migrans* (Palmer)	....	....	....	1	....	....	....	....	....	....	....	....	1	....	....	2	....	....
Brown thrasher *Toxostoma rufum* (L.)	....	....	....	2	....	....	....	....	....	1	....	....	1	....	....	4	....	....
Eastern robin *Turdus m. migratorius* (L.)	....	....	....	1	....	1	....	....	....	....	....	....	4	....	3	5	....	4
Number of borders observed	68	24	78	24	6	19	....	3	....	4	5	2	4	2	1	100	40	100
Number of pairs observed	20	1	8	38	6	23	....	2	....	9	15	5	16	5	8	83	30	44
Number of species	4	1	2	9	4	6	....	2	....	5	5	3	8	4	4	10	6	9
Miles of border observed	9.6	6.5	9.5	4.3	1.4	2.9	....	1.0	....	.4	.6	.2	.8	.8	.2	15.1	10.2	12.8
Pairs of birds per mile	2.1	.1	.8	8.7	4.3	7.9	....	2.0	....	23.3	25.0	25.0	19.2	6.1	40.0	5.4	2.9	3.4
Acres of area	2.9	2.7	3.4	2.0	.8	1.4	....	.5	....	.3	.6	.1	1.1	1.1	.3	6.3	5.7	5.2
Pairs of birds per border acre	6.9	.4	2.3	19.0	7.5	16.4	....	.4	....	32.1	25.0	33.3	13.6	4.5	29.6	13.1	5.2	8.5
Number of borders occupies	16	1	8	21	4	....	....	1	....	4	5	2	4	2	1	45	13	....
Per cent of borders occupies	23.5	4.1	10.2	87.5	66.6	....	....	33.3	....	100.0	100.0	100.0	100.0	100.0	100.0	45.0	32.5	....

order would be \$0.52, \$2.13, \$3.30. Another economic consideration is the reduction in yield of crops immediately adjacent to borders.

Insect population studies conducted during the summer months indicate that few insects injurious to grain and forage crops occur on woody vegetation adjacent to crop fields. Many beneficial insects, however, do frequent such areas. Insects collected from sodded field borders are largely crop pests or closely-related forms.

Overwintering insects and other invertebrates occur in greater abundance in field border litter than in litter in adjacent crop fields. The proportion of crop pests in field border populations is, however, much less and particularly so in the case of leaf litter from woody plants. The number of grain and forage crop pests in such litter is comparatively small. Orchard and truck crop pests, however, are more abundant in this type of litter than in sod or crop fields.

Populations of small mammals (mice and insectivores) are much greater, three to nine times, in field borders than they are in adjacent crop fields. Borders composed largely of sod support heavy populations of destructive species while those composed chiefly of woody plants are occupied mainly by species of beneficial or neutral habits. Some economically important species are harbored by woody borders, notably pine mice and some meadow voles.

Breeding bird populations in crop field borders containing woody vegetation greatly exceed those composed of herbaceous plants. Annual per border acre populations in shrub field borders ranged from 25.0 to 33.3 pairs while in bluegrass borders, the range was from 0.4 to 6.9 pairs. Theoretically, at least, the population of breeding birds on an average southwestern Ohio 100-acre farm could be increased three and one half times if all of the field borders were maintained in shrubby growth.

The data presented in this report are based on a review of pertinent literature and on limited samples in a single township in southwestern Ohio. It is believed, however, that they are representative of conditions in a rather large section of the Midwest where corn-hog and general livestock farming is practiced on rather fertile land of moderate to flat topography. In a general way, at least, the data indicate that the following general conclusions can be drawn concerning the ecologic and economic relations of crop field borders.

1. Field borders are an essential part of the farming pattern whenever livestock are included in the farm enterprise.
2. There is a minimum width of field border below which efficient use of farm equipment is impractical. By observation and measurement on farms using modern farm equipment, this width

was found to be approximately 4 feet (considering both sides of fenced borders).

3. Border width in excess of 4 feet represents a loss in potentially productive land without reduction in the tax load.
4. Crop field borders supporting vegetation more than 6 feet in height may cause a material reduction in the yield of cultivated crops immediately adjacent to the border. The area so affected may extend two or more rods into the cultivated field.
5. Crop field borders harbor larger numbers of insects including injurious and beneficial species and species of no economic importance on a unit of area basis than do adjacent crop fields.
6. Crop field borders harbor larger populations of small mammals such as mice and shrews (at least during the winter months) on a unit area basis than do the adjacent crop fields.
7. The more nearly the vegetation in a crop field border is related to the adjacent crops, the greater is the danger of its serving as a center for infestation of crops by insect and small mammal pests.
8. The clean tilled, sod and weedy or herbaceous types of field borders are more important as sources of grain and forage crop pests than are woody borders. The converse is true of truck and most orchard crops.
9. Field borders composed largely of woody plants are occupied by many more nesting birds than are nonwoody borders and greatly exceed in numbers of nesting pairs comparable areas of crop fields.

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MANAGEMENT OF BOB-WHITE ON THE OAK-TALL GRASS PRAIRIE, NORTH CENTRAL OKLAHOMA

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A 5-year study was conducted on the Lake Carl Blackwell Project and adjoining farms near Stillwater in north central Oklahoma, to determine management measures for the bob-white quail (*Colinus virginianus*). Many approaches to this problem were based on the discussion by Errington and Hammerstrom (1936) of census methods and techniques useful in determining ecological relationships.

According to the classification of Oklahoma game lands made by Duck et al. (1943), the study area lies in the zone where the post oak (*Quercus stellata*)-black jack oak (*Q. marilandica*) forest meets the tall grass prairie. From the point of view of bob-white use, five distinct plant associations occur commonly. These are: upland prairie dominated by bluestem grasses (*Andropogon scoparius* and *A. furcatus*); black jack-post oak savannas on the sandy slopes; fringe forests along the streams characterized by elms (*Ulmus*) and hackberries (*Celtis*); cultivated fields with grain sorghums, corn, cotton, wheat, and alfalfa the major crops; and abandoned or idle fields dominated by annual grasses and annual and perennial weeds.

MANAGEMENT OF FOOD AND COVER

Habitat requirements.—Winter bob-white range in this area is confined largely to the timbered and brushy ravines and patches of oaks when such associations are bordered by grain fields or by idle and abandoned croplands. Timbered and brushy areas however, when completely surrounded by pastures, have seldom been found to support coveys of quail. Occasionally rank growths of tall weeds in idle fields or along roadsides also provide satisfactory winter range. During the spring bob-white spread out into the open grasslands for nesting and rearing of the young, but gradually shift back to the timbered and brushy areas as grazing, harvesting of crops, and frost reduce the amount of escape cover.

Control of grazing.—On a typical farm practically all of the fields as well as the timbered areas and grasslands are grazed during the winter season. Consequently, in an area showing a suitable pattern of food and cover, it is the amount of grazing which determines the winter carrying capacity for bob-white.

The relationships between degrees of grazing and bob-white populations were studied on the Lake Carl Blackwell Project. As shown in

Table 1, continuous overgrazing finally resulted in the complete elimination of bob-white coveys from an experimental pasture which, prior to grazing, had supported a high quail population. In contrast, two other areas, one completely protected from grazing and other only moderately grazed, maintained fairly stable populations except for severe mortality during a 20-day period of snow in the winter of 1939-40.

The same relationships between bob-white populations and grazing pressure were observed on several farms. Farmers who persistently overgrazed their pastures had comparatively few coveys of quail in the fall and practically no birds in the late winter.

Control of fires.—Another serious problem in quail management is the common practice of burning off the pastures particularly in late winter. Fall and early winter fires, in both cases studied, made quail ranges uninhabitable during the remainder of the winter (Table 1). Even more extended damage was done by the two late winter fires of March 16 and March 31, 1943 which burned over a solid block of some 1,100 acres. On the day following each fire all of the coveys known to range within this area were located in the burned off pastures. With the exception of two birds that flew poorly and appeared to have ragged wings as if they might have been burned, all of the birds appeared to be vigorous and the covey sizes were comparable to counts made earlier in the year. But within a 10-day period six of the nine coveys had moved to new ranges bordering the fire or had disappeared. Some of the ravine bottoms were too wet to burn and three coveys were consequently able to spend the remainder of the winter in their normal ranges. With the growth of spring vegetation, many birds

TABLE 1. BOB-WHITE POPULATIONS ON AREAS OF DIFFERENT GRAZING PRESSURE

	AREA I (300 acres)		*AREA II (300 acres)*		*AREA III (150 acres)*	
Date	Number of bob-white	Remarks	Number of bob-white	Remarks	Number of bob-white	Remarks
April 1, 1939......	29	Ungrazed	15	Ungrazed	52[1]	Ungrazed
Nov. 1, 1939........	31	"	45	"	116	"
April 1, 1940......	13	Ungrazed; part of area burned over in Dec., 1939, one covey fed	0	Ungrazed; no emergency feeding; birds died off during January	76	Ungrazed; all coveys fed
Nov. 1, 1940........	33	Ungrazed	28	Ungrazed	74	Ungrazed
April 1, 1941.....	47	"	26	"	38	"
Nov. 1, 1941.......	35	Ungrazed; part of area burned over in Sept.	52	Moderately grazed; one head to 15 acres	84	Overgrazed; one head to 7.5 acres
April 1, 1942.....	53	Ungrazed	49	"	32	"
Nov. 1, 1942.......	92	"	38	"	48	"
April 1, 1943......	79	"	40	"	30	"
Nov. 1, 1943.......	53	"	57	"	20	"
April 1, 1944.....	59	"	43	"	0	"

[1]Population figures doubled in order to make them comparable with those for areas I and II.

shifted back into the burned areas yet the following fall the population had decreased from 96 to 88 indicating that conditions had not returned to normal during the growing season. On the other hand the unburned areas revealed an increase from 222 to 270 in spite of very unfavorable weather conditions during the nesting and brood seasons. By the fall of 1944 the number of quail on the burned areas was again comparable to that found on unburned areas. These data indicate that bob-white populations did not completely recover from late winter fires until the end of the second nesting season.

An educational program pointing out the value of fire prevention in preserving the fertility of the soil and preventing serious soil erosion has been conducted for several years by the Extension Division of A. and M. College, the Soil Conservation Service, and the Izaak Walton League. Already the acreage of burned over pastures and croplands has been materially reduced. It is apparent that this program is of real benefit to wildlife through the preservation of necessary cover and food.

Experiments on the improvement of food and cover.—Numerous attempts were made to create new covey ranges and stabilize existing ranges on the project. Since cultivation had been discontinued and seed-bearing weeds in old fields had been gradually replaced by grasses that do not furnish much seed, a shortage of winter food was a serious limiting factor. To correct this condition, in 1939 and 1940 a total of 14 plots ranging in size from one quarter to 2 acres were listed and planted to grain sorghums (darso and redtop). Mung beans or domestic sunflowers were added to the mixture in four plots. In both years the planting dates were late and the production of seed was mediocre, so that the tests may not have been adequate. Food patches located in the open far removed from natural escape cover showed no indication of bob-white use. Plots adjoining suitable cover, although occasionally used, did not appear to be any more attractive than old fields.

The value of winter feeding was also tested on the project. Small shelled grains were fed daily to several coveys throughout and following a 20-day period of snow and low temperatures extending from late December 1939 to the middle of January 1940. The fact that the 400-acre area where quail were fed regularly supported 56 birds at the end of the winter while the remaining 2,700 acres under observation carried only 19 birds is conclusive evidence of the success of emergency feeding. Furthermore, local bird dog trainers have held coveys on areas lacking cultivation by continuous feeding throughout the winter while coveys disappeared from similar habitats where feeding was not practiced.

The lack of winter cover is also a serious limiting factor in areas where solid blocks of 100 acres or more are completely devoid of woody vegetation. In order to correct this condition 30 tent-type pole or low board shelters, as recommended by Lehmann (1941), were constructed on the edges of food patches and in the middle of old fields that appeared to provide food but lacked natural cover. No evidence has been obtained to suggest that these small artificial shelters increased the range of coveys. A low fence of oak limbs built around one food patch was used to some extent as a loafing ground, suggesting that the pole and board shelters may not have been extensive enough to provide adequate protection from natural enemies. Large piles of tree tops in old fields were immediately occupied by coveys evacuated from adjoining ravines by timber cutting and were used to some extent every year. Trees felled in a ravine bottom and allowed to lie furnished excellent cover and also harbored important food plants since the tangles of branches acted as barriers to heavy grazing.

Recommendations on habitat improvement.—Four more or less distinct quail habitats occur in this region, each requiring special treatment in order to improve conditions.

One of these situations is found on the tall grass prairie where as much as 80 per cent of the farm is cultivated and the remainder heavily grazed. The writer concurs with the opinion of Duck and Fletcher (1944) that on such farms a program of habitat improvements for bob-white is impractical since both winter food and cover are lacking over large areas.

In contrast, many farms show a good distribution of timbered and brushy ravines and patches of oaks bordered by croplands and small grasslands. The practice of moderate grazing, the prevention of fires and the protection of field gullies, natural ravines and farm ponds by fencing out stock would undoubtedly permit more coveys of quail to winter successfully and probably would also increase the production and survival of young birds.

The third situation occurs in extensive pastures where cover is provided by an adequate system of ravines and patches of oaks, but the absence of cultivation results in a winter-food deficiency even under moderate grazing. A system of disced fire guards, which grow up to seed-producing weeds, might increase the carrying capacity for bob-white and other seed-eating animals. Pasture improvement through the use of legumes and fertilizers also benefits wildlife by increasing the amount of food and cover.

Many prairie pastures lack both winter food and cover. A system of disced fire guards, the use of legumes and fertilizers in pasture improvement should improve food conditions. Plantings of ornamental and shade trees and shrubs about the farm house and post lot plantings of black locust (*Robinia pseudoacacia*) may provide the necessary cover and food to carry bob-white through the winter.

EFFECTS OF HUNTING

As discussed in an earlier paper (Baumgartner, 1944) the removal of approximately 20 to 55 per cent of the fall population by shooting during a 5-year period did not prevent an area from maintaining a high population each fall. Population figures obtained on several farms, although admittedly subject to error, indicate that approximately 50 per cent of the birds present at the beginning of the hunting season (November 20) disappear before the beginning of the mating season in April regardless of the intensity of hunting. Furthermore, Duck and Fletcher (*ibid*) found that the average winter mortality in Oklahoma was 54 per cent of the fall population on both game refuges and hunted areas. All of these data indicate that average hunting losses leave a considerably larger number of bob-white than survive the winter.

SUMMARY

A 5-year study of bob-white management near Stillwater in north central Oklahoma indicates the following relationships:

1. Adequate winter food and cover are limited chiefly to timbered or brushy ravines and patches of oaks when such associations are bordered by cultivated or idle croplands.

2. Overgrazing materially reduces fall population and forces coveys to abandon ranges in the late winter. Light to moderate grazing pressure does not appear to reduce seriously the winter carrying capacity.

3. Fall and early winter fires destroyed covey ranges for that season. Late winter fires forced coveys to shift to new ranges and affected the population as much as a year later.

4. Food patches far removed from cover do not appear to provide new covey ranges for bob-white and are not considered consistent with good range management.

5. Winter feeding is desirable on areas where natural foods are limited.

6. Pole and board shelters do not provide adequate escape cover. Fences of oak limbs, large piles of tree tops, and felled trees furnish satisfactory cover.

7. Plantings of ornamental and shade trees and shrubs about farm homes and black locust post lots may provide sufficient cover and food to meet the winter requirements of bob-white.

8. Normal hunting does not appear to be an important limiting factor since the average winter loss is about 50 per cent of the fall population regardless of the presence or absence of hunting.

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WATER, FISHES, AND CROPLAND MANAGEMENT

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Water is a natural resource which we use in many ways, and the public values of the various types of usage need to be appraised to determine if some needs are not now neglected which should receive preferential consideration while other present uses may need restriction or regulation. The unrestricted use of water has been considered one of the prerogatives of American enterprise, but there are evidences that our prodigalities have not always been wise.

We must drink water and we must supply water to our food plants and animals in order to keep our bodies functioning, and these uses of water must be given the highest preferential rating from the standpoint of public values. We can use water for the removal of our wastes, for the production of power, for transportation, recreation, and countless other purposes. The exploitation of this resource for these uses has been directed towards personal rewards for the enterprise involved in guiding the work efforts of water into the desired channels, but it is now apparent that these practices have not always operated for the greatest public good.

The following instances illustrate the obvious conflict between private and public values which can and do occur. The lumber producer who cuts every tree from steep hillsides, then burns his "tops" and with them burns the ground-covering vegetation and humus, is setting the stage for the rapid runoff of rainwater which leads to floods and droughts and loss of soil by erosion. The farmer whose stock grazes his fields to nudity and tramples the creek banks into muddiness, and who burns his meadows and marshes is creating muddy streams which shift from flood to drought and thereby adversely affect all people who use surface or ground-water supplies. The power man who builds and maintains a dam across a stream is placing a barrier in the path of fishes which may keep them from conditions which are necessary to their very existence. The county engineer who gives contracts to his dredge-owning friends to convert good streams into ditches, is adversely affecting everyone in his district. The manufacturer who pumps clean water from an impoundment, or from underground, and then turns waste waters back into a stream or lake is spoiling those waters for further use. The operator of sand or gravel dredges who takes away the stream beds and the coal mine operators who leave their shafts spilling toxic materials into the streams are detracting from the public values of those streams. Canneries, tanneries, paper mills, villages and cities, all do things which are detrimental to some kinds of further uses of our waters.

The values which are most commonly destroyed by misuse or neglect are biological values, the ones which should be given the highest ratings, and our need is great for aggressive action to safeguard those values. The general welfare requires that some cooperative effort be directed toward that end, i.e., the need is acute for some able biological engineering. Failure to meet this need can lead directly, and perhaps quickly, to scarcity of this essential resource ("scarcity" meaning inadequate supplies of adequate quality). This is well illustrated by the food producing industry of fishing.

Some pertinent facts about these water problems have been brought to light by scientific research into the causes of the changing abundance of fishes. About 600,000 anglers buy licenses to catch fish from Ohio waters, and they invest a large amount of money, time, and effort in this form of recreation. Because this kind of harvest cannot be accurately measured, the value of the crop and the wisdom of their investment cannot be readily determined, nor can much reliable information be obtained about the biological productivity of the inland waters, but fairly accurate statistics are available for the fishes and the fisheries of Lake Erie.

The Great Lakes yield about 100 millions of pounds of fishes each year for use on American tables, and Lake Erie is the most productive of the series with its contribution of over 30 million pounds. The American fishermen take about 70 per cent of all of the fishes caught in Lake Erie, and the Ohio fishermen take about 85 per cent of the total American catch. The large Ohio share is believed to be due to the extensive shallow-water areas and numerous tributaries at the west end of the lake, while the lower share of the Canadians is associated with the lack of north shore streams.

The history of the commercial fishing industry of Lake Erie is a record of the development of more and more efficient methods of catching, processing, transporting, and marketing the available species of fishes, and the industry of today is the end product of this development. It began about one hundred years ago with the small-scale incidental operations of farmers whose lands touched the shore. They made their catches in off-hours, and in off-seasons with hooks, small seines, and small set nets or traps, working from rowboats or by wading near shore, and they marketed their fishes from peddlers' carts. The set nets grew into pond nets which were anchored with long stakes driven into the bottom, and these pots had stretches of webbing to lead the fishes into them. These nets were set in strings which reached so far from shore that sail boats were used to get to them, and the fishes were marketed in shops in nearby towns. The advent of steam boats led to more extensive operations, as the steamers towed small fleets of sail boats out to the distant fishing grounds. Gill nets came into general use about 1880 with the discovery that herring could be marketed if kept well iced. The pond nets were succeeded by trap nets which have pots closed on top so they can be used under water at greater depths, and these were fixed in place with anchors instead of stakes. Gasoline-powered boats came into service about 1910 and, when used in conjunction with trap nets, gave great flexibility to use of fishing equipment. The development of large-scale methods of preparing fish for market, or refrigerating systems, and of improved shipping facilities have expanded the market for fresh-water fishes to the big cities of the East Coast.

The history of the biological productivity of Lake Erie is a separate record, including aquatic plants as well as fishes, and it would be incomplete without the story of the bays and tributary streams. The lake fishes have run through the bays upstream to spawn on the riffles or rapids, and the young fishes, hatched on the rapids, have dropped down to the bays where they have made their early growth amid luxuriant vegetation, protected against the storms and predators of the open lake. The vegetation contributed also to the welfare of wildfowl, and the early records show that the mouth of the Raisin River, Maumee Bay, and Sandusky Bay were famous duck nesting and feeding grounds. Beds of dense aquatic plants offer the best resistance known to wave action, and the shorelines of the bays were protected against wave washing by the plants which thus rendered multiple service.

The kinds of fishes which have maintained the industry have not been always the ones which were first caught for market, though some of the same kinds are still present and show in the production figures. Early fishing efforts were concentrated on whitefish, pickerel, and bass. Later the herring became the most valuable species, with an annual catch which varied from 15 to 45 million pounds. Sturgeon were removed because of their ability to wreck fish nets, and were used for fuel or fertilizers until their flesh and eggs attained value as food. Perch were caught by the millions of pounds for a period, and at present the blue pike, pickerel, and saugers are the most valuable species. Carp, suckers, sheepshead, and catfish are now forming larger shares of the total catch as the more choice species become less abundant.

Efforts to maintain the fishery for particular species have consisted of limiting the "take," and adding young fishes from hatcheries at Put-in-Bay, Ohio, at Erie, Pennsylvania, and at Normandale, Ontario. These young fishes were hatched from eggs taken by fishermen from fishes caught on their up-lake spawning run. These costly efforts have been futile because fishes produce so many eggs that only a few breeders are needed to supply more than enough young to replace the fishes removed, and because the habitat conditions which reduce the numbers of surviving young do not favor hatchery produced young over those hatched on the natural grounds.

Fishermen are businessmen who profit by making fish flesh available for use as human food and their profits are determined by the efficiency of their operations. They cannot catch the "little fish that aren't there," and they are anxious to see that the fishes are there to be caught or their business cannot survive. They are becoming aware of the fact that the measures needed to provide suitable conditions for the production of fishes in Lake Erie and its bays and tributary streams are the same measures needed to promote the welfare of other groups of people and of other industries. It is logical for them to think that the responsibilities and costs of these measures ought to be shared by all people or industries who would share the benefits.

During the period of development of the commercial fisheries of Lake Erie, most of the northwestern section of Ohio was cleared of woods and drained of swamps and put into agricultural production. People grouped to form villages which grew into cities, and the terrific concentrations of many people on small land areas has been accompanied by great needs for water and food. On farmlands, crop production has been so stepped up that a few farmers can supply the food needs of many city people, and the recent development of methods of using some farm products, like soybeans, in making industrial products has increased the intensity of land use. Farmers, lacking help, must use their own time to advantage, so they plow their farms on the clear autumn days, and their lands are left bare and exposed to erosion by winter winds and spring rains. Fields are tilled to hasten rainwater away, while ditches are dug deep and left with bare, steep slopes which wash away with every rainfall. Meadows, and marshes, and windrows of soybean tops are burned over, and the fire removes the humus from the soils, leaving them more compact and with pores sealed against penetration by water. According to Tom Kennard of the U. S. Soil Conservation Service, 1 cubic foot of Paulding clay loam weighed 57 pounds before, and 74 pounds after this kind of compaction.

The melting snows and heavy rains of spring are not held for later use, and streams rise quickly to flood stages. Topsoil is eroded from lands which may be quite flat, and the streams carry vast loads of silt down into the lake. The fine materials gathered by sheet erosion in northwestern Ohio, carried by the Maumee River, Portage River, and the Sandusky River, remain long in suspension in Lake Erie. At the Ohio State University's Franz Theodore Stone Laboratory at Put-in-Bay, on an island 50 miles from Toledo, Dr. D. C. Chandler and Dr. Owen Weeks have found that the turbidity of the lake thereabouts is directly correlated with the discharges of the Maumee River. By analyzing the water near South Bass Island at regular intervals throughout the year they have found that the nitrates which are lost from the farms of the Maumee valley are present in the lake water after the occurrence of heavy rains and flooded streams.

Floods and droughts have always happened, but the extremes of both conditions have been aggravated by changes in the conditions which tend to stabilize stream flow. The volume of water which is discharged by the Maumee River into Lake Erie has been measured by the U. S. Geological Survey and records submitted by Mr. C. V. Youngquist show the rapid rise and quick decline of flow which follows heavy rainfall. On April 9, 1944, the discharge was 2,800 cubic feet per second. It rained on the tenth and the volume rose to 16,200 cubic feet per second. On April 11 the flow had risen to 42,500, on the 12th to 69,000 and on the 13th to 70,000. Thereafter it declined to 64,200 on the 14th, 50,700 on the 15th, 39,800 on the 16th, 33,600 on the 17th, 28,300 on the 18th, 21,100 on the 19th, 15,500 on the 20th, 10,500 on the 21st and 8,270 on the 22nd. On the 23rd more rain fell and another rise was recorded. The low water stage of late summer frequently drops now to the point of no flow at all in the smaller streams. Beaver Creek, which enters the Maumee River below the dam at Grand Rapids, was bone dry, without even a damp pool on August 4, 1944, though it had been at flood stage the previous April. The series of small streams which enter Lake Erie east of Sandusky have their mouths stoppered shut by wave-deposited sand and gravel during much of the year, lacking sufficient flow to flush these materials out of their mouths.

Many species of fishes are dependent upon streams for use as spawning and rearing areas, and changes in the abundance of these fishes in Lake Erie may be due in part to changes in the accessibility and suitability of the streams for their uses. Early records show that pickerel and muskellunge formerly ascended each spring the Huron River nearly to Ann Arbor, Michigan, the Maumee River to "Les Grande Rapides," the Sandusky to the rapids at Fremont, the Vermilion River to above Wakeman, the Cuyahoga River to the rapids above Akron, the Grand River to south of Geneva, and other streams. In 1846 Kirtland described the spawning runs of pickerel, muskellunge, and sturgeons up the Cuyahoga River through an area which is not suitable now for any use by any kind of fishes. The Grand River receives the overflow and seepage from the "soup ponds" of the Diamond Alkali Company near its mouth into Lake Erie, and is spoiled for fish use, while the discharges of heavy, greasy sludge at Toledo have coated the floor of Maumee Bay with materials which make it unfit for biological productivity. Many of the other streams have been used to move away the waste products of people and their machines, and during droughts there is inadequate dilution. These zones of pollution act as physiologic barriers to the free movements of fishes, up and down stream.

Fortunately, pollution need not be considered a permanent evil and we know of at least one instance where correction has occurred. For some years there were refinery wastes dumped into the quiet waters of Gibraltar Bay, near the entrance of the Detroit River into Lake Erie. The practice was stopped and 6 years later the bay bottom was covered with rooted vegetation which had formed dense beds, and the fish population was thriving. Similar results might be expected in other areas if and when the addition of pollutants is stopped.

Silt carried into the lake must be considered a particularly harmful form of pollution. In the bays at the mouths of the Raisin, Maumee, Portage, and Sandusky Rivers the silt has been responsible for eliminating most of the beds of rooted vegetation which are so essential to fish welfare. The plant physiologists at the Stone Laboratory, Dr. B. S. Meyer and associates, have shown that silt accomplishes this feat in two ways, namely, by curtaining off the sunlight and by actually smothering the plants by coating over their surfaces. Years ago these bays were used as feeding and nesting grounds for wildfowl as well as for the spawning and nursery grounds of perch, white bass, and other fish species. At the present time there are no aquatic meadows, and unimpeded wave action is cutting the banks back to the great detriment of the summer resort industry.

From Huron eastward the high shore line is battered by waves and is cutting back at the rate of 2.2 feet per year, though the greatest destruction occurs during storm periods. At the Ohio-Pennsylvania boundary line the 57-foot clay cliff was cut back from 10 to 20 feet by the one storm of November 2, 1942. Some wealthy home owners of East Cleveland have protected their sites by placing expensive sea walls at the foot of the cliff, but the job is too big for private handling. There is some talk now of a breakwater to extend all of the way from Cleveland to Buffalo to protect the shore line and to provide canal facilities for boats. There are now breakwaters to protect the harbors at several cities, and others are planned.

Some Ohio streams have falls which have always stopped fish migrations, notably the Black River with its falls at Elyria, the Cuyahoga River with its falls near Stow, and the Chagrin River with its falls at Chagrin Falls. There are many dams on the tributary streams, for water supply or power, which also bar these passageways to fish, and they are located usually at the lower end of rapids or riffles. The dam at Grand Rapids, on the Maumee River, stops the upstream migrations of most fishes during most of the year. The power dam at Fremont on the Sandusky River closes off the best rapids on the stream, the unused old Bixler Mill dam closes the Grand River above Painesville, and the state dam on Conneaut Creek stops the annual spring run of smallmouth bass from Lake Erie.

The need is great for coordinated planning for the best use of the waters of Lake Erie and its tributaries, and the varied interests of transportation, waste removal, resorts, domestic consumption, fish production, etc., suggest an over-all agency, such as a Great Lakes Valley Authority. Within the state problems could be met best by the establishment of Conservancy Districts in every major watershed area as only in this way could there be any good prospect of accomplishing the objectives of better land use and regulated stream flow which are essential to every citizen in the region and nation. The things which must be done to maintain the capacity of Lake Erie and its tributary streams to produce fishes must be done also, to maintain the capacity of the lands of northern Ohio to produce farm crops, to provide good hunting in the valleys, to protect the water supplies of the people and industries of many cities, and to protect the farms, homes and cottages on the shores of Lake Erie and its bays.

A FARMER LOOKS AT WILDLIFE MANAGEMENT

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In the discussion of croplands and wildlife it is fitting that the farmer should voice his opinions, for the farmer owns and controls the croplands, and in a large measure determines the kinds and quantities of wildlife on those lands. When we consider the extent of the cropland or farmland of this country, we begin to appreciate the importance of the farmer's attitude toward wildlife management and conservation.

As a farmer I would like to discuss wildlife management from a farmer's point of view, showing: First, the possible attitudes that farmers can and do have regarding wildlife; second, wildlife as a farm crop or product; third, ways in which the farmer can improve and increase this wildlife crop; and fourth, ways of educating farmers to cooperate in a long-time wildlife management program.

Now, in regard to the attitudes which farmers take toward wildlife, it seems to me that there are three groups. In the first group we find those who regard wildlife as pests and enemies. They know only that the rabbits bark their raspberry bushes, the squirrels eat the ears of corn growing along the woods, the pheasants pull the young corn and peck holes in their tomatoes, the robins steal strawberries and cherries, the muskrats make holes in the pasture where their cows may break a leg, the skunk makes a bad smell when he isn't stealing their chickens, and poor little Jenny Wren gets on their nerves with her incessant chattering. I have overdrawn the picture, perhaps, but I know farmers who see far more of the nuisance in our wild friends than they do of the benefits to be derived from them. If the farmers of this group, and their sons, are people of energy, wildlife will find the going hard, and will probably seek a more friendly atmosphere. Fortunately, this group is small.

In the second group are those who accept wildlife for what it is. They are glad to see the first robins in the spring, put up with a little damage now and then without much fuss, are glad to see plenty of rabbits and cock pheasants for the hunting season, and feel no further interest or responsibility. If we ask them how the game is faring with all this ice and snow, the answer is glib, "Pretty tough, I expect, but there ought to be some seeds out in the woods and thickets," and the matter is forgotten again. This is the largest group of the three, except where definite educational work has been done among the farmers.

The third group is composed of those who are interested in wildlife, who regard our wild animals and birds as friends and as farm assets. They are concerned about food and shelter for wildlife. They see the good that our birds and animals do, and they know that the good outweighs the bad. This group knows the thrill of a new bird seen for the first time, the satisfaction of seeing some big fish in the pool below the bridge, the enjoyment of having a flock of pheasants that come like chickens to eat the corn they have scattered just beyond the clothesline, where the whole family can see them from the dinner table. The farm families of this group accept the responsibilities of wildlife care, and on their farms we can expect a well-managed wildlife program and a goodly crop of wildlife. This group is, like the first, small, but it is growing as more and more educational work is done.

Next, let us consider wildlife as a farm crop. In the first place, wildlife is a crop in that it has certain values which are tangible in an economic, social, and educational sense. From an economic point of view, think of the good done by our birds and animals each year in insect and rodent control. This item alone could run into millions of dollars in damage to crops, were it not for our wild friends. As I plow I like to watch the crows and blackbirds following my furrow to seek out the grubs turned up by the moldboard or disk. I know that those grubs will never bother me again and so I can forgive the bold black rascals for the corn that they may steal at planting time.

The game, fish, wild fruits, and nuts, that find their way to our table, are certainly of value to us. Many of our ancestors found most of their living in this fashion and a pheasant or a grouse stuffed with apples, celery, and walnut meats, and roasted to a golden brown, will make the most fastidious mouth water in anticipation; and who will scorn a rabbit stew, a venison steak, or a plate of fried brook trout? Many a farm boy earns his pocket money, and sometimes even his clothes for school, with muskrat or skunk hides. Wild berries and nuts are most welcome additions to the farm menu both in season and when preserved, frozen, or dried.

Equal in importance to the economic value of wildlife is its social and recreational value. Each year millions of dollars are spent for sporting equipment, clothes, and gasoline to be used in hunting, fishing, picnicking, camping, hiking, trapping, nature study, and so on. Wildlife and its habitat furnish us with one of our largest, healthiest, most desirable recreational opportunities. In this respect wildlife is a thing of value to all our nation, not just to the farmer who owns the land.

In a discussion of wildlife as a farm crop we must think not only of its value, but also of the fact that wildlife is quite definitely a product of soil and water, a crop of the land. There is no type or variety of wildlife which is not directly or indirectly dependent upon the soil for food and shelter. If my farm does not produce satisfactory wildlife food and furnish proper and adequate cover, my farm will harbor little or no wildlife, regardless of how careful I may be about hunters or hawks, foxes, and other predators. My rabbits and pheasants are as dependent upon the proper production of my farm as are my purebred Guernseys. They are a farm crop, a resource that needs some care and attention, and that carries responsibilities for the farmer. What shall the farmer do to properly care for this wildlife crop, which is one of his responsibilities and assets? There are many things that he can do which follow good practical farm management. The first method of caring for wildlife is through proper land use. By proper land use I mean the devotion of different types of land to those crops and cropping practices to which they are best suited. For instance, smooth, level fields should be devoted to cultivated crops, in rotation of course; smooth, gently-to moderately-sloping fields should also be devoted to farm crops, but in contour strips, alternating intertilled crops with close-growing crops. Rather steep land and land subject to serious erosion should go into permanent hay or pasture, or perhaps back to woodland. Very steep land, rough land, gullies, ravines, big rock outcrops, sink holes, and waste land of any kind should go back into woodland of some sort. By using the program suggested above, each type of land is adequately protected from erosion, streams are protected from silting, each type of land is producing the crops for which it is best adapted, and wildlife cover and food is provided in logical places. It is interesting to notice that contour strips of close-growing crops, alternated with the strips of row crops, furnish lanes of travel for wildlife, as do wooded gullies or ravines and occasional shrub fence rows.

The proper management of the farm woodland is another important factor in providing the ideal habitat for wildlife. A woodland in which selective cutting is practiced to remove undesirable specimens and to preserve a balanced production of mature trees, second growth, and immature trees and shrubs, will provide abundant food and cover, and will give the highest return for wood products. A stand of mixed hardwoods and conifers is ideal, but not always practical. Woodland should not be cut in such a fashion as to have only one or two varieties in the stand. Occasional den trees should be left standing, and a good brush pile here and there is appreciated by our wild friends. Woodland should be protected from fire and pasturing, so as to preserve as much undergrowth as possible. An occasional well-cleaned fire trail is good insurance for woodland and wildlife alike. The borders of a woods should be planted to shrubs and bushes which are low growing, and which will provide desirable food for birds and animals.

In making new woody plantings, especially in small areas, plan to use as many low-growing, food-producing species as possible, and limit the varieties of trees to those whose size when mature will not make them a hindrance to the crops.

I am very much interested in the planting of wildlife food patches here and there over the farm, wherever there are odd shaped corners of ground that would be difficult to till in a certain rotation. A strip of food patch or farm grain along the edge of a woods makes ideal feeding conditions for game. The mixture which I am using for my bird-feed patches this year contains sunflowers, broom corn, sorghum, buckwheat, millet, sudan grass, soybeans, and corn. We fertilize the ground with a complete fertilizer and in the past have broadcast and harrowed in about 6 pounds of seed per acre. This year we shall plant in rows about 18 inches apart in the hope that the corn and soybeans will mature better, and that the sunflowers will make larger heads. Our feed patches have always been well patronized by wildlife, especially pheasants.

Another important factor in caring for wildlife is the provision of refuges where wildlife may escape when hunted too hard. These refuges should provide good food and cover and should be large enough to carry a good sized flock of quail or pheasants, and several rabbits for a matter of days, but should not be large enough to harbor many predators, such as foxes, weasels, and hawks. The refuge should be carefully protected by fire trails, if it is in woodland, and should be surrounded with a single strand of smooth wire, and well marked with signs. Five acres of refuge for 100 acres of farmland is a good proportion. I like to follow up all these natural means of wildlife care with regular feeding through severe winter weather, such as we have experienced this year. We mix corn, wheat, oats, broom corn, soybeans, sunflower seeds, timothy, and weed seeds cleaned from clover seed. Small amounts of this mixture are placed in shelters, hollow stumps, under wood piles, and under thick, spreading evergreens. The results are most gratifying—well worth the 4 or 5 bushels of grain that we have used.

The main task of a farmer as regards the farm streams is to keep silt out of them by conservation farming, and by stream bank control. The stream will generally take care of itself if that is done, and good clean streams generally mean good fishing, unless there are too many fishermen.

Finally, I would like to discuss this matter of philosophy, education, and organization, for upon these elements the whole wildlife management program seems to hang. Wildlife management should not be a goal by itself, but should be part of an integrated program in which the farmer has caught the spirit of conservation. The spirit or philosophy of conservation is the desire to improve and increase the resources which the goodness of the Lord has given to us. It is the desire to hand on to the next man a better farm than we received, not a poorer one. It means that the farmer recognizes the soil, water, woodland, and wildlife as resources to be tended with care and thankfulness.

But the problem in the past has been to arouse this conservation spirit among the farmers. Certain soil men have achieved it among small groups; the forestry leaders have accomplished a comparable spirit among groups of forestry enthusiasts, and game commissions and sportsmen's clubs have striven unceasingly to work out their plans for a wide application of good wildlife management. The difficulty has been to arouse the desire to conserve all resources, not just certain specific resources. As regards wildlife management, it was not difficult to interest farmers in doing a little winter feeding, or in helping restock the game supply, or perhaps planting a little bird feed, but how about reforestation of rough land, contour stripping for lanes of travel, and woodland management for best wildlife conditions. These last named features of a good wildlife management program were ignored by the large majority of farmers for years. There was too much work simply for wildlife conservation.

Beginning in the late 1930's, a new movement spread rapidly over this country, the soil conservation district movement. All over the United States farmers began to band together to form soil conservation districts, local organizations of farmers, established according to law, but operated democratically by the farmers themselves to carry on a broad and effective soil and moisture program for the general welfare of the people in the districts. With these district movements, has gradually developed the conservation philosophy, the desire to conserve our resources, whatever they may be, the desire to make a poor farm good—a good farm better, the desire to improve a piece of woodland, the wish for a better and broader wildlife program. The conservation philosophy, or the spirit of conservation, is by no means an accomplished fact. It is just starting; it is a great and growing thing in this nation of ours. It is bringing stream pollution bills into our legislatures; it is bringing new regulations concerning forest care and forest fires; it is bringing better laws and plans for soil conservation; it is bringing new ideas for wildlife care and protection. It is, in short, the awakening of a careless nation to new responsibilities.

In our wildlife management program the soil conservation district plays another important part, besides awakening a broad conservation interest of which wildlife conservation is a part. The district is authorized by law to seek aid from, and to co-operate with other agencies, such as the Forestry Service, River and Stream Commissions, Game Commissions; Soil Conservation Service, and many other organizations. The district can coordinate the work of all these agencies so that on my farm, through the help of the district, the Soil Conservation Service and the Extension Service are teaching me how to contour strip and terrace my fields, the Department of Forests and Waters is teaching me good woodland management, and the State Game Commission is helping my neighbors and me to solve our wildlife management problems through a well-coordinated State Farm Game Land Project, which embraces several thousand acres of farmland. The State Farm Game Land Project is most successful, first, because the farmers are conservation-minded to start with; second, because the project furnishes the needs of the wildlife by providing refuges, feeding programs, and supervision; third, because it provides protection to the farmer from improper and illegal hunting through safety zones and game warden supervision; and fourth, because it provides for hunters, country or city, a well-stock hunting area of ample size, open to all. It is a complete program. As a conservation-minded farmer, I am most optimistic about the future of our farm wildlife program in this country. We have a big job to do, but we are starting in the right direction when we are aiming toward a program that conserves all our resources.

Chairman: WALTER P. TAYLOR

Texas Cooperative Wildlife Research Unit, College Station, Texas

EDUCATIONAL FORUM

This session arranged by the Wildlife Society

EDUCATION AND WILDLIFE CONSERVATION

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Director, Fish and Wildlife Service, Washington, D. C.

What are the primary needs in conservation education? This is a pressing question that will require increased consideration and concerted action in the postwar period. All will agree that the most immediate and vital need is for the general public to understand the basic importance of soils and waters, and the products of those soils and waters to our everyday living. In other words, to lay the foundation for such education there is needed a clear-cut appreciation of the natural basis on which all life depends.

We now expend much energy in talking to and writing for those who are already converts. We write for the sporting and conservation magazines with a circulation limited largely to those already interested, and we prepare scientific articles for the technical magazines that reach our fellow workers in the conservation field. We attend meetings and make talks to each other and carry on our correspondence with our friends and coworkers. Much of our energy is devoted to these fenced-in efforts. Important though they are, they still fail to meet all the needs in the field of conservation education. No one questions the necessity of exchanging ideas and viewpoints through all available media. Such activities serve the very useful and fundamental purpose of exchanging new information and of keeping the workers posted on trends in conservation concepts and techniques. Even the faithful must have meat and drink to remain strong in the faith, and such activities furnish the meat and drink for all.

Granting the vital importance of the foregoing activities, it is still true that when we have furnished new information to the technicians and given new ideas and greater understanding to all who are now interested in conservation, we have done no more than prepare the team for action. We are exactly in the same predicament as the city fire department which has been given new equipment and taught the latest techniques in fire fighting. They are better equipped and better trained to meet emergencies but, unless the general public is at the same time kept informed by a continuing educational program on elementary fire prevention precautions, the incidence of fires and the aggregate losses caused thereby may go upward despite all of the expenditure for new equipment and the training given in its use.

In the conservation field we have in recent years devoted much effort to training better men. We have made great progress in providing them with more accurate basic knowledge and better methods of management of the resources. Furthermore, until the war interfered, each of these men by their individual efforts have helped to inform better than ever before some of the public on the value of the living natural resources.

Even that progressive trend, however, does not meet the vital need of a better public understanding of the fundamentals of conservation. We must admit that we have not succeeded in solving the problem and I am quite certain that no individual can outline a method which can be guaranteed to give the public basic concepts and enlist them in a unified nation-wide conservation crusade. There are, however, some available avenues through which we can better accomplish this objective. Most of these avenues have already been tried in a limited way by individuals or institutions. The gradually growing public appreciation of the importance of conservation can be attributed to the success of these fragmentary efforts. A considerably larger percentage of the public is informed now than 10 years ago. The methods used have thus proved successful to a limited extent. Undoubtedly they will accomplish more if we improve the methods and *direct* more effort into these avenues which have been explored thoroughly and tested. Certainly this is the sensible approach until we find better methods. Indeed it is hardly probable that we will ever discover a quick, painless, and 100 per cent successful method of injecting conservation ideas and ideals into the general public consciousness. Results are far more apt to come slowly and as a result of increased efforts along conventional lines. There are three obvious methods:

The first, and undoubtedly the most important, is getting basic conservation programs into the schools. Many agencies have worked at this successfully, including both private and public organizations. Cornell University for years has prepared material for use in rural schools to teach nature study and conservation. Iowa State College has put more than the usual amount of emphasis on similar types of information. Many other schools and colleges have participated in this helpful type of work to a greater or less degree. A list of private conservation organizations which have had school programs is almost as long as a list of public conservation organizations. The National Audubon Society has carried on Junior Audubon work for a long time, both in and outside of the schools, and certainly has reached many thousands of young people with its efforts. The National Wildlife Federation has not been in existence so long but its pamphlets and literature have been used widely in schools in various sections of the country. The Boy Scouts have made nature study a part of their work and have given basic wildlife information to thousands of boys at the most impressionable age. The Izaak Walton League with its promotion of father-and-son outdoor activities and general education efforts among the younger people has made a genuine contribution. Many others could be given honorable citation for their efforts in this field and these are, therefore, only sample types of work which can be greatly expanded with great benefit to the conservation movement.

These activities all help in interesting young people in the out-of-doors, a sound step towards creating a basic knowledge of the natural resources and their value. In the past many of these efforts have been too limited in the scope of material included, and too narrow in their appeal to take the next step and present the basic philosophy. In other words, children have been taught to appreciate birds or trees or flowers or something else without being given a basic understanding of the total interrelationships of each to the other, and of all forms of life to the manner in which we manage the soils and waters of America. Many organizations have realized this defect in their programs and are to a greater extent each year including basic conservation in their presentation.

Many people who have given much thought to this problem consider that the best approach may be an effort to present the fundamentals as an integral part of history, geography, botany, biology, and kindred courses. The advocates of this philosophy believe that it could be carried into the primary schools through the introduction of suitable material into readers and other grade-school texts. By furnishing sound conservation material to educators and particularly to writers of school texts, such persons believe conservation philosophy will eventually become a basic part of the thinking of the younger generation. I have a great deal of sympathy with efforts of this kind, largely because any progress in this field can only be productive of good. My philosophy is somewhat similar to that of the farmer who was trying to get an unwilling horse into a new barn. He was not at all concerned as to which end got into the barn first, as long as the animal finally got in whole. Therefore, he very sensibily tried various devices to accomplish the result, caring not at all which formula worked. If only conservationists could work with the same singleness of purpose instead of devoting so much energy to disputes over methods, we might get our particular horse into the barn much more quickly.

In recent years I have seen texts on such varying subjects as biology, zoology, botany, commercial geography, physical biology, and history in which the writers have endeavored to inject conservation principles. While this will not satisfy the conservationists who want to see formal conservation courses taught in the schools, it certainly can become a much greater vehicle for getting more conservation thinking into the schools than will be derived from many years of campaigning for formal conservation courses. I cite two examples. Nearly every book on the history of the West tells that the first settlements were built to carry on the fur business. They tell of the great fortunes which were made on furs and of the economic value of them to the early settlers. Few of these history texts follow through and point out the fact that many of the lands and waters of that same territory are still capable of producing the same values in fur that they did in the beginning. They do not do so now because of overexploitation in the earlier history of the lands.

Many of our present school texts devote too much space to boasting of our undoubtedly great achievements in settling and developing the country, and too little to pointing out the important mistakes made in that development. Some of these mistakes must now be slowly and painfully corrected at public expense if we are to get the maximum production out of our natural resources. Seldom is mention made of overdrainage with its destruction of aquatic values and disastrous lowering of water tables, of pollution which has reduced the productivity of our waters, of deforestation of lands which should have remained forested to yield the most bountiful permanent return to us, of the plowing up of the arid lands and of steeper lands in the better-watered areas to bring about destructive losses, and of the loss of our valuable top soils by the erosive action of wind or water. The failure to recognize and control the foregoing practices is reflected in the total lack of understanding that reduced wildlife and fishery values have occurred over wide areas due to these and many other lesser mistakes which were the by-products of the strenuous haste with which our forefathers attacked their job of settling the land.

Schools could well point out these mistakes, not as carping criticism nor on the basis of sentimental yearning for the return of the ''good old days,'' but on a constructive basis by showing that here are constructive things to be done which will make this an increasingly better land in which to live. Schools should teach that conservation provides continuing supplies of things we need in order to live and to enjoy our lives.

Examples of this kind could be multiplied and, I am quite convinced, used most successfully in getting into the fundamental consciousness of people generally the fact that those natural resources which are products of the lands and waters will renew themselves each year if we give them adequate chance to do so.

The second of the three obvious methods is better use of the more modern methods of information. We have made sporadic and frequently very successful use of such media as radio and pictures, but in few cases have we "cashed in" on the possibilities of these methods of reaching the public. Too many of our own endeavors have been conceived only in terms of entertainment. We have taken beautiful pictures and presented most entertaining wildlife motion pictures too often without any attempt to follow through with the basic story. It would not be too difficult to go the rest of the way and make the pictures and the captions or accompanying sound track tell the real story and still be good entertainment. This defect has been equally characteristic of the conservation radio programs of recent years. I believe that generally the radio programs have done somewhat better and been somewhat better organized from a fundamental standpoint than the pictures which I have happened to see. However, there is still room for a vast improvement in this field.

This last phase of a large effort and its inadequacy have been undoubtedly partially due to lack of time on the part of personnel that already have full-time jobs. It seems also to be due to a failure to realize clearly and forcefully that a simple fact, and even more the bare outlines of a brief story, must be repeated over and over again to make an impression on the minds of a now interested public. Those who pay vast sums for radio and magazine advertising understand much better than do conservationists the necessity of constant repetition to make the public remember a single name or slogan. Conservationists need to adopt the same procedure and endlessly weave the few simple fundamentals into every presentation regardless of its slant or emphasis.

This brings me to the third point, which is obvious. We still lack adequate machinery for getting into actual use both the material now available and the results of new research studies. In other words, we have built a research program which, while still far from adequate to do the job, is far ahead of the facilities for applying that knowledge. For want of a better term, let's call it an extension machinery which should compare in aims and objectives with the present agricultural extension service or with the advertising and demonstration programs of the larger corporations. Both types of work go out and sell a program based upon research findings. They present new applications for old ideas, new uses for old products, or promote and demonstrate the use of new products as the need arises. They are in fact sales organizations which may sell either ideas or gadgets. The important point is that in neither case is the responsibility given to a research staff, already busy at its important specialized job, to do the selling. Salesmanship of good quality is also a skilled profession. In effect, we have tried to use the wrong talents to too great an extent in conservation education. We need to wake up and start to build a sales organization for the important job of selling ideas and new techniques. Until we do so and do it on a scale large enough to handle the job competently, the necessary public support for the wise management of these important resources will not be forthcoming.

In conclusion, may I say that there is little that any of us can do until the end of the war. However, I can say for the Fish and Wildlife Service, that we have been giving serious thought to this problem and have made some plans for meeting our share of the responsibility.

First, we are already vigorously cooperating with various organizations and individuals working on the school approach to the problem. We have furnished a considerable volume of basic information to these people and have also encouraged them in every way to go ahead. We hope to be able to present much more graphically the material in our own bulletins and releases.

Secondly, we have already made considerable progress in the preparation of color movies that will do a better job of both instructing and entertaining. These programs cannot be released until after the war when facilities and film for making copies become available.

The Division of Information has been staffed with a skeleton organization, working on these and other forward-looking programs. We hope to expand this organization somewhat after the war to the extent necessary to carry our part of the load.

Third, we hope to see legislation passed to provide a sufficiently effective extension program to carry our story to the general public. By that I do not visualize a great extension machine comparable to the Extension Service in the Department of Agriculture with its County Agricultural Agents, in practically every county of the United States. Rather I have visualized a small corps of specialists, organized cooperatively by the Fish and Wildlife Service and the state conservation groups, which will be sufficiently well trained to translate into local terms the general information and research results that are now available. Some states that have strong conservation machinery do not need this. Other less fortunate states which are not now able to finance such a program could finance it by cooperation on some such basis as that now used in maintaining the 10 cooperative research and demonstration units. With such machinery available the chances would be much greater that we could get material into nontechnical and nonsporting publications, could get more material that was accurate and instructive on the local radio broadcasts, and could provide more pictures to be used locally that have the same quality and objective, than it is now possible to get with existing machinery. I must admit frankly that such efforts as the Fish and Wildlife Service has been able to make in this field are largely sporadic in character and occur as the result of the overwhelming interest in the program, or some part of it, on the part of the individuals in the Service. We should be able to do a better job than we are doing at present in selling basic conservation. I hope that legislation permitting such a program can be enacted so that a good program can be started in the postwar period when America is going to be seeking methods of adjusting herself to many unforeseen, and probably unforeseeable, new complications.

POSTWAR PROBLEMS IN FORESTRY EDUCATION

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Representatives of 25 of the 27 forestry schools in the United States gathered at the University of Michigan for a conference on February 19 and 20, 1945. The Society of American Foresters, Division of Education, of which Joseph S. Illick is Chairman, sponsored the meeting. The object was to discuss the phases of forestry education especially as they apply to the period following the present war.

The general subjects discussed were forestry training in colleges, handling of war veterans, correspondence courses and subprofessional forestry training, accrediting of forestry schools, new schools, scholarships, fellowships, placement service, research, public relations and civil service examinations.

It was felt that inevitably there will be a real shortage in educational facilities after the war. This should result in a careful selection of students and raising the level of training of the men turned out.

A well-trained forester should have enough liberal arts courses so he can compare in community usefulness with the lawyers and doctors. He must have an ample biological background with a major field of specialization. The tendency is getting constantly stronger to regard 5 years as the period necessary for adequate training. This is due to the fact that, starting with a single course in 1898, there have now developed some 14 lines of specialization. Beside concentration in his major field, a forester should know at least the elements of the others

There is some tendency to give professional forestry degrees only after a fifth year of college training.

In master's work the tendency is toward greater emphasis on the thesis requirement. Work for the doctorate in forestry should be encouraged in some fields. The candidates should be kept to relatively small numbers and they should be very carefully selected. Maturity of the candidate in his particular field is very desirable.

The University of Minnesota, in studying student records, has found that the greatest basic training problems are selecting good men and giving them good teaching. In some cases state laws prevent elimination of applicants before the college work is begun. Either students should be selected who are definitely qualified for forestry training or they should be advised to transfer to some other course as soon as possible.

The feeling seemed to be general that we are going to get some very good men returning from the Armed Forces and wanting to take forestry training. Many will lack specific college entrance courses, but, because of greater than usual maturity and training in Service, some will be able to carry college work. Promising men can well be accepted as special students regularizing them in the course when they have demonstrated competence. Most institutions are not intending to let down the bars but are planning to be liberal in admitting well-qualified students.

While most college men in the Armed Services think they need refresher courses to again get in touch with their fields, experience is showing that the ones who have returned adjust much more readily than they expect. In most cases veterans who are undergraduates should be urged to take new courses with only a light load until they get reestablished. Those with a bachelor's degree should take postgraduate work rather than a refresher course. A seminar course covering several related fields or recent developments in a particular field has definite usefulness in reorienting the veterans. Many men are apt to need a course in how to study. Sympathetic and careful counseling by staff members who have been in Service, if possible, is an absolute essential. The returning veteran needs individual attention and is hungry for advice on what he should do in readjusting to civilian life.

Following the war, we should encourage married students and provide housing for them.

Several correspondence courses in forestry are being given by the Armed Forces Institute and some of the colleges. A general forestry course seems well adapted to being given by correspondence but professional courses requiring field or laboratory work should not be attempted. In describing any correspondence course, it should be made clear that professional training is not being given.

Opinions were divided as to whether forestry schools should give subprofessional training. Some felt that the subprofessionally trained men would crowd out those professionally trained from the lower paid jobs. These are very necessary in the period following college to give professional workers practical experience. Others felt there was a definite need for the training of a new generation of woods workers but that perhaps these should be trained in separate schools. In Connecticut, woods workers are being trained by the state forestry department. The New York State Ranger School has filled a need over a long period of time and it should be continued. No more ranger schools are needed, however.

The accrediting of forestry schools, begun in 1935 by the Society of American Foresters, is aimed at setting up acceptable standards of performance in order to turn out satisfactorily trained students.

During the past year proposals have been made to start several new forestry courses. The organizations proposing such courses should be told what is needed for accreditation. The junior college program can well be used to supplement existing forestry schools.

Scholarships and fellowships fill a definite need in stimulating scholarship and promoting research. They make training possible for many men who could not otherwise get it because of financial difficulties. A graduated scale of increasing payments as a student progresses in his research is very desirable. It tends to hold men and attract more advanced ones.

Representatives from 12 Central and South American countries are now taking forestry work at the University of Michigan.

With the increasing need of the forest industries for trained men, forestry schools should cooperate as far as possible. Someone from a given school should know the industries in the region, what their needs for men are and what training is needed. Contacts with company officers and alumni in the industries are very helpful. The graduates should know how to get a job from the standpoints of appearance, manner, approaches, letters of application, etc.

In developing esprit' de corps among students, forestry clubs are second only to forestry summer camps. No effort should be spared to bring out latent student leadership. Clubs should have faculty advisers but these should not try to run the clubs.

At least some members of each forestry school staff should carry on research. A proper balance between teaching and research is necessary to keep teaching alive. Full time research for part of a year is much better than part time during the whole year.

Forestry schools should furnish leadership in the forestry movement in the states and nation.

Under the Veterans' Preference Act of 1944 the Civil Service Commission is given the power to set up or waive minimum training for any federal Civil Service position. This is resulting in professional examinations being set up on the basis of "progressive experience" alone or with the provision for the substitution of technical training for experience. This, obviously, is a grave threat to professional training in forestry as well as in many other fields.

While there was not, of course, complete agreement on many subjects, this conference was most worth while. It brought all present up to date on what the others were doing and were planning in forestry education and gave a chance to compare viewpoints. It is planned to hold another meeting in 1947.

EXTENSION SPECIALISTS FOR WILDLIFE A NECESSITY

GEORGE W. MCCULLOUGH
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For many years we have been debating the question of conservation education, its values, method of application, manner of teaching—to be handled as an extra-curricular subject or the integrating with other subjects, and at what levels and how it should be taught, as well as who should teach these subjects and the required qualifications of those who teach. As a result of these deliberations, or simply as a natural sequence to our present economic needs, vastly more conservation is being taught in our public schools today than we realize.

Many splendid contributions have been made by individuals through their sponsoring organizations—Fink of the Ohio Department of Education and Conservation, Palmer and his associates of Cornell, fellow members of our Wildlife Society, the American Wildlife Institute, and many others. Many contributions have been made by individuals which are too numerous to mention.

Divergent opinions are often reflected through the available materials, but only as to methods. All have the same objectives.

In the humble opinion of the author of this brief article, as an approach to the teaching of conservation in the elementary and secondary schools, the directives offered in Curriculum Bulletin No. 3, *Helps in Planning Conservation,* published by the Wisconsin State Department of Education, provides both principles and methods sufficient to achieve a firm understanding and knowledge of the basic principles of conservation education.

The practical application of conservation education leads one into another and quite different field. The concepts and attitudes developed through the primary conservation education is but a draft which keeps the fire burning that generates the steam. Unless this steam can be utilized in the terms of correctives, expansions, and accomplishments, the steam merely evaporates into the atmosphere of procrastination or utter indifference.

In this day when so much information is available and a great deal more will be, we become disturbed in finding that so little of this knowledge is being put into practice. Therefore, one is prone to wonder why bother finding causes and effects and curatives; why continue research stations or the training of wildlife managers, if all this is not to be put to its fullest use.

The question arises: In what field of related activities, what people, and where can this application be made? One naturally must turn to the agricultural field—the rural people—and the land.

If our suppositions are correct, the second question: Who then can best approach this field and its people? The answer naturally will be the Extension Service personnel and Vocational Agricultural teachers. But it will be readily recognized this is not the full and complete answer, since the present personnel of these two services have but a partial training in conservation. Ten years of experience working with and through the Extension Service, with rural youth and the 4-H Club group, have definitely convinced me of the need for an additional specialist to be attached to that force, serving in a similar capacity as does the agronomist, forester, veterinarian, crop specialist, etc. If such a specialist is well trained in game management and has a thorough understanding of agricultural practices and problems, much would be accomplished through a broad correlated program which would be beneficial to both the land and wildlife. The county agricultural agents have, as a result of the changing social and economic situation, plus the war emergencies, been overloaded with activities and without doubt will be expected to continue many of these activities after the war is ended. Therefore, it is imperative that the county agent be given assistance if conservation is to receive proper consideration through such channels.

We realize there exists considerable resentment against the apparent intrusion of the numerous newly-born federal agencies. No one need have any fear of the Extension Service's influence. For over 30 years the government has promoted a cooperative program through the land grant colleges of the states without attempting to dominate or establish any policy bordering on what might be considered usurpation of authority or infringement upon state rights. It has been suggested some other agency such as the state department of game and fish might well control and direct the activities of the proposed wildlife extension specialist. To this may we say: with all due credit, and without prejudice, no agency has the prestige with the rural people equal to that of the Extension Service. Its advice is sought on many problems, some quite foreign to agriculture. The farmer may respect and accept the functions of the state game and fish department as a part of the necessary government; yet it is doubtful if in all cases the farmer will react favorably, or at least enthusiastically, to suggestions where change of land management is involved unless he is certain that such suggestions come from an agency interested in his welfare. We must admit, it has been difficult in many cases for even the U. S. Soil Conservation Service with their fine program, to induce a landowner to change his long-established practices.

Until the inauguration of a 4-H Club conservation program, and inclusion of a wildlife division to the Soil Conservation Service, it was a rare case, indeed, where any important suggestion was offered the farmer which would benefit wildlife, that took into account, first of all, the effect such improvement might have upon the land involved. We must recognize the fact, where small upland game is involved, the farmer is expected to extend almost unlimited privileges to those who are harvesting the game crop. In most states the land occupant may hunt upon his own land without a state license, but he cannot extend this privilege to his neighboring farmer, nor can he hunt throughout his township unless he first procures a license. Perhaps we should, when considering the part the farmer is to play, give some consideration to measures which would extend a few additional courtesies to our benefactors.

The question of financing the proposal of adding a wildlife specialist to the Extension Service and its attending program has been raised. When the Pittman-Robertson bill, which provides funds for furthering wildlife conservation and restoration, was in its embryonic stages, we suggested an amendment providing for an extension specialist for each state land grant college staff. For various reasons it was considered best to drop the matter at that time. Whether this plan, or some other method, will provide the necessary funds to make possible the employment of an extension specialist, makes little difference. The fact is, we face a need. We have at least a partial answer, but too few of us recognize or see our opportunity to take one of the most important steps which will eventually bring about a more practical application of the already known better game management practices. It will also go a long way toward solving this perplexing problem which has been referred to time and time again—the sportsman-farmer relationship, or what have you.

Under the direction of the Extension Service there is this organization known as the 4-H Club, and an extension specialist would be in a position to help guide the activities of this group, adding to their program such information as might be available from time to time. Surely all of us appreciate the potential possibilities of the 10 million farm youth of America. Need I say more in an effort to convince anyone interested in education of the need for a wildlife extension specialist?

ECOLOGY AS THE BASIS FOR TRAINING TEACHERS IN NATURE AND CONSERVATION EDUCATION

RICHARD L. WEAVER
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The Audubon Nature Center, located in Greenwich, Connecticut, 35 miles from New York City and in the heart of one of the world's most populated metropolitan areas, would seem like a poor place to undertake the task of training teachers of nature and conservation through an ecological and field approach.

But on the contrary, the 280 acres of land given to the National Audubon Society in 1942 by Mr. and Mrs. Hall Clovis is ideally suited for ecological teaching for several reasons. They are situated near suburban New York where land was needed for living space for those who preferred to live in the country and commute to the city. As a result the greater part of the farm land in and around Westchester County, New York, and Fairfield County, Connecticut, in which Greenwich is located, was taken out of farming about 1900 to provide the land for numerous estates, many of which encompassed two or three of the original farms. Thus, in the last 40 to 50 years much of this land, once intensively farmed, has returned to the wild and is now covered with a great variety of habitats suited for the production of birds and mammals, particularly deer, grouse, fox, rabbits, and squirrels. It probably has a much greater stock of these species today than ever before. A few species such as the bob-white and the ring-necked pheasant have no doubt decreased in numbers.

The 280-acre wildlife sanctuary, not being adapted for the preservation of any particular species requiring sanctuary protection, has been dedicated to the preservation of ideal habitats for the many common forms of wildlife in Connecticut and for use in teaching and research.

As has been recognized by most game or wildlife managers but little understood by many laymen, such habitats as found in the sanctuary at Greenwich must be managed in order to be preserved in a great diversity to prevent them from all growing up into one more-or-less similar type of forest in which would be found a few species in a static condition. Thus, some cutting of trees to favor berry-producing shrubs, scattered apple trees and red cedars, and sumac groves is being carried out. Ashes and maples are being cut on one area to preserve the fine stand of bayberry and bittersweet now present, both of which would disappear in 10 to 20 years from shading by the rapidly growing trees.

In order to fully understand how the various habitats were produced naturally, it has been necessary to investigate the geological origin of the soils, most of which has been glacially produced, and to determine the character and extent of the humus and the distribution of the water available. Thus, a complete soil, water, and humus survey was made by the staff of the Connecticut Agricultural Experiment Station at New Haven. This will soon be correlated with the resultant forest and plant growth.

A cover map has been made of the 280 acres indicating the usual age stands and habitat distribution. In addition an intensive plant census by species and age class has been undertaken to determine the dominant species and the stages of succession in each habitat.

A bird census has been made each year and observations are being made on the number and species of mammals on the area. This information is being correlated with the plant census data.

With the surveys of the soil, water, humus, trees, and other plants, birds and mammals on which to base our studies, our students are introduced to the study of nature and wildlife protection through an ecological approach showing interrelationships, dependencies, predation, food chains, natural successions, and life history requirements.

Need it be pointed out, that being able to study these diverse habitats, the management practices required to keep certain ones as they are to preserve certain species in their present abundance, and to observe the plants and animals competing for their existence in undisturbed areas, is probably the soundest method possible and the only one which will permit a full understanding of the background for much of our wildlife management of today.

Certainly this approach and objective is far removed from the original ones in nature study which emphasized the esthetic and relied heavily on classification and distribution of the species of plants and animals for arousing interest. True, we need to know what certain forms are and where they are to be found, but these facts should be actively correlated with knowing what their life history requirements are and how to go about increasing them if rare or of keeping them at their present level of abundance so as not to be reduced by current demands being made upon them.

Chairman: ORANGE A. OLSEN
U. S. Forest Service, Ogden, Utah

RANGE LANDS AND WILDLIFE

This session arranged by the Wildlife Society

INTRODUCTORY REMARKS

JAMES N. TEMPLER[1]
U. S. Forest Service, Washington, D. C.

The papers submitted relative to the subject "Range Lands and Wildlife" were received too late for the Chairman, Orange A. Olsen of the Forest Service at Ogden, Utah, to prepare an introduction. However, the following will outline some important items in the various papers.

Range trends will be influenced by man and his works and when sufficient pertinent facts are available for acceptable range management adopted as a result should be the "maximum public benefit by the conversion of range forage into animals which can best use the range and contribute most to public needs and welfare."

Recent studies indicate that numbers of big game present are not as important as the relationship the numbers bear to range conditions and big game carrying capacity. Population trends, both aerial and ground, have proved satisfactory and practical. "Key species" system of range appraisal is preferable over other systems since the average field man readily understands its application. The population trend plot system, if carried over a period of years, will give a good index of herd variation in relation to range and become an important tool of sound management.

The stockman's basic resource is the forage production of the land he owns and controls. His livestock merely harvest it for him and transform it into a transportable and required commodity. Sportsmen should know something of proper utilization as it applies to forage resources, plant succession, and ecology. Knowing this, they may acquire a new philosophy regarding wildlife and livestock and understand more fully that on a range already stocked to capacity, the introduction of elk or other big game without a commensurate reduction in the number of livestock leads to disaster.

[1]Chairman Olsen met his death by accident before he had written the Introduction to this session.

There is a possibility that some range rodents, under some conditions, may assist in the recovery of deteriorated ranges, by differential pressure on plant species typical of early successional stages. There is food for thought in this statement and studies to determine the possibilities inferred appear warranted.

It is stated that diseases of wildlife can be attacked through management procedures by prevention or control, but therapeutic treatment of individual animals is impractical and usually not feasible. An understanding of the relationships of diseases of livestock and deer, as well as other game animals, by conservation agencies would do much to create better cooperation between stockmen and game managers.

Elk and deer tend to stick to their home ranges and hesitate to migrate. The effect of hunting on migrating big game is worthy of more study. Periodic reduction programs have been found necessary in Yellowstone and other national parks to prevent destruction of ranges. In some of the national parks of the Southwest, domestic livestock, grazing under permit, and wildlife on these ranges compete for the forage and water. Continued heavy utilization of the forage plants augmented by sheet erosion through loss of ground cover, causes the gradual disappearance of desert vegetation. In this respect the giant cacti on parts of the Saguaro National Monument in Arizona is an example of the results of competition between herbivorous animals. Under such conditions certain wildlife species tend to increase in numbers exceeding the carrying capacity of the available ranges. Thus, competition for forage between the conflicting species insures that the species unable to compete successfully must give way to the stronger, more adaptable ones. Progress has been made in obtaining authority to reduce herds in the national parks, where such action is definitely for the good of the area and the animals involved. However, the termination of grazing by domestic livestock is important in some of the southwestern park areas where the natural balance is too easily upset, if the ground cover is to be preserved.

BIG GAME AND LIVESTOCK ON THE WESTERN RANGE

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It is well known that during the past 20 or 25 years big game populations have increased tremendously throughout the western range area. In proportion to this increase has been the slowly rising tide of complaints from stockmen. Members of local livestock associations have stated that in many instances range deterioration has been due to big game animals rather than to livestock. In one recent meeting stockmen demanded a commitment to the effect that no further livestock reductions would be made on national forest areas, where large game populations exist, until after game numbers have been reduced and controlled.

The evidence purporting to sustain such demands is usually colored by emotion and stems from a naive form of direct reasoning from cause to effect. Deer eat forage and cattle eat forage, therefore the two compete and by removing deer proportionally more cattle can be grazed or vice versa. Unfortunately, sound biological facts are not always available to appraise the facts of such situations in detail. Much of the data available is based on observation rather than on research and accurate statistics. Furthermore, too often the technician who is faced with such a problem does not have sufficient training and experience, both in game management and livestock range management, to properly evaluate the facts.

Within the scope of this paper it is possible to review briefly only a few of the results of range use by livestock or game and to suggest only general ways in which the situation may be improved.

In attempting to present a broad picture of the results of heavy range use it is well known that the various kinds of animals affect the vegetation differently due to differences in choice of food plants and in habits. Bell and Dyksterhuis (1944) point out that brush, principally mesquite and juniper, have invaded an estimated 51 million acres of former grassland in Texas and have reduced grazing values 40 million dollars annually. The effects of fire and overgrazing are cited as the probable causes. Similarly, large areas in the Southwest, infested with burroweed, and even more extensive areas farther north which have been invaded by big sagebrush or fringed sage, are the direct result of cattle overgrazing as pointed out by the *Range Plant Handbook* (1937). Thousands of acres of former grassland have been or are in the process of being lost to brush and practically universally the result has been a very sharp decline in the grazing capacity for domestic stock.

In addition to the increase in brush and shrub, domestic stock grazing, coupled with incidental or planned fire protection, has also resulted in a marked increase in timber stands and in some cases in an extension of timber types. Most noteworthy in the latter category is the encroachment of pinion and juniper into grasslands and semi-desert throughout the Southwest. Ponderosa pine has closed in many of the grassy parks which formerly characterized much of the type in places like the Front Range in Colorado. Undoubtedly, this area consisted of much more open stands of pine with extensive bunch grass parks and slopes. Partly through grass competition and partly through periodic fires which swept the grasslands, reproduction was probably held in check. With the advent of grazing animals grass was often depleted, the fire hazard was reduced and in addition, voluntary or organized fire protection has practically eliminated the burning. As a result the trend is toward a more or less solid stand of pine, much of which is now 40 to 60 years old. As Graham (1944) points out, cessation of burning may have been largely responsible for the brush invasion in the Southwest much in the same way as suggested for the pine type. It is difficult to dissociate the dual influences of fire and grazing, however.

Sheep grazing has in most instances resulted in conversion of types to a more grassy character, usually dominated by the coarser grasses and often with an almost total absence of forbs or palatable browse. Many instances could be cited, as the thurber fescue mountain parks in Colorado where under intensive sheep use practically a pure grass stand has developed. In some of the semi-desert areas of Colorado such shrubs as sagebrush and shadscale are often severely hedged or even killed under intensive winter sheep grazing while native grasses, like galleta grass and bluestem wheatgrass, seem to be increasing.

The effect of game animal use on the range seems generally to have been more like the effect of sheep grazing. Data have been presented by Gaffney (1941), De Nio (1943) and others to the effect that elk eat and may damage both grass and shrubs. General observations indicate that they prefer a more varied diet than cattle and normally relish grass to a less extent. For instance, West (1941) lists the palatabilities of 50 species of grasses and grasslike plants. For elk 50 per cent are credited with a high or medium palatability and 50 per cent low or worthless. For cattle the proportions are 88 per cent high and medium and 12 per cent low or worthless. Pickford and Reid (1943) cite direct competition between elk and sheep but the experimental range had been depleted and choice of food plants was limited. It is probable that on a range in better condition competition would have been less intense. Correctly differentiating between range damage on grassland caused by elk or cattle is extremely difficult, while destruction of browse usually can be more easily assigned.

Deer food data presented by Carhart (1941), Hill (1943) and others indicate that ordinarily a very few plants make up the great bulk of forage consumed during any one seasonal period by these animals. In the Rocky Mountain and Black Hills areas these forage plants generally are such browse as sagebrush, rabbitbrush, juniper, serviceberry, and mountain mahogany during the winter season. In addition, deer seek out and relish a few plants as hollygrape and boxleaf myrtle which do not appear to enter into domestic stock diets. A fair portion of grass is taken early in the spring for a short time. During the summer weeds or forbs are eaten in quantity and considerable competition undoubtedly takes place between deer and sheep because of similarity in diet.

Although deer eat fair quantities of grass in the spring, it has not been demonstrated that such use has been detrimental to the grass cover in most instances. On the other hand, there are numerous examples, as the Sheep Mountain Refuge in Wyoming, where grass has flourished and increased under very intensive deer use if protected against cattle grazing. Reduction of competition from browse may be one reason for such an increase in grass.

It becomes apparent then that only very general conclusions can be drawn relative to competition between game and livestock. Such conclusions must be interpreted in the light of local conditions and may not apply everywhere. Cattle grazing, in some instances, has possibly increased the abundance of plants which furnish valuable deer food. On the surface it appears that conditions for deer may have been improved although the reduction of grasses as well as certain browse plants might have an adverse effect on spring deer ranges. Sheep, on the other hand, would certainly seem to have an adverse effect on deer winter ranges if they use them heavily.

It has been suggested that some of the grassy mountain parks, formerly largely free of brush and comprising splendid summer cattle range, may have developed as a result of use by browse-eating game, such as deer. Range men rate most of the typical mountain bunch grasses with a lower resistance to grazing than the common plains grasses. It is interesting to speculate that the bunch grasses have developed where they were not subject to heavy use by grass-eating game. On the other hand, perhaps only the grasses that were able to withstand the impact of the vast herds of buffalo and other grass eaters could survive on the plains. Such great changes in vegetation have come about entirely through chance. Certainly there was no intent to increase deer food deliberately through overgrazing by cattle. However, it is recognized by many technicians that such phenomena may be turned to useful ends, as by alternating sheep and cattle use on some ranges and thereby preventing the range from swinging too far toward either a weed or grass type. Undoubtedly game animals may also be used to give direction to plant succession when more is known about their influence and when game numbers can be more closely controlled.

On the other hand, there is grave danger in such manipulation if it is thoughtlessly undertaken. The conversion of grass to sagebrush and other browse often results in deteriorating soil and watershed conditions. The attempt to reverse the process through sagebrush burning as advocated by Pechanec (1944) might prove disastrous if applied on a large scale on certain deer winter ranges.

Even in such phases of range management as rodent control considerable care is required in interpreting what may appear to be obvious facts. Most range managers have assumed that such rodents as pocket gophers compete directly with cattle for forage. As a result of recent studies (Buechner, 1942) it is indicated that overgrazing may improve the pocket gopher habitat to such an extent as to cause a sharp increase in numbers. Kangaroo rats, regarded as detrimental to range, seem to have caused an increase in forage palatable for sheep in some parts of California (Hawbecker, 1944).

In charting a future course in an attempt to approach these problems in a more logical manner, the need for greatly accelerated and expanded research is so evident and has been stated so many times that it hardly bears repeating here. Nevertheless, research in range management has barely scratched the surface. Administration still depends too much on apparent truths derived only from observation, often faulty and frequently inconclusive.

Probably the second step should be in the field of improved resource inventories. Two of the public land manager's most vexing problems are the matter of competition and compatability in range use of wild and domestic animals, and the true capacities of land units. This is due partly to the lack of inventories of the range resources and partly to lack of a basis for determining the wildlife population potentialities of a state or other area. When ranges which are well adapted to domestic stock are properly and conservatively stocked, there will still exist, in addition, on nearly all areas a definite capacity for game animals which can, through improved techniques, be determined within narrow limits. Furthermore, the attempt to find forage for the maximum number of livestock has resulted, in some cases, in attempting to utilize ranges which are distinctly submarginal or which cannot be used without the risk of unwarranted damage to cover and soil. The fallacy of attempting to use such areas is being recognized and without a doubt eventually the attempt to utilize them will be given up. Many of these areas are ideally suited to game and will have a greater utility if devoted to that type of use. When an analysis is made in this way the relative values of the ranges for livestock and for game may be determined and it should not be too difficult to decide upon those winter ranges and other critical areas where over-all good land use may dictate the elimination of stock grazing and the reservation of such areas for game. The ultimate result will be the determination of potential game numbers, based upon what the country can support with due consideration to other land uses rather than upon hunter demand or other untenable proposals.

Finally, it will be necessary to consider ecological facts from a practical rather than a theoretical viewpoint. Most of the recognized textbooks on plant ecology insist that the range climax is a plant formation developed very largely through the influence of climate and that other factors as influences of animals or fire have been minor influences. This has led to the assumption by many range managers that no range is really acceptable unless the climax vegetation is attained. However, evidence is accumulating to the effect that much of the vegetation which has been considered climax was most probably a disclimax, produced not only by the prevailing climate but also by fires, by game animals such as the buffalo herds, and by other biologic or cataclysmic factors. Graham's (1944) suggestion that southwestern grasslands developed as a result of fire is just one example.

Regardless of these arguments, as long as man is on the scene, range trends will be influenced directly by his logging, fire protection, his domestic livestock and by the numbers of big game which he either tolerates or encourages on the range. In fact, the term "range management" infers that direction will be deliberately given to range trends, aiming toward a definite objective. This objective must include complete protection or improvement of the soil and water resources of the land since no range use, either by livestock or game, can endure if these are damaged. Within these limits, however, the plant cover can be modified to a considerable extent through the kind of use made of the range. To produce the highest value from the range it will be necessary to accumulate more facts concerning the effect on plants and plant succession by the various wild and domestic animals. After that it should be possible to apply much more intelligently such treatments as burning, seeding, rodent control, grazing with particular kinds of animals or rotating the use between various kinds of animals and other practices. The result ought to be maximum public benefit by converting range forage into the kinds of animals which can best use the range and which can contribute most to public needs and welfare.

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ALL FLESH IS GRASS

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Near the base of the Bighorns there lives a stock rancher. His spread is about what would be expected in that country: hay meadows around the home ranch; corrals, line cabins, and other improvements; range lands extending to the pine-fringed summits; a nice lot of white faces and saddle stock; a few bands of sheep; and some elk and mule deer. Just a good average outfit run by a man no different from thousands of other ranchers from the Milk River to the Rio Grande. No different, except for one thing.—He raises grass.

Most stock ranchers raise beef, or mutton, or maybe palominos, with some big game for good measure. But this rancher—and there are a few others like him here and there—raises grass. By his own statement, that is his crop. His steers and lambs harvest his crop for him and take it to market in the form of beef steaks and lamb chops. He figures on raising about twice as much grass each year as his animals can eat and convert into meat and wool. The grass that is left is his insurance against drought, market slumps, and other unpredictable things that plague ranchers who don't carry that kind of insurance. It is also an insurance that he will keep on raising bumper crops of grass equal to what his forbears found on this selfsame range when they first occupied it.

A century ago the grass on the western ranges seemed inexhaustible. It supported millions of buffalo, deer, and antelope; a quarter of a million cattle were already in Texas, and a half million in California. Grass was a bonanza, not a crop. For 40 years it was the lodestone that attracted ever-increasing investments in livestock, until by 1885 there were estimated to be more than 12 million cattle and horses west of the Mississippi. Scarcely any of the cattle barons realized that the range was becoming depleted by overstocking; and even when the dry summer and hard winters of 1885-87 brought death losses as high as 85 per cent in some herds, many ranchers placed the blame entirely on the weather. That was easier than blaming themselves for not carrying insurance in the form of reserve grass. They shut their eyes to the fact that for at least a decade the range had been stocked beyond its capacity. The grass crop had failed because of misuse.

Since the collapse of the cattle boom the more provident ranchers have begun to learn the importance of raising a good grass crop each year. Experience has proved that deferred and rotation grazing give the grass an opportunity to reseed itself and to build up strong roots full of reserve plant food. The Forest Service and now the Grazing Service have improved the management of ranges that had been eaten into the ground during the years of free range and destructive competition. Range experiment stations have demonstrated the value of conservative stocking. Typical of these is the Jornada experimental range in New Mexico, where the Forest Service has been improving the grass crop for more than 30 years. The calf crop on the Jornada experimental range has averaged 70.5 per cent as compared to 45 per cent on adjacent ranges that have poor grass crops because of overgrazing. The old notion that a cattleman's profits increase in proportion to the number of cattle per hundred acres has been proved entirely false. Ranchers, range managers, and scientists are finally coming to complete agreement on the importance of large sustained crops of grass in the production of range livestock.

Though the principles of good range management are widely accepted among stock raisers, the application of these principles is still far from universal. On private holdings it is rare that grass production is given the attention that it receives on the Bighorn Mountain ranch previously mentioned. Even on national forests and grazing districts the conservation of range resources is often below standards set by administrative officers. As one rancher expressed it: "A man may know that fewer and better cows mean bigger calf crops and heavier steers, but he can't win unless his play is backed by his banker and the tax assessor."

Without going into detail on the economics of range livestock production, which are outside the scope on this discussion, a few generally accepted ideas can be stated. Range lands, in the main, are assessed at 30 per cent to 400 per cent above their actual forage-producing value. Credit to stockmen is too often based on the number of animals owned rather than the forage production of the range on which the stock feeds. Tax assessors and bankers should literally get down to the grass roots and learn the true nature of the resource upon which their levies and loans are dependent.

Sportsmen interested in western game should also cooperate more closely with ranchers in the conservation of range forage. It is probable that sportsmen are in a better position to promote good range management than any other group. Within the ranks of sportsmen all who benefit from the range—bankers, ranchers, public officials, packers, and consumers—meet on common ground in the good fellowship enjoyed by hunters everywhere. Yet, with the exception of some ranchers and public land managers, sportsmen have a great deal to learn about the range and its crop—grass and other forage—before they can use their influence to the best advantage.

Few people have the ability to recognize in its early stages the excess use of range by either game or livestock. Even experts find it difficult until they have had many years of experience in looking for inconspicuous signs such as the different appearance of grass cut down by mice and that cropped by cattle. Small wonder, then, that few sportsmen have learned such lore in the few weeks spent afield each year.

Much has been said and written about "browse lines." Such evidences of overused range can be seen at a glance by motorists passing through certain sections in Pennsylvania, Utah, Oregon, or any other states having excessive local concentrations of game or livestock. But long before the browse line became easily seen, there were other signs of too many deer or sheep—small signs such as too many twig tips missing on a cliff rose or bitterbrush bush.

It is surprising how chewed-up a bitterbrush bush can be without showing much damage to a casual observer. After several years of severe overbrowsing, however, the brush starts to die, and all at once the deer hunters come in with stories of some mysterious disease that has suddenly killed off the best deer feed. When the situation is explained to the sportsmen, and a doe season is proposed in order to reduce quickly the excess numbers of deer, they assume an injured expression and vow to get a new game commissioner. They would do better to give themselves a new viewpoint, to think of grass and browse as the crop and deer or elk as the harvesting machines.

Sportsmen are not finding it easy to change their views on this subject. New knowledge and a new philosophy are required. The knowledge in itself is not too difficult to acquire, especially among sportsmen lucky enough to have ranch-owning friends who think of grass as their crop. A day spent in riding the range with such company helps a man to change his philosophy; to see things through the other fellow's eyes; and to realize that on a range already stocked to capacity it is foolish to introduce elk or other new game without a commensurate reduction in livestock.

Commensurate does not mean that one steer should be removed for every elk that is introduced. One kind of grazing animal is seldom 100 per cent competitive with another kind. Cattle and buffalo come about as close as any to being 100 per cent competitive. At the other extreme, there are no two species that are completely noncompetitive. Even mountain goats compete occasionally with bighorns and domestic sheep for forage around the high crags.

On this subject of competition for range forage much nonsense has been printed under the guise of scientific information. One so-called scientist went so far as to state that deer and domestic stock did not compete in eating mountain mahogany because they ate it at different seasons! Other nonsensical things have been written on the subject of supplemental winter feeding for game. Such feeding of game may have a legitimate place in certain special cases and is often a necessity in the range livestock business. But before you let anyone tell you that it is a solution to overstocking of game on the range, you should read what Dr. D. I. Rasmussen and Everett Doman said about it in the *Journal of Wildlife Management* for October 1944 (pp. 317-338).

For a complete story of the importance of grass and other forage, nothing is better than *The Western Range* (Senate Document No. 199, 74th Congress, 2nd sess., 1936). For a discussion of range management problems, an excellent reference is *Range Management* by Laurence A. Stoddart and Arthur D. Smith. (McGraw Hill, 1943.) Both these books deal principally with forage production for domestic stock but are almost equally applicable to game, because both game and livestock are subordinate to the basic resource in essentially the same way.

In studying the problem of range conservation, every practical man will sooner or later discover a serious gap in our knowledge of the subject. It is this: there are as yet no simple, readily-usable measures of range use and productivity. Range misuse often shows its effects so slowly that even the best and most experienced ranchers are unable to judge accurately the amount of use that is safe. There are several methods of measuring annual production of grass or browse and of estimating the amount that can be safely eaten off; but all these methods are slow, expensive, and usable only by well-trained workers. These methods are being used by managers of forest, grazing, and Indian lands, and by appraisers in the A.A.A. range development program. The methods are so slow and expensive, however, that it is not practicable to use them at the frequent intervals needed in keeping abreast of changes in use and productivity. Nor are they readily usable by tax officials and credit agents, nor readily understood by sportsmen's groups, who are puzzled by complex problems of joint game-livestock use of the range. Sportsmen want a method that will quickly and easily indicate how to balance range use by game and livestock. Development of a readily usable measure of range use is one of the most urgent needs in wildlife and range management today. It is a challenge to all investigators in these fields.

When the tax assessors, bankers, ranchers, sportsmen, land administrators, and scientists get together on a common appreciation of the importance of raising grass, then we can expect at long last a concrete application of the philosophy implied by the prophet Isaiah, about 700 B.C., when he said, "All flesh is grass." We have been slow to learn the necessity of dependence upon our most important renewable resource and the still greater necessity of conserving it. While we have blundered around in pursuit of easy profits, big livestock holdings, and a deer for every hunter, the grass has been getting shorter and thinner, gullies have been washing deeper into meadows, and dust storms have had a field day. But it is not too late. Our western range has not yet been reduced to the barrenness seen in parts of China, North Africa, and Arabia. Even so, it will be a long and expensive job to restore the ranges to their original level of forage production. The longer the delay, the worse the problem becomes. Fortunately, grass itself is our greatest ally. As Senator John J. Ingalls, of Kansas, said in 1872: "Grass is the forgiveness of nature—her constant benediction—forests decay, harvests perish, flowers vanish, but grass is immortal—its tenacious fibers hold the earth in place and prevent its soluble components from washing into the wasting sea."

RANGE RODENTS AND PLANT SUCCESSION

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It is widely accepted that jack rabbits and many species of rodents are likely to be more numerous on a rather depleted and weedy range than on one in climax or near-climax condition (Taylor, 1936; Smith, 1940a), and that large populations of these "range pests" are a symptom of poor range condition rather than a cause of it (Taylor, Vorhies and Lister, 1935; Smith, 1940b). This is well stated by Vorhies and Taylor (1940) who say: "As the grazing range deteriorates, in various parts of the Southwest, brush and small trees, . . . cholla cactus and prickly pear tend to increase. The superior perennial grasses tend to be replaced by annuals, . . . and numerous weeds become abundant . . . cottontails, cotton rats, meadow mice, harvest mice and other species characteristic of thick grass tend to decrease, and jack rabbits, kangaroo rats, prairie dogs, ground squirrels, and wood rats . . . tend to increase."

This range relationship seems to have at least two independent causes. In the case of the California and antelope jack rabbits (Taylor, Vorhies and Lister, 1935; Smith, 1940b; Taylor and Lay, 1944), ground squirrels (Smith, 1940b; Grinnell and Linsdale, 1936; Horn and Fitch, 1942; Evans and Holdenried, 1943) and prairie dogs (Osborn, 1942; Taylor, 1940), heavy stands of tall grasses appear to discourage the animals, in part at least, because their view is shut off, and they cannot keep adequate watch for dangers. In the same case of the pocket gopher (Garlough, 1937; Buechner, 1942), the greater proportion of tap-rooted and bulbous-rooted plants in deteriorated range is more probably the deciding factor. The larger and more numerous seeds usually afforded by the annual components of deteriorated range probably tend to increase the populations of certain spermophilous (Smith, 1940a) rodents, such as certain kangaroo rats (Monson and Kessler, 1940), pocket mice (Smith, 1940; L. W. Arnold, 1942) and probably ground squirrels (Smith, 1940a and b). Some rodents, such as the Beechey ground squirrel, may be benefited both by more open vegetation and a better food supply. As quoted above from Vorhies and Taylor (1940) the degree and even the direction of the effect of range deterioration will not be the same on all rodents; meadow mice and cotton rats (Phillips, 1936) are probably most favored by range in climax or near-climax condition, and this may also be true for some species of cottontail (Taylor and Lay, 1944), although the latter have unquestionably increased and spread into areas of grass climax where range deterioration has involved the increase of shrubs or shrubby weeds. It is also clear that range deterioration can be carried so far that the rodent and rabbit population will be greatly reduced (Smith, 1940a and b).

It has been frequently pointed out that a large rodent or rabbit population consumes great quantities of forage that would otherwise be available for livestock and would end up as beefsteak and finally, by implication, as money in the bank (Grinnell and Dixon, 1918; Taylor and Loftfield, 1924; Horn, 1938; Cully, 1939; I have about 800 references that might be inserted here).

This is certainly true, but it is seldom pointed out that where serious competition exists, it is usually for a very inferior type of forage. In addition, the point seems to have been missed by most authors that a large population of herbivorous small mammals must be exerting a *dynamic* force on the vegetation, unless they feed with no more choice than a mowing machine, which does not seem to be the case.

A few recent studies, and some unpublished observations, make it appear possible that small mammals of the range may exert enough preferential pressure on range vegetation to help speed up plant succession, and therefore range improvement, since range is usually most productive at or near the climax stage. The different mammalian groups will be considered separately.

Prairie dogs.—Of studies mainly on prairie dogs (*Cynomys gunnisoni zuniensis*) Clements and Clements (1940) say: "rodent-proof enclosures, in northern Arizona . . . regularly contain a larger percentage of forbs than does the range outside or the cattle-proof unit which is open to rodents. After the forbs had disappeared from the latter, a small plot was fenced with hardware cloth, and the forbs reappeared in a few years, only to vanish again when the fence was removed. . . . In one large town in the mixed prairie, 15 species have been eaten to some degree, whereas none of the grasses had so far been touched. This by no means signifies that rodents do not consume grass, but the latter seems to be a second choice, except when forbs are few or hard, or a protected range adjoins a depleted area." Osborn (1942) says of *Cynomys ludovicianus* in oak shinnery savannah in Oklahoma, that once cattle have grazed down the tall *Andropogon* so that rodents can colonize the area, "prairie dogs seem to be able to keep the woody components of the community well under control and, with the aid of domestic stock, indefinitely maintain a condition resembling short-grass or mixed-grass prairie."

Ground squirrels.—Unfortunately, I know of no studies on ground squirrels made in an area where climax species still persist, in which the relative pressure on perennial grasses and on annual plants is clearly indicated. Evans and Holdenried (1943) discussing *Citellus* *beecheyi beecheyi* east of San Francisco list as favored foods only plants low on the successional scale. Climax remnants such as *Stipa pulchra, Melica imperfecta* and others are still to be found in their general study area, but the authors do not indicate what, if any, effect the squirrels have on these species. Horn and Fitch (1942) found in an enclosure on the San Joaquin Experimental Range that *Citellus beecheyi* in a 5-year period had the effect of substantially decreasing the abundance of *Erodium botrys* and *Lupinus bicolor,* while increasing *Bromus mollis,* a grass definitely higher on the scale of succession than the two forbs, but not a member of the climax association, nor even a native species.

Pocket gophers.—Buechner (1942) near College Station, Texas, found mounds of *Geomys breviceps brazensis* to be 1867 per cent more numerous on a "moderately" overgrazed area of mixed grass prairie climax than on an area in near-climax condition. Since the gopher was "competing with the goats for food," it must have been exerting a heavy pressure on the forbs and woody plants that characterize the low stage of succession present. Garlough (1937) discussing gophers (*Thomomys* sp.) in mountain meadows in eastern Oregon does not blame rodents for the original breakdown of the climax sod, but gives evidence that they *prevent* or slow down plant succession in this environment once the damage is done, though this may not be true in many other types of grassland. Grinnell and Linsdale (1936), for example, give photographs (Plate 37) which show the increased vigor of the climax *Stipa* at the edge of a mound of *Thomomys bottae bottae.* Unquestionably pocket gophers tend to slow down succession by their disturbance of the soil, burying plants and preparing a "seedbed" for weed species, as well as tending to speed it up by differential pressure on tap-rooted and bulbous plants. Which effect will predominate in a given area will depend on what plant species are involved, and on what their individual reactions may be to gopher digging and feeding.

Kangaroo rats.—These animals unquestionably sometimes have an effect on the composition of the vegetation (Hawbecker, 1944) but there is little to show what effect they may have on plant succession. Hawbecker (1940) found that *Dipodomys venustus* in west central California did not take seed of planted perennial grasses which were available, but fed only on annual grasses and forbs. Monson and Kensler (1940) working on *Dipodomys s. spectabilis* and *D. m. merriami* reach the tentative conclusion that these rodents, which are rare perennial grasses are dominants, actually prefer annuals. Monson (1943) on the basis of later work on *D. s. spectabilis* on another area, voices the suspicion that availability is more important than preference in determining the animal's diet, but his data do not seem to support this thesis. The later study area is stated to contain "extensive, almost pure, stands of tobosa grass (*Hilaria mutica*) and sacaton grass (*Sporobolus wrightii*)" which are important members of the climax. The fact that these make up respectively only .1 per cent and 1.0 per cent of the food stores of the animals make the earlier conclusion still appear reasonable, and also suggest that the rodents are tending to hasten the spread of the climax grasses at the expense of such species as *Bouteloua rothrockii, Triodia pulchella, Aristida adscensionis* and *Aplopappus gracilis,* which are all pre-climax or lower on the successional scale, and which together make up 56 per cent of the stores.

Pocket mice.—L. W. Arnold (1942) found in *Perognathus penicillatus pricei* near Tucson, Arizona, that 43 out of 51 individuals with food in their cheek pouches were carrying products of mesquite (*Prosopis*), 20 pouches containing mesquite seeds. This plant is one of the vigorous invaders of the overgrazed short grass of the desert. No grass seeds were found in the cheek pockets of these mice, although *Zizyphus, Larrea,* and *Acacia* seeds were found.

White-throated wood rat.—Vorhies and Taylor (1940) found that a large majority of the food of *Neotoma albigula albigula* consists of woody plants, such as mesquite, and to weedy herbs, such as cholla and prickly pear cacti (*Opuntia* spp.), and it appears that on ranges not being overgrazed, they may, to some extent, assist the climax perennial grasses in re-establishing themselves. Spencer and Spencer (1941) state: "Thus it would seem that, far from being a factor in the spread of chollas, the white-throated wood rat tends to restrict reproduction of the plant. Not too much emphasis should be placed on this influence, however, as the peak infestation of 20 rats an acre failed to keep more than a portion of the area cleaned up." Spread of seed of prickly pears, however, may fully counterbalance destruction of that group of species.

Jack rabbits.—These animals are, of course, not rodents, but are usually so classed by the stockmen. J. F. Arnold (1942) found that *Lepus californicus* and *L. alleni* on the Santa Rita Experimental Range near Tucson, Arizona, ate by choice about equal quantities of grasses and weeds. It would then appear that on a range only moderately deteriorated, the rabbits would exert a force in favor of succession toward the climax, whereas on a range that had deteriorated to the point of having more weeds than grasses, their effect would be towards further deterioration. This may explain the difference between the observations of Parker (1938) and of Taylor, Vorhies and Lister (1935) and of the Spencers (1941). Jack rabbits have been implicated in the spread of prickly pear cactus in Kansas by Timmons (1942), and Cook (1942), but only on overgrazed or drought-stricken areas. Riegel (1942) found viable seed not only of prickly pear and pigweed in rabbit pellets, but also of sand dropseed which is a valuable perennial grass, and believes that "rabbits may have a part in the early appearance of sand dropseed in land retired from cultivation."

None of the above observations is conclusive, but the possibility is strongly suggested that some range rodents, under some conditions, may assist in the recovery of deteriorated ranges by differential pressure on plant species typical of early successional stages. Studies to investigate the possibility would be very desirable, and future studies of any kind on range rodents should endeavor to test this hypothesis.

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METHODS OF DETERMINING TRENDS IN BIG GAME NUMBERS AND RANGE CONDITIONS

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Successful management of wildlife is dependent upon three factors: range utilization, game numbers, and herd drain. Often census figures on game herds are made without sound analysis of the relation they bear toward the range. Various systems of census have been used. One that is quite common is the system of counting a small localized area and comparing the entire herd from this count. The fallacy of this procedure is that counts are generally made in areas that do not give a true picture of the average condition. Others merely take the estimates of their fieldmen and in many cases it is known that these estimates are little more than a guess. Game managers should not be too concerned as to whether their estimates show 50,000 or 100,000 big game animals on a game management unit provided the range is in a condition to carry this number of animals in addition to the allotted domestic stock. However, they should be particularly interested in the population trend of the herd, as this serves as an index to herd increase or decrease in relation to range.

Colorado has developed a simplified method of evaluating herd-range relationship, partially based on the progress report as submitted by Messrs. Beck and Hatch at the Western Association of Game Commissioners in 1942. This simplified system uses a maximum amount of man power and is designed to show the population trends of big game animals over a period of years in relation to carrying capacity and utilization. The same procedure, with some variations, is used on game birds and fish as well as big game animals. However, I will confine my remarks to its application in regard to deer and elk and later briefly touch on its use with other species. For the sake of clarification, the large plots referred to in this paper will be called "Population Trend Plots" and the small plots located within the population trends will be referred to as "Range Utiization Plots." In working out the application of this system, representatives of all land-use agencies are called in on the range examination. This procedure is the outcome of cooperative game management agreements practiced in the State of Colorado.

Two types of population trend plots are used—ground and aerial and both are located on the winter ranges. Ground population plots vary in size depending upon location, as those along a road may be 20 to 30 miles long, while on the other hand plots that require walking or the use of horses may be from 2 to 5 miles long. All are located areas that represent an average use rather than an abnormal use, as such selection has been found to give a better cross section of range and herd conditions. Aerial plots naturally cover much larger areas and in many cases take the greater part of a range, this is particularly true in regard to elk. Experience has proved that 50 square miles of area can be counted by plane in 2½ hours flying time.

The important factor of this population trend plot system is that the boundaries of the population trend plots, regardless of whether they are ground or aerial, must remain constant from year to year.

METHOD AND PROCEDURE

Population growth trend—(location and examination).—Prior to the time the population trend plots are established, examiners cover the game management unit and if possible pick an area that is comparable to the general range condition that exists throughout the entire unit. Preliminary examination and location of the plots may be made at any time of the year. When the study of the plots is undertaken, generally from January to April, examiners proceed along the center line of the population trend plot counting all animals on the right and left within the boundaries of the plot. The tally of animals counted is listed on the population trend plot form as well as other information requested. Three or more counts are made on the same plot at approximately the same hour on different days each month during winter grazing period. Counts should be continued each year thereafter during the winter big game grazing season. Change of population due to weather variation from year to year would be considered in the final analysis. Sample population trend form is a part of this paper (Table 1).

Population aerial trends—(location and examination).—In locating aerial plots, a check flight is made to the upper and lower limits of the deer and elk ranges. Preliminary work is generally done in early spring when the snow is still on the ground so that the limits of the range are easily determined. Entire area is then mapped.

After plot is established, pilot starts stripping at the upper end of the area and works down the drainage or slope. Strips are one-quarter of a mile or less, depending on cover, and may either parallel or run at right angles to the drainage. Observer is always on the downhill side, which gives him the advantage of continually looking into new terrain. In this position he can better observe deer or elk through the trees and cover. Plane is flown at a speed of 60 to 70 miles per hour at an elevation of 50 feet above the tree tops and no effort is made to break down the count by sex or age classes. In counting deer the plane must be kept as low as safety permits as this frightens the animals so they are continually on the move and do not freeze as is commonly supposed when a plane is used. During the census, should a large concentration of deer or elk be encountered, it may be necessary to circle this herd a few times. Such procedure allows the observer sufficient time in which to make his count.

In using a plane, particularly on deer, the entire secret is the technique of the pilot. It is believed that most of the complaint against the use of a plane on deer was brought about by the fact that most pilots would swoop down on a herd, then climb to a higher elevation. Such procedure has a tendency to force deer to freeze or hide.

The most satisfactory type of plane to use is one with a stalling speed of 40 miles per hour and a high speed of 115, service ceiling between 14,000 to 17,000 feet. Either a tandem or side by side plane can be used. However, the latter is preferred as the pilot can talk to the observer and in many cases help him count, whereas if the tandem is used, it is rather difficult to carry on a conversation due to the noise of the motor.

Range utilization plots—(location and examination).—Grazing utilization plots are established within or adjacent to the population trend plots. When possible three check plots or more of approximately 100 by 100 feet are located; one where range use is critical, one where it is average, and another in a little used section of the range. Plots

TABLE 1. SAMPLE COPY
POPULATION TREND UNIT

Game Mgt. Unit Grazing District 1 Sub-Unit Douglas Observer J. G. Reed

Mule Deer
(Species)

West Douglas
Name and Number of Plot

Date	*Time of Day*	*Bucks*	*Does*	*Fawns*	*Undetermined*	*Total*
3/16/44	7:30 A.M.	125	255	186	25	591
3/17/44	7:00 A.M.	141	243	152	20	556
3/18/44	5:30 P.M.	138	208	116	15	477
3/19/44	4:30 P.M.	142	259	175	42	618
Total for Period Counted		546	956	629	102	2,342
Average Counted		137	241	157	26	561

Sex ratio 1 Buck 1.7 Does 1.15 Fawn Herd Composition 25% Bucks 45% Does 30% Fawns

Clear and Cold 14" snow last week	32	12"
Weather	Temperature	Snow Depth

Good	Fair and Good	*Common
Visibility	Condition of animals	Estimate of predator population

Remarks: 3/17/44 10 Elk observed on plot near W. Fork; 12 dead deer counted—3 does, 2 bucks, 5 fawns. Of this two were coyote kills, balance of animals died of malnutrition, 5 had bots. See letter attached.

*Use: Coarse, Common, Abundant.

are inconspicuously marked so as not to disturb the normal grazing of the game. Rocks, boulders, trees, etc., can be used. After the plot has been properly marked, one corner marker should be used as a photographic hub or camera point and a photograph made each year at the start of the study. Plots must be tied in to some permanent feature so they can be found in the future. Location of all plots are indicated on map and the same procedure applies to utilization plots in aerial trends. It is advisable to have the assistance of a range examiner on the original location of the plots. After this the warden or other personnel can make annual checks.

Plots are examined each year at the close of the winter grazing season, the object being to measure the trend in utilization of the four to six primary and secondary forage species which are most heavily used.

These primary species are called "key" species and four intensities of use are recorded which are as follows:

LIGHT.—Range has appearance of "topping" or "skimming" use only, or only most convenient parts of the area may be grazed in "patches." Generally only certain plants of choice or good value are being selected, while low value plants are untouched; seed stalks of primary plants abundant, most young plants intact.

PROPER.—Range appears uniformly utilized in so far as natural features and facilities will allow. Occasional or very choice "ice cream" plants may be completely taken, but on primary forage plants a sufficient amount of the current year's growth has been left to assure future maintenance (for most shrubs about one half of current growth, for most grasses and weeds at least one fifth should remain unused). Use of low value or less desirable plants usually is slight; some seed stalks of primary plants are left, some young plants are intact. (The real object here is to be sure the ranges with choice and good forage plants or average ranges under average growth conditions are able to maintain themselves indefinitely without undue wastage of usable forage.) Depleted ranges should improve, perhaps slowly, under average growth conditions.

We are at the present time conducting an experiment at Mesa Verde National Park to determine the "proper" amount of utilization for the key browse species. The indication at the present is that about 50 per cent is the proper browse utilization in Colorado.

SEVERE.—Range has mown or hedged appearance, with indications of repetition in use and some trampling damage in patches of concentration. Primary forage plants have current growth almost completely taken, removing the maintenance safeguard. Choice and good forage plants have been injuriously used. Low value plants are carrying most of the grazing load. Seed stalks on primary forage plants are only occasional, while few, if any, young plants are left uninjured. Shrub clumps may be slightly broken up. (The range capital is being drawn upon. Ranges in average condition will decline or show improvement only in unusually favorable seasons.)

DESTRUCTIVE.—Range appears "grubbed" rather than grazed, a definite browse line is evident. Primary forage plants show much death loss. Only remnants of choice or good plants are present, even low value plants are closely taken and cause active soil movement by washing or blowing or by creeping on slopes. Range is in critical state.

In this type of study the "key species" system is preferred over the more elaborate systems of range appraisal as experience has shown that the average fieldman readily understands its application and can make a fairly accurate study. A sample form of range utilization study sheet is made a part of this paper (Table 2).

PREPARATION OF MAP

Ground trends.—The first procedure after preliminary examination is to make a map which can be used for future reference. Eight by eleven excerpts of Forest Service base maps or Grazing Service maps are used.

Scale of maps ranged from one quarter to 1 inch per mile depending on the length of the plot.

Starting and ending points of the trend plots are clearly indicated and tied in to some permanent feature.

Population trend plot boundary lines are indicated by a heavy line, the center line is a fine broken line of one-half-inch dashes, the latter referring to ground trends only.

Side boundaries of population trend plots are parallel to the center line and the distance of these boundaries from the center line vary with the individual plot depending on the topography and cover.

When the region is rough or has heavy cover, a strip 10 chains (660 feet) each side of the center line is satisfactory. In areas which are flat and open, greater distances may be included in the strip. However, too great a width should not be used as distance would limit the accuracy of the observation. Generally when a car is used for purposes of counting, the smaller strip is advantageous as the animals under observation allow a person to come much closer in a car.

Range utilization plots, located within the large population trend, are indicated on the map and tied in to some natural feature. These range plots are designated by figures and letters; number one plot is nearest the starting point and letter "L or D, etc.," indicates the amount of utilization originally found on the plot. Detailed map of

TABLE 2. SAMPLE COPY
RANGE UTILIZATION CHECK

Grazing District 1 Game Mgt. Unit, Sub-Unit Douglas Date 3/15/44

Trend Plot West Douglas Examiner:

1. Location T 1 & 2 S, R 101 W (See map attached)
2. 1 month before close of deer winter grazing period
(Time of examination in relation to period of grazing and period of growth)
3. Pinion, Juniper — Sagebrush, Rolling Hills — Winter — Deer
General Type of Range — Cover, Topography — Season and species of game animals
4. FORAGE PLANTS: List in order of forage importance; by brackets indicated with (1) Primary plants, with (2) Secondary plants, with (U) Undesirable plants. For each plant describe degree of use, relative vigor, evidence of reproduction or death loss.

	PLANT NAME		DESCRIPTION OF CONDITIONS
1.	Big Sage Brush	Proper	½ current annual growth remains, many young plants.
	Oak Brush	Proper	Good annual growth; many seedlings.
	Mtn. Mahogany	Severe	Hedged appearance, all annual growth taken.
	Bitter Brush	Destructive	Plants appear grubbed, many dead plants.
2.	Shadscale	Light	Many plants untouched.
	Rabbit Brush	Proper	Browsing appears uniform, 50% annual growth remains
	Chokecherry	Slight	Many plants untouched.

5. SOILS & EROSION: Comments on character, evidence, influence and management:
Rocky clay soil, good heavy soil in bottoms, some traces of old erosion, no new erosion appears.
6. OTHER FACTORS: State particular conditions of location, topography, water facilities, methods, etc., which affect management:
Range is adjacent to number of large cattle ranches and has 3,000-4,000 cattle during summer. Slopes not steep; water in most gulches, good deer range.
7. FORMER USE: State kind of degree, evidence, effect on present conditions:
Heavily used in past winter and summer by cattle. Evidence of old erosion. Range now controlled by Grazing Service and improving.
8. GENERAL COMMENTS: Explain use of range by Domestic Stock, giving kind using unit:
Present stocking cattle is satisfactory, should not be increased. Endeavor to have users remove salt ground near dry gulch.

utilization plots, as well as survey notes on population trend plots, are placed on the reverse side of the map.

Examiners make comprehensive notes on the range conditions which prevail over the entire population trend plots. Such notes are very valuable to men who will make the examination in subsequent years.

Aerial trend map.—On aerial trends the boundaries of the flight areas are mapped and range utilization plots are located on the ground using the same procedure as those located on ground trends.

OTHER USES OF POPULATION TREND PLOT SYSTEM

As stated previously the population trend is also being used in relation to game birds and fish. When applied to pheasants, trends have been set up on various highways throughout the state and the roadside count system used. These particular roads are covered each year and if there is any change in cover, this is also brought out in the yearly report.

In its application with other upland game birds, such as sage grouse and sharptails, strutting grounds are used as trend areas.

Relative to fish, certain sectors of various streams have been designated as trend areas and these are covered regularly each year at about the same time by a warden. During these trips all fishermen within the area are contacted and a creel census made. Later a biologist takes food counts at regularly established stations within the trend areas.

While the system has not been tried on fur bearers in Colorado, it is very evident that its application would be practical, and at a later date we hope to do this.

Summary

1. Numbers of big game present are not as important as the relationship the numbers bear to range condition and big game carrying capacity.
2. Population trends, both aerial and ground, have proved satisfactory and practical.
3. Population trend plot system uses a minimum amount of man power.
4. Population trends should be taken at least once a month during winter grazing season.
5. "Key species" system of range appraisal is preferred over other systems as average fieldman readily understands its application.
6. Population trend plot system can be used on big game, game birds, fish, and fur bearers.
7. Population trend plot system, if carried over a period of years, will give a good index of herd variation in relation to range and become an important tool of sound game management.

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DEER MANAGEMENT PROBLEMS AS RELATED TO DISEASES AND PARASITES OF DOMESTIC RANGE LIVESTOCK

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Many diseases occurring in domestic livestock are also prevalent in deer. From the viewpoint of the stockman, deer serve as reservoir hosts to these diseases and, as such, are a potential source of infection to his herds and flocks. Some of these diseases are equally fatal in deer, others are believed to do little harm, and many have been too little studied to learn their pathogenicity or their resultant mortality. Since deer are sharing range with livestock in many regions, these factors and any attendant ramifications should be seriously considered in a program of deer management. Ranchers and agricultural agencies are expending large sums annually for the control of disease and parasites but little has been attempted with deer. The problems are of importance not only for the maintenance of a healthy deer herd but also for the maintenance of a proper range balance between deer and livestock.

Knowledge of disease in domestic animals is extensive while knowledge of disease in deer is extremely scant. Various practices of treating disease have proved successful in domestic animals but the methods of combating disease in deer are limited and untried. Often disease in domestic animals, as in man, is attacked by administration of medicines —by mouth or injection. This technique generally is not practicable in combating disease in wildlife populations. Most drugs used in the treatment of disease have a minimum and maximum dosage value. Below the minimum amount they are of little value, above the maximum dosage they may be extremely harmful. Since individual dosage cannot be controlled, the often suggested technique of supplying salt blocks containing medicines for the purpose of treating disease in deer, therefore, appears to be an impractical approach to the problem.

Many diseases of domestic livestock are attacked from the aspects of prevention or of ecological control. Frequently similar methods would be applicable in the control of disease in wildlife.

No attempt is made to give a complete list of diseases common to deer and cattle or sheep, but rather a few outstanding examples are presented for the purpose of pointing out some of the problems involved and possible management procedures which might better the situation.

Control of food supply.—In the coastal counties of California, probably the greatest loss in deer can be attributed to several species of stomach and intestinal round worms. Annually a great number die from infection with one or another of these round worms. These parasitic worms also occur in cattle and particularly in sheep and the problem undoubtedly is of equal importance in other regions where these animals share the range with deer. A typical symptom is diarrhea or scours.

The worms all have a direct life cycle. Eggs of the worms are passed out onto the soil with the droppings of the host. Extensive research has been done on many species of these parasites as they relate to cattle and sheep. It has been shown that a period of time for development outside the host is required differing somewhat with the species of parasite, temperature, and humidity. When the larval worms hatch from the eggs and reach the infective stage, they climb up blades of grass where they are then available to deer or livestock which becomes infected by eating the contaminated grass. Fatalities occur primarily in younger animals.

To combat these worms, calves and lambs may be treated with drugs and sometimes an attempt is made to keep them out of particular areas on the range where the worm burden is known to be severe. In considering the problem from the standpoint of the deer, two important facts should be emphasized. First, infected animals (cattle, sheep, deer) must be present on grassy areas to deposit the worm eggs; and second, the deer must feed on the grass in such areas. Another point to bear in mind is that a few worms may do little harm; it is the heavy infections that are fatal. The number of parasites in an individual deer is dependent not only on the concentration of infective stages in the grass but the amount of grazing done by the animal. However, mild infections may serve to lower the resistance of an infected animal and thus make it more vulnerable to other diseases.

Very little research has been done on the nutritional requirements of wildlife. Food habits research tends to show what animals eat rather than what they need for a well-balanced diet. Superficial field observation seems to demonstrate that deer thrive on browse better than on a grass diet. It is possible that deer subsisting almost exclusively on grass have a lowered resistance from nutritional deficiencies, which, in turn, makes them more vulnerable to the ravages of the worm infections.

Therefore, it is evident that the control of these deer stomach and intestinal parasites becomes a problem of range or forage management. While the ultimate goal is to get the deer, particularly yearlings, to take browse entirely and thus keep away from the source of infection, any change in this balance toward more browsing and less grazing will tend to reduce the intensity of the infection in the individual deer and thus reduce mortality. This is a particularly important problem because the mortality occurs in younger animals. It is better to have mortality occur in older animals past maturity than to have the losses in younger or immature stock.

It has been noted over a period of years that the greatest losses in yearlings occur during years when there is an early spring and green grass is available over a longer period of time. Field observers have frequently recognized the relationship of grass eating to losses in yearling deer. In California, it has also been observed that the greatest mortality to young deer occurs in areas where there is little or no browse available to the smaller animals.

There is need for much further research before this problem will be solved. There has been much controversy over the value of control burning as a technique of attack. Many stockmen advocate this method as a means of increasing range forage conditions but the wildlife interests should bear in mind that the rancher seeks more grazing land while the requirement for deer is more available low, new growth browse. Artificial propagation of browse species and restocking of certain plants on a large scale in deer areas may also prove to be a valuable management procedure.

Grazing agencies limit the amount of stock that can be run on range land, based on the available food supply, but conservation agencies have given little consideration to this phase of the problem in deer management. It is not the purpose of this paper to discuss the merits of any management procedures but merely to suggest some of the techniques which may be related to disease control. These methods are as yet untried but they are worthy of consideration and investigation.

Stockmen are often careless in control of stomach and intestinal worms in their domestic animals which may cause further infection of their herds and of deer as well. Most of these parasites originated in the livestock rather than in the deer. However, stockmen cannot fully solve their problems with these parasites by drug treatment of their animals while deer continue to be a factor as carriers or reservoir hosts. Any efforts in wildlife management by conservation agencies to control the condition in the deer will go a long way towards better relationships with stockmen as well as bettering the health condition of both the livestock and the deer.

Population control.—The classic example of a livestock disease causing repercussions in deer management is the epidemic of hoof and mouth disease in California in 1924 when, as a part of the disease eradication program by agricultural authorities, it was found necessary to slaughter over 22,000 deer. In Florida, in the late 1930's, a similar procedure of deer eradication was attempted in an effort to reduce the ticks which transmit Texas cattle fever. The purpose of management is to maintain the highest density practical in any given area. The elimination of a species to control an epidemic is an extremely drastic measure. It should be practiced only in an emergency and when no other method of control is available.

Necrobacillosis, a bacterial disease manifest as foot rot or necrosis in sheep, diphtheria in cattle, mouth infection in elk and both foot rot and mouth infection in deer, on occasion has reached epidemic proportions. Epidemics of various diseases and parasites seem more likely to occur when there is an overpopulation. Management by cropping to keep a deer population within a particular limit of density, may prove to be a valuable stop-gap in reducing the occurrence, or intensity, of such epidemics.

Control of intermediate hosts.—The liver fluke constitutes an important disease problem in the livestock industry. This flat worm not only causes losses to young livestock but also the comdemnation of many livers of animals brought to market. It requires a snail as an intermediate host. The same liver flukes that occur in cattle and sheep have been reported from deer in many parts of North America. The mortality in deer from this parasite is not known.

The chief approach of agricultural interests in combating this disease is an attack on the snail intermediate host. This has been done mainly by bluestoning streams and standing water where the snails occur. Since deer serve as a reservoir host to this parasite the problem becomes of particular concern to conservation agencies. It is felt that cooperation with stockmen and agricultural agencies in combating this parasite would go a long way towards cementing better relationships between ranchers and sportsmen.

It should be pointed out that concentrations of bluestone are capable of damaging fish. This factor has often hindered the use of copper sulphate in some areas. It would be well worth the effort if investigations were encouraged by wildlife interests to find other means of controlling the snails which would not be harmful to the fish and plant life in our streams. Often conservation agencies are prone to expend great effort against the use of certain techniques of disease control for man or domestic livestock, which techniques are more or less harmful to wildlife, without suggesting an alternative approach.

CONCLUSIONS

Very little is known of the diseases of deer or other wildlife. There is a great need for further work in this field. Much experimental work is needed in the development of tools and methods of investigation and a great deal of research is required to determine practical methods of control. Diseases of wildlife can be attacked through management procedures by prevention or control but therapeutic treatment of individual animals is impractical and usually not feasible.

An understanding of the relationships of diseases of livestock and deer by conservation agencies will do much to create cooperation between stockmen and game management agents. Control of these diseases in deer will not only better conditions in the deer population and aid the programs of agriculture but will ultimately better the health of all species concerned.

NATIONAL PARK WILDLIFE RANGES

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The purpose of this paper is to review some of the problems of national park wildlife ranges, and the policies of the National Park Service in managing wildlife on overcrowded ranges.

Many of the western national parks are what may be termed "mountain-top parks." The summer ranges of species such as the elk, deer, and bighorn are confined to the higher elevations, much of which are above timberline. The wintering grounds for these parks are restricted by private developments closely bordering the parks, so that the elk and deer are kept crowded on ranges that in many cases have become so overgrazed that the animals are unable to maintain themselves on the area allotted.

In such circumstances, and with the former complement of predators (including the Indians) now greatly reduced, certain species have increased in the parks until they are in direct competition with each other for forage. One example of this is indicated at Rocky Mountain National Park where the elk are crowded back on areas formerly used almost exclusively by the bighorns. As a result of this competition for forage by the two species, the bighorns have been forced to remain on higher wind-swept areas above timberline for a large portion of the year, whereas formerly they migrated in winter to lower elevations in the ponderosa pine belt which are now used extensively by the elk and deer. The lower elevation ranges are now so badly overgrazed that in many instances the elk themselves are wintering above timberline in ever-increasing numbers, thereby using forage badly needed by the bighorns.

The solution of this problem, in some cases, appears to lie not in adding more range, but in enticing the elk and deer by some means to areas outside the park boundaries, where the surplus may be taken by hunters during the state hunting seasons. The desirable solution is for the national parks and national monuments to act as wildlife reservoirs, with the excess spilling over and being taken during the hunting season. However, it often doesn't work out that way; particularly where civilization has moved in close to the park. The elk and deer tend to stick pretty close to their home ranges and sometimes will even starve before they will migrate to other areas, even though the distance is comparatively short. Also, when hunting starts, the animals that have gone to outside ranges will return to the park, probably not because they know they will be safe, but from an instinct to return to their home range when frightened.

The so-called "firing lines" formed by hunters along the park boundary, notably along the north side of Yellowstone National Park at Gardiner, Montana, is a barrier through which the elk hesitate to pass in order to get to lower elevations. However, hunting seasons on lands outside the park boundaries have been changed in many cases to coincide with migration of elk and deer to lower elevations, and at times this measure has worked quite well.

During the fall of 1942 and early in 1943 the northern Yellowstone elk herd was reduced by some 10,000 animals. This reduction was carried on in cooperation with the State of Montana, fish and game organizations, and sportsmen's clubs, by post-seasons hunting and extending the season until the desired number of animals was killed. In order to complete the reduction, some animals were killed and butchered inside the park boundaries by the rangers. The meat was shipped to various Indian agencies.

A point which will require considerable study is the effect of hunting upon migrating animals. In some instances the kill is made on herds which normally migrate, with the result that this herd is killed off and the large herds remaining inside the park boundaries are not touched and they keep increasing until the ranges are deteriorating and the animals themselves are in poor physical condition and unable to withstand the hardships of the long winters.

In areas where wildlife has increased beyond the capacity of the ranges to care for them, the National Park Service has obtained authority to decrease the herds so that the ranges may be restored to somewhere near their former carrying capacity.

The periodic buffalo reduction program, which has been necessary to prevent destruction of the range in Yellowstone National Park, has brought benefits reaching beyond the confines of the range itself. Scores of animals have been shipped to points throughout this country and abroad for the stocking of zoos and public game preserves. Hundreds of buffalo which could not be thus disposed of have been transferred to various Indian agencies for food.

A reduction of elk and deer in Rocky Mountain National Park has just been completed by park personnel in cooperation with the Colorado State Fish and Game Commission.

Deer, especially, seem to thrive in the presence of human occupation of their habitat, and in many cases, such as Zion Canyon, Utah, they have increased to the point where both the range and the deer were decimated. In the case of the excess deer in Zion National Park, the reduction of some 300 animals was carried on through cooperation with the Utah State Fish and Game Commission, the meat being distributed to the needy of the community.

In some of the larger western national parks where saddle and pack stock is used for recreational purposes, some of the high mountain meadows are so heavily grazed by this stock that there is little or no forage left for the wildlife species. This is particularly true in the national parks of California, such as Kings Canyon-Sequoia National Park, and to a somewhat lesser degree in Glacier National Park, Montana, where the pasturing of large numbers of saddle and pack horses has affected the welfare of the bighorns using the same ranges.

The competition between saddle and pack horses and wildlife can in most instances be remedied through elimination of such pasturing by supplemental feeding of hay and grain. In addition to reducing the amount of grazing, this will pay dividends for the park operator in the long run because of the better physical condition of the horses that are being kept up and fed compared to grass-fed stock, for the heavy work of packing in rough, mountainous country.

In some parks, horses are not allowed to graze except in connection with pack trips to the back country where it would be impracticable to pack in feed for them. In areas where stock must be grazed, the situation may be helped in some degree by regulating the length of stay by any one party in a given area, by the erection of drift fences in the proper locations to control the movement of stock, and by rotation of pastures to relieve the heavy use. This is no small problem, especially in the High Sierra country of California, where large pack strings spend many nights in the back country and desirable camp sites are few and far between. Some of the smaller meadows are being invaded by lodgepole pines to the extent that, unless these measures are carried out, before many years the meadows will disappear entirely and there will be nothing but forest where formerly there were meadows.

Privately-owned land within the boundaries of some of the national parks and national monuments also has a decided effect upon the amount of range available to elk and deer, through the utilization of forage by domestic stock and the use of meadows for harvesting of hay. In other areas, particularly some of the larger national monuments of the Southwest, the grazing of domestic livestock, cattle and sheep, is still carried on under permit, and the wildlife on these ranges must compete with the livestock not only for forage but for water. The continued heavy utilization of forage plants by livestock, augmented by sheet erosion through loss of ground cover, is causing the gradual disappearance of desert vegetation. This is particularly true in the case of the giant cacti on portions of the Saguaro National Monument, Arizona.

In most of the parks where domestic livestock is grazed under permit, the policy provides for gradual elimination of such use, either through the issuance of permits limited to the lifetime of the original permittee and not transferable by sale of the property, or through gradual reduction in numbers of livestock over a period of 10 years, thereby giving the owner an opportunity to obtain range elsewhere.

In the early days of unrestricted grazing, the bighorn of what is now Lava Beds National Monument were exterminated during a winter of unusually heavy snowfall, because practically all of the forage had been previously removed by domestic stock. Sagehens dwindled to the vanishing point because of this competition with domestic stock, although a few individuals have survived in the region. In recent years more conservative grazing practices in the Monument have considerably reduced the yearly damage caused by sheep. Although the native bighorn will never again be seen on their ancestral trails, which show clearly on the pumice slopes of buttes that dot the area, it is possible that the sagehens may some day be restored, when grazing pressure on the range is further reduced.

In Death Valley National Monument, desert bighorns were disappearing as a result of competition with wild burros, which fouled the water holes and destroyed the forage. These wild burros were descendants of occasional escaped tame burros, plus animals abandoned by prospectors in favor of the automobiles, which have almost universally taken the place of burro transport. As the years passed, the wild burros multiplied by the thousands, until eventually a reduction was necessary to save the bighorns.

Due to the vastness and inaccessibility of the country, these burros can only be reduced in numbers to a certain point and can never be exterminated. However, the reduction program has helped to check the decrease of bighorns and has established a certain balance between the two.

SUMMARY

In summary, it can be readily seen that with limited range, and in the absence of native predators, certain wildlife species tend to increase in numbers far exceeding the capacity of the available ranges to support them. This results in competition for forage between the affected species, so that the species which is unable to compete successfully must inevitably give way to the stronger, more adaptable ones, and eventually some species, notably elk and deer, increase to where reduction is necessary for the welfare of the animals themselves to say nothing about allowing the range plants to recover. Considerable progress has been made in obtaining authority to reduce herds where it is definitely for the good of the area and the animals involved. Extension of the state hunting seasons to coincide with the time of migration also has helped.

Damage by pack and saddle stock can be reduced by supplemental feeding of hay and grain, by regulation of the period of stay of pack strings in the case of certain critical areas, and by the establishment of drift fences and a system of pasture rotation.

In areas where the grazing of domestic stock is carried on under permit, the National Park Service is attempting to improve the situation through gradual elimination of such use. The termination of grazing is particularly important in some of the arid southwestern areas where the natural balance is easily upset because of the case with which ground cover can be destroyed, thereby allowing severe erosion to take place. In some of these desert areas there is also serious competition between wildlife and domestic stock for both forage and water.

BIG GAME—RANGE LIVESTOCK COMPETITION ON WESTERN RANGES

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Big game herds in the western United States have shown a definite and marked increase during recent years. Increases have been greatest in the pronghorned antelope, elk, and deer, but have also occurred in mountain goat, bison, and moose. Decreases have, however, occurred in numbers of bighorn sheep. Jackson (1944) in a study of the nation's big game numbers for the 5-year period of 1937 to 1941 reported that "big game as a whole increased 30.8 per cent." This increase has caused both stockmen and sportsmen to become increasingly alarmed over possible range conflict between big game animals and domestic livestock. The game herds must be fed and they exert definite pressure upon the ranges. It is important that game managers and sportsmen understand range livestock production problems and land managers and stockmen understand game habits in order to obtain a maximum yield from the range.

Factors affecting appraisal of ranges.—Western ranges have certain characteristics which must be clearly understood. Most are dry, and drought limits production of forage. Even under best management, some western ranges look bad, and may appear to be misused.

Dry climate results in a delicate balance in vegetation, and a plant struggling against adverse climate cannot stand heavy grazing. Therefore, the best forage plants are sometimes killed, leaving less valuable plants which are little grazed. These are green and appear to the uninformed to be good feed. The "armchair" sportsman examining such a range is inclined to argue that there is plenty of feed, although deer and livestock actually may be starving. Range management is no job for an amateur. Stockmen who live on the range have not all learned to recognize good and bad plants, and they, too, often are misled in judging range conditions.

Further, many western ranges are very steep, so uniform grazing is impossible. Livestock, especially cattle, congregate in easily accessible areas as canyon bottoms and ridge tops and leave much feed on the steep slopes. Holding cattle on the range to force them to use the slopes results in a too heavy use of the accessible areas. This localized overuse ultimately will ruin the range. Inexperienced appraisers often do not appreciate that ranges may be misused and yet have excellent feed in local areas. Since deer and elk reach areas which livestock normally do not, they are able to use feed not available to livestock.

Snow on high ranges forces seasonal migration of both big game and domestic stock. The grazing capacity of the seasonal range units must balance with the time the animals spend on each unit. *The least productive unit, therefore, limits the capacity of the whole.*

Deer and elk in the West usually move to winter ranges on the foothills. The winter range almost everywhere in the West is the area of limited feed for game. Its capacity to support deer must determine the population supported throughout the year. Sportsmen who see plenty of feed on summer ranges are inclined to feel that the range could carry more deer, often overlooking the fact that winter ranges may not carry existing populations without damage. Regardless of abundant summer feed, maintenance of big game herds is dependent upon winter range capacity.

Spring range often is the "short" range, and, hence, the limiting range for livestock numbers. Since spring range is most likely to be overused, these lands are the key to livestock-growing potentials of an area. They are the "weakest link" which determines the strength of the chain.

The key area for domestic stock, spring range, and the key area for big game, winter range, often are one and the same, since deer winter where domestic stock spend the spring. Attempts of stockmen and sportsmen to maintain more animals on this "short" range than it can properly support have resulted in serious misuse. This misuse reduces the capacity on the very area that everyone is so anxious to make more productive. Here is an example of killing the goose that lays the golden egg!

Livestock-big game populations.—In the West there are local areas with too many livestock and others with too many big game animals on the ranges for maximum production. Livestock ranges have been generally overstocked, and, in many locations, they are still overstocked. The fact that there are more big game in many areas than the land can support is true regardless of livestock numbers, and the best interest of the sportsmen is served by reducing game numbers on such areas. In the same reasoning, some areas support less big game than are desirable. *Overgrazing is a fool's paradise.* Stockmen after 100 years of trial and error only now are realizing that proper grazing gives larger animals, higher calf, and lamb numbers, and healthier animals as well as maintaining the range land. Overuse is the mark of greed and results in reduced yield and, worse, a decreasing capacity of the land to produce. Many ranges can support less animals now than originally. Hence, extra care and unusually small numbers are necessary to build the range back to normality.

Big game, like domestic livestock, cannot reach maximum production except when sufficient food is available. For this food, they are even more dependent upon the range than are domestic livestock because they are on the range 12 months each year and, with minor exceptions, they cannot be aided by supplemental feeding as can livestock. Further, big game unlike livestock cannot be moved to areas of better feed. As a rule deer will starve to death before they will leave their customary range and seek areas of better feed.

Experiments on supplemental feeding of mule deer in Utah (Doman and Rasmussen, 1944) and in Colorado (Carhart, 1943) have shown the fallacy of trying to maintain large mule deer herds by winter feeding. Elk respond more favorably than do deer to supplemental feeding, but observations in a number of Western States show that winter feeding of elk is not entirely successful and has very serious shortcomings.

Murie (1944) on basis of wide experience with big game animals, particularly elk, has outlined the three obstacles to properly providing for big game in winter as follows: 1. Too much reliance on feeding of hay rather than herd reduction to range carrying capacity. Hay feeding concentrates animals and will destroy the browse. 2. Lack of realization that available lands for winter use by game are rapidly going into other uses. 3. Tendency to give attention to methods of harvesting, predation, poaching, open and closed season, rather than to the real issue which is adequate winter range.

Effect of feed shortage upon animals.—Neale (1937) showed range cattle weight at maturity, weight of weaned calf, and percentage of calf crop to correlate directly with quantity of feed up to an optimum level (Table 1). Similar data for big game are not available, but a parallelism is certainly suggested by limited examples. Fall weights from 3,503 mule deer in northern Utah where summer range is nearly optimum are compared in Table 2 to weights of 289 mule deer taken in southern Utah in an emergency removal during late November necessitated by deficient year-long range.

Conclusive data on per cent of fawn crop under various range conditions are not available but it is known that the deer in northern

TABLE 1. CALCULATED EFFECT OF GRAZING VARIOUS NUMBERS OF BREEDING COWS ON A GIVEN RANCH UNIT (DATA FROM NEALE, 1937)

Number of cows grazed	78	92	116
Calf crop expected (per cent)[1]	90	60	30
Weight of cows at maturing (pounds)	1,000	800	650
Weight of calves at 8 months (pounds)	400	340	280

[1]For domestic animals, per cent of young is based upon number of females of breeding age rather than upon total female herd as is necessary in wildlife calculations.

TABLE 2. FALL WEIGHTS, HOG-DRESSED, OF MULE DEER TAKEN FROM GOOD RANGE IN NORTHERN UTAH AND FROM OVERSTOCKED RANGE IN SOUTHERN UTAH, IN POUNDS

Class	*Northern Utah* Number	*Northern Utah* Average weight	*Southern Utah* Number	*Southern Utah* Average weight	Per cent southern deer weights are of northern deer weights
Bucks	2,409	141.1[1]	98	103.4	73.3
Does	815	101.0	161	71.1	70.4
Fawns	279	55.2	30	38.1	69.0

[1]Effect of age upon body weight is shown in figures used for this average as follows: yearling bucks averaged 106.2 pounds, 2-year olds, 135.9 pounds, and those 3-year olds and over, 171.0 pounds.

Utah produce an annual fawn crop of near 75 per cent of the female herd based on early winter counts. Deer on other and comparable ranges in central Utah produce 77 per cent fawn crop (Robinette and Olsen, 1944). In the southern Utah herd shown in Table 2, the removal was considered an approximate cross section of the total herd. The 18.7 per cent fawn crop indicated is far below normal. There is no question that an underfed deer not only is smaller than a normal deer but also its capacity to reproduce is less.

Deer have died by the hundreds from malnutrition during the winter in many parts of the West. Dead deer serve no one. On poor range, even the animals which live cannot produce normally. If one doe can produce as much as two then no wise sportsman will insist upon two when by so doing he ruins the range which furnished his sport.

Game managers and sportsmen should not make the mistake of blaming livestock growers for having damaged public lands that rightfully belong to game. In some instances this surely has happened, but it cannot be remedied now by insisting upon more game than can rightly be supported. This only results in still further reduction in the ability of the lands to grow game.

In the opinion of the authors, too much emphasis has been placed upon big game numbers, whereas actually, condition of the range should be the index to proper management. Even if the exact number of big game were known, still we would have to look at the land to determine whether that number was too many or too few. Scientific appraisal of range land is not easy, but neither is it impossible. Surely it is the wise approach to improved big game management.

Livestock-game competition.—Sportsmen and taxpayers often feel that livestock growers are using federal and state range at a cost below its true value and that this land rightly should be used primarily by game animals. Also, stockmen sometimes insist that they alone are the "rightful" users of public land. Actually, the majority of the lands used by big game in the West are public lands. The question of how these lands should be used for the greatest benefit to the whole population needs careful consideration.

Livestock production is the backbone of western agriculture. In addition to the millions of dollars income derived annually from range livestock, hundreds of other businesses are directly or indirectly benefited by a thriving livestock business, and no thinking taxpayer or sportsman wants to destroy the industry. Elimination of livestock from all western public land is economically unthinkable.

It is entirely possible to produce both big game and livestock on the same range. First of all, competition is far less than generally supposed, although it has received unfortuate emphasis from agitators. It is entirely erroneous to assume that no competition exists, but certainly the maximum productivity of land comes from multiple use. As already pointed out, big game can use parts of a range not grazed by livestock such as steep and rocky slopes. Without game, these areas might be unused. Mule deer have vastly different forage habits from cattle, and somewhat different from sheep. They eat many plant species which domestic stock normally do not, and which, otherwise, would be wasted. Poor deer ranges are sometimes perfectly satisfactory cattle ranges because cattle eat plants unused by deer.

Deer normally are browse eaters, although they also eat forbs and some grass. Essentially, however, they live on browse and do not thrive without it. Deer practically never compete with cattle for grass. Elk eat much more nearly the same plants as cattle, hence, there may be marked local competition. Sheep feeding habits more closely resemble those of deer. When sheep range is overgrazed, the competition with deer may be severe because the sheep will take what deer normally eat. When the range is properly stocked, sheep will not eat appreciable amounts of the plants which make up about 50 per cent of the deer's diet. On properly used range, the removal of deer would make available to cattle only 10 to 50 per cent of the feed which was formerly consumed by the deer depending upon type of range and season of the year. This results because the deer eat different plants and gather part of their feed in areas not used by cattle. Since a deer eats but about 17.5 per cent as much as a cow,[1] it would be necessary to remove from 10 to 50 deer to make room for one more cow. There are probably few western ranges upon which as high as a 25 per cent increase in numbers would be possible in either game or livestock were animals of the other kind removed.

[1]Although many factors are involved in determining the quantity of feed eaten by grazing animals, body weight probably is the most practical basis for comparison. Body surface (weight to 0.734 power) is much used by animal husbandmen (Brody et al., 1934) for conversion, but it seems to have little to recommend it over body weight for estimating food consumption of grazing animals. Following are calculated average fall weights (herd run) of animals of various kinds on western ranges and their ratio to beef cattle on a weight basis and on a body surface ratio:

Animal	Live-weight, pounds	Ratio based on live-weight	Ratio based on body surface
Beef cattle	800	1.0	1.0
Domestic sheep	100	8.0	4.6
Elk	425	1.9	1.6
Mule deer	140	5.7	3.6
Antelope	85	9.4	5.2

Solving the competition problem.—Usually, severe misuse of land results from either big game or livestock; seldom from both. Range inspection will show which animal is overusing the range. That animal should be reduced in number until forage and numbers balance and stability of the range is assured. On the few and localized areas of public land where serious competition between deer and livestock does exist, it should be remembered that livestock can be moved or artificially fed. Practically, big game cannot. This does not mean that livestock should always yield to big game, for, in every instance, intelligent and scientific analysis must precede action.

When big game are determined to be doing damage to forage on private land, the sportsmen and state game commission have an obligation to stop damage. If the livestock operator cannot relinquish the land for purchase or exchange, then removal of game by hunting is usually the only economic answer. Control of deer by fencing or herding is rarely feasible. Paying for damage by deer is usually unsatisfactory, but in some instances may prove the logical solution.

In summary, good game and good livestock result from good land management, and every sportsman and stockman should strive for a better comprehension of what a good range consists of and how that range must be managed and protected if the game herds and livestock herds are to continue to thrive. Even on areas where no livestock graze, still game numbers must be limited and the herds managed on the basis of the range forage supply.

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RECENT DEVELOPMENTS IN WILDLIFE RESEARCH

This session arranged by the Wildlife Society

INTRODUCTORY REMARKS

Douglas E. Wade

These remarks, changed by necessity because of the cancellation of the Conference, are of two parts: those in which I explain what I had hoped we might have done had the Conference been held; and secondly, those by which I would have opened the research session. These I have differentiated by the use of *Explanatory* and *Introductory.*

Explanatory.—The usual procedure for most technical sessions in the past has been to have six or seven papers read and discussed. The amount of discussion has varied considerably; and has, for the large part, in most sessions been recorded and published as a part of the Transactions. However, had the Tenth North American Wildlife Conference convened, I planned a departure from past practices. This is all perhaps more easily explained by reference to a letter which I had sent out to the prospective participants in this session. This letter, in part, follows:

"I have come to the conclusion, after considerable correspondence and reading, that in recent years some of the fundamental research has centered about the *population turnover concept,* or, as it is known to some workers, *natural mortality.*

"Six or seven persons have been asked to prepare written papers which will be published in the Transactions. These papers, if possible, *but not necessarily,* will relate to the general topic of *turnover.*

"In addition, I shall ask several persons who have been actively engaged in *turnover* research, to form the nucleus of a forum which will discuss natural mortality or the turnover concept. Those who have been asked to prepare written papers will NOT read them, but will assist in the discussions and may, if they see fit, read pertinent parts of their papers whenever the occasion seems proper for interjections.

"All forum participants, including the 'writers,' will come fortified with notes, thoughts, illustrative material, new or old, relative to *turnover*. From all indications of advanced information there will be some new and original thoughts, as well as rehashes. All needed accessories, such as a screen and slide projectors, a blackboard and chart-easels will be on hand for the convenience of participants who wish to use illustrative materials. Participation will be open to all attending the session. A fishery researcher will assist as a co-chairman.

"This new approach for the conduct of technical sessions has merits and should be given a fair trial. Now to get started on your reading and preparation for the forum may I refer you to the paper on 'Population Turnover on a Wisconsin Pheasant Refuge' by Leopold et al., in the October, 1943 (Vol. 7, No. 4) *The Journal of Wildlife Management.*"

The responses to this letter, not withstanding the absence from the country of many workers who had been actively engaged in research related to the turnover concept, was encouraging. Among those who had hoped to take part were: Bert Cartwright, Ducks Unlimited, Canada, John Emlen, Johns Hopkins University, Roy Bach, North Dakota Game and Fish Department, Aldo Leopold and Robert McCabe, University of Wisconsin, Melvin O. Steen, Missouri Conservation Commission, Willet Wandell, Massachusetts Department of Conservation, Leonard Foote, Vermont Fish and Game Service, Lloyd L. Smith, Jr., Minnesota Department of Conservation, in addition to those who had written papers for publication in the Transactions. All in all, a lively 2 hours had been anticipated.

Introductory.—It is usual for chairmen to open a session with a few pointed remarks. Mine are simply these: That there are an increasing number of wildlife research men who have become very dissatisfied with, as one correspondent put it, "fallacies of misplaced concreteness that continue to be so prominent in analyses of losses or productivity" made in research directed toward wildlife populations. This same correspondent pointed out that the density factor, as well as intercompensatory trends, were receiving little or no attention.

Granted that these criticisms are just, I cannot help but feel that the author of those remarks had placed his fingers indirectly on a sore spot of wildlife research in this country: namely, a lack of tenacious, solid, and persistent research work. And, it takes this type of work to pry into the mazes of population studies.

Dr. Alan Gregg, director of medical science, Rockefeller Foundation, has made some remarks, intended for the medical world, which can be applied almost word for word to wildlife research. I quote him:

''Research should be on a long-term basis, at least eight to ten years, and preferably in perpetuity. We will never get original minds to get into the field of research unless we make it attractive for them from a financial standpoint. . . . The country has the brains to contribute vastly to our [wildlife management] knowledge, but sadly lacks the proper intellectual and economic environment for them to thrive in.'' ''Originality'' is the essential required for effective fundamental research. ''Here in the United States there are men of eminence and reputation who discourage men with real ability. We have too many of those who provide truck loads of confirmatory observations and too few who make original observations. Fundamental research comes from a curiosity about fundamentals, not from a desire to do what others have already done before you.''

It takes time, perhaps inducive surroundings, and perhaps a sense of leisure to bore to the heart of some fundamentals. I suspect greatly that some of those original thinkers of olden Greece sat and discussed in the shade of their templed meeting-places day after day for many years before much of their philosophy and arrival at fundamental truths took form.

Here [this morning] we shall attempt to boil down our knowledge of the ''turnover concept'' or ''natural mortality'' in 2 hours.

SOME RECENT COOPERATIVE RESEARCHES AT WISCONSIN IN FISHERY BIOLOGY

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As each field of science expands its borders a researcher is faced with such a complexity of subject matter within his own field he seldom has the capacity to command all that is necessary for a full and complete study in a sister science. This is especially true of the ecologist; therefore he is forced to join with others to carry out his objectives. Such a union implies cooperation among specialties and with organizations whose interests impinge upon the problem in question.

At Wisconsin a tradition was established early in biology when Drs. E. A. Birge and C. Juday initiated their classic studies in limnology. Dr. Birge, the surviving partner of this team, continues, at the age of 93, to maintain this tradition. He is now preparing a monograph with physicist Dr. H. James on the role and fate of sunlight penetrating into lakes.

Our group here at the University of Wisconsin (the Department of Zoology and the Geological and Natural History Survey) has been fortunate in entering into cooperative projects with the State Conservation Department. We have, moreover, continued to receive the support of several departments of the University—they have lent equipment, facilities, and have assigned experts to work with us where their specialties could contribute helpfully.

It is the object of this paper to review briefly the results of some of these studies and the role played by collaborators who made these researches possible.

The results will be briefed from published papers in my own group and some from unpublished manuscripts. Because there are other cooperative enterprises in aquatic biology at the University, this paper will be restricted to projects in which my group has participated; however, it is not implied that we are unique in fostering cooperative research at Wisconsin. The point in question is simply to reemphasize the expanding possibilities and new approaches to research which come from receiving the aid of fellow scientists and associated organizations.

Application of endocrinology in fishery biology.—My colleague, Dr. R. K. Meyer, endocrinologist, joined us (Hasler, Meyer, and Field, 1940) in applying some principles of the hormone field to fish. The Conservation Department was confronted with the problem of procuring eggs from muskellunge whose normal spawning migration had been blocked by a newly constructed power dam on the Chippewa River. Attempts were made to hold these big game fish in ponds to await ripening, but this proved ineffectual. Because we had been successful in inducing spawning prematurely in trout by injection of pituitary glands of carp (Hasler, Meyer, and Field, 1939) we believed a similar treatment might induce ovulation in muskellunge. The W.P.A. supplied us with assistants to extricate these primary glands from carp which were injected subsequently into the spawning-inhibited muskellunge. As a result of this treatment over 90 per cent of them expelled their eggs, and fry were released in the flowage. None of the controls spawned. This method is therefore of value in the conservation and management of fish populations in streams obstructed by dams, thus permitting the preservation of this species until arrangements can be made for fishways to be constructed around the dams, and allow them to pass to natural spawning grounds.

Throughout the United States the construction of irrigation or power dams has created a problem in conservation of fishes which depend upon migration upstream to gain appropriate spawning ground. In many instances inefficient or no fishways have been provided where a complete negotiation of the stream otherwise would be possible; consequently the reproductive potentialities of these fish are lost to the maintenance of an adequate population.

The pituitary method is now being applied by the Fish and Wildlife Service to the large salmon of the West Coast in an attempt to procure eggs from salmon unable to reach the spawning grounds because dams obstruct their normal migration routes.

A tagging method.—The extent of survival of small hatchery raised trout has been a problem of long standing, largely because current methods of tagging are not wholly efficient. The Department of Anatomy, University of Wisconsin, placed their X-ray equipment at our disposal. We (Hasler and Faber, 1941) were able to recognize by X-ray small fingerling trout injected with thorotrast, 2½ months after injection. The fish grew at the same rate as controls and appeared to be in healthy condition. Dr. Justin W. Leonard, Institute of Fisheries Research, Michigan Department of Conservation, and I (unpublished) injected 2-inch trout with thorotrast and released them in a natural experiment stream. The "tag" (thorotrast) could be seen by X-ray in the viscera one year after the injection. The fish were healthy and had grown as rapidly as uninjected ones. Apparently this colloid remains in an unexcretable form in the reticulo-endothelial system for the life of the fish as it does in mammals.

Although this method would be impractical in the hands of untrained personnel it offers a tool, nevertheless, to research workers to test the efficiency of survival of fingerlings tagged with some device which alters the external appearance of a fish. It has not been established whether fin clipping, the current tagging practice, places the fish at some disadvantage in nature.

Turnover and fluctuations in population.—Cycles of abundance are common phenomena among game populations, but fishery biologists have just begun to record examples of irruptions and declines of fish populations in inland waters. To contribute further to our knowledge of these fluctuations the Conservation Department, the Lake Geneva Institute of Natural Science, and Frank W. Schwinn, bicycle manufacturer of Chicago, undertook a problem with us to study the walleyed pike in Lake Geneva (Nelson and Hasler, 1942). We observed the walleyed pike had become almost extinct whereas it was recorded (Pearse, 1921) to have been abundant in gill-net catches in 1921. In spite of heavy plantings of this species in Lake Geneva, the walleyes were virtually absent in net hauls and anglers' creels. Replacing the ecological niche of the walleye, however, was the northern pike which is now abundant in the gill-net catches and common in the creels, whereas in 1921 it was rare.

Another example of fish-population fluctuations is that observed in our Crater Lake studies: from 1937 to 1941 one or the other of us (Hasler and Farner, 1942) cooperated with the National Park Service in a fishery study of Crater Lake, Oregon. Our data showed that the year-class of fish which gave the best return to the angler for 2 years, the 1934 year-class or brood, was hatched in a year when no plantings were made. This proved that trout could spawn successfully in a lake whose shores appeared unsuited for spawning. In addition the study showed that the population did not depend upon artificial stocking for its maintenance. The silverside salmon also spawned in Crater Lake successfully. In both species there were wide variations in the survival of year-classes or broods of fish from year to year.

Fast growing sunfish populations have been under observation in the University Arboretum. In one pond a pumpkin-seed population was dominant in 1943 by a large margin over a bluegill population (unpublished data). The following season showed the reverse picture.

Thirty years ago, winter ice fishermen on Lake Mendota could capture 400-800 perch by hook and line in a single day, but the adult perch averaged only 6.5 inches in length (Pearse and Achtenberg, 1918). Now this population is considerably reduced and an ice fisherman works hard to get his limit of 25 in a day. These fish, however, average 8 inches with some of them 10-11 inches in length. Therefore, a strong correlation exists between increased size of perch and reduced numbers. We found further (Hasler, 1945) by extensive winter netting under ice, that this winter population was most abundant in the deepest water of the lake, i.e., nets set at the deepest points (24 meters) caught significantly more fish than those set simultaneously at shallower stations (18, 16, 14 and 7 meters). Moreover, the fish traveled in schools of definite size-classes. Of the environmental conditions which might influence the concentration of fish in deep water, such as oxygen content of the bottom water, temperature, abundance of plankton crustacea and bottom fauna, correlation with the last was most striking. Not only were bottom-dwelling midges more abundant in the deeper stations, but the perch there consumed more of them than those at the shallower regions. Even though oxygen was zero on the bottom in late winter it did not retard the perch from plying the bottom for food.

The Wisconsin Conservation Department invited the University (Schneberger and Hasler, 1945) to engage in a survey of the cause of the decline of fishing in the Bois Brule River, Wisconsin. Dr. N. C. Fassett (Fassett, 1945), University botanist, contributed a unique study to the project, an innovation in stream-survey techniques. He was able to measure fairly accurately the qualitative and quantitative condition of the cover of the watershed before white men began to cut the forest crop. He compiled maps based upon detailed records of surveyors who tramped the section lines of the Brule watershed in 1940. These maps and tables show the concentration of types and density of timber of that period. They were compared with the present type and quantity of vegetational cover by Dr. J. W. Thomson (Thomson, 1945) which has been estimated from air photos and checked in the field. The results of these surveys have led the Conservation Commission to purchase large tracts of cedar bog adjacent to the stream in order to preserve a floristic feature which is important in maintaining even flow and low temperatures in the Brule River.

Bait minnows.—Because of the scarcity of minnows in many Wisconsin streams it has been necessary to impose more severe restrictions on seining operations of bait dealers and anglers. To gain information on minnows we have undertaken a cooperative project with the Conservation Department to study the natural history of bait minnows in addition to their culture in artificial ponds (Thomsen and Hasler, 1944). Since information regarding the optimum spawning conditions was incomplete, the following experiments were conducted: strips of gravel and sand were placed in the shallow water along the shore line, and boards were submerged on these strips at various depths. The boards varied in size and materials. One end was elevated in order to see how high above the bottom the fish would deposit their eggs. Stones, tiles, and strips of sheet metal were also placed in the pond.

The fathead minnow chose the sandy shore region in preference to any other spawning location. Marl bottom rated second in choice. Gravel was chosen only when all other spawning areas had been taken over. Of 320 nests under observation 80 per cent were at a depth of 2½ feet. Some of the nests were excavated under the board itself, others were placed approximately 3 inches above the bottom on the under side of the board. The majority of nests, however, were found at the point of contact between board and lake bottom. Old water-soaked boards were preferred to painted ones. Tiles and stone rated high in preference. No preference for one width spawning device over another was shown. Objects 2 inches in width were selected as readily as 3-foot boards. This study is being continued.

Natural history studies.—A higher incidence of capture during the sundown period was observed in the catches of the neighborhood children while angling for perch at our habitual fishing station on Second Point of Lake Mendota. The question arose: Are the perch omnipresent at that location and induced to bite by the setting sun, or do they feed continuously and simply migrate over that region as the sun sets? The following result was obtained when this was tested experimentally: We (Hasler and Heffner, 1944, unpublished Ms.) found a strong correlation between the migration of schools of perch over a "bar" in Lake Mendota and increasing or diminishing daylight. Where experimental gill-nets set one-half hour before to one-half hour after sundown captured 13 to 50 fish, nets set one hour before this time caught none. Similar behavior was recorded in the sunrise hours.

Pelagic life in lakes has attracted the attention of many limnologists and there exists a mass of published data on the taxonomy of these forms, seasonal distribution, and quantitative representation in the plankton. Littoral life, on the other hand, while having been thoroughly speciated, has attracted little attention from limnologists. Seasonal fluctuations and the production of fish foods in the plant zone, a zone which is a very important niche for the majority of pan fish during the summer months in our southern Wisconsin lakes, has been largely ignored. One of my students, Captain Jay D. Andrews (Andrews and Hasler, 1943) in cooperation with the Department of Botany worked out an acceptable method of getting a quantitative sample from the weedy areas of Lake Mendota's shore. Andrews' measurements showed 8.1 grams of macroscopic invertebrate organisms inhabiting the plants growing immediately over a square meter of bottom in the littoral zone. Where *Chara* was in a pure stand it harbored 54 to 68 pounds of organisms per acre of bottom, consisting chiefly of the scud *Hyalella*, a crustacean, while a mixed stand of plants yielded 72 pounds of invertebrates per acre. We also observed that those aquatic plants with the greatest-dissected leaves produced the most organisms. Numerous seine hauls over 7,500 square feet of this weedy zone in 3 different summers showed a mean forage and pan fish population of 96 pounds per acre, chiefly perch. Because seine hauls do not give an accurate figure, this estimate of fish populations is considered low for the littoral zone of Lake Mendota.

Physiological studies.—When some fresh fish, e.g., carp, are fed to foxes they become afflicted with "Chastek's paralysis." We undertook, with the Department of Physiological Chemistry (Deutsch and Hasler, 1943), a survey of the species distribution of an enzyme which destroys vitamin B_1, a factor in fresh fish which appears to be responsible for the destruction of this essential vitamin in the foods to such an extent that foxes become diseased. We found this factor in a number of species of fish. Of the 31 species assayed it occurred in 16. It was more common in the fresh-water than salt-water forms. None of the fresh-water Centrarchidae assayed contained this vitamin B_1 destroying enzyme.

A series of studies on the physiology of fish are in progress at the University which involve cooperation with scientists and departments offering specialized facilities. Results of one phase have been published (Hasler and Meyer, 1942).

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CAUSES OF DEATH AMONG INDIANA FISHES[1]

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A practitioner of fishery biology has many questions asked of him, but among them there is one that recurs especially frequently: What *happens* to all the fish? If the fish in question are little ones, planted from a local hatchery, for example, then there is an easy answer: They get eaten up. If, however, the fish have disappeared after reaching some considerable size, then the ready answer is: They must have been caught. If it is well known that there is insufficient fishing to accomplish this, the biologist hesitates, and then the questioner will usually answer his own question: Predators must have eaten them. He then follows it up with a demand for their control. The biologist gets distinctly uneasy at this point, but as a rule he will have no actual data on whether predators are or are not responsible. Perhaps he will hedge, and say that maybe the big fish emigrate to parts unknown. The idea that they may simply *die* will also occur to him, of course; but that is a difficult point to make. Fish in the wild usually look remarkably healthy, and there is a popular belief that since some individual fish are known to grow to a considerable age and size, all similar fish ought to be able to do the same.

It is partly to provide a satisfactory way out of unsatisfactory situations like the above that Indiana's fishery research program in recent years has been attacking the problem of the relative importance of fishing and natural mortality in fish stocks, and also the problem of what are the components of natural mortality. To date most of the work has been done on small lakes, less than 50 acres in size, a detailed account of two of which is about to appear (Ricker, 1945). Samples of the legal-sized or large-sized game fishes in these lakes are marked by removing one or more of the paired fins, following which an almost complete creel census determines the percentage caught out per year; that is, the *rate of exploitation*. The census is repeated in at least one

[1]This report is a part of the work of the Indiana Lake and Stream Survey, sponsored by Indiana University and the Department of Conservation, Division of Fish and Game. Contribution number 344 from the Department of Zoology, Indiana University.

subsequent year, and from the marked fish retaken the following year the annual *total mortality rate* can be computed. An analysis of age frequencies in the catch serves as a check on this. The difference of these two statistics is the *annual expectation of natural death,* for the fish concerned. For many purposes it is convenient to convert these items to *instantaneous* terms: that is, so that they represent the ratio of the number of deaths which would occur in a year if population did not change, to the size of that population (cf. Ricker, 1944).

In Table 1 there are shown some of the determinations of instantaneous rate of fishing, natural mortality, and total mortality. Two points are at once evident. In the first place, mortality for the most part is heavy: no estimate is less than 55 per cent per year, and some exceed 90 per cent. Secondly, fishing usually accounts for less than half of all deaths, sometimes very much less than half. The rate of fishing is greatest for the pumpkin seeds and perch, and least for the crappies. The fishing rates shown (except those for 1941) are probably only about two thirds as great as those which prevailed prior to the war; but even if they were doubled, they would in most cases still be less than the natural mortality.

Another very interesting feature of Table 1 is the fact that for most species the mortality rate increases sharply with age, and this increase is almost wholly in the category of natural mortality; in addition to

TABLE 1. INSTANTANEOUS MORTALITY RATES AND THE PERCENTAGE TOTAL ANNUAL MORTALITY FOR CERTAIN FISHES. DATA FOR MUSKELLUNGE LAKE ARE FOR 1942. (DATA FROM RICKER, 1945.)

Kind of fish	Age[1]	*Instantaneous mortality rates* Rate of fishing	Natural mortality	Total mortality	Annual mortality, as percentage
		p	q	i	a
Bluegills					
Muskellunge Lake	II-V+	0.29	0.63	0.92	60
Shoe Lake, 1941	III-VI+	0.60	0.83	1.43	76
Shoe Lake, 1942	III-VI+	0.42	0.82	1.24	71
Pumpkin seeds					
Muskellunge Lake	II	0.90	0.71	1.61	80
Muskellunge Lake	III	1.14	1.86	3.00	95
Redear sunfish					
Shoe Lake, 1941	III-VI+	0.42	0.38	0.80	55
Black crappies					
Muskellunge Lake	II	0.13	0.89	1.02	64
Muskellunge Lake	III	0.11	2.29	2.40	91
Perch					
Muskellunge Lake	II	0.96	1.44	2.40	91
Yellow bullheads					
Shoe Lake, 1941	II	0.78	0.83	1.61	80
Muskellunge Lake	II	0.41	1.89	2.30	90

[1]Age II, say, includes the period from June 16 of the year the fish becomes age II to June 15 of the year following

the age comparisons shown, the age III mortality for perch and bullheads is close to 100 per cent, as practically no age IV fish of these species can be taken after June 15.

Coming back to the question of what happens to fish, it looks as though the problem were even more serious than we thought. Here are several groups of fish of prime size for catching, living in rather heavily-fished lakes, yet they are found to be suffering much less from the fishermen's efforts than from other causes of death. And examining these other causes, we find that it is impossible to assign any significant part of them to the activities of large predators. Rough estimates of the abundance of gar, bowfin, pike, and large bass in these lakes show that there are not nearly enough of them present to make any significant dent in the abundance of legal game fish (cf. Ricker, MS-1). Furthermore, it is not possible to imagine predacious fishes or birds favoring the *largest* crappies, bullheads, etc., which are hardest to get at and hardest to swallow. Emigration and other possible explanations of the disappearance of the large fish are similarly inadequate.

We are driven then to the conclusion that senility in all probability must account for most of this mortality. Since the deaths occur among fish of far less than the known maximum size or age for the species, it would seem that senility may appear over a wide range of ages, relatively much wider than in man, for example. This is particularly true of the bluegill, where the natural mortality rate seems to be rather constant up to a fairly advanced age—VI or VII years. Of course, disease may play a role too, but, as in man, its effects will be very difficult to distinguish from senility: if a man of 75 dies with pneumonia, is it the result of disease or of old age? We can only note that epidemic and conspicuous types of fish disease have not been observed in the lakes included in our studies to date.

From the standpoint of fish management, these studies seem to suggest that in order to salvage some of the crop now going to waste, some relaxation of restrictions on fishing could be tried. This could take the form of either (1) abolition or lowering of the minimum size limit on bluegills, redears, and crappies, which is 5 inches at present (for the other species there is no limit); (2) abolition or restriction of the closed season on the species mentioned, from May 1 to June 15); (3) abolition or increase of the daily catch limit; (4) permitting the use of gear not now legal (traps, etc.).

Of these, the reduction of the size limit would probably be least effective, since the writer has shown elsewhere (MS-2) that the total weight of catch taken will change only slowly as the limit is varied in the vicinity of its optimum value. As it happens, the Muskellunge bluegills and crappies both have, right now, the correct minimum size limit for the probable prewar rate of fishing; and if the crappies were to be exploited as heavily as bluegills are now, a larger size limit for crappies would be somewhat better. However, the important point is that no possible changes in size limits, from what now prevail, could produce any startling change in utilization of the crop.

The taking of fish during the present closed season, or by means of gear now illegal, would certainly increase the annual rate of fishing and (though it does not *necessarily* follow) would probably also increase the catch taken from a year-class of any given size (Ricker, MS-2). Unfortunately we know too little, as yet, about the relation between number of eggs available for spawning and the resulting recruitment, to make such a recommendation for general application. On Shoe Lake, where the bluegills are numerous and grow exceptionally slowly, removal of additional spawners could be tried without qualms. On this same lake, however, the crappies were far from being overstocked, and one of the year-classes studied was almost nonexistent. In Muskellunge Lake the bluegills are less numerous than in Shoe; they grow fairly rapidly, and the year-classes vary considerably in numbers. Of two year-classes which have been best studied, one was about twice as numerous as the other; and though it grew somewhat more slowly, the net effect was a very considerable increase in the availability of bluegills (in pounds) during the 2 years when it made its important contribution to the fishery. It might be that these fluctuations would average out over a period of years, so that say the 20-year catch of all species would, within broad limits, be independent of recruitment, in the manner suggested by studies of fish production in ponds. It would certainly be useful to have more light on this question, as well as on that of the relation of recruitment to spawners, but meantime we are far from being able to say that spawning and recruitment, in lakes of this sort, are everywhere and always adequate to make best use of available food supplies. Consequently if any really serious increase in fishing effort by relaxing regulations were being contemplated, it would be best to try it out on a few lakes first. It would be likely to be most beneficial to lakes in which the important game species are making slow growth.

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RELATION OF BUFFER SPECIES ABUNDANCE TO FOX PREDATION ON GROUSE NESTS

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Wildlife technicians have coined the term "buffer" to designate a species which presumably minimizes predation on a game bird or animal through serving as a major component of the diet of one or more of the latter's important predators. Similarly it has been recognized that changes in the availability of such food supplies often affect inversely the predator pressure on game. But the role of buffers as an influence on the degree of predation suffered by a game population has usually been thought of as involving a more or less conscious shift on the part of the predator in the focus of its hunting efforts. Accounts have frequently stated that, as buffers became scarce, predators *turned increasingly to* game. Recent studies, however, indicate that this is not always the case, although the end result may be much the same.

In the first place it may be noted that game birds such as the ruffed grouse, for example, seldom, if ever, become a staple food of any predator. In New York the chief natural predators of this bird are the great horned owl and the fox, yet occurred in less than 6 per cent of the stomachs, pellets and droppings of these species examined, whereas the principal buffers (rabbits and mice) occurred in nearly 75 per cent. Secondly, even when they are scarce, these buffers are still much more numerous than grouse. It, therefore, seems unlikely that such predators, as species, ever divert much of their hunting efforts toward grouse. Nevertheless an inverse relationship between buffer abundance and predation on game appears to exist.

One mechanism by which this may come about has been revealed by data gathered during the New York Ruffed Grouse Investigation on its Connecticut Hill study area—a tract of some 5,000 acres in southwestern Tompkins County. Here coexistent populations of grouse, predators and buffers were under observation for a period of several years. The most striking relationship to come to light was that between foxes and buffers with respect to grouse nest mortality.

Beginning in the winter of 1933-34 tracks of the various buffer species were tallied along a series of half-mile trails well distributed

[1]The author wishes to express his deep indebtedness to his associate and colleague, Walter F. Crissey, to whom is due the credit for the biometrical treatment of the data presented. Without it this paper would have been impossible. Walter Crissey is now on leave with the Navy.

throughout the area. During that season and each winter thereafter (through that of 1940-41) a circuit of these trails was made immediately following each suitable tracking snow. The tally for each half-mile unit was recorded separately.

These data have been subjected to biometrical adjustment through analysis of covariance (Snedecor, 1938) to obtain the most comparable values for the different years involved. Because food habits analyses had shown rabbits and mice to be the staple diet of the fox only these species were considered, except that shrews were also included due to the fact that they were not differentiated in the track tally. Since the home ranges of these animals are small and their food supply quite constant it is felt that the values obtained afford a reliable index of trends in abundance. This conclusion is corroborated by sight records and trapping results. Finally, in order to obtain an estimate of the composite status of these buffers as a food supply the values for the two groups were combined giving rabbits a weight of 2 against 1 for mice and shrews. This ratio represents an effort to take into account the greater degree to which a rabbit constitutes a full meal for a fox than does a mouse as well as the fact that, because of their size and habits, mice tend to be somewhat less conspicuous. These data have been plotted graphically in Figure 1 and show a strongly fluctuating trend.

Records were also kept of the frequency of fox tracks. It was found, however, that the half-mile trails did not furnish sufficient data. Therefore, the full tally of fox tracks recorded per route mile by field crews doing grouse census work under suitable tracking conditions was used. These data were also treated biometrically and the resulting values have been plotted in Figure 1.

These, too, varied widely from year to year—much more widely than there is any evidence that the actual fox population varied. One of the chief indicators of the general level of fox abundance is the number of occupied dens each spring and this remained quite stable throughout the period involved. Reports of trappers operating in adjacent territory also indicated no great changes in the abundance of this animal. Undoubtedly its numbers fluctuated, but not as abruptly as did the frequency of its tracks.

On the other hand, the home range of a fox is large and its food supply is not constant. Furthermore, when plotted graphically along with the trend in the abundance of small mammals which are their principal food, a strong inverse relationship between the two is revealed (Figure 1). This suggests that the fox data are more indicative of relative fox activity than they are of numbers. Another reason for believing that the fox track data represent activity is the fact that the number of droppings picked up by field crews over the same period varied inversely to the abundance of small mammals.

Thus it appears that, as its principal food species decreased, the foxes on this area spent more time hunting and ranged more widely in order to satisfy their appetites. Conversely, when small mammals were abundant, they traveled less although the fact that fewer fox tracks were not recorded in 1934-35 may mean that a fox will travel about so much at this season regardless.

With respect to the effect of this relationship on grouse nest mortality, the trend of losses due to predation, for which the fox was the

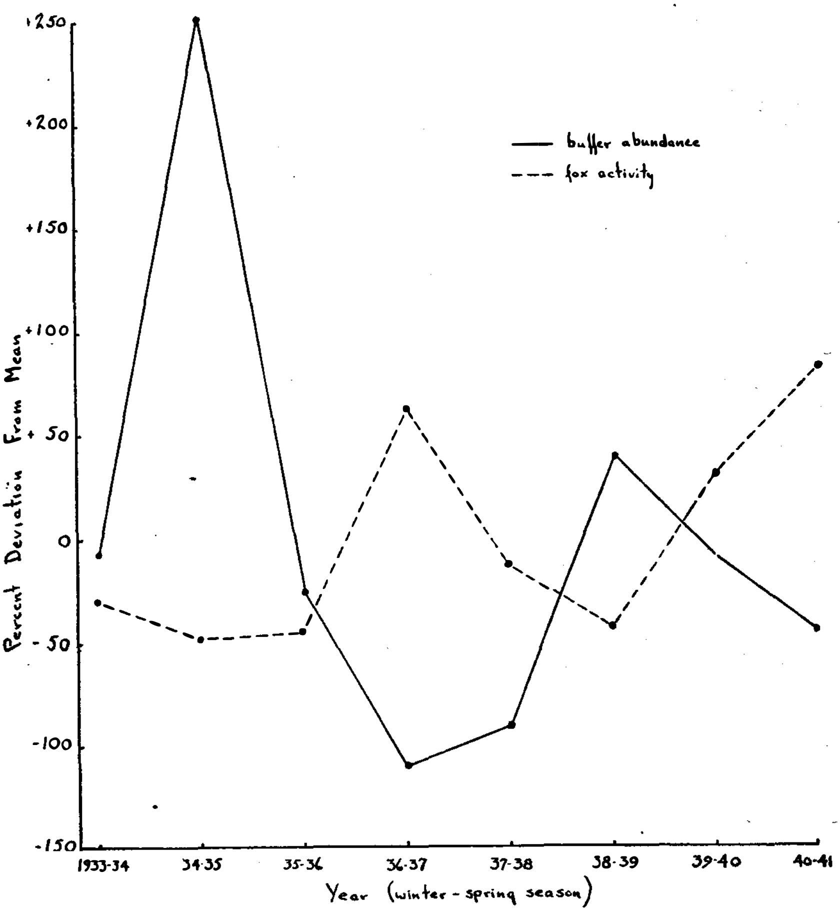

Figure 1. Comparison of fluctuations in buffer abundance and fox activity—Connecticut Hill study area.

chief agency, is shown in Figure 2 together with that of fox activity. A marked similarity between the two is quite evident. Yet grouse eggs constituted only a negligible proportion of the food of a fox even during the spring. Apparently, although the eggs are well liked, grouse nests were encountered primarily by chance. Thus it seems that when a low abundance of buffers, their staple food supply, forced foxes to cover the area more intensively to get enough to eat they happened onto and destroyed a greater proportion of the grouse nests present. But, as far as grouse were concerned, it was incidental rather than the result of a direct diversion of effort.

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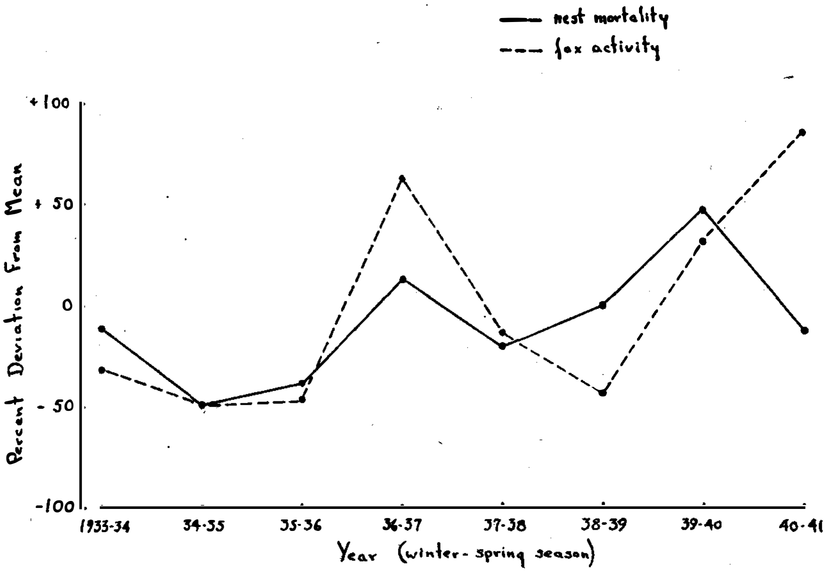

Figure 2. Comparison of fluctuations in grouse nest mortality and fox activity—Connecticut Hill study area.

WATERFOWL AND THEIR MANAGEMENT IN INLAND TEXAS

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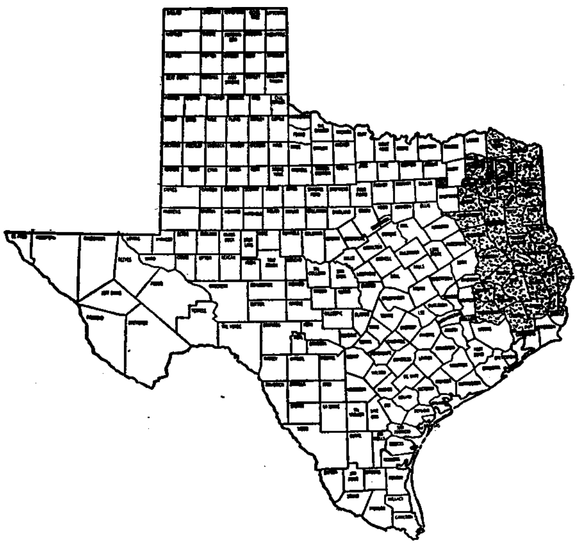
The study of the activities of ducks and geese during the winter months and, particularly, of their management in the South, has been hitherto much neglected. It is hoped, therefore, that the research conducted in eastern Texas from 1939 to 1944 might be duplicated and augmented in a number of other Southern States. A summary of the procedures and some of the results of that study follow.

The study area — eastern Texas.—A common complaint among sportsmen in Texas is that most of the ducks go to the Coast leaving poor hunting inland. The purpose of this study was to learn of means by which to induce more ducks to "winter" away from the Coast.

The study was conducted in the timber belt of eastern Texas. The 37 counties involved, as shown in Map 1, cover an area of about 28,850 square miles. There are 610 streams in this region. All of the larger streams have a resident population of mallards and wood ducks during the winter months, and Red River annually harbors some Canada geese. The only large lake in this region is Caddo Lake on the Texas-



Map 1. Area covered in this study (shaded part of map).

Louisiana line. It has a total surface area of about 110 square miles, of which 52,800 acres lie in Texas. There are many small natural lakes of which practically all have been formed by the cutting off of the horseshoe bends of rivers by changes in the river channels during flood stage. These cut-offs or sloughs are of great importance to waterfowl. There are also a large number of artificial lakes which range in size from barnyard ponds to one lake with a surface area of 1,800 acres. There are at least 222 lakes and marshes in the 37 counties of eastern Texas which are 20 acres or larger in surface area. Of these, 75 are natural river-bottom lakes, and 147 are artificial. The state, Federal Government or municipalities own 18 of these; sporting clubs have control of 58; and 139 are in private ownership. The public is allowed to fish and hunt on at least 71, while 10 lakes are recognized as waterfowl refuges. These lakes, including Caddo Lake, give the area under consideration about 76,300 surface acres of water.

Waterfowl in eastern Texas.—Eastern Texas is the recipient of ducks and geese from two of this continent's major flyways, the Mississippi and the Central Flyways, since both border in this region. We differentiate between several types of migration. In the major fall and spring flights great numbers of a variety of species pass over on their way south to the Coast or farther, and then back again to their nesting grounds in the North. During this period numerous species of waterfowl stop on the many small lakes of eastern Texas for intervals of several hours to several weeks to rest and feed. The peak of these flights in autumn generally occurs between November 1 and 15, and in the spring during March. Another type of migration occurs when various species of waterfowl have eastern Texas as their ultimate goal for the winter months. Although some individuals of all species which pass over this region spend much of the winter in eastern Texas, the common mallard, the ring-necked duck, and the lesser scaup are the most common winter residents. (The wood duck is also a common winter resident, but is also a summer resident.) Some Canada geese are regular winter residents. The American coot of the rail family and the pied-billed grebe of the grebe family can also be found throughout the region during the winter.

The various species of waterfowl are rather consistent in the order in which they put in their fall appearance. In spring the picture is complicated due to the fact that some individuals of most species lag behind while the greater number of their kind leave for the North.

A thumbnail sketch of the waterfowl picture in eastern Texas is as follows: In June and July wood ducks and occasional pairs of mallards are the only ducks present. Some blue-winged teal appear the first part of August and thereafter quickly increase; pintails, pied-billed grebe, and American coot appear the last part of August; pintails top the list by the end of September, whereas the blue-winged teal populations decline. Between the middle of October and the first week in December at least 20 different species of ducks and geese can be seen; scaups, ring-necked ducks, and pintails are the most numerous migrants during this period, although a spectacular goose flight takes place the last 2 weeks in October; mallards, which first appear around October 15 show only a slight increase until the first cold spell around Thanksgiving when their numbers show an abrupt rise to surpass in numbers all other species combined during December and January; the ring-necked ducks rank second. Toward the end of February pintails again become numerous but mallard flocks begin to decline. The greatest variety of waterfowl species passes northward through eastern Texas during March; by the end of April most species have left, and the American coot again heads the list, although blue-winged teal and shovelers are still common. Thereafter, wood ducks once more reign supreme with only an occasional pair of mallards to keep them company.

Some food-habit notes.—The preferences of both dabbler and diving ducks were determined through a study of the contents of 250 duck stomachs collected from various lakes in eastern Texas during November, December, and January of 1939, 1940, and 1941. The results are summarized in the following table:

TABLE 1. THE TEN FOOD ITEMS, LISTED IN THE ORDER OF THEIR IMPORTANCE, MOST COMMONLY FOUND IN STOMACHS OF DABBLER AND DIVING DUCKS, BASED ON ANALYSIS OF 250 STOMACHS COLLECTED OVER A PERIOD OF 3 YEARS

Dabblers		Divers	
1. *Quercus* spp.	acorns	1. *Potamogeton pusillus* and *americanus*	pondweeds
2. *Eleocharis equisetoides* and *quadrangulata*	spike rushes	2. *Chara* sp.	musk grass
3. *Polygonum punctata* and *longistylum*	smartweeds	3. *Polygonum* spp.	smartweeds
4. *Ceratophyllum demersum*	coontail	4. *Castalia* sp.	water lily
5. *Potamogeton* spp.	pondweeds	5. *Brasenia schreberi*	water shield
6. *Verbena* sp.	verbena	6. *Naias guadelupensis*	bush pondweed
7. *Cephalanthus occidentalis*	buttonbush	7. *Ceratophyllum demersum*	coontail
8. *Nymphaea advena*	spatterdock	8. *Eleocharis parvula* and *equisetoides*	spike rushes
9. *Scirpus* spp.	bulrushes	9. *Nymphaea advena*	spatterdock
10. *Sparganium* sp.	bur reed	10. *Cephalanthus occidentalis*	buttonbush

Hunting habits.—In eastern Texas hunting comes under four major categories, each with but minor variations: (1) club lake hunting, (2) public and private lake hunting, (3) Caddo Lake hunting, and (4) river-bottom hunting.

In general, duck hunting on club lakes is mediocre. The two largest clubs in eastern Texas are exceptions. In 1940 members of Koon Kreek Klub in Henderson County, the largest club in the region, averaged 5.1 ducks per man-day hunt. In 1941 they averaged 4.8 ducks per man-day.

Hunting on one of the several hundred small artificial lakes open to the public is poor with but few exceptions. Most hunting in eastern Texas is however done on public lakes.

A large part of the hunting on the overcommercialized and poorly-managed Caddo Lake is done through commercial camps. Hunting success on this lake is far below its potential possibilities.

River-bottom hunting, or "jump hunting," is practiced by much of the rural population but by only a small percentage of sportsmen from urban centers. This type of hunting has many unexplored potentialities both in sporting qualities and in hunting success.

Hunting success and cost.—Eighty-nine experienced duck hunters from six different communities in eastern Texas were questioned in regard to their hunting during the 1939 season. They shot a total of 790 ducks and geese, an average of 8.87 waterfowl for the season for each hunter. They went hunting an average of 3.71 times each and bagged an average of 2.46 waterfowl on each hunt. This is equal to or above the average of public hunters in numerous other regions of the country, but below the average of hunters on the Gulf Coast. This figure does not however take into consideration the thousands of tyros whose poorer hunting would naturally bring this average down. By making a total of $2,741.71 worth of purchases, an average of $30.80 for each hunter, the 89 hunters spent an average of $3.47 for each waterfowl they brought home. A large variety of business establishments, laborers, the state and Federal Government benefited from these purchases.

Since the prime purpose of the waterfowl project was to provide better hunting in inland Texas, experimental management techniques were inaugurated at the very beginning of the study. The experiments showed some techniques to be impractical while some proved to be highly successful. These studies are the basis for the following conclusions:

Lake construction.—More and larger lakes in eastern Texas will increase the resident winter waterfowl population in this area. The construction of large lakes should rank high in any waterfowl management in eastern Texas. All things being equal, the larger the lakes, the more attractive they seem to be to waterfowl. The smaller the lakes are, the more essential does it become to take into consideration other management practices.

Establishment of refuges.—Next to large lakes, refuges are the most important device by which to hold ducks and geese in inland Texas. Paradoxically, these refuges provide better hunting in their immediate vicinity while they also help to conserve waterfowl. However, refuges within 50 miles of, but not on, the coastal plains seem to be of little if any benefit. Waterfowl within this distance of the Gulf Coast seem to prefer to go to and stay near the rice fields of the plains.

There are in eastern Texas 10 well-established waterfowl refuges. Of these, eight are Federal-Aid Game, Fish and Oyster Commission refuges. These 10 refuges cover 27,720 acres of land, have 2,522 surface acres of water, and have built up a daily average waterfowl population from a few thousand ducks in 1939 to 61,500 ducks and 1,250 geese during the winter of 1943-44.

Cover.—On a large lake the need for a refuge is inversely proportional to the amount of cover present. Cover can consist of islands, peninsulas, and tall plants and brush.

Food.—In eastern Texas food conditions may be improved principally by saving acorn-bearing oaks in river bottoms, by saving and fostering the growth of buttonbush (*Cephalanthus occidentalis*) thickets, occasionally by planting, by fencing against grazing, and most important, by inundating more land. The last method is recommended above all others wherever it is at all possible, for in the South aquatic vegetation grows surprisingly fast whenever fertile land is inundated. Planting in such cases is generally a needless expenditure. However, where planting is attempted some common mistakes should be avoided. No wild rice should be planted in eastern Texas. It will not grow. Submerged vegetation should not be planted in a persistently murky lake. It is useless to plant aquatics in an old lake which is barren of plants. The lack of plants indicates that something is basically wrong which cannot be corrected by the addition of plants.

The use of grain fields did not prove successful in attempts to attract waterfowl to refuges in eastern Texas. Winter greens did, however, attract geese.

The control of obnoxious weeds, particularly in the various swamps and marshes, is often very desirable. The most troublesome weed in eastern Texas is giant saw grass (*Ziziniopsis miliacea*), but practical means of controlling this plant are still unknown.

Finally, a major cause for poor hunting lies with the average sportsman himself in his mental attitude and his method of hunting. His concept of sportsmanship is still in the kindergarten stage. It is based on "bag limits," and, in his mind his hunt is not completely successful unless he obtains the full limit allowed him by law. He seems to derive a greater satisfaction out of 10 mallards obtained with the most modern equipment while sitting in a blind to which a guide called the ducks, than out of one mallard obtained through his own skill under trying conditions. In all other sports he demands maximum competition, yet in the sport of hunting he prefers the greatest kill with the smallest effort.

Efficiency in the art of calling ducks is a major asset in the river bottoms of eastern Texas. There are still too few sportsmen who have taken the time to develop this art. If they had, we should hear fewer hunters bewailing the good old days when the use of live decoys was permitted.

It is surprising that despite the abundance and easy accessibility of major river bottoms in eastern Texas, where the greatest number of mallards are to be found in December and January, the average sportsman from urban centers will persist in doing his hunting on the small public artificial lakes where the fewest mallards are to be found. To top it off, he will do most of his hunting at the beginning of the season in November, before mallards have arrived. Late in the season when the great mallard flights have arrived very few sportsmen can be found hunting ducks.

Much poor hunting success must be credited directly to the hunter and not to the lack of ducks.

CONCLUSIONS

1. A phase of waterfowl study which has been too much neglected is the activities of waterfowl during the winter months and, particularly, their management in the inland portion of the South.

2. On the basis of the data contained in the first part of this paper relative to streams, lakes, refuges, and waterfowl flights, it appears that the major reasons for subnormal hunting in eastern Texas are an insufficiency of large lakes, and lakes which are open to public hunting, and refuges.

3. On the basis of 3 years of studies we conclude that the foods listed in Table 1 are the 10 most attractive to dabbler and diving ducks in eastern Texas.

4. In 1939, 89 experienced hunters in eastern Texas went hunting an average of 3.7 times each, shot a total of 790 ducks and geese, or an average of 2.46 waterfowl on each hunt. These hunters spent an average of $3.71 for each duck.

5. To hold more ducks in eastern Texas the following items of management, placed in the order of their importance are recommended: more and larger lakes, more refuges, more cover on lakes, and more food.

6. Repeated trials have shown the inadvisability of certain management practices in eastern Texas.

7. The control of obnoxious weeds, particularly in the various swamps and marshes, can at times be a helpful management device.

8. A major cause for unsatisfactory hunting in eastern Texas lies with the average hunter himself: his misguided concept of sportsmanship based on "bag limits"; his lack of ability in the art of calling ducks; his ignorance of the possibilities in the river bottoms; and his habit of doing most of his hunting at the beginning of the season rather than later when most mallards have arrived.

EXPERIMENTAL COOKERY WITH SURPLUS FISH AND WILDLIFE[1]

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Some of the problems considered and a few of the tentative conclusions drawn in experimenting with nongame fish and game cookery are presented in this paper. The existing shortage of domestic meats, despite record maximum production has modified the food habits of all Americans. Wildlife can contribute substantial amounts to the nation's meat supply and release comparable quantities of domestic meats and the more commonly used fish for both civilian and military use. The home use of local fish and game also helps to relieve a much overtaxed transportation system of an appreciable amount of double hauling of domestic meats. An estimated 15 million pounds of nonrationed fish and game yearly are available in Iowa, and can be taken without endangering the seedstocks. By utilizing inland fish largely neglected, such as the carp, buffalofish and fresh-water sheepshead, and mammals such as the opossum, musquash (muskrat) and raccoon in addition to an enlarged harvest and use of favored fish and game, 15 million pounds of superior food can be added to Iowa's supply of protein foods.

Present status of research on fish and wildlife as food.—Nongame fish and wildlife as vital food resources open an extensive field for research with far-reaching possibilities. The effects of physical factors as temperature, type of heat transfer, the chemical and physical changes that occur in cookery are fundamental problems largely to be solved. Very few quantitative determinations and vitamin assays have been made on the nutritive values of fresh and cooked fresh-water non-

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game fish and game. However, all fish and game are classed with meats and poultry as sources of excellent proteins. Some work has been reported on the more practical fish and game cookery problems concerned largely with the various methods of cookery.

Experimental cookery with Iowa's fish and game.—The program of research on fish and wildlife as food has been limited to practical fish and game cookery problems concerned largely with testing the various methods of cookery to determine which ones are best suited to each type.

In all types of meat cookery studies certain fundamental facts apply to all types of meats. Structurally and chemically meats of all animals are essentially alike and undergo similar changes in cooking. Muscular tissues consist of bundles of fibers surrounded and bound together by connective tissue. Every muscle is a composite of water, proteins, fats and lipoids, carbohydrates, inorganic salts, vitamins, nitrogenous and nonnitrogenous extractives, pigments and enzymes, some concentrated in the fibers, others in the fluids of the muscles. Each constituent reacts basically in the same way to heat regardless of source. Water, proteins, fats, pigments and enzymes are most affected in cooking. Some of the water and extractives evaporates and some collects in the drippings or stock; some of the fat melts, some is decomposed; the soluble proteins are coagulated; collagen is partly changed to gelatin while elastin is not affected to any extent by the usual cooking temperatures; color changes are partly due to the pigments present, the temperature reached within the meat and the time the meat is held at this temperature; aroma and flavor are affected by many factors such as the decomposition of fats and proteins, the coagulation of proteins, the loss of volatile substances and the caramelization of carbohydrates. (Lowe, 1943; National Cooperative Meat Investigations, 1942.)

Meat is cooked to destroy microorganisms which may be present and to make it more palatable and attractive. Basic methods for cooking meats have been followed. Testing of the various methods of cookery with temperature and time variations has not been done generally on paired samples or right and left sides of the fish and small game studied. With the larger game this usual method is observed. Palatable, attractive and practical dishes of local and general appeal are developed for each type.

All prepared dishes are scored subjectively on aroma, flavor, texture and/or tenderness and juiciness and sometimes appearance, by a panel of 7 to 11 chosen from the foods and nutrition, institution management and science staffs, and research workers in foods. The grading charts have a gradation of 10 for each palatability factor and are patterned after the record charts for meats and poultry used in the experimental and research laboratories at the college (Table 1). Taste thresholds have not been established for the judges, and each one has to determine his own standards, especially difficult for palatability factors such as flavor and juciness for a meat entirely new to many. Persons vary greatly in their responses; the scores have been interpreted as reflecting the tastes and other reactions of a group with definite and high standards. The scores are used in formulating basic methods for cooking each, and in determining the experimental procedure to follow in qualifying the flavor of the dish when indicated. As protein foods, fish and game are cooked according to the conventional or basic methods used for meat and poultry cookery. The amount of fat present, the toughness of the fiber with increased age as in game, and the lack of much connective tissue as in fish, determine largely the method of cookery best suited for each, the time for cooking and the degree of heat to be used.

Iowa's nongame fish (carp, buffalofish, and fresh-water sheepshead) as food.—As a direct aid in reducing the protein shortage in the food conservation program, all efforts at first were concentrated on the preparation of a bulletin on Iowa's nongame food fish (carp, buffalofish, and sheepshead).

From 35 to 50 dressed carp, buffalofish, and fresh-water sheepshead, thoroughly chilled and iced, were shipped from Lake Okiboji twice a week during May, June, and July, and arrived iced and in excellent condition. Prepared dishes from these fish were cooked twice a day, 5 days a week, and scored on aroma, flavor, and texture morning and afternoon by a panel of seven.

The carp and buffalofish are lower in fat and coarser in texture than sheepshead. Fish are more tender than meats. The shorter and finer muscle fibers are held together by small amounts of connective tissue, almost entirely collagen, and the cooking of fish to retain its shape becomes a special problem. By baking or steaming the fish on cloth or boiling or poaching it wrapped in a cloth, it is easily removed intact. Tender protein foods, such as fish, should neither be cooked at too high a temperature nor overcooked. Too low a baking temperature will not develop that browned surface so essential to fish with its delicately neutral color. Fish are best when cooked just long enough to flake the muscle and separate it easily from the large bones; at this stage the natural flavor of fish is preserved, the flesh is tender and moist. All three types scored highest when broiled with little or no difference between the three. With the limited amount of work done on baking stuffed fish, those baked at 350° to 375° F. scored higher than those baked at 425° to 450° F.

TABLE 1. GAME COOKING RECORD

Date: ....

Sample Nos. .... Grading Chart for Cooked .... Scorer: ....

Factors	10	9	8	7	6	5	4	3	2	1	Remarks
	Extremely Good	Very Good	Good	Plus	Medium	Minus	Fair	Poor	Very Poor	Extremely Poor	
Appearance											
Aroma											
Flavor {Fat											
Flavor {Lean											
	Extremely Tender	Very Tender	Tender	Plus	Medium	Minus	Fair	Tough	Very Tough	Extremely Tough	
Tenderness											
	Extremely Juicy	Very Juicy	Juicy	Plus	Medium	Minus	Fair	Dry	Very Dry	Extremely Dry	
Juiciness											

Aroma		*Flavor*		*Lean*		*Prepared Dish*	
Mild	______	Flat	______	Dark	______	Salty	______
Sharp	______	Mild	______	Moderately	______	Sour	______
Strong	______	Strong	______	Slightly	______	Bitter	______
Swampy	______	Swampy	______	Pale	______	Sweet	______
Sour	______	High	______	Bright	______	Gamy	______
Foreign	______	Old	______	Moderately	______	Rich	______
Gamy	______	Bitter	______	Dull	______	Flat	______
Normal	______	Gamy	______		______	Juicy	______
Abnormal	______	Normal	______			Dry	______
	______	Abnormal	______			Pleasing	______
			______				______

Preference ....
Among samples scored

Approximately one fourth of the time was devoted to canning, pickling and smoking the three types of fish. Points in technique were stressed, including ease of method, time involved in each process, equipment available in the average home, desirability and keeping qualities of the final products. In the canning of fish, experimenting was done with the following: size of jar, brining and salting, the addition of vinegar or lemon juice, pre-cooking, the pressure canner and the boiling water bath, 10- and 15-pound pressure-processing with variations in time. Four jars were processed with each experiment: one jar was tested shortly after processing and the other three were held in storage and tested at the end of 3, 6, and 12 months. The recipe edited for canned fish incorporates the results. About 90 pounds of fish, divided equally between the three kinds, were smoked in the Animal Husbandry meat laboratory smokehouse. Three different methods of curing (dry salt, spiced and straight brine) and two hot-smoke processes (cold and hot smoked combination and hot smoke) were tried. All three types of fish were palatable and delicious when cured and smoked by the different methods, with scores ranging from 7.1 to 8.9. Smoked fish was served twice on a cold plate to 90 or more patrons of the Institution Management Tea Room. Judging by the comments handed in, the remarks overheard and the cleanness of the plates, Iowa's fish when smoked compares favorably with commercially smoked fish.

Iowa's game as food.—The second and present phase of this project has as its objective the preparation of popular bulletins largely on recipes for cooking and preserving game birds and mammals with emphasis on those available in larger surplus, and those not commonly used: musquash, opossum, raccoon, woodchuck, jack rabbit, coot, and crow. Since December 1943, musquash, bob-white, pheasant, venison (from the Ledges State Park at Boone), squirrel, cottontail, coot, opossum, and raccoon have been experimented with in the laboratory. While this study has followed in general the outline used for fish, the problem differs radically in some respects. Game is more difficult to obtain; many are seasonal and have open and closed seasons; numbers are limited; data on food habits and habitats are not always obtainable. Most of the fur-bearing animals are trapped, not shot, and therefore likely to be improperly bled and diffused with blood.

Game tends to be tough and strongly flavored, varying in degrees with age. Judging of age, therefore, is most important in determining. tenderness and/or texture. Data on factors useful in age determination on the live or undressed game, on percentage losses in dressing game and on facts which affect weights of dressed-out game are collected by the research student as he obtains and prepares the game for the laboratory. Observations are made on the carcasses to determine the method of procedure. A strong gamy odor and a carcass diffused with blood indicate the need for soaking to draw out the blood and reduce the gaminess. Conformation whether blocky and compact or rangy and angular; finish as to the amount, distribution and color of fat; quality as to firmness of fibers, marbling, pliableness of bones and cartilages, are characteristics indicative of grade, and determine whether dry or moist heat is best suited for the specific game.

Flavor plays a most important part in judging all game dishes and is one of the most difficult factors to understand in all meat research. After searching for research material bearing on meat flavor in general and game flavor in particular, we concluded that very little is known about the chemical nature of meat flavor, factors affecting flavor and means of measuring flavor. A consultation with an outstanding chemist and letters written to twelve eminent scientists in different but related fields, brought many interesting and varied replies but gave no conclusive answers to the points in question. The few attempts made to date to determine through scoring if game flavor is localized in lymph glands or "kernels," if it permeates the entire muscle, if it varies in degree in different parts of the muscle, or in different parts of the animal have not been decisive. Providing three paired samples (hindquarter, forequarter, and saddle) from the right and left sides of the same carcass, differently treated, is almost impossible with all but large game such as the raccoon.

Three months have been devoted to the study of musquash. About 100 were sent to the college in two consignments by Iowa trappers shortly after the opening of the trapping season in November. They had been skinned and drawn. Each was wrapped in paper or coated with a layer of ice to reduce evaporation, sharp frozen and stored in the College locker plant. The dressed carcasses weighed from 13 to 22 ounces each. Musquash are muscular rather than fat animals with well-developed hind legs and short forelegs. The flesh is dark red in color, fine textured and tender; the bones are brittle and break easily with jagged edges. The gamy odor is stronger in the older carcasses. The flavor of musquash is rather strong and quite different from most game and you either like it or you do not, according to the reactions of the panel. When soaked overnight or longer, and well prepared (broiled, breaded, baked, barbecued, stewed or braised) musquash scored consistently from 7 to 9 with some judges and lower with others. It has been interesting to note the apparent similarity in flavor between musquash and coots in recent identification tests. Another rather striking observation is the low score for musquash when judged with three or four different kinds of game, all prepared to develop the flavor peculiar to each. The study on game flavor and tenderness has been extended to include the effects of trapping or shooting, delayed evisceration, aging or ripening, freezing and storing.

Carp, buffalofish and fresh-water sheepshead are palatable and delicious when well conditioned and properly prepared. Fish removed from warm and roily waters and strongly flavored game are improved by soaking in a salt solution before cooking; a vinegar solution or a seasoned marinade modifies the flavor. The red lateral streak common to the carp and buffalofish need not be removed except for appearance. The percentage of waste in fish is high, about 42 per cent is edible. Ordinary cooking has little or no effect on the bones in fish. Canning of surplus fish is practical; with the addition of a small amount of lemon juice or vinegar and the use of a pressure canner, the bones are softened. Game diffused with blood is greatly improved if soaked in a salt solution. The effect on game flavor of the "kernels" found in the foreleg pits of the squirrel, muskrat, and raccoon is questioned. The musk glands in the muskrat are attached to the intestines and removed when the animal is eviscerated. The sooner the game is cleaned and cooled the more palatable it is. The flavor of different game is not easily recognized even with game enthusiasts. General principles of protein cookery apply to fish and game. Age and the condition of each species determine largely the best method of cooking for each. Broiling, frying, braising, and baking or roasting, properly done, develop the natural and distinctive flavor of the young and not too gamy species. A greased cheesecloth covering and frequent bastings with drippings will help to keep the skinned animals juicy and moist in roasting. Game flavor may be enhanced, supplemented, or modified by a wise choice of condiments, sauces, spices, herbs, and vegetables in stews, casseroles or other braised and baked dishes.

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Chairman: ALFRED TUCKER

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COMMERCIAL FISHERIES

THE ECONOMIC FUTURE OF THE ATLANTIC FISHERIES FROM THE POINT OF VIEW OF AN OCEAN POUND-NET OPERATOR

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The lot of the pound-net or trap fisherman after the war and when food is once more abundant is most certainly to be a precarious one. All the fisheries will be affected, but the pound net more so than others.

To prove the point, a brief description of pound-net operations may be in order. In this case a fish pound is a structure built in the ocean under federal and, in some instances, also state permits. These pounds, from a structural angle as well as a permit angle, cannot be moved and, hence, are entirely dependent on fish swimming into them to be caught. They are expensive to build, expensive to maintain, and a shore plant must be maintained as well as the pounds. Due to the work involved in operating pound nets other than just fishing the nets, remuneration for employees has always been straight wages rather than the lay system used in other types of fishing. A pound-net outfit, therefore, is saddled with a heavy fixed overhead that cannot be materially changed regardless of a large or small supply of fish or high or low prices. The pound-net operator has the competition of constantly more and more boats of the dragger class with better and better machinery and gear.

The economics of the thing is that the pound operator runs as many nets as he possibly can to get as much volume as he can to offset low prices caused by too much fish being produced. This does not apply now for there is not enough fish being produced due to a shortage of help and extra heavy demands caused by the present meat shortage. This condition will disappear as soon as the war is over, and then—look out!

Marine engines are being manufactured on a scale undreamed of a few years ago. Boats are being built mass-production in a manner thought impossible, and to top it off the government will have countless boats for sale many of which will no doubt make excellent fishing vessels. The fish business will be overmanned and overvesselled, and some means of control will eventually evolve. If producers get together they will be up for violation of the Sherman Anti-trust laws. So either producers get together with the various states and the Fish and Wildlife Service to get some sensible regulations as to the amount of gear that can be used in any locality both inshore and offshore, or we will have a labor union control that will in the long run do no one any good except those who run the union.

The regulations mentioned should strive to accomplish two purposes: (1) To keep production somewhat in line with demand, and (2) to keep an eye on the various fisheries, so that no species be depleted to the extent that it can no longer reproduce itself.

Matters of this kind are easily put on paper, but difficult of achievement. However, it is a problem that faces the fishing industry. It can be neglected to everybody's loss, or it can be tackled and a solution found. I am convinced that Mr. William C. Neville and his associates in the Fish and Wildlife Service together with the various states and the industry can accomplish something of a constructive nature if given the green light to go ahead.

INTERSTATE COOPERATION IN THE FISHERY FIELD ON THE ATLANTIC COAST

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Within the last few years a significant change in interstate relationships with respect to fisheries has taken place. The serious depletion of many of the Atlantic fisheries and the bickering and conflict between the states with respect to fishing regulations, licenses, and other details that too often characterized the relationships between the states in the past have given way to a new habit of cooperation, and a new technique for getting things done.

This change dates back several years to a series of interstate conferences between 1938 and 1941, at which representatives of the conservation departments and the legislatures of the Atlantic States gathered to see what could be done. The result of their efforts was the creation of the Atlantic States Marine Fisheries Commission. This new joint interstate agency was established by treaty or compact between the states with the consent of the Congress. Identical legislation has been adopted in 12 of the 15 states along the Atlantic Coast, and it is expected that one or possibly two of the remaining three states may during their current legislative sessions elect to join the 12 now banded together.

Under this compact each state is represented on the Commission by its chief administrative officer in charge of the fisheries, by a member of the legislature appointed by the Commission on Interstate Cooperation, and by a person appointed by the governor who "has an interest in and a knowledge of the fisheries." Each state contributes annually to the support of the Commission a sum which is proportionate to the value of its catch as compared to the total value of the catch of the Atlantic Coast. This is arrived at by a formula which under the compact the Commission itself has power to vary. Acting under that power, the Commission has recently increased the minimum contribution from each state from $200 to $500 annually. The balance of the budget required by the Commission is apportioned among the remaining member states in accordance with the value of their catch.

The Commission has a paid executive with a title of Secretary-Treasurer, and occupies a very modest office in midtown New York. The bulk of its funds, exclusive of salaries, are spent for travel of commissioners and expenses of meetings. It has no funds other than those provided by member states.

The Commission is advisory only. It has no power and wants none. Its strength lies in the fact that it is part of the great movement for interstate cooperation developed during the last decade under the leadership of the Council of State Governments. It solves problems between the states by providing a favorable forum for discussion where representatives of states involved can discuss such problems until solutions are reached.

Under the compact the Commission can only make recommendations to the several states, and only those states which have a direct interest in a particular species may participate in the panel dealing with such species. Those states concerned with the shrimp can have no voice in any recommendations regarding the lobster, and vice versa. Under the compact the U. S. Fish and Wildlife Service of the Department of the Interior is the primary research agency of the Commission, and members of that Service under the compact are directed to attend its meetings. The Service has been undertaking such investigations and research as the Commission has requested, and the help of the technicians of the Service has been invaluable in arriving at proper recommendations with respect to policy.

The Commission for convenience has divided itself into sections comparable with the divisions of the coast employed by the Fish and Wildlife Service, with some modifications. Thus the Commission has sections as follows: North Atlantic, Middle Atlantic, Chesapeake Bay, and South Atlantic. Within the Middle Atlantic Section, there is also a subsection on Delaware Bay, and later there may be one on Long Island Sound. In addition to these sections there are panels of interested states dealing with lobster, oysters, striped bass, blue crab, channel bass, shrimp, shad, and clam.

While the purpose of the Commission is not merely to secure uniform legislation, there have been a number of measures promoted by the Commission where uniform legislation appeared to be the answer to the problem. Among these are the uniform lobster act now law in Maine, New Hampshire, Massachusetts, New York, New Jersey, Pennsylvania, and Delaware. Connecticut and Rhode Island have considered it, and the matter is up for action in the current session of the Connecticut Legislature. A uniform blue crab act has been adopted in Maryland and Virginia, New York and Delaware and is pending in New Jersey. Maryland and Virginia with special assistance from the Fish and Wildlife Service are making an intensive study of the blue crab in Chesapeake Bay.

Following a recommendation of the Fish and Wildlife Service the uniform striped bass act has been adopted by Massachusetts, Rhode Island, Connecticut, New York, Pennsylvania, and a similar act is in force in New Jersey. Maine has made it a game fish, and fixed bag limits. A measure forbidding netting is now pending in New Hampshire.

To assist in the enforcement of fishery laws generally, a number of the states have adopted the reciprocal warden act which evolved out of conferences leading to the formation of the Commission. Among the states having adopted this act are Maine, New Hampshire, Connecticut, New York, New Jersey, and Pennsylvania. Massachusetts is considering such a measure at its present session and other states have expressed an interest therein.

Even while the Commission was in process of formation, identical recommendations dealing with the shad were adopted by New York and New Jersey with respect to minimum lifting periods, for nets in the Hudson River. This device plus additional controls developed in the two states have contributed greatly to the restoration of the shad in the river now up to its former peak. New York and New Jersey have adopted identical legislation for the protection of young sturgeon in the hope that thereby the restoration of that fishery in the Hudson may be promoted.

In the interest of the sport fishermen the channel bass panel has recommended a uniform channel bass protection act which has been introduced in Delaware, New Jersey, and New York.

New Jersey and Delaware in individual and occasional joint meetings have been seeking agreement upon a revision of the laws governing fishing in Delaware Bay under the compact between those two states adopted in 1905. It is hoped that this agreement will be enacted and thus terminate a controversy of 30 years standing between these two states.

All of the states up and down the Atlantic Coast which are members of the Commission have endorsed the proposal for the development of adequate state systems of catch statistics. Maine has an excellent system. South Carolina has recently increased the coverage of its records. Maryland has instituted such a system, and in New York and Massachusetts the departments are seeking an addition to their personnel in order to permit the establishment of similar records. An appropriation by the last legislature in Virginia included provision for the beginning of a system in that state.

These actual evidences of interstate cooperation are significant in view of the controversies that have raged between states on fishery regulations in the past.

Even more important in its significance for the future is the work of two special committees of the Commission, one dealing with fishery education, the other with fishery stabilization, sometimes called management. These committees composed of members from the interested states, have presented carefully-considered reports outlining the objectives and methods for their attainment. Both reports have been referred by the Commission to the authorities in several member states for their special consideration and for such action as each state may deem fit to take. Time does not permit me to outline the scope of these reports. What each state may elect to do will be of vital importance within that state. For the purpose of this discussion which deals with interstate cooperation we can only say that the reports themselves are a striking evidence of such cooperation because they represent the conclusions of committees made up of representatives of the states which are cooperating with each other through the Commission in the ways already mentioned.

The Commission is now studying the whole question of pollution as it affects the fisheries, particularly the shellfisheries and has recommended that the commissioners from each state take up with their appropriate state health authorities the question of a frontal attack upon those sources of pollution which are injurious to the fisheries.

One of the most striking instances of interstate cooperation undertaken under the Commission's leadership is a joint study by the states of New York, New Jersey, Pennsylvania, and Delaware, with the help of technicians of the Fish and Wildlife Service looking toward the possible restoration of the once great shad run in the Delaware. This run, now unbelievably low, once resulted in a take of 13 million pounds per year. Officials of the four states last year conducted preliminary surveys with the help of specialists in the Fish and Wildlife Service. Further studies are underway for the spring of 1945. It is hoped that from the investigations of 1944, 1945 and 1946, facts will be produced which will permit the presentation of a joint program to the legislatures of those four states in 1947. The principal obstacle to the shad restoration in the Delaware appears to be pollution. But this problem has been under consideration of a joint Commission of the same four states, the Interstate Commission on the Delaware River Basin, for a number of years. When man power and materials again become available after the war, it is hoped that the pollution abatement program and the program for the restoration of the shad may move forward hand in hand. If this industry can be restored to its one-time peak it will mean the recreation of an economic asset valued at from one and one half to two million dollars or more annually.

These measures which have been enumerated emphasize the fact that this Atlantic States Marine Fisheries Commission has no theoretical program but one which is intensely practical. Since many of the species concerned are of interest both to the sports fisherman and the commercial fisherman, it is obvious that they will assist in carrying out the objectives of the Commission, for the restoration and maximum utilization of the fisheries of the Atlantic Coast, which in turn will mean better sport for the fisherman, a better living for the commercial fisherman, and a greater supply of wholesome seafood for the consumer.

In the field of national legislation the Commission has likewise endeavored to exert its influence for the protection of the fisheries. It has asked that whenever the Congress considers measures for the improvement of rivers and harbors that there shall be submitted to the Congress along with the engineering and other reports connected with such improvements, reports indicating the effect of such improvements upon the fisheries so that the Congress shall not, without full consideration of the facts, authorize improvements which may be damaging to the fisheries.

Since the organization of the Commission in June 1942 its officers have been Edmund L. Dunn, President of the New England Fish Exchange, Boston, Massachusetts, as chairman; Edwin Warfield, Jr., Chairman of the Department of Tidewater Fisheries, Annapolis, Maryland, as Vice-chairman, and Wayne D. Heydecker, Secretary-Treasurer.

There have been some changes in the personnel of the Commission during the 3 years of its existence, but fortunately these have been relatively few, as the participating states have recognized the value of continuity of membership and have followed it wherever possible.

The Commission represents a new concept of intergovernmental cooperation, a joint agency of many states working in close cooperation with federal technicians on programs which the states believe will benefit their respective fisheries. The Commission could not have achieved what it has were it not for the wholehearted assistance of the Commissions on Interstate Cooperation in the several states which have sponsored the Commission's various recommendations for legislation or other state action.

Its officers believe the Commission through its form of organization and method of operation is demonstrating that results can be achieved even in so complicated a field as the coastal and migratory fisheries when men of good will from the several states are determined to accept their respective responsibilities and cooperate to fulfill them.

UTILIZATION OF THE SURF CLAM *MACTRA SOLIDISSIMA*

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It is well known that many valuable seafood resources in our Atlantic Coast waters are undeveloped. Within the last 2 years one of these, the surf clam, *Mactra solidissima,* sometimes known as the skimmer clam, hen clam, or sea clam, has begun to be taken in increasing amounts. Previously, this species was used in limited quantity, chiefly for bait in the commercial cod fishery and also by sports fishermen. For many years, the fishermen and seaside residents were aware that these clams had excellent eating value, and sporadically, on very low tides, were dug by clammers and shipped to market. The take for 1944, from Long Island waters, amounted to over 2 million pounds, and at present, is rapidly increasing. It is the purpose of this paper to describe, briefly, a few aspects of the utilization of this new fishery. It should not be confused with that, concomitantly developing off Rhode Island, with another member of the clam family, the so-called ocean quahog, *Arctica islandica.* This species resembles the hard clam, *Venus mercenaria,* while the surf clam has more characteristics in common with the soft clam, *Mya arenaria.* The ocean quahog industry appears, at the moment, to be equally as promising as the surf clam, and is an example of still another ocean food resource coming into use.

Biology.—Little is known of the biology of the surf clam. This is unfortunate, as a knowledge of some of the biological facts would be of use in the conservation and production of this species. For example, it would be well to know the critical temperatures for spawning and the effect of temperature on feeding and growth, as well as something of the behavior as to environmental conditions. Also, little is known of the distribution. Roughly, it seems somewhat the same as that of the soft clam, *Mya,* except that it requires an environment of higher salinity, approaching that of the open ocean. The geographical range is probably from the Gulf of St. Lawrence to Cape Hatteras with optimum conditions obtained off southern New England and Long Island. A prognostication of the future extent of the industry would hardly be valid until a distribution survey can be made. Professor Thurlow Nelson, well-known shellfish biologist, states that he has observed a set of surf clams in the somewhat brackish waters of Delaware Bay and has noted they seldom attain a size in excess of 2 centimeters in length. In the waters off Long Island, spawning seems to take place in the latter part of July. Occasional specimens of surf clams are taken in various parts of Long Island Sound and in some of the bays in eastern Long Island where salinities range from 28 to 30. Surf clams grow to a size of 7 inches in length. At present, those less than 4 inches in length are not used commercially. Since extensive beds seem to be located just off the beaches, they become subject to regulation by state authorities whose marine jurisdiction generally extends out to the 3-mile limit. With the rapid exploitation such as now is taking place in the surf clam fishery, it becomes imperative to consider regulations designed to best conserve the resource, by such means as a closed season and restriction of areas for spawning. Such legislation must be based, however, on sound biological observations.

Taking.—In shallow areas, surf clams are tonged in the same manner as hard clams. For the most part, however, dredging is employed. Boats of the dragger type built for catching finny fish are easily converted for coaching surf clams. Certain of the fishermen were reluctant to change over, since they claim that shellfishing is more arduous and damaging to gear. The dredge, used on the average 60-foot dragger, employed in the fishery, has an opening of about 2 feet with teeth that cut into the bottom up to a depth of 8 inches. The average take per day, with one man on deck, is about 100 bushels.

Methods of handling.—The fishermen deliver the clams to shucking houses in bushel bags. Currently they are being paid $1.50 per bushel. A bushel weighs about 65 to 70 pounds. Openers are paid by the bushel, and in most plants they also eviscerate, that is, squeeze the stomach portion out. In other plants, the evisceration is performed as a separate operation. The yield of meats averages 13 pounds per bushel. Equipment such as used in the washing of oysters is very well adapted for rendering the surf clam meats clean and free from sand. In dredging, comparatively large amounts of sand find their way inside the surf clam, and it is quite necessary, in preparing for market, that the sand be eliminated. The standard type of washer used for oyster meats called a blower accomplishes this operation quite well. The blower gets its name from the use of allowing air compressed under several pounds pressure to bubble up through the tanks of water in which the clams are being washed, agitating the mass of clams to free particles of shell and sand which settle below the false bottom. The washed clams are shipped to market (1) fresh in gallon cans surrounded by ice, (2) frozen in paper or tin, and (3) minced and processed in cans. A large proportion is used in the production of canned clam chowder.

Utilization.—It is of interest to speculate on reasons why the surf clam has not been utilized more freely in the past. Perhaps, chief among these, was the fact that fishermen considered that the more readily available supply of hard and soft clams saturated the market. Just before the war, however, the soft clam was demonstrating a very much increased popularity, chiefly in the guise of New England fried clams and the supply was fast becoming inadequate. The war created a very much stimulated interest in production of seafoods, offering as they do, a splendid protein food. Thus in an effort to bolster the soft clam demand and, at the same time, add to the effort in securing more protein food from the ocean, the surf clam industry obtained a good start. As to eating quality, the surf clam has a valuable attribute in that it is perhaps the tenderest of the clam family, which, in general, have carried a reputation for toughness in texture. A second reason that the surf clam was not previously taken in quantity was due to the fact that methods of processing and packing were not readily available in the past. For example, when the Bluepoints Company began using the surf clam last year, they marketed it quick-frozen in moisture vapor-proof paper cartons. This method, of course, eliminates the difficulty of expanding distribution in distant markets. The fresh product, as with other types of clams, has very limited keeping quality, even when shipped surrounded by ice. One is reminded here of the rosefish (*Sebastes marinus*) industry of New England, which had its inception with the advent of quick-freezing and distribution in paper cartons reaching the consumer in frozen condition and permitting a market expansion not only in coastal areas but throughout the Middle and Far West of the United States. In 1933, the experimental production of rosefish amounted to 19,190 pounds. Previous to this the fishermen had avoided the fishing banks populated by rosefish, considering them a nuisance, and quite unmarketable. Currently, this fishery is producing well over 100 million pounds annually.

Although a healthy demand has always existed for canned clams, whole minced, or as an ingredient of clam chowder, efforts to use the surf clam in such production resulted in failure. This was perhaps due to two reasons. First, the approved method for the production of the canned product was to steam the clams in the shell. This is not easily done with the surf clam because the muscles do not separate readily from the shell when steamed as with other types of clams, and secondly, it is practically impossible to eliminate the sand and grittiness. Production, using the oyster industry technique, avoids both these difficulties.

CONCLUSION

The surf clam industry is a typical example of the possibilities in the utilization of ocean resources. There is a crying need for studies on the biology of this species. At the same time, fishermen and producers in this new industry must assume responsibility for the developments of the best methods of catching, processing and distributing the product, so that the consumer is assured of the finest possible article. There is considerable gratification in the knowledge that this hitherto dormant resource is being rapidly brought into realization at a time when the harvesting of seafood protein resources can aid so materially in the successful prosecution of the war effort.

Chairman: JAMES NELSON GOWANLOCH

Chief Biologist, Department of Wild Life and Fisheries, New Orleans, Louisiana

MARSHES, WATER, AND WILDLIFE

This session arranged by the Wildlife Society

INTRODUCTORY REMARKS

JAMES NELSON GOWANLOCH

It is a pleasant privilege to serve as chairman of the Conference Section on Marshes, Waters and Wildlife, which fields of experiment and thought inevitably include so many problems of ecology and management that are of deep importance to so many of us.

It is obvious that the pattern of biological reactions in our so highly diversified ponds, streams and lakes is also woven inextricably into the structure of problems vitally interesting to hunter and fisherman alike.

The six papers that form this program present data (data in some instances covering as much as a decade of careful work) which include some of the widest and most significant aspects of aquatic management.

It is unfortunate and inescapable that the presentation and the interpretation of these facts and principles cannot be supplemented by the actual face-to-face discussions that so characteristically augment the interest and usefulness of such a program as this. It is, however, I am sure you will agree, a very fine decision that the American Wildlife Institute made plans to arrange for the publication of the Conference on this panel so that in spite of the inexorable vicissitudes of war that compelled the cancellation of an actual physical Conference, much at least of the service that the North American Wildlife Conferences provide will still be available in permanent form, and the continuity of the activities of the Conference will round out an uninterrupted decade.

IMPROVEMENT OF FISHING IN OLD PONDS

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In the past 5 years over 300,000 ponds have been constructed in the United States for the purpose of water conservation, watering of stock, production of fish and other types of wildlife, irrigation, and for purposes of recreation. At conservative estimates, the value of these ponds would exceed $45,000,000. The peak of pond construction is still to be reached, and should come within a 10-year period following the war.

As a result of this rapid pace of construction, in many states, there was no program for the stocking and management of these ponds based on adequate research work. For this reason, and others, thousands of these ponds will be practically total failures from the standpoint of fish production, while in others the production will be so low that the owners will lose interest in them and the ponds will be practically abandoned to the surviving fish, water weeds, and mosquitoes.

Methods for the renovation of such ponds and men trained in these methods will be needed in all sections of the country in the period following the war. Where ponds can be drained and started over, the problem will be relatively easy. Many, however, were not provided with means for draining; thus the problem is much more difficult, being essentially the same as that of renovating natural ponds and lakes. During the past 10 years as the principles underlying fish production became better understood from work in carefully-controlled ponds, experiments were begun upon the improvement of fishing in old ponds and lakes in various sections of Alabama. The methods tried in these experiments and their relative success are discussed in this paper under species combinations, balanced populations, weed control, fertilization and yearly restocking.

Species combinations.—Results of experiments over a 10-year period have indicated that in the Southeastern States a combination of bluegill bream (*Lepomis macrochirus* Raf.) and largemouth bass (*Huro salmoides* Lac.) should be used in all ponds regardless of size. Without either one or both of these species, much poorer fishing resulted. This is directly contrary to recommendations for small ponds published by other writers (Cheatum, Fontaine, and Longnecker, 1943; Missouri Conservation Commission, 1943; Nagel and Clark, 1938) who recommend that no bass be stocked in ponds less than 2 to 3 acres in size. The alternate recommendation of these writers of stocking with catfish

[1]Published with the approval of the Director.

alone or with bluegills and crappie did not produce good fishing in experiments at Auburn, while a combination of bluegills and bass gave excellent results in ponds as small as 0.1 acre (Swingle and Smith, 1940; Smith and Swingle, 1943).

Although bluegill and bass alone have given excellent results, the additional presence of certain other species has not been found objectionable. The presence of some of these appears to increase the total catch somewhat, although clear-cut evidence for such increase is still not available. Shellcracker, or red-ear bream (*Lepomis microlophus* G.) may be substituted for bluegills at least up to 50 per cent with an apparent slight improvement in the fishing. Green sunfish (*Lepomis cyanellus* Raf.) may also be present without material harm; preliminary tests appear to indicate that this species tends to become a minor part of the population in a few years or may disappear entirely in a bluegill-green-sunfish-bass combination. Warmouth perch (*Chaenobrytus gulosus* C. and V.) add somewhat to the interest of fly-fishing, but are always a very minor element in a mixed population that also contains bluegills and bass. Bullhead catfish (*Ameiurus* sp.) may be a predominant element in a bass-catfish-bluegill population for several years, but subsequently becomes much less abundant or may disappear completely. In several experiments, crappie (*Pomoxis annularis* Raf.) added to a bass-bluegill combination increased the total yearly catch of fish, but additional experimentation will be needed to accurately determine the value of this species for use with bass and bream. The results of all experiments of this type at Auburn may be summarized by the statement that for the production of the best fishing over the longest period of time in ponds in the Southeast, bluegill bream and largemouth black bass must both be present and additional species may be used if desired.

It is of importance, therefore, in determining what may be done to improve fishing in old ponds in this section to first determine if bluegill and bass are present. The easiest method is to question those who fish the pond regularly as to what species of fish are caught. The catch will almost without fail include practically all species present in the pond and is usually as accurate as very extensive seining. Where the desired information cannot be obtained by questioning, seining must be resorted to. If investigations prove that bluegills are absent, the pond should be stocked with fingerling bluegills at the same rate that would be used if the pond contained no fish (Swingle and Smith, 1942). Only a portion of those stocked can be expected to reach maturity, but these survivors will furnish adequate brood stock, and, as other species are removed by fishing, the bluegills will normally become more and more abundant in the pond.

If bass are absent, the pond will be found in an unbalanced condition.

Balanced populations.—For good fishing there must be a proper balance between bream and largemouth bass. Experience has shown that this is the most important factor in the production of good fishing in impounded water. Sufficient bass must be present to keep the bream population under adequate control so that overcrowding will not result, but too many bass must not be present or insufficient bream will survive to replace those caught and the bass will have insufficient food for satisfactory growth. Without the correct balance between fish-eating species such as bass and insect-eating species such as bluegills, all other measures for the improvement of fishing in ponds are worthless. It was found in repeated experiments during 1935-39 that bluegills were much harder to catch in ponds where they were so overcrowded that growth had ceased than in ponds where overcrowding did not occur and where sufficient food was available for rapid growth. Results of experiments during the 1933-1939 period also revealed that, in ponds containing excessive amounts of food for bass, it was practically impossible to catch these fish. Since, when insufficient bass are present, the pond becomes overcrowded with bluegills, the result is that fishermen catch very few bluegills and extremely few bass (Swingle and Smith, 1943a, 1943b).

It is extremely important, therefore, to know if the correct balance exists between bream and bass in any pond or lake. Fortunately, this may be determined rather easily. It has been found in hundreds of controlled experiments over a 10-year period that, if a proper balance exists between bass and bluegills in ponds, the bluegills will bed and produce young each month from spring to fall (May to October in Alabama). If insufficient bass are present to balance the pond, the bluegills may spawn only lightly in the early spring and not at all the rest of the summer, or they may not spawn until early fall; or under very severe overcrowded conditions, they may not spawn at any time (Swingle and Smith, 1943). Examinations of the ponds, therefore, should be made during June, July, and August in the South, using a small minnow seine with 4 or 6 mesh to the inch. The seine should be used at intervals around the pond in the shallow water to determine the presence or absence of recent hatches of bream. If recent hatches are found during June, July, or August, it can safely be assumed that sufficient bass are present to control adequately the bluegill population and that restocking with bass would be worthless. If no recent hatches of bream can be found during this period, it is an indication that either no bass or insufficient bass are present to balance the pond, and, that restocking with bass will be necessary. Under this condition, a considerable number of 1- to 3-inch bream can usually be caught in the minnow seine.

Since in ponds overcrowded with bass the bream will reproduce at intervals during the summer and since bass fail to reproduce in ponds overcrowded with either bass or bream, it is also necessary to determine the presence of a spring-hatch of young bass before one can be certain that neither bream nor bass are overcrowded and that both are in proper balance in a pond. This can be done with a minnow seine (4 or 6 mesh per inch). However, as there is normally only one hatch of bass in the spring (usually before June 1 at Auburn) and as, in a pond containing adequate numbers of large bass, the number of small bass will be decreased rather rapidly by predation, seining to demonstrate the presence of small bass should be done within one to two months after spawning. If done at later dates, rather extensive seining should be necessary and relatively few small bass should be found.

The finding of a spring hatch of bass and midsummer hatches of bream indicate that a pond or lake is in relatively satisfactory balance. If no newly-hatched bream can be found in midsummer, additional bass should be added at the rate of 50 per acre for unfertilized water and 150 per acre for fertilized water. Fingerling bass, if available, should be used, but fry have also been used successfully (Swingle and Smith, 1943a). At the same time the number of bream should be reduced by heavy fishing or by seining, or their food increased by fertilization so that bass may subsequently spawn unmolested. In a 2-acre fertilized pond where these methods were used to bring a pond into proper balance, the yearly pole-and-line catch while in unbalanced condition was 86.8 pounds of fish per acre in 1942, and 88.7 pounds per acre in 1943; upon being brought into balance, the catch in 1944 rose to 165.8 pounds per acre, or an increase of approximately 90 per cent. In a 3-acre unfertilized pond, a combination of bringing the pond into proper balance and of fertilizing to increase the total productivity increased the pole-and-line catch from less than 10 pounds in 1938 to 233 pounds of fish per acre in 1939, or an increase of 2,230 per cent.

Weed control.—One of the most important means for the improvement of fishing in old ponds is the control of various types of pond weeds. In the Southeastern States, where most of the ponds are relatively shallow and the winters are mild, all clear-water ponds eventually become so choked with weeds that fishing is seriously interfered with and both bream and bass tend to become overcrowded. The only types of old ponds in this section that do not have serious weed problems are those where the water remains muddy during most of the growing season, where the ponds are fed by black swamp water streams, or where the water is kept highly colored with plankton by fertilization.

The extent to which heavy weed growths interfere with fishing is often not realized, and no information is available in the literature as to the effect of weed control alone upon the catch. Experiments at this Station with *Najas guadalupensis* throw some light upon this problem. In 1937, a 0.0025-acre pond was planted with *Najas* and a check pond was kept entirely free of all water weeds. Each pond was stocked at the rate of 20,000 bluegills per acre. By early spring the *Najas* completely filled the pond. After one year the ponds were drained; the *Najas* pond was found to be supporting 84 pounds of fish per acre, and the weedless check was supporting 96 pounds per acre. Similar experiments in 1938 resulted in 100 pounds of fish per acre in the *Najas* pond and an average of 85 pounds per acre in two weedless checks. In the winter of 1935, a 1.8-acre pond was stocked with 3,625 bluegills, 520 chub suckers, 29 brood red-eye bass, and 298 brood catfish. The pond was unfertilized and free of weeds. When drained one year later, it was supporting 162.9 pounds of fish per acre. In 1936 this same pond was stocked with 10 brood bluegills, 4 largemouth black bass, 8 brood crappie, 2 channel catfish, and 10 brood bullheads. The pond was again unfertilized and free of weeds. When drained one year later, it was found to be supporting 164.3 pounds of fish per acre. In 1937 this same pond was stocked with 10 brood fish of the following species: bluegill bream, white crappie, black bass, and yellow bullheads. In addition, 83 goldfish and 8 channel catfish were added. The pond was again unfertilized, but became filled with *Najas guadalupensis* by midsummer. When drained at the end of the year, it was found to be supporting 134.4 pounds of fish per acre. The foregoing experiments indicate that, within the limits of experimental error, *Najas* had little effects upon the total fish production in a pond.

The same 1.8-acre pond was stocked in January 1940, at the rate of 400 bluegill fingerlings and in May with 30 largemouth bass fry per acre of water. The pond was unfertilized throughout this experiment. It was drained November 1940, at which time it was supporting 147.2 pounds of fish per acre. All fish were returned to the pond and fishing was begun in 1941. The water in the pond remained clear during 1941, and *Najas guadalupensis* almost completely filled the pond from bank to bank. The total catch for the year was 16.4 pounds of fish per acre. In 1942 the pond became muddy and remained muddy for such a length of time that *Najas* was killed, except in a narrow band extending from the bank 5 to 30 feet into the water. That year the catch rose to 56.2 pounds of fish per acre. The pond remained sufficiently muddy in 1943 to keep the *Najas* confined to a narrow border around the pond, and the catch was 51.8 pounds per acre. The pond was again drained, November 1943, and was found to contain 121.3 pounds of fish per acre.

The foregoing experiments indicate that although *Najas* had relatively little effect upon total fish production in a pond, the control of *Najas* by muddy water increased the catch approximately 230 per cent.

In clear-water ponds weed control by mechanical means alone has not been found to be practical. Where water lilies, spatter dock, and similar weeds have been controlled by repeated cutting, the areas formerly occupied by these weeds became filled with underwater weeds within one or two months. Where underwater weeds were mechanically removed, they again filled the space almost to the top of the water within one to two weeks. For this reason, fertilization for underwater weed control is a more practical means of control because the resulting growth of plankton retards the penetration of light into the water and prevents the growth of weeds except in the very shallow water (Smith and Swingle, 1942a). For the same reason it is impractical to attempt the control by cutting of emergent water weeds, such as lilies, spatter dock, watershield, and similar pests, unless the pond can be fertilized to prevent the growth of underwater weeds which otherwise rapidly invade these cleared areas. The combination of fertilization with weed control has been found to be one of the most outstanding means of improving fishing in old ponds.

Unfortunately, many old ponds cannot be fertilized economically because they receive prohibitive amounts of water or remain muddy during a considerable part of the growing season. Unless these conditions can be corrected by diversion of the water or by vegetation of the watershed, weed control in such ponds should not be attempted.

Fertilization.—Fertilization for the improvement of fishing has been discussed extensively in other papers (Swingle and Smith, 1939, 1942; Smith and Swingle, 1942b), and has been reported to increase the total fish-carrying capacity of ponds in Alabama 300 to 400 per cent. In addition, fertilization has several other important effects upon fishing. First, it retards or prevents weed growths in ponds, thereby making the pond easier to fish. Second, the heavy plankton growth caused by fertilization makes the water cloudy, which increases the ease of catching fish. In extremely clear water it is very difficult or practically impossible to catch large numbers of fish. In many artesian-well ponds in Alabama, the water was so clear before fertilization that considerable numbers of bass could be caught only at night; after fertilization the water became sufficiently cloudy for bass to be caught readily during the daytime. It was a curious fact that after fertilization practically no bass could be caught at night, apparently due to the reduced visibility. Because of these added benefits of fertilization, the catch in a fertilized pond usually is proportionally greater than would be expected from the increase in the fish-carrying capacity alone. The catch during a 5-year period is given in Table 1

TABLE 1. CATCH OF FISH IN AN UNFERTILIZED AND IN A FERTILIZED POND

	Total catch per acre in pounds	
Number years after stocking	Unfertilized pond[1]	Fertilized pond[2]
Second	10.9	110.4
Third	19.9	172.2
Fourth	26.9	273.4
Fifth	15.4	162.2
Sixth	22.9	222.4
Average	19.2	188.1

[1]Area of unfertilized pond, 30 acres.
[2]Area of fertilized pond, 12.5 acres.

for a 30-acre unfertilized pond and a 12-acre fertilized pond at Auburn, Alabama, both of which are fished by the Auburn Outing Club. The fish present in each pond were bluegills, shellcrackers, largemouth bass, crappie, and catfish (*Ameiurus nebulosis marmoratus* and *A. natalis*). The average catch in the unfertilized pond over a 5-year period was 19.2 pounds of fish per acre, whereas in the fertilized pond it was 188.1 pounds per acre, or an increase of 879 per cent as the result of fertilization.

Where fertilization was possible, it always has proved one of the most effective means for improvement of fishing in old ponds. Where fertilization was impractical very little could be done to increase the catch.

Yearly restocking.—Yearly restocking of ponds for the improvement of fishing is an old custom, apparently as old as fish hatcheries. Restocking was undertaken because of the mistaken idea that fish were finding it difficult to produce enough small fish to replace the large fish that were being removed under heavy fishing pressure. In practically all cases, however, the real trouble lay in the fact that the water areas involved were insufficient to produce the large supply of fish that a rapidly increasing number of fishermen was demanding.

In hundreds of experiments on controlled ponds at Auburn, where the results were obtained by counting and weighing the fish produced, no need for yearly restocking could ever be found in ponds that were correctly stocked at the start with a bluegill-bass population. Corrective restocking was occasionally found to be necessary in ponds originally understocked with bass or in ponds where this species had been omitted entirely. Such ponds within 12 to 18 months reach the unbalanced condition discussed previously; however, after this condition has been corrected, additional restocking with bass is of no value. The only ponds where young bluegills were present in insufficient numbers were those so badly overstocked with bass that none of the bass were able to reach a size of 6 ounces in a 2-year period. The large bluegills in these ponds were smaller than those in nearby ponds stocked with smaller numbers of bass, indicating that the overcrowded bass were utilizing part of the food ordinarily consumed by bluegills. Under these conditions, also, restocking with bluegills would have been useless, as the only successful corrective measure would be a drastic reduction in the number of bass present.

Although it appeared certain that annual restocking was useless as a method for the improvement of fishing, it was tried in a 30-acre unfertilized pond. Approximately 3,000 bass fingerlings were placed in a 0.5-acre brood pond and raised to a size of from 5 to 8 inches. They were then turned into the 30-acre lake that already contained a balanced population of bluegills and largemouth black bass. This restocking overcrowded the pond with small bass and the stocked bass failed to reach a legal size during the 2 succeeding years.

Because of this experience, it was decided that it would be much more sensible to continually restock with bluegills, since these fish were utilized by the bass for food. Consequently, a restocking program for bluegill bream was carried on from 1932 to 1937. The amount of restocking and the results are given in Table 2. It is probable that the decline in the total catch is unrelated to the restocking program, but certainly there is no indication that yearly restocking was of any benefit whatsoever. A similar lack of benefit from restocking with both bream and bass has been repeatedly noted in club ponds throughout Alabama.

Yearly restocking with fry or fingerlings is one practice that apparently can be depended upon to be of no benefit, and that occasion-

TABLE 2. EFFECT OF YEARLY RESTOCKING ON THE CATCH OF BREAM IN A 30-ACRE UNFERTILIZED POND

Year	Number of bream caught	Number of bream added by restocking
1930	1,234	
1931	1,460	
1932	2,766	2,500 and a
1933	1,905	a
1934	1,829	a
1935	911	6,000 and b
1936	1,099	41,000
1937	1,333	30,000
1938	530	

a. Unestimated number produced in an unfertilized 0.5-acre brood pond stocked with bream (bluegills and shellcrackers) only.

b. Unestimated number produced in an unfertilized 0.5-acre brood pond stocked with a mixed population of bream and crappie.

ally is detrimental, since it may cause an overcrowded condition in certain ponds.

SUMMARY

Because of the rapid increase in pond construction during the past few years, in many sections there was available no program for their management based on adequate research. Consequently many ponds have been improperly managed and are failures from the standpoint of fish production. Experiments dealing with the renovation of such old ponds have been conducted in Alabama during the past 10 years. The types of investigations necessary to determine the corrective measures to be employed and the relative values of various corrective measures are discussed in this paper.

Experiments have demonstrated that, for the best fishing over the longest period of time, ponds in the Southeast must be stocked with both bluegill bream and largemouth black bass, but that additional species may be used if desired. If either bass or bluegills are not present in a pond, corrective restocking with that species should first be resorted to.

For good fishing to result, the fish-feeding species (such as bass) and the insect-feeding species (such as bluegills and other forage fish) must be present in proper balance. In ponds with unbalanced populations, relatively few bream and very few bass can be caught. Methods for the determination of balanced or unbalanced conditions and the corrective measures necessary are discussed. Correction of an unbalanced condition in one pond resulted in a 90 per cent increase in the catch.

Fertilization to increase the food supply has been found to increase the fish-carrying capacity of Alabama ponds 300 to 400 per cent. Because fertilization aids in weed control and increases the ease with which fish can be caught, the average catch over a 5-year period in a fertilized pond exceeded that in an unfertilized one by 879 per cent.

Weed control is one of the principal problems involved in the renovation of old ponds. Control of *Najas guadalupensis* in a pond, without materially changing its fish-carrying capacity, resulted in a 230 per cent increase in the catch of fish. Pond fertilization should be used whenever possible in weed control because the resulting growth of plankton greatly retards or prevents the growth of weeds except in very shallow water.

Yearly restocking for the improvement of fishing was of no value.

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THE RELATION OF LAND RECLAMATION TO AQUATIC WILDLIFE RESOURCES IN SOUTHEASTERN LOUISIANA

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The reclaiming of aquatic land areas for agricultural, industrial, and recreational purposes in southeastern Louisiana received its initial stimulus from the "effort of New Orleans in 1893 in planning the development of the marshy areas between the river (Mississippi) and the lake (Ponchartrain) through a comprehensive and long range reclamation plan" (Jacobs, 1939). "Beyond the limits of New Orleans and within the part of Jefferson, Plaquemines, St. Bernard, and St. Charles parishes (counties) between 1894 and the present time, sixty-seven drainage districts have been organized, embracing a total acreage of approximately 284,217 acres. . . . In addition to these publicly organized and large scale enterprises, three privately financed reclamation projects were attempted" (Jacobs, 1939). As of 1940, only 34 of the 70 projects existed as legal entities and only 8 projects were in actual operation. At present, certain ones of the latter group are having a difficult time financially and may not continue to operate in the near future.

Reclamation projects have been inaugurated either for agricultural purposes alone or for industrial (and recreational) purposes in connection with urban and suburban development. Most of the agricultural reclamation projects in Louisiana have been complete failures. Aside from the speculative nature of some projects, failures have been almost inevitable due to the high initial cost ($50.00 to $200.00 per acre) of levee building, canalization, clearing and soil preparation, and to the high maintenance costs ($1.00 to $5.00 per year) on levees, canals and pumps and to the lowering of the soil level subsequent to drainage.

In the City of New Orleans reclamation by positive drainage (pumping) has been the practice except for the excellent hydraulic fill along the Pontchartrain lake front. Reclamation of land by pumping results in a lowering of the soil level due to oxidation of organic matter, ground firing of the peaty substratum, and especially by subsidence. This lowering of the substratum results in higher maintenance costs. Settling has increased in the City of New Orleans as the water level has been progressively lowered, with resultant high costs in repairing buildings and relaying sidewalks and paving. Although hydraulic fill would have eliminated much of the maintenance cost, the relatively recent advent of the practice and the higher initial cost ($376.46 per acre; Jacobs, 1939) has limited its utilization. Nevertheless, it is the feeling of the writers that, wherever thriving communities are established in wetland sites in the lower Mississippi River delta, that hydraulic fill is preferable to positive drainage for urban and suburban development.

The interest of the biologist, however, centers primarily on the current and long term effects of reclamation (draining) and abandonment (reflooding) on the plant and animal population in the affected areas. The changes in the flora and fauna accompanying drainage are often catastrophic and may result in the complete elimination of interesting or economic species. It is the purpose of this paper to discuss the effects of reclamation and abandonment on native plants and animals as well as their effect on the economy of the region.

Drainage projects.—Land reclamation projects have been inaugurated in fresh-water as well as brackish areas. The problems connected therewith are somewhat different, since the organic matter in the soil and depth of peaty material is greater in brackish areas. Furthermore, cropping is often less successful in drained brackish areas due to the residual salt. We should like to discuss three drainage projects which have been studied in some detail for the past 12 years:

Project A, Brackish, drained, operating.
Project B. Brackish, abandoned.
Project C. Fresh, abandoned.

Project A is located on the shores of Lake Ponchartrain, which is a slightly brackish lake (0.1 per cent to 0.6 per cent of salt). From the lake ridge inland the land slopes gradually downward to a point about 1 foot below lake level but rises again gradually as the Mississippi River is approached. In similar undrained areas along the lake shore the following plant communities are encountered from the crest of the lake ridge inland to the crest of the Mississippi ridge: buckbush, cane, brackish marsh, nearly fresh marsh, cypress-gum swamp, and evergreen oak forest. The only wetland communities of considerable area are the brackish marsh, the nearly fresh marsh and the cypress-gum swamp. These associations are characterized by standing water (4-12 inches deep) and peaty substrata as much as 9 feet thick.

Reclamation Project A was organized in 1924 with an area of 20,000 acres. Requisite levees, canals and pumps (4) were installed and drainage was initiated the next year. At the present time only one pump is operating and most of the canal mouths are clogged with peaty sediment. Despite the 20 years of its existence less than 10 per cent of the area is under cultivation and, although some benefits have been derived from the reclamation procedure, the project is generally recognized as an economic failure.

TABLE 1. ORIGINAL AND PRESENT VEGETATION IN A LARGE DRAINED AREA NEAR NEW ORLEANS (PROJECT A).

Original vegetation	Present species
Brackish marsh *Spartina patens*	*Spartina patens, Scirpus olneyi*
Brackish and nearly fresh *Spartina patens* *Mariscus jamaicensis*	*Baccharis halimifolia, Phragmites communis, Solidago mexicana, Eupatorium capillifolium; Ambrosia aptera.*
Nearly fresh marsh *Mariscus jamaicensis*	*Carex lupulina, Phalaris angusta*
Cypress-gum (cleared) *Taxodium distichum* *Nyssa aquatica*	*Sambucus canadensis, Rubus* sp. *Ambrosia aptera*

The effect of drainage on the plant communities has been catastrophic, as is indicated in Table 1.

Except for insignificant, relict patches of *Spartina patens, Scirpus olneyi, Juncus roemerianus,* and *Mariscus jamaicensis,* the predominants of the brackish and nearly fresh marshes are gone. In their place have come the relatively worthless species listed in Table 1. This project "represents a huge weed field which was originally a wetland area with valuable wildlife resources." "The marsh at present is dominated by the seaside goldenrod, *Solidago mexicana,* and the marsh cane, *Phragmites communis,* neither of which can compete with *Baccharis halimifolia* under undisturbed conditions." (Schneidau, 1940). It is probable that the above three species constitute at least 90 per cent of the total vegetation on the project, well over half of this being contributed by the seaside goldenrod.

That a previously valuable aquatic wildlife asset has been eliminated is obvious. At present the area is relatively worthless for wildlife since it is producing practically no food plants. Of the plants listed *Am-*

brosia aptera, Carex lupulina, Phalaris angusta, Rubus sp., and *Sambucus canadensis* are of value to upland birds, but constitute only a small fraction of the plant population. Until such time as colonization occurs or the project is abandoned, the area will be nearly worthless from the wildlife standpoint. On the other hand, if it had been left in the natural state, it would have contributed about $2,000,000 during the 20-year drainage period (at $5.00 per acre per year) to the economy of the region.

Project B is located along the more saline portion of Lake Ponchartrain. In adjacent areas the land slopes rapidly away from the lake ridge (with buckbrush and cane communities) to a brackish marsh which extends to the pine flatlands about 2.7 miles away. Since the brackish marsh (and open lagoons) constituted well over 90 per cent of the area we shall concern ourselves only with these units. The original marsh was a beautiful stand of *Spartina patens* except for a fringe of *Juncus roemerianus* along the pineland border, and occasional scattered colonies of *Scirpus olneyi, Distichlis spicata* and other marsh species. The water depth ranged from 4 to 8 inches and the depth of the peat varied from 2 to 3.5 feet. Since the original marsh was extensively trapped for muskrats it constituted a valuable wildlife resource ($5.00 to $15.00 per acre per year).

The drained project was studied in detail from 1932 to 1935. At that time the area consisted of large areas of former marsh with a deep peaty substratum and several lagoons with a clay substratum about 2 feet below the marsh level. Although the evidence is not absolute, it is probable that these lagoons were formed by firing of the peat during dry periods or subsequent to drainage. In any event, the invaders into the lagoon area were quite different from those migrating into the former marsh (Table 2). In general the invaders into the

TABLE 2. DESTRUCTION OF INVADERS INTO A LARGE, DRAINED, BRACKISH AREA (PROJECT B), BY REFLOODING (ABANDONMENT)

Plants during drainage (1935)	Condition after reflooding[1]
Brackish Marsh	
Baccharis halimifolia	Dead
Phragmites communis	In flower
Spartina cynosuroides	Dead
Solidago mexicana	Dead
Eupatorium capillifolium	Dead
Spartina patens (residual)	Unhealthy
Scirpus olneyi (residual)	Dead
Mariscus jamaicensis (residual)	In fruit
Lagoons	
Eleocharis elongata	Sickly
Scirpus robustus	Dead
Juncus roemerianus	Dead
Spartina patens	Sickly
Typha latifolia	Healthy
Mariscus jamaicensis	Healthy

[1]In 1938, after one year of reflooding to a mean depth of 2.5 feet.

drained marsh were species of the next higher communities in the area (*Phragmites communis,* and *Spartina cynosuroides* from cane belt; *Baccharis halimifolia* and *Solidago mexicana* from shrub zone). Despite the 9 years of drainage, *Spartina patens* was still predominant in areas with poorer drainage. Invasion into the lagoon (lower) areas consisted of the submergent-emergent *Eleocharis elongata* and normal marsh species.

Utilization of the drainage project consisted of the raising of cotton and truck crops. Excellent crops (up to three bales per acre) of long staple cotton were produced. Other plots were given over to the raising of truck crops such as asparagus, beans, corn, and turnips. Nevertheless, less than 5 per cent of the project had been cultivated during the 9-year period of drainage.

With the breach in lake front levee in 1937 the area was again reflooded and advantage was taken of the opportunity of studying the new hydrosere which we thought was about to be initiated. Observations were made in 1938, 1940 and 1944. By November 25, 1938, all the invaders into the former brackish marsh were dead except *Phragmites communis,* which possesses a remarkable ability to survive dissimilar environmental conditions. Of the former marsh residents, *Spartina patens* and, in the shallower areas, *Scirpus olneyi* were all surviving nicely. In the fresher areas, *Typha latifolia* and *Mariscus jamaicensis* were also doing well. By 1940, *Scirpus* and *Typha* were established sufficiently in certain areas to permit the establishment of many muskrat colonies. Despite the increase in certain species in localized areas, the general trend has been one of destruction of practically all marsh species, especially in the deeper areas of former lagoons. Even the water-loving alligator-weed, *Achyranthes philoxeroides,* has decreased greatly, especially during the last 5 years (1940-1945). This is noteworthy in view of the abundance of this aquatic pest in brackish ditches and lagoons in the vicinity of this project. What was assumed to be a rehabilitation of former marsh areas was merely survival of colonies established during the drainage period. By 1944 nearly all the marsh species had succumbed with the result that what was an excellent brackish marsh is now an open lake of about 12 square miles. This has been due largely to the decay of the peaty substratum during the drainage period. How long it will take for the area to be reclaimed by marsh grasses is hypothetical. Perhaps it may never occur.

To those interested in land reclamation for agricultural purposes, the abandonment of the project was an unmitigated tragedy. In the opinion of biologists, fishermen, hunters, and trappers, there have been many compensations. Since abandonment, this project has become the fisherman's paradise of the New Orleans area. Catches of green trout, *Huro salmoides,* goggle-eye perch, *Chaenobryttus gulosis,* bream, various species of *Centrarchidae,* crappie, *Pomoxis* spp., speckled trout, *Eriscion nebulosis,* flounder, *Paralichthys lethostigmus,* shrimp and crabs indicate the versatility of this brackish lake. Furthermore, it has become the mecca of hunters of migratory waterfowl. Whether reclamation of the area should be contemplated in the near future is questionable, since the project now constitutes a valuable wildlife asset with little or no maintenance.

Project C is an abandoned, but formerly successful agricultural venture, located in a fresh-water area close to New Orleans. The project was initiated in 1908, was given over largely to sugar cane production for 10 years, but was abandoned in 1919. The area was originally occupied by cypress-gum swamp or fresh marsh with a water depth of about 10 inches. At the present time the average water depth is about 36 inches, indicating a lowering of the soil level, during the drained period, of about 2 feet.

The project slopes gradually from the Mississippi River ridge to its lowest point about 1 mile south. From the higher ridge land to the original swamp and marsh areas, the communities encountered at present are as follows: black willow forest, buttonball shrub zone (often absent), cattail marsh, water hyacinth mat, and coontail (submerged) community. As of 1941, about half of the project was occupied by the coontail, *Ceratophyllum demersum,* and somewhat less than half was appropriated by the water hyacinth, *Piaropus crassipes.* Since 1941, however, the water hyacinth has encroached rapidly over the submerged beds of coontail and now occupies more than 60 per cent of the total area. The other (shallow water) communities are encroaching slowly over the water hyacinth and coontail areas, but the evidence suggests that the marsh and swamp stages will not be reached for several decades.

Project C is now widely known as one of the finest wildlife areas in the southern part of Louisiana. Large creels of green trout, *Huro salmoides,* bream, various species of *Centrarchidae* bluegill, *Lepomis macrochirus,* and crappie, *Pomoxis* spp., are common. Croakers, *Micropogon undulatus,* and speckled trout, *Eriscion nebulosis,* are caught near the lower end of the project, indicating the infiltration of brackish water from Lake Cataouatchie in times of drought. Since the area is very attractive to migratory waterfowl, this relatively small project is literally teeming with hunters during the shooting season. Coots, teal, and other duck are shot in great numbers and occasional geese are taken. Muskrats and other aquatic mammals are filtering back as the marsh area is increased, but trapping is as yet a minor activity compared with fishing and shooting.

One of the current activities of the management of Project C is to maintain a sufficient open area (coontail community) for the operation of boats, and the activities of migratory waterfowl and fishermen. Mechanical removal of water hyacinth has been attempted, but the use of sodium arsenite has been resorted to by the private operators of Project C since 1939. The water hyacinth is the worst offender in respect to the destruction of wildlife habitats in this project. In fact, if this pest could be eliminated, Project C would probably continue as a fine wildlife area for several decades.

Management of wetland areas.—In connection with the failure of land reclamation projects, Kenney and McAtee (1939) state that "much drainage has been done that should never have been undertaken" and that "Furthermore, there is merit in attempting to reclaim drained lands and to increase water impoundments wherever practicable." Our observations indicate that drained lands which have been reflooded not only become excellent wildlife areas, but that they usually produce a greater variety and a greater quantity of wildlife than the original marsh or swamp which was drained.

In general, marshes (with emergent plants) are valuable primarily for the production of fur animals. Relatively open water, such as streams, bays, lagoons and ponds (with submerged plants) are most valuable for fisheries. As a general rule, a combination of marshes and open water is necessary for the maximum production of migratory waterfowl. Landing strips (and food) for waterfowl are provided in the open water areas and shelter (as well as food) is afforded by the marsh areas. It is obvious, therefore, that a marshland threaded with streams or dotted with lagoons would provide more variety and probably a greater volume of wildlife than either marshes or open water.

The wildlife potential of a marsh depends not only on the proximity of open water, but also on the nature of the substratum and the predominant species of plants. In general, the fresh marshes have a low muskrat potential because the peaty materials are decomposed too fast to provide the soft, fibrous substratum so desirable for the construction of muskrat runways and nests. In many of the fresh-water marshes (*Zizaniopsis miliacea* and *Mariscus jamaicensis* types) there is insufficient food for good muskrat production. In the brackish marshes, the muskrat potential is usually high because of the deep peaty substratum, but may be moderate or low if the marsh succession is well advanced and the dominant species are *Spartina patens, Distichlis spicata,* and *Juncus roemerianus.* The muskrat potential of salt marshes is low not only because they contain very little peat but also because the dominant species (*Spartina alterniflora*) has little food value.

It is obvious from the above statements that marshes have their highest muskrat potential only when the marsh succession is arrested short of the climax. In this connection, Lynch states (1941) that "climax marsh . . . usually contains little wildlife of any kind." Firing of the marshes has been practiced regularly in Louisiana as a tool in muskrat production. The primary objectives have been to prevent destructive fires, to facilitate trapping, to accelerate spring growth and to promote the development of muskrat food plants (especially *Scirpus olneyi, S. americanus,* and *S. robustus*).

A closed marsh is of little value to migratory waterfowl. Cover burns (surface material only) are important in opening up the habitat and making the food more available to migratory waterfowl. "Clean burns are essential in goose management" since "Geese of all species prefer open areas with a minimum of tall vegetation" (Lynch, 1941). Spotty burns, on the other hand, are excellent for shorebirds and ducks, in that landing strips, feeding areas and cover are provided in close proximity. Deep burns (as opposed to cover burns) are important in destroying dominant vegetation (if only a few inches deep) or in production of ponds (if deeper). "Fires in the late summer of that year [1924] burned out many square miles of peat in the coastal marshes of Louisiana and Texas. A large part of the best waterfowl habitat in this region is the direct result of [these] deep burns" (Lynch, 1941). If the peat burns are deep enough, these ponds and lagoons also constitute a valuable fishery habitat. Obviously, burning may be utilized as a wildlife management practice not only to promote the production of muskrats but also the development of waterfowl and fishery resources.

The marshes have often been improved as a wildlife habitat in ways other than through fire. It has been shown that grazing increases the food for geese on the wet prairies of southwestern Louisiana. In the active delta of the Mississippi River the destruction of fresh-water marshes (*Zizaniopsis miliacea*) occurs when alluviation at the head of a distributary cuts off the flow of fresh water. On the other hand, the destruction of salt marshes (*Spartina alterniflora*) takes place with crevassing of distributaries. The destruction of these relatively worthless dominants results in the production of better food plants and in improvement in wildlife conditions. In many cases, an overproduction of muskrats results in the destruction of the marsh dominants and the promotion of better and more varied wildlife resources. It has been pointed out previously that reflooding of drainage projects results in superb wildlife conditions. Subsidence may also result in improved wildlife conditions. In the active delta of the Mississippi River, subsidence of the marsh occurs whenever distributary streams are alluviated at their heads. The relatively worthless dominant plants are destroyed, a slow retrogression sets in and wildlife production is augmented.

Let us now examine the situation regarding open water areas. It has been shown by Swingle and Smith (1942) that "Weed-filled ponds are generally poor fish ponds. The weeds form such a tangled mass of vegetation that it is difficult or impossible to fish and it may be difficult to paddle a boat in the pond. They protect small fish from larger ones so well that the pond may become overcrowded and the fish stunted." They found that fertilizing of relatively small ponds brought greater returns than allowing the ponds to grow up to aquatic weeds and recommended fertilization not only for fish production, but also for aquatic weed control. This means in effect that Swingle and Smith have recommended the practice of arresting succession at the planktonic stage or promoting a reversion to that stage for maximum fish production.

In large, natural fresh-water areas where fertilization is impractical, the shallow streams, ponds and lagoons pass through the following succession: planktonic, submerged, floating, and emergent (marsh) stages (Table 3). With some exceptions, the fishing becomes poorer and poorer as the succession progresses. In shallow water bodies, the planktonic stage is soon supplemented by the submerged stage. The plants in this stage are excellent oxygenators and provide an abundance of fish food. Apparently, they provide ideal conditions for fishes, but may become so abundant that they produce only small fish (due to protection) and make fishing difficult or impossible.

Floating plants are much less desirable from the standpoint of fish production. Free-floating plants, such as the duckweeds, are poor oxygenators, and reduce the light from the submerged species below. The mat-forming species are still worse. Mats of alligator weed (*Achyranthes philoxeroides*) or water hyacinth (*Piaropus crassipes*) are not only poor oxygenators, but they usually destroy the submerged vegetation and make boating and fishing practically impossible. It is the opinion of the authors that these two introduced, and nearly worthless, species are responsible for the destruction of many fine wildlife areas and constitute the greatest threat to aquatic wildlife resources in the State of Louisiana. Those species which are attached to the bottom and have floating leaves are not so undesirable as the mat-forming plants, since some of them may exist along with the submerged species. All of them, however, are poor oxygenators and some of them may actually cause fish kills by contributing to low oxygen tensions. They contribute little in the way of fish food and make boating and fishing difficult.

Although the emergent (marsh) species represent the final stages in

TABLE 3. AN ESTIMATE OF THE WILDLIFE FOOD VALUE OF THE PREDOMINANT EMERGENT, FLOATING AND SUBMERGED PLANTS OF THE GULF COASTAL PLAINS

Type of marsh	Dominant plants	Fur animals	Wildlife value waterfowl	Fisheries
	Emergents (Marshes)			
Salt	*Spartina alterniflora*	Poor	Poor	....
Brackish	*Spartina patens*	Fair	Poor	....
	Distichlis spicata	Poor	Poor	....
	Juncus roemerianus	Fair	Poor	....
	(*Scirpus olneyi*)[1]	Excellent	Fair	....
	(*Scirpus robustus*)	Excellent	Good	....
	(*Scirpus americanus*)	Excellent	Fair	....
Fresh	*Zizaniopsis miliacea*	Poor	Poor	....
	Typha latifolia	Good	None	....
	Scirpus validus	Good	Fair	....
	Panicum hemitomon	Fair	Poor	....
	Mariscus jamaicensis	Poor	Poor	....
	Floating, Attached			
Fresh	(*Nelumbo lutea*)	....	None	Poor
	(*Nymphaea advena*)	....	Fair	Poor
	(*Castalia odorata*)	....	Good	Poor
	(*Brasenia schreberi*)	....	Excellent	Fair
	Mat-forming			
	(*Piaropus crassipes*)	....	None	Poor
	(*Achyranthes philoxeroides*)	....	None	Poor
	Free-floating (pleuston)			
	(*Spirodela polyrhiza*) etc.	....	Fair	?
	Submerged			
	(*Ceratophyllum demersum*)	....	Fair	Excellent
	(*Myrophyllum pinnatum*)	....	Poor	Good
	(*Cambomba caroliniana*)	....	Poor	Excellent
	(*Utricularia gibba*)	....	Poor	Good ?

[1]Plants in parenthesis ruderal in character.

marsh succession, these species sometimes become established during an earlier stage in succession. In such cases they are no more obnoxious than the floating plants and probably much less so than the alligator weed, water hyacinth, cow-lily or lotus because the leaves are more or less vertical. In general, these plants come in after the fishing has been pretty well ruined and because of this are of little importance to those concerned with fishing and fish production.

It will be recalled that marshes attain their highest fur animal production when the marsh succession is arrested short of the climax. It may be remembered also that marsh areas are most inviting to migratory waterfowl in the subclimax stage and especially when threaded with bayous or dotted with lagoons. From our discussion on relatively open water areas, it should be clear that they attain their greatest fish production in an early stage of succession. With regard to wetland areas, it is the opinion of the writers that, with few exceptions, any practice which will prevent, or retard, aquatic succession, or return it to an earlier successional stage, will result in an increase in wildlife production. These practices include controlled flooding, draining and reflooding, recession, salting, freshening, fertilizing, poisoning, burning, grazing and overpopulation. Controlled burning has been the most widely used and most valuable tool up to the present, but it is predicted that much greater planned use will be made of the other desirable practices in future management of wetland areas in the State of Louisiana.

CONCLUSIONS

In general, land reclamation of wetland areas for agricultural purposes, has been a failure. In fact, very few projects, inaugurated for agriculture alone, have survived. Certain projects, involving suburban development additionally, have proved successful ventures. In all projects that reached the drainage stage, the original aquatic environment was eliminated and the endemic wildlife was destroyed. The potential economic return from these plant and animal resources has been estimated (conservatively) at $5.00 per acre per year. This loss has not been compensated by crop returns in the reclaimed areas, since very little of the land (probably less than 5 per cent) was ever put into agricultural use. At the present time, less than 1 per cent of the area of all drainage projects is under cultivation. However, many of these abandoned (reflooded) projects now constitute some of the finest wildlife areas in the United States. It is not recommended, however, that reclamation projects be initiated to provide such wildlife areas.

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A WATERFOWL BANDING STUDY ON A NEW IMPOUNDMENT

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The Charles Mill Reservoir of the Muskingum Watershed Conservancy District (Plate 1) is one of 14 artificially created reservoirs on the headwaters of the Muskingum River. All of these reservoirs were constructed for flood-control purposes. Eleven of the 14 are so made that permanent pools may be maintained in them, while the remaining 3 are "dry" dams.

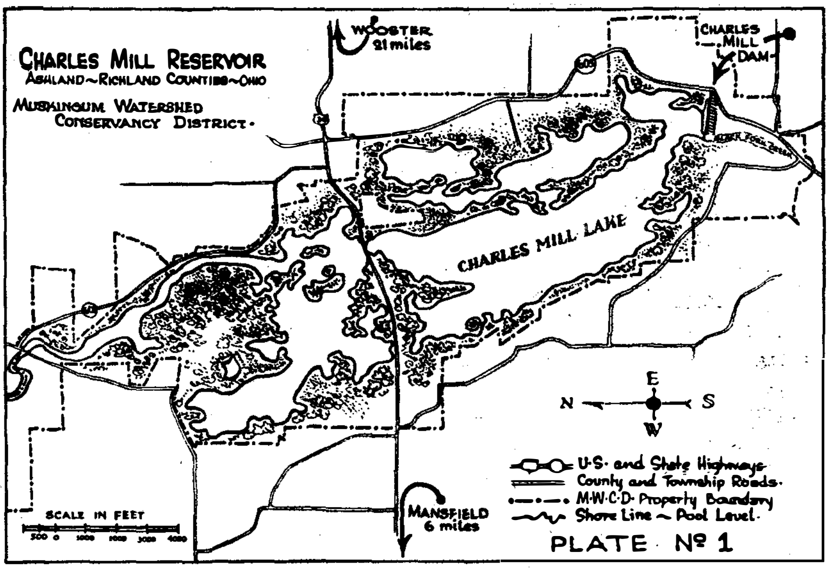


PLATE No 1

The Charles Mill Reservoir, located in Ashland and Richland Counties, Ohio, on the Black Fork of the Mohican River, is a "wet" dam and has a permanent pool of 1,350 surface acres with an average depth of 5 feet. This reservoir was first brought to pool in June 1938.

During the fall migration of 1938, waterfowl response to this new body of water, now closed as a refuge, was remarkable. If it be considered that this reservoir lies outside and between the Atlantic and Mississippi Flyways as outlined by Dr. Lincoln and in a region approximating the apex of the "gap" existing between these two flyways, this response by waterfowl becomes even more remarkable.

In order to obtain factual information regarding waterfowl utilizing the refuge, it was decided to live-trap and band and Table 1 is a summary of this work.

TABLE 1. SUMMARY OF WATERFOWL BANDED ON THE CHARLES MILL REFUGE, 1939-41; RETURNS LISTED UP TO FEBRUARY 1945

Species	Number banded 1939-40	1940-41	1941-	Totals	Returns
Mallard (*Anas platyrhynchos*)	136	367	174	677	103 (15.2 per cent)
Black duck (*Anas rubripes*)	557	1.088	653	2,298	495 (21.5 per cent)
Pintail (*Dafila acut t.*)	167	32	21	220	29 (13.1 per cent)
Wood duck (*Aix sponsa*)	2	....	....	2	....
Green teal (*Nettion carolinense*)	3	....	....	3	2 (66.6 per cent)
Gadwall (*Chaulelasmus streperus*)	1	1	2	4	....
Ring-necked (*Nyroca collaris*)	4	8	2	14	3 (21.4 per cent)
Baldpate (*Mareca americana*)	1	7	1	9	1 (11.1 per cent)
Redhead (*Nyroca americana*)	....	1	....	1	....
Totals	871	1,504	853	3,228	633 (19.6 per cent average)

Terminology.—On pages 100 and 101 of *Manual For Bird Banders,* a U. S. Department of Agriculture publication, Lincoln and Baldwin define a "repeat" as a "short-time return of a live bird at the original station and is used to indicate recoveries of banded birds that have apparently not been absent from the neighborhood since the time they were last handled."

On page 101 of this same publication, a "return" is designated as a "recovery from the same or any other station during or following a migration period and also for all banded birds meeting death at or near the station where banded. Returns recorded at the original station, after migration, are usually banded birds that have come back to the neighborhood where they were a previous season. As it may at times be difficult to distinguish definitely returns of this class from repeats, a time limit of three months has been arbitrarily adopted. Hence, if a banded bird is recaptured three months or more after the time of its last capture at the station, it should be listed as a return."

It might be added that if a banded bird is retrapped at the station where banded *within* 3 months after the time of its last capture, it is considered as a repeat.

Summary.—The total number of ducks banded, according to year and species, may be found in Table 1. The returns listed are in accordance with the definition of "return" as found under "Terminology," with the exception that no foreign bands are listed.

The 1939-40 banding operations began on September 18, 1939, and continued through October, November and December of that year. In addition, 98 ducks were banded during January 1940, and 4 (ring-necked) were banded in April of the same year.

The 1940-41 banding operations began on October 22, 1940, and continued throughout November and December of that year. In addition, 160 ducks were banded during January, 295 during March and 61 during April of 1941.

The 1941 banding operations began on October 29, 1941, and continued on through November and until December 6, 1941.

Inasmuch as the black duck and mallard were the predominate species banded, Table 2 summarizes their respective returns according to

TABLE 2. SUMMARY OF MALLARD AND BLACK DUCK RETURNS FROM ALL SOURCES UP TO FEBRUARY 1945

Locality	Mallard		Black duck		
	First year	Later years	First year	Later years	Totals
Ohio:					
Retrapped at station	10	7	168	54	239
Taken remainder of state	13	7	103	51	174
Other states	20	31	36	34	121
Canada	5	10	18	31	64
	48	55	325	170	598

whether recovery occurred within one calendar year or more than one calendar year after banding; whether recovery occurred in Ohio and if so, whether it was a retrapped return at the banding station or whether it was reported from the remainder of the State. Also in this Table, returns from the various states are segregated from returns received from Canada.

TABLE 3. DISTRIBUTION OF MALLARD AND BLACK DUCK RETURNS FROM ALL SOURCES UP TO FEBRUARY 1945

Province or state	Mallard		Black duck		Totals
	First year	Later years	First year	Later years	
Alabama	....	2	1	2	5
Arkansas	2	3	1	....	6
Illinois	3	1	2	1	7
Louisiana	2	3	....	1	6
Manitoba	2	6	1	....	9
Michigan	3	3	8	6	20
Minnesota	2	3	1	1	7
North Carolina	1	....	3	1	5
Ohio	23	14	271	105	413
Ontario	3	4	16	28	51
Iowa	2	....	....	....	2
Indiana	2	2	....	....	4
Kentucky	....	1	1	0	2
Mississippi	1	2	1	1	5
New York	....	1	3	2	6
South Carolina	....	2	3	7	12
Tennessee	2	2	5	3	12
Virginia	....	1	....	1	2
Wisconsin	....	3	3	1	7
Maryland	....	1	1	2	4
New Jersey	....	1	1	1	3
Florida	....	....	1	1	2
Georgia	....	....	1	2	3
Pennsylvania	....	....	....	1	1
Quebec	....	....	....	3	3
New Brunswick	....	....	1	....	1
	48	55	325	170	598 (20 per cent average)

Table 3 shows the distribution of black duck and mallard returns of all categories (including those retrapped at the station). Locality of recovery (state and province) is shown as well as time interval elapsing between banding and recovering (within one calendar year or more than one calendar year).

Of the 677 mallards banded, there were 103 returns (15.2 per cent) as shown in Table 1. Reported from 21 states and provinces, 37 were from Ohio, 51 from other states and 15 from Canada.

Of the 2,298 black ducks banded, there were 495 returns (21.5 per cent) as shown in Table 1. Reported from 24 states and provinces, 376 were from Ohio, 70 from other states while 49 were from Canada.

Of the 220 pintails banded there were 29 returns (13.1 per cent) as shown in Table 1. Reported from 16 states and 1 province, 9 were from Ohio, 19 from other states and 1 from Canada.

A total of 244 returns, originally banded on the refuge, were retrapped where banded (mallard, 17; black duck, 222; pintail, 5). These latter figures, with the exception of the pintail, are noted separately on Plates 2 and 3.

During the 3-year banding program, there were 1,634 repeats, some ducks repeating as many as 10 times.

Twelve ducks bearing foreign bands were trapped on the refuge during the course of the banding operations.

CONCLUSION

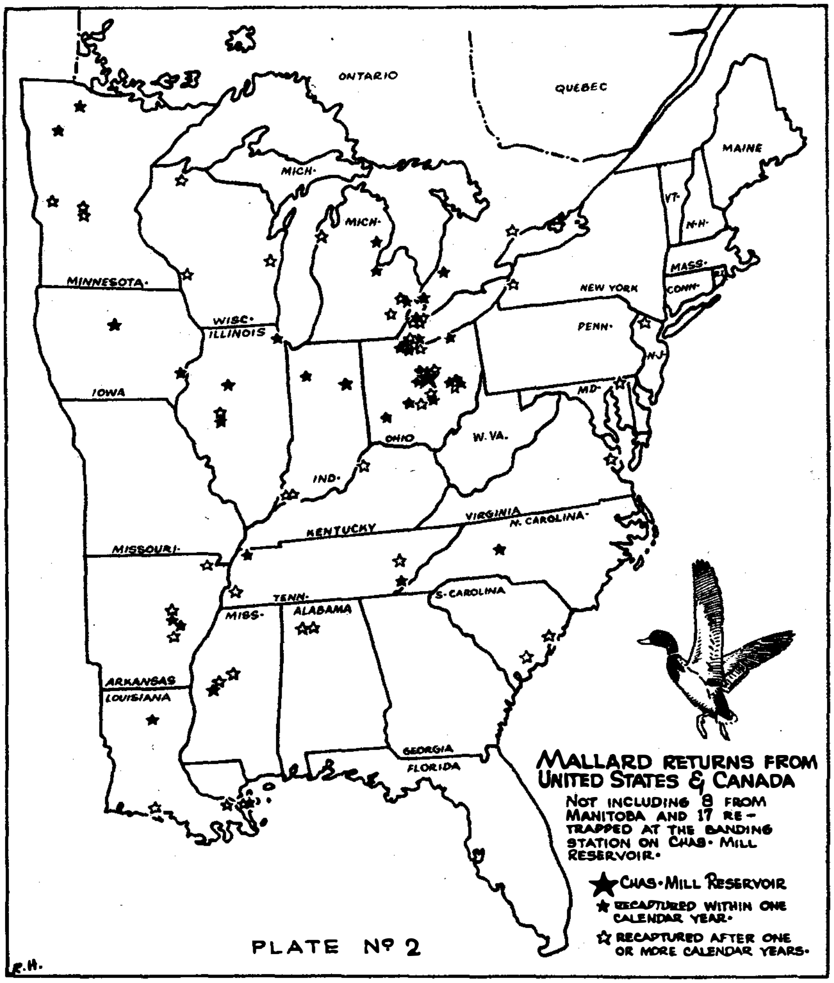
The Charles Mill Reservoir, a new impoundment in Ohio, although outside the waterfowl flyways as we generally think of them, attracts waterfowl of the puddle-duck variety in appreciable numbers.

Black duck, mallard, and pintail, in the order named, were the predominate species utilizing the impoundment.

A new impoundment, to be attractive to waterfowl of the puddle-duck variety, need not have natural waterfowl food present if physical conditions (shore line, islands, depth) are suitable and if the impoundment is not shot over its entirety. Daily utilization of surrounding grainfields (mostly of the picked-corn variety) apparently supplies most of the food requirements.

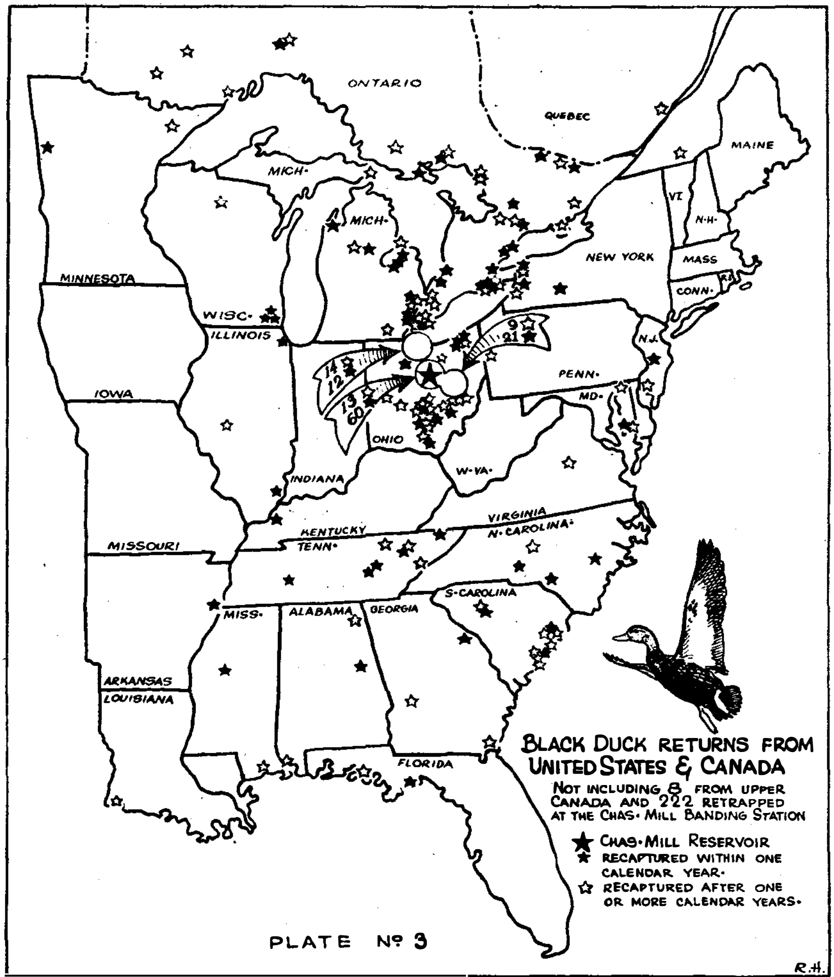
Based on the average stay of the repeats, it was determined that during both the 1939-40 and the 1940-41 seasons an average black duck remained in the vicinity of the refuge for approximately 12 days. The impoundment, serving as a refuge in an area where lack of suitable water was the limiting factor, held waterfowl longer in the vicinity, thereby bettering hunting in the surrounding counties.

The mallards.—Plate 2 illustrates mallard returns according to



exact location where taken and according to time interval elapsing between banding and recovering. It can readily be seen that this species closely follows the Mississippi Flyway, with only five returns being from the Atlantic Coast.

The black duck.—Plate 3 illustrates black duck returns according to exact location where taken and according to time interval elapsing between banding and recovering. From the data at hand it is apparent that this species returned to the impoundment more consistently than any other species. As stated previously, 376 returns were from Ohio



from a grand total of 495 for the species. In so far as Ohio is concerned, several "nuclei" where returns were greater and more concentrated than in general can be seen: to the north of the station and slightly west, the Toledo-Sandusky Bay regions; to the east and slightly south, the Killbuck Bottoms of Wayne County; directly south of Columbus and following the Scioto to its outlet at Portsmouth; 73 returns were from the immediate station area.

Several other relatively small areas, outside Ohio, where takes were somewhat concentrated, can be seen on Plate 3: along the coast of

South Carolina; the eastern half of Tennessee (T.V.A.); the Detroit-St. Clair region and the eastern end of Lake Erie.

Notwithstanding this broad distribution, but four returns were reported from the Mississippi Flyway west of the Mississippi River itself. Essentially, the drift is toward the southeast.

While the Charles Mill Reservoir is on the headwaters of the Muskingum River it should be noted from Plate 3 that more returns came from the Scioto River below Columbus than from the Muskingum River from the banding station to the Ohio River, excepting, of course, the Killbuck Bottoms and the immediate station area. No reason for this apparent shift from one drainage system to another can be given unless the Scioto drainage, with its greater soil fertility, offers more picked-corn fields as sources of feed.

Speaking collectively of the mallard and black duck returns, it can readily be seen from either Table 2 or Table 3, that of the 598 total returns of all types from all sources, 413 are from Ohio; in percentage, the 413 figure becomes 69 per cent. In other words, 69 per cent of the returns came from Ohio.

Still speaking collectively of the mallard and black duck returns, it can be seen from Table 2 that of the 413 returns from Ohio, 239 are of the retrapped variety (retrapped where banded) and 174 are of the "taken" variety. Disregarding momentarily the 239 retrapped returns, the 174 figure, converted into percentage of all ducks *taken* of these two species, becomes 48.4 per cent. In other words, 48.4 per cent of the banded blacks and mallards were taken in Ohio.

The data on the blacks deserve closer scrutinization because of the great number of this species utilizing the refuge. From Table 2 it can be seen that 154 blacks were taken in Ohio, 70 in other states and 49 in Canada. These figures do not include the 222 retrapped returns. The Ohio hunter therefore took 56.4 per cent of all black ducks taken.

ACKNOWLEDGMENT

The author is most grateful to Mr. Robert Winchell, formerly connected with the Ohio Division, for valuable services rendered in banding operations during the last 2 years of operations; also, to Mr. Robert Hines, for his art work on this paper and his assistance in tabulating data.

To Messrs. Short, Rinehart and Olds, of the Ohio Division of Conservation, whose farsightedness made this work possible, we owe a great deal.

HALF A THOUSAND MILES OF PUBLIC TROUT STREAM

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One of the fascinations of stream fishing is the anticipation of wondering what is just around the next bend. It is part of the sport to be ever hopeful that the next turn will bring into sight a stretch of casting water at least a little bit better than the one we have been trying. This frame of mind is not a peculiarity of angler's alone and in considering what is around the next bend in any fish conservation activity we may do well to cultivate this hopeful frame of mind. The angler, however, is entitled to approach the next pool in a relaxed and, one might say, fatalistic mood, for good, bad or indifferent he must take the stream as he finds it. The fish conservationist cannot approach the future with a comparable relaxation of mind for he is seeking to mold this future, trying to plan a course of action that will bring a progressive amount of improvement in conditions. Such future plans must involve coordinated action of many persons, since effective work depends upon managing environmental conditions of the waters on a broad scale. Trout streams comprise a type of aquatic resource in which at least partial progress has been made toward favorable modification of conditions limiting production of recreational angling.

In New York the acquisition of public fishing rights on 575 miles on 33 streams may be considered as a start toward public trout stream management. Despite some years of experience in acquisition of fishing rights and in stream improvement this program, when again resumed after curtailment which is expected to be temporary, is to be looked upon more as a foundation for subsequent building than as a finished achievement. Best results are to be expected by constant remodelling and revision. These processes have operated in the past and a brief statement of the history of previous work toward improvement of public fishing on such streams may help in developing future plans in New York or other states having comparable stream conditions.

Since fish are by law the property of the public, enforcement of protective legislation extends to all waters. Stocking has also been done rather generally on unposted waters and comparatively small mileages of streams are posted against fishing by landowners except in the more densely populated areas. The important point, however, is that the public could be excluded from a very large mileage of stream if or when landowners wish to prohibit public use. On most streams the lack of a permanent public right prevents formulation of a long-time plan for intensive improvements by a public agency. This situation does not mean abandonment of all attempts by the State to build up trout fishing generally, irrespective of how the permanent public right of access may stand, but it does mean a limitation in scope of management plans on waters other than those on state lands or those on which permanent public rights have been secured either by purchase of lands or by acquisition of fishing rights.

Of the two types of public fishing streams in New York the state-land type came first. Due to a considerable mileage of trout stream on such lands, especially within the Adirondack and Catskill Parks, it was possible in 1934 to begin stream improvement when facilities could be provided, through availability of Civilian Conservation Corps labor. This subject has been dealt with elsewhere (Greeley, 1936). Although state-owned lands along trout streams comprise valuable public assets state ownership is not generally continuous on large mileages and some areas of stream are in such poor condition from adverse land management practiced on the upper reaches that it is not practical to put into operation improvement of all short pieces which cross state land tracts. Looking back at the period of C.C.C. improvement work on state-owned streams it is now clear that the most worthwhile results were in the outgrowths of this program rather than in the individual improvements; although better fishing conditions were provided by the work even more important than these results was the information resulting from trying out a large number of devices and methods on numerous streams affording a wide range of conditions. Most of the streams were small and admirably adapted to trying different types of deflectors, dams, cribwork or other devices, and the evolution of these over a period of years provided much better methods for the later work on large streams than would likely have resulted if these more difficult situations had been tackled without previous experience.

The second development, the acquisition of permanent, public fishing rights was begun in 1935. Procedures, costs and other details in this program have been reported elsewhere (Hopkins, 1940 and N. Y. S. Cons. Dept., 1943, p. 36). The purpose in view was to obtain easements from private landowners setting up designated areas as public fishing grounds and giving also permission to build stream improvement structures. Unlike leases these contracts are permanent. They are not land purchases as they involve no transfer of ownership and thus avoid the difficult or impossible situation of buying a strip through a farm or other private tract. The landowner retains title and all rights except the right to prevent fishing on the specified stream or traversing the banks within a specified distance. In many instances access rights of way by which anglers can reach the stream are also described in the contract. The areas designated in the easement convey no other privileges such as hunting or trapping, and the landowner retains all rights on the specified fishing areas to post against trespass for any purposes other than fishing or traversing the designated area for that purpose.

For consideration of managing trout fishing these easements are similar to areas actually owned by the State for the way is clear for stream improvement or other desirable practices to develop up to the limits of the facilities for such management. With C.C.C. and through labor supplied by the Conservation Department a large amount of stream improvement work was accomplished up to the recent cessation of this activity (N. Y. S. Cons. Dept., 1942, pp. 46-47). However, in view of the large amount of fishing rights acquired, mainly on trout streams of large size, only a minor percentage of the areas in need of improvement have yet received any of such work.

The acquisition of permanent public fishing rights easements has averaged about $500 per mile of stream (Hopkins, 1940). Against this outlay there are permanent benefits of all time access by anglers and also a right to improve fishing. Whether or not the benefits accomplished are large in relation to cost naturally depends upon evaluation in specific streams but bearing in mind that expenditures for rights have only been made on high quality streams the cost seems very small. On a permanent basis the cost per year would be indeed trivial but, perhaps, the cost on a lifetime basis is a more practical way to figure. Considered on a 50-year basis at $10 per year per mile one generation of anglers would be paying a very reasonable figure for lifetime use and the right to fish free would be inherited by the next generation.

Erosion of banks obviously detrimental to the maintenance of optimum conditions for enjoyment of trout fishing in a large mileage of New York streams, especially where cultivated or pastured lands adjoin a stream and the natural bank cover of brush or trees has disappeared. Progressive erosion at bends results in an unstable condition to be deplored by both the landowner and the trout conservationist. Where tons of soil are gouged out of the stream bank each year trout habitat conditions are unstable, the pools changing from year to year. Long areas of flat, wide shallows develop and through exposure to the sun the mileage cold enough for trout is decreased.

These conditions of stream bank erosion have proved to be readily controllable both by structures designed for individual sites and by revegetation of banks. The evaluation of costs against benefits however, is by no means a simple problem. Balancing of the accounts would require on the one hand the cost and the durability of improvements and on the other hand the benefit in terms of increased values in improvement of fishing over the life of such improvements. An accurate job of evaluation, requiring the accumulation of census of fishermen using the streams over a period of years and other detailed data might well cost more than the original improvements.

Stream improvement should be based upon scientific principles including knowledge of the habits of trout, types of bottom most productive of insect life and other facts but when the stream has been improved the only really adequate and final test is by the angler. If, as often happens, the angler skips a large piece of water because it does not appear worth fishing but, after improvements of the area, casts his fly hopefully into pool after pool this is good evidence that recreation has been increased. And if, from first cost and observations of durability the improvements have cost a moderate figure per year it is possible to balance the account closely enough to say whether the work has been worth while. Observations on improved streams in New York every year since 1934 indicate that bank cribbing, deflectors and low dams can be built so as to accomplish their purpose over a long period. Many improvements 9 or 10 years old are functioning effectively while from growth of bank vegetation and the maintenance of a permanent channel the streams grow progressively more attractive for fishing. The different improvements have one common denominator in that they all work toward stabilized conditions.

As the stream itself grows better the adjoining land also improves materially, for a stable stream does not skin the valuable topsoil by making attempts to cut alternate channels. Many New York farms greatly need a few acres of productive bottom land suited to cultivation in order to balance up a high percentage of upland pasture. In the program of acquiring and developing trout streams no improvements to adjoining lands have been made for their own sake, but the favorable changes in streamside lands, through protection to farm lands and buildings, has been perhaps as great as though the primary purpose had been to improve such property. In looking toward future plans in New York it is clear that the quality of stream trout fishing for the public will depend, to a considerable extent, upon the nature of the management of stream banks.

Definite plans are in progress for resuming the acquisition of public fishing rights on the better class of trout waters and for continuing stream improvement work on such streams, especially bank erosion control by methods whose value has been demonstrated through previous experience. Experience in acquiring stream easements by numerous District Foresters has shown that landowners who are considering signing the necessary agreement almost invariably want to know first of all what the plans for management of the tract in question are to be. There is, of course, a lag between the steps of acquisition and management but it is considered essential to the best progress of the acquisition program to integrate management steps as closely as possible. Perfected plans are not to be expected during the acquisition stages but every effort to follow up with desirable management work should be made, for a policy of leaving the areas without further attention after easements have been acquired is not conducive to good will and is likely to make future progress in acquiring rights more difficult.

If or when all public trout streams are improved by methods such as have been mentioned so that they are more attractive recreational areas for use by trout anglers, this accomplishment will go part way toward the goal of providing better fishing. From studies of improved streams, however, we know that stabilized conditions resulting in good pools and attractive riffles still do not correct all factors in fish production; they do not solve all problems of producing the most trout in the minimum space. Before maximum results can be attained, we know that we shall need to manage the fish populations as well as the physical environment, especially to decrease heavy populations of the fish detrimental to trout. In stream management this problem was recognized some years ago and barrier dams have been built in several streams to keep bass, suckers and other fish from running up into trout sections. Preliminary surveys have shown that many unfavorable fish population conditions still exist and effective remedy of these situations is a problem for the future.

A start has been made in studies of stocking on public fishing rights areas through investigations on Crystal Creek (N. Y. S. Cons. Dept., 1942, pp. 140-142) and the Wiseoy-East Koy streams (N. Y. S. Cons. Dept., 1943, pp. 124-125). Conclusions from these field studies are useful as applied to stocking generally but looking toward future development of intensive management of the public fishing areas there is a need for further research bearing upon the most effective and economical methods of stocking.

It is apparent that there is no miracle by which the full capacities of a trout stream to serve the public for recreation can be brought about merely by the processes of acquisition and placing of signs proclaiming public fishing grounds. Even though highest quality streams have been acquired the full development of all of them will require intensive management suited to the individual deficiencies that exist. By building a program from the bottom, by diagnosing limiting factors and applying management suited to correct these, the recreational capacities of individual streams can be improved. On this basis the details of the program can be expected to unfold gradually in proportion to the rate of progress in lines of diagnosis and application. The immediate question to be determined is whether possible future applications justify expenditures for the necessary steps of research and testing.

There is no question of the need for individualized management of trout streams, although a long period of attempts to apply programs of a blanket nature has been necessary to point this out. A program of stocking, starting as a generalized procedure, has become progressively more individualized through fitting recommendations to each body of water. Laws tend to be of a blanket nature but progress has been made even here toward individualization as, for example, by special change in the bass law on one public fishing stream (Schoharie Creek) where bass conflict with trout.

It is to be expected that new methods of managing trout streams will enter more prominently into use in the near future. Progress already made in stream improvement, together with favorable results shown by experiments in controlling fish population conditions, indicate two directions upon which new methods might build. Acquisition of public rights has provided sufficient mileage of streams for special management to become an important factor toward providing better returns to the angler.

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SOME RESULTS OF WATERFOWL BANDING IN WESTERN CANADA BY DUCKS UNLIMITED (CANADA)

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Ducks Unlimited (Canada) has banded 31,911 ducks since 1938 to December 31, 1944, in the Provinces of Manitoba, Saskatchewan, Alberta and British Columbia. Numbers of each species banded, recoveries received to December 31, 1944, and percentages are listed in Table 1.

TABLE 1

Species	Total banded	Total recovered	Percentage
Mallard	10,152	984	9.7
Mallard × black duck	4	0	....
Mallard × pintail	2	0	....
Black duck	16	0	....
Gadwall	466	32	6.9
Baldpate	581	42	7.2
Pintail	6,084	409	6.7
Green-winged teal	1,129	31	2.7
Blue-winged teal	7,076	183	2.6
Cinnamon teal	2	0	....
Shoveller	424	23	5.4
Wood duck	3	0	....
Redhead	1,217	170	14.0 (In Canada 5.1)
Ring-necked duck	11	4	36.4
Canvasback	281	13	4.6
Greater scaup	1	0	....
Lesser scaup	4,084	290	7.1
American golden-eye	88	5	5.7
Barrows golden-eye	11	0	....
Bufflehead	165	13	7.9
White-winged scoter	55	2	3.6
Ruddy duck	59	1	1.7
	31.911	2.202	6.9

All 1944 bandings are included in the totals but not all 1944 recoveries have been received from Washington as of March 21, 1945. The percentages are therefore subject to increases but probably not more than 1 per cent in species that have been banded in significant numbers.

The redhead is under shooting pressure out of all proportion with other species. The reason for this is not immediately apparent. Many late broods are in evidence in Canada and many immature birds are noted in hunters bags in the early part of the hunting season. In Canada 5.1 per cent of the redheads were recovered so the shooting pressure in this country is not very different from that in the United States.

The small percentage of blue-winged teals shot is probably due to the fact that a majority of this species migrates south before the hunting seasons open in Canada or the United States. This does not

TABLE 2. RETURN OF BIRDS TO SAME LOCALITY SUBSEQUENT YEARS

Banding station	Species	Age	Sex	Date of banding	Date of recovery	Location of return	Manner of recovery
1. British Columbia							
Swan Lake, Tupper	A. Golden-eye	J	....	8/2/41	6/11/43	Vicinity of banding station	Killed by hawk
Swan Lake, Tupper	mallard	J	F	8/5/41	9/1/43	Vicinity of banding station	Shot
2. Alberta							
Athabasca Delta	Mallard	....	....	9/18/40	5/13/41	Vicinity of banding station	Shot
Athabasca Delta	Mallard	J	....	8/—/39	5/—/40	Vicinity of banding station	?
Ministik Lake	Mallard	J	....	8/16/39	9/15/40	Vicinity of banding station	R. and R.[1]
Ministik Lake	Mallard	J	F	8/2/40	6/6/41	Vicinity of banding station	R. and R.
Ministik Lake	Mallard	J	F	8/3/40	6/25/41	Vicinity of banding station	R. and R.
Ministik Lake	Mallard	A	F	9/18/43	8/4/44	Vicinity of banding station	R. and R.
Ministik Lake	Mallard	A	F	9/17/40	6/26/41	Vicinity of banding station	R. and R.
Ministik Lake	Mallard	A	F	7/23/40	summer 41	Vicinity of banding station	R. and R.
Ministik Lake	Mallard	J	M	9/2/40	10/5/41	Vicinity of banding station	R. and R.
Ministik Lake	Mallard	J	F	9/5/40	10/13/41	6 miles from banding station	Shot
Ministik Lake	Mallard	J	F	9/21/41	11/1/42	18 miles S. W. of banding station	Found dead
Ministik Lake	Mallard	A	F	9/22/40	10/6/41	24 miles N. of banding station	Shot
Ministik Lake	Mallard	A	F	10/8/40	9/17/41	Vicinity of banding station	Shot
Ministik Lake	Pintail	A	M	9/11/40	10/25/41	5 mi. from banding station	Shot
Ministik Lake	L. scaup	J	....	8/23/40	10/15/41	12 mi. from banding station	Shot
Brooks, Alta.	Pintail	J	F	6/30/43	11/8/44	Vicinity of banding station	Killed by car on street
Many Island Lake	Mallard	J	F	8/4/40	10/21/42	12 miles from banding station	Shot
Many Island Lake	Pintail	....	....	8/24/39	6/23/41	18 miles from banding station	?
3. Saskatchewan							
Wascana Lake, Regina	Mallard	J	M	9/1/43	11/6/44	Vicinity of banding station	Shot
Wascana Lake, Regina	Mallard	J	M	11/1/40	5/—/41	Vicinity of banding station	Caught in muskrat trap
Wascana Lake, Regina	Mallard	J	M	9/28/40	fall 41	Vicinity of banding station	Shot
Wascana Lake, Regina	Mallard	A	F	9/9/40	10/6/43	Vicinity of banding station	R. and R.
Wascana Lake, Regina	Pintail	A	F	9/8/43	9/18/44	Vicinity of banding station	Shot
Last Mountain Lake	Mallard	A	M	9/5/40	6/15/41	Vicinity of banding station	Shot
Yorkton	Mallard	J	F	9/19/43	7/28/44	Vicinity of banding station	R. and R.
Yorkton	Mallard	J	F	8/24/43	9/9/44	Vicinity of banding station	R. and R.
Yorkton	Redhead	J	F	9/9/43	9/14/44	Vicinity of banding station	R. and R.
Yorkton	Redhead	J	F	9/10/43	7/30/44	Vicinity of banding station	R. and R.
Kazan Lake	Mallard	A	M	9/30/42	10/—/44	About 25 miles from banding station	Shot
4. Manitoba							
Big Grass Marsh	Mallard	A	F	8/31/40	9/15/43	Vicinity of banding station	Shot
Big Grass Marsh	Mallard	A	F	8/6/43	4/21/44	Vicinity of banding station	Caught in trap
Big Grass Marsh	Mallard	J	F	10/13/40	10/29/43	Within 24 miles of banding station	Shot
Crescent Lake	Mallard	A	M	11/5/40	10/19/41	Vicinity of banding station	Shot
Crescent Lake	Mallard	A	....	10/25/42	11/25/43	15 miles from banding station	Shot
Libau, Man.	Mallard	A	F	8/15/40	9/23/41	Vicinity of banding station	Shot
Libau, Man.	Redhead	J	F	9/13/41	9/18/44	Vicinity of banding station	Shot
Libau, Man.	Redhead	J	F	9/28/41	9/26/42	Vicinity of banding station	Shot
Libau, Man.	Redhead	J	F	9/8/41	9/11/42	Vicinity of banding station	Shot

Summary

Province	*No. of returns*	*Adult male*	*Adult female*	*Juv. male*	*Juv. female*	*Adult sex?*	*Juv. sex?*	*Sex and age?*
British Columbia	2	....	....	....	1	....	1	....
Alberta	18	1	5	1	6	....	3	2
Saskatchewan	11	2	2	3	4	....	....	....
Manitoba	9	1	3	....	4	1	....	....
	40	4	10	4	15	1	4	2

[1]Retrapped and released alive.

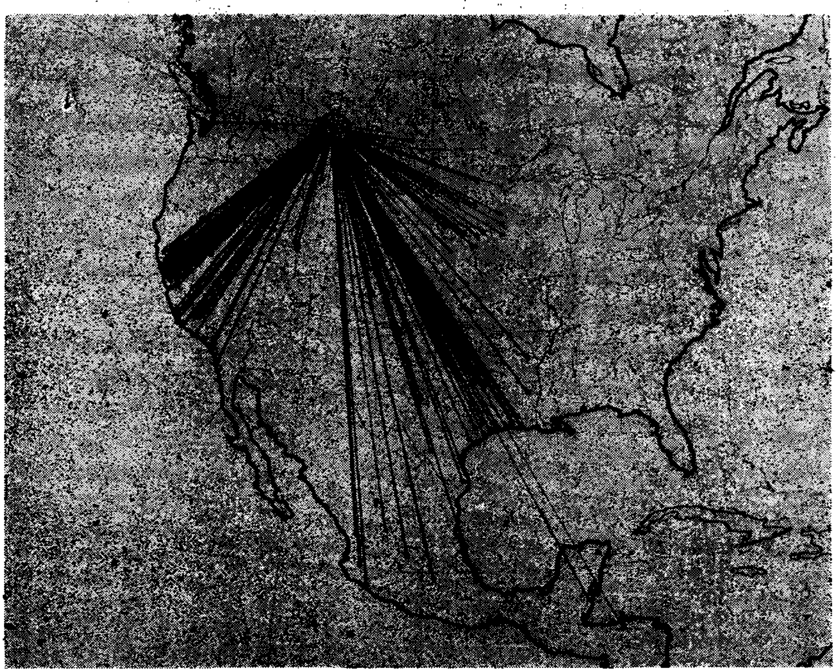
TABLE 3. RECOVERIES INDICATING AN EASTERN MIGRATION ROUTE THROUGH ONTARIO

Banding stations	Species	Age	Sex	Date of banding	Date of recovery	Location of return
Alida Lake, Erickson, Man.	B-w. teal	Juv	M	Aug. 22/44	Sept. 30/44	1½ mi. S. of Collingwood, Ont., Georgian Bay, Lake Huron
Big Grass Marsh, Langruth, Man.	B-w. teal	Juv	M	Sept. 3/43	Sept. 25/43	Calverts Camp, Rainy River, Ont.
Long Lake, Simpson, Sask.	B-w. teal	Juv	M	Sept. 4/43	Sept. 15/43	Fort William, Ont.
Roussay Lake, Yorkton, Sask.	B-w. teal	Juv	F	Aug. 24/43	Sept. 28/43	Lake St. Clair, Ont.
Big Grass Marsh, Man.	Mallard	....	M	Oct. 9/40	April 25/41	Whitefish Bay, Ont.
Big Grass Marsh, Man.	Mallard	Ad	M	Sept. 11/40	May 7/41	Red Lake, Patricia District, Ont.
Regina, Sask.	Mallard	Ad	M	Sept. 20/40	Nov. 13/42	Dover Marshes, Ont.
Netley Marshes, Petersfield, Man.	Pintail	Juv	F	Aug. 20/44	Oct. 9/44	Port Rowan, Lake Erie, Ont.
Libau, Man.	Redhead	Juv	F	Sept. 13/41	Nov. 1/41	Long Pointe Bay, Norfolk, Ont.
Libau, Man.	Redhead	Juv	M	Aug. 6/42	Oct. 23/42	Mississippi Lake, 4 mi. from Carleton Place, Lanark, Ont.
Libau, Man.	Redhead	Juv	F	Sept. 26/41	Oct. 22/41	Rondeau, Kent Co., Ont.
Libau, Man.	Redhead	Juv	F	Oct. 10/41	Oct. —/43	Lake Erie, Ont.
Libau, Man.	Redhead	Juv	F	July 23/42	Sept. 18/42	South Bay of Lake Nipissing, Nipissing, Ont.
Big Grass Marsh, Man.	Canvasback	Juv	F	Sept. 15/40	Oct. 24/40	Waubaushine, Ont.
Big Lake, Athabasca Delta	Lesser scaup	....	....	Sept. 6/39	Nov. 3/39	Cherry Valley nr. Picton Lake, Ont.
Ministik Lake, Alta.	Lesser Scaup	Ad	M	Aug. 31/41	Nov. 7/41	Lake of the Woods near Crozier, Ont.
Big Lake, Athabasca Delta	Lesser Scaup	Ad	M	Sept. 12/39	Mar. 8/40	Toronto, Ontario
Neilburg, Sask.	Mallard	Juv	M	Aug. 19/44	Oct. 13/44	Trout Lake, Sudbury, Ont.
Neilburg, Sask.	B-w. teal	Juv	F	Aug. 21/44	Sept. 13/44	Lake St. Peter, Quebec
Ministik Lake, Alta.	Lesser Scaup	Juv	....	Aug. 28/44	Oct. 17/44	Burlington Bay, Hamilton, Ont.
Big Grass Marsh, Man.	B-w. teal	Juv	F	Aug. 12/43	Sept. 30/44	At region bordering Lake Scugog, 20 mi. of Oshawa
Neilburg, Sask.	Mallard	Juv	M	Aug. 19/44	Oct. 13/44	At Trout Lake, Sudbury, Ont.
Roussay Lake, Sask.	Redhead	Juv	F	July 31/44	Oct. 24/44	Lake St. Francis, 55 mi. W. of Montreal, Que.
Roussay Lake, Sask.	Redhead	Juv	M	Sept. 17/44	Nov. 2/44	Rondeau Bay, Ont.
Big Lake, Athabasca Delta	Lesser Scaup	....	....	Sept. 12/39	Nov. 7/39	Howland, Penobscot Co., Maine
Libau, Man.	Mallard	Juv	M	Sept. 3/41	Nov. 23/41	6 mi. S. Dalton. Maine
Ministik Lake, Alta.	Lesser Scaup	Juv	....	Aug. 15/40	Nov. 5/41	Buffalo, New York
Libau. Man.	Redhead	Juv	M	Sept. 13/41	Nov. 1/41	Cayuga Falls near Seneca Falls, New York
Libau. Man.	Redhead	Juv	M	Aug. 24/42	Nov. 30/42	Cayuga Falls, New York

explain the low percentage of recoveries for the green-winged teal which migrates much later. Sportsmen probably prefer to use their shells on larger ducks.

New migration route to California.—Analyzing the recoveries by states we find that Minnesota with 202 (9.17 per cent of total recoveries) tops the list; Texas next with 175 (7.9 per cent) and California third with 127 (5.7 per cent). The first two were to be expected but the important percentage of recoveries from California reveals a previously unrecognized migration route from Western Canada to the Pacific Coast. Two species predominate in this route: pintails (81 recoveries) and lesser scaup (29 recoveries). A majority of the Californian recoveries are from ducks banded in Alberta but all three Prairie Provinces contribute to California's pintail flight (Maps 1 and 2).

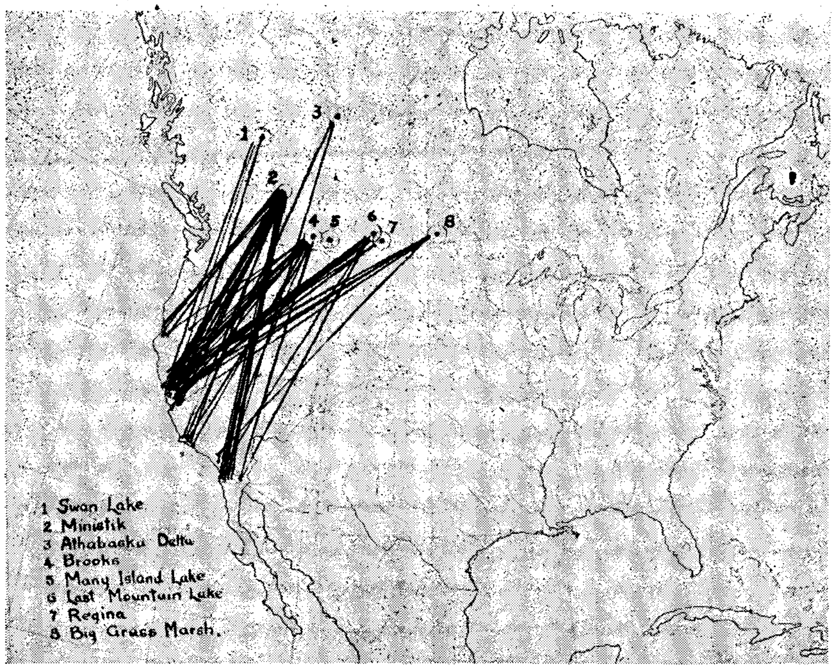
Return of females to same breeding grounds.—Since 1940 nearly all ducks banded have been sexed and aged by the cloacal method. Table



Map 1. Returns from 1,673 pintails banded at Many Island Lake in 1939 and 1940. Forty-six out of a total of 127 recovered in the United States are from California, indicating the existence of a previously unrecognized migration route from western Canada.

TABLE 4. RETURNS SHOWING A POST-BREEDING NORTHERLY MOVEMENT

Banding station	Twp.	R.	Mer.	Species	Age	Sex	Date banded	Date recovered	Location of return Twp.	R.	Mer.	Direction of return	Airline distance
Ministik Lake	50	21	W4	Mallard	Ad.	M	Aug. 30/40	Oct. 21/40	54	13	W4	N E	87 mi.
Ministik Lake	50	21	W4	Mallard	Juv.	....	Aug. 1/41	Oct. 14/41	58	25	W4	N W	54 mi.
Ministik Lake	50	21	W4	Mallard	Juv.	....	July 26/41	Oct. 31/41	59	6	W5	N W	90 mi.
Ministik Lake	50	21	W4	Mallard	Ad.	M	Sept. 22/41	Oct. 30/41	65	22	W4	N	90 mi.
Ministik Lake	50	21	W4	Mallard	Juv.	....	Oct. 1/43	Dec. 2/43	54	9	W4	N E	76 mi.
Ministik Lake	50	21	W4	Mallard	Ad.	M	Sept. 14/42	Oct. 4/42	59	27	W4	N W	66 mi.
Ministik Lake	50	21	W4	Mallard	Ad.	M	Oct. 1/40	Nov. 4/40	56	15	W4	N E	51 mi.
Ministik Lake	50	21	W4	B.-w. teal	Ad.	M	Aug. 31/42	Oct. 3/42	52	3	W3	12 mi. N	108 mi. E
Ministik Lake	50	21	W4	Bufflehead	Juv.	....	Sept. 9/41	Oct. 2/41	57	2	W5	N & W	107 mi.
Tenaille Lake	13	27	W3	Mallard	Ad.	....	Sept. /40	Oct. 12/40	24	1	W5	N & W	60 mi.
Many Island	13	1	W4	Mallard	Ad.	F	July 16/40	Sept. 17/40	44	13	W4	N W	207 mi.
Many Island	13	1	W4	Pintail	....	....	Aug. 24/39	Sept. 11/39	52	2	W5	N W	292 mi.
Many Island	13	1	W4	B.-w. teal	Juv.	F	Aug. 17/40	Sept. 30/40	29	12	W4	N W	116 mi.
Many Island	13	1	W4	B.-w. teal	Juv.	F	Aug. 13/40	Sept. /40	43	9	W4	N	186 mi.
Neilburg	44	27	W3	Mallard	Juv.	M	Aug. 24/43	Fall /43	49	8	W4	N W	57 mi.
Ministik Lake	50	21	W4	L. scaup	Ad.	M	Sept. 25/41	Oct. 10/41	55	21	W4	N E	51 mi.
Big Grass Marsh	16	11	W1	Mallard	Ad.	M	Aug. 16/41	Oct. 28/41	19	5	W1	N E	40 mi.
Big Grass Marsh	16	11	W1	Mallard	Ad.	M	July 5/43	Oct. 1/43	26	28	W1	N W	120 mi.
Big Grass Marsh	16	11	W1	Pintail	Juv.	F	Aug. 6/43	Oct. 10/43	27	20	W1	N W	85 mi.
Big Grass Marsh	16	11	W1	G.-w. teal	Juv.	F	Sept. 16/43	Sept. /43	22	16	W1	N W	46 mi.
Libau, Man.	16	6	E1	Redhead	Juv.	M	Sept. 10/41	Oct. 1/41	21	7	W1	N W	84 mi.
Big Grass Marsh	16	11	W1	Canvasback	Juv.	M	Sept. 3/40	Oct. 8/40	22	9	W1	N E	36 mi.
Long Lake, Sask.	28	23	W2	Redhead	Juv.	F	Sept. 24/43	Oct. /43	34	20	W1	36 mi. N	222 mi. E
Netley Marshes	17	4	E1	Mallard	Juv.	M	Aug. 15/44	Sept. 19/44	22	5	W1	30 mi. N	54 mi. W
Netley Marshes Libau	16	6	E1	Mallard	Juv.	M	June 6/42	Oct. /42	18	19	W1	12 mi. N	150 mi. W
Big Grass Marsh	16	11	W1	L. scaup	Ad.	F	Aug. 28/40	Oct. 14/40	22	9	W1	N E	38 mi.
Big Grass Marsh	16	11	W1	Mallard	Juv.	F	Oct. 8/40	Nov. /40	21	15	W1	N W	40 mi.
Regina, Sask.	17	20	W2	Mallard	Ad.	F	Oct. 20/40	Nov. 1/40	28	17	W2	N	69 mi.
Regina, Sask.	17	20	W2	Mallard	Juv.	M	Sept. 28/40	Oct. 31/40	28	23	W2	N	69 mi.
Duncairn, Sask.	13	15	W3	Shoveller	Juv.	M	Aug. 8/40	Sept. 23/40	49	26	W2	N W	243 mi.
Regina, Sask.	17	20	W2	Mallard	Juv.	F	Oct. 5/43	Nov. 5/43	23	25	W2	N W	46 mi.
Biggar, Sask.	35	14	W3	Baldpate	Juv.	F	Aug. 9/40	Oct. 14/40	38	11	W3	N	26 mi.
Biggar, Sask.	35	14	W3	Shoveller	Juv.	M	Aug. 9/40	Sept. 2/40	39	16	W3	N	20 mi.
Nokomis, Sask.	17	20	W2	Mallard	Ad.	M	Sept. 9/40	Nov. 4/40	29	22	W2	N	72 mi.
Yorkton, Leech Lake	24	6	W2	Mallard	Juv.	M	Aug. 21/44	Oct. 5/44	26	1	W2	12 mi. N	30 mi. E
Yorkton, Leech Lake	24	6	W2	Mallard	Ad.	F	June 14/44	Oct. 7/44	39	21	W2	N W	128 mi.
Regina, Sask.	17	20	W2	Mallard	Ad.	F	Sept. 21/43	Oct. 16/43	50	11	W3	N W	240 mi.
Leech Lake, Sask.	24	6	W2	Mallard	Ad.	F	Sept. 17/44	Oct. 17/44	30	3	W2	36 mi. N	162 mi.
Louisiana Lake, Alta.	18	12	W4	Shoveller	Juv.	F	July 21/44	Sept. 17/44	35	28	W4	N W	108 mi.
Louisiana Lake, Alta.	19	12	W4	Shoveller	Juv.	M	July 21/44	Oct. 10/44	42	19	W4	138 mi. N	42 mi. W
Louisiana Lake, Alta.	19	12	W4	Pintail	Juv.	M	June 16/44	July 8/44	55	3	W4	N E	225 mi.



Map 2. Californian recoveries from birds banded at stations other than Many Island Lake. Eleven species are represented in these recoveries, 35 of which are pintails, 29 lesser scaups (all from Ministik), baldpates, 3 green-winged teals, and single records for mallard, blue-winged teal, shoveller, redhead, canvasback, bufflehead and white-winged scoter.

2 lists birds recovered in subsequent years at or within 25 miles of the banding station. Twenty-five of 33 birds of known sex and age were females, suggesting that the female tends to return to the same breeding grounds year after year bringing with her a male with whom she paired on the wintergrounds. The first wave of migrating mallards and pintails to Canada are invariably paired. The accumulation of further data on this important point correlated with group habit and sex segregation on migration and heavily shot localities along the migration routes will be most enlightening. We have long suspected that the reduction in breeding stock observed on some areas without apparent cause is probably due to them breeding together, migrating together and habitually stopping at heavily shot locations on their way south. We are getting returns which tend to confirm this but they are too few as yet to justify publication.

To Atlantic Coast via Ontario.—Table 3 lists 29 recoveries indicating the existence of a migration route from the Prairie Provinces through Ontario to the Atlantic Coast. Redheads, lesser scaups, and blue-winged teals are chiefly involved. The preponderance of juveniles in these returns is noteworthy.

Post breeding northerly movement.—Field observations on summer flock movements have definitely indicated a post breeding northward movement from the southern prairies to lakes and marshes in the parkland belt along the northern edge of cultivation. Aerial observations in August and September in the years 1938-42 located huge rafts of moulting male canvasbacks and lesser scaups in remote lakes in northern Manitoba, Saskatchewan and Alberta. It is a general belief among prairie farmers that ducks move northwards in considerable numbers after the young are on the wing. There are, of course, great post-breeding concentrations on permanent waters on the prairies and there are some very early southern migrations, particularly of male pintails.

Table 4 which lists 41 returns of birds shot north of where they were banded strongly confirms a widespread post-breeding northerly movement involving adults and juveniles of both sexes.

ECONOMIC IMPORTANCE OF THE WATER HYACINTH, *EICHHORNIA CRASSIPES*, IN MANAGEMENT OF WATER AREAS

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The major problem that the water hyacinth (*Eichhornia crassipes* (Mart.) Solms.) presents in the management of ponds, lakes and slowly moving streams for wildlife has only in recent years become generally apparent in the South. It is conservative to state that this species is the most difficult and dangerous of all our introduced plant pests when considered in its water management relations.

The water hyacinth, a floating plant with an inflorescence of orchid-like beauty, is evidently tropical American in origin. Some considerable controversy exists regarding its actual original native area but after examining the published data and conducting extensive correspondence with the leading botanical authorities in every republic of Central and South America, and the British, French and Netherlands Guianas, the writer has come to the conclusion that the species is definitely tropical South and Central American, as above indicated. Singularly attractive in its beauty, this plant has been carried widely over the world and has become established as an element of the flora in parts of all continents.

The circumstances of at least its major introduction into United States are well known and worthy of mention. When in 1884 the International Cotton Exposition was held in New Orleans, the Japanese government representatives imported these plants from Venezuela (where the plant is a serious pest) and gave them away as souvenirs there. They were disseminated by visitors to this Exposition and carefully introduced widely over the country. Florida, through this means, received the disastrous gift of this aquatic.

So rapidly did the water hyacinth acclimate and flourish that just 6 years later (1890) an agitation was begun in Congress to seek measures for its control. Congress, in 1897, made its first appropriation of $5,000 for the study of this plant in waters of Louisiana and Florida. The degree to which the cost to the Federal Government of the campaign against the water hyacinth increased may well be realized when in comparison of that initiation appropriation, the Federal Government, before the beginning of the present war, had been using equipment in the southern half of Louisiana alone costing over $500,000 and requiring many additional thousands of dollars annually to operate.

It is interesting to note that the water chestnut (*Trapa natans* L.), a serious pest in certain parts of the Atlantic Coast, was introduced into United States from Burma in the same year (1884) that the water hyacinth was brought to New Orleans. Although there seems to be no particular reason why the water chestnut could not succeed and cause equivalent damage in Louisiana, the plant, fortunately, has never become established there.

Water hyacinth is a typical floating aquatic belonging to the pickerel-weed family (*Pontederiaceae*). Its buoyancy depends upon the greatly inflated petioles. The plant spreads with great rapidity by vegetative means and also reproduces by means of seeds that probably average a production of 500 seeds per plant per year.

Although the water hyacinth is evidently responsible for no economic damage in many of the South American areas, where it occurs naturally, and also in many areas in the Pacific, into which it has been introduced, it has proved completely disastrous in such widely separated regions as the Lower Orinoco of Venezuela, the states bordering on the Gulf of Mexico, certain South African lakes and certain water areas in Australia.

The water hyacinth is apparently valueless as a source of food or shelter for any useful form of wildlife (fish and waterfowl). Although cattle will, on occasion, eat it, chemical analyses revealed that its nutritive value is so low that it would scarcely balance the energy accounts the animal expended in securing it.

A comprehensive program of study of the life history and ecological relations of the water hyacinth is being undertaken by the Louisiana Department of Wild Life and Fisheries.

A survey of all the published data concerning possible economic use of the plant in industry reveals that, although attempts have been made to manufacture paper and types of sheeting useful in construction, the processing involved, because of the excessively high water content, makes such manufacture impractical except under the circumstances of the fantastically low-priced labor in the Orient.

Damage by the water hyacinth may be summarized as follows:

1. Water hyacinth alone, or often in raftlike consolidations with the alligator weed (*Alternanthera philoxeroides* (Mart.) Griseb. (*Achyranthes philoxeroides* [Mart.] *Standl.*)) or certain sedges, may block streams, particularly the slow moving "bayous" of the South, so that navigation by boat is impossible. The power plant in an ordinary fishing lugger is quite incapable of forcing a vessel through such a blocked stream.

2. Water hyacinth, where uncontrolled, rapidly forms such a dense surface mat that the biological pattern of the body of water becomes completely disorganized. Submerged aquatics blocked out from light

die. The useful role played by certain submerged aquatics as oxygenators, shelter for fish food and for young fish, terminates, and fish, both commercial and game species, must migrate or starve.

3. Even where a body of water is not completely covered by water hyacinths, rafts formed by this species and driven back and forth by wind will mechanically tear up useful aquatics in shoal waters and transform valuable fish ponds and duck ponds into barren areas.

The Department of Wild Life and Fisheries of the State of Louisiana has been conducting experimental work on water hyacinth control over a period of 4 years.

Briefly stated, methods of water hyacinth control fall into four categories:

1. Control by biological means.
2. Chemical control.
3. Control of physical methods (use of flame throwers).
4. Mechanical removal.

A brief survey of the status of each of these follows:

1. *Biological control.*—No seriously effective biological agents for the destruction of water hyacinth have yet been found as far as the writer can ascertain. Inquiry directed to the chief botanical research agencies of all of the Central and South American Republics and of the three Guianas reveals that although many organisms (gastropods, insects and arachnids) are present in water hyacinth "rafts" and in the masses of water hyacinth covering streams and may be numerously present associated with the mortality of the plants in such aggregations, in no instance was such an association demonstrated to have a causal status. The writer has found on occasions large populations of the various mites (Hydrachnidae) on moribund water hyacinths but microscopical examinations failed to indicate that their presence was any other than incidental. It is obvious that even if some parasitic organism, plant or animal, fatal to the water hyacinth be found, its introduction into United States would require the most serious study of its destructive potentialities since, in its new environment, it might well become an uncontrollable agent of damage to useful plants.

2. *Chemical control.*—A program of chemical control of water hyacinth was long carried on but is now abandoned by the Federal Government. Sodium arsenite, distributed by means of various spraying devices, was the agent employed. Although effective, this chemical procedure was abandoned when the poisoning of the crew of one of the spray boats occurred, an episode that involved the death of the captain. It is of interest to note that very early in the history of water hyacinth control attempts, the use of poisons was prohibited by State statute in Florida.

Effective though such arsenical poisoning can be, its use, for reasons of safety, has been completely abandoned.

3. *Physical control.*—It seemed a possibility that, with the end of the war, there might become available great quantities of flame-throwing equipment already manufactured and of very restricted possible civilian use for any civilian needs yet capable of becoming instruments in water hyacinth control. Such possibilities were investigated with convincing proof that they are without value. Through the cooperation of the U. S. Engineers and of the U. S. Army, flame-throwing equipment of the most modern type, operated by expertly-trained officers, was used on experimental areas of water hyacinth. Compactly summarized, this whole approach may be dismissed with the statement that flame throwers, developing as they do between 2,400° and 3,000° C. and capable of melting in a matter of seconds the engine block of an automobile, are utterly useless against water hyacinth. The extraordinary, thermal characteristics of water could scarcely be demonstrated in a more spectacular manner than it was in these experiments. When the entire 17-second charge of a flame thrower, the fuel of which consisted of a mixture of crude oil, kerosene and gasoline, ignited by electrically sparked hydrogen and propelled by compressed nitrogen, was directed on a mass of floating water hyacinth, the emerged plant structures were instantly and completely charred, yet the submerged portions of the plants remained entirely unharmed. Regrowth in the flamed area was actually accelerated, due evidently to the release of needed substances from the ignited plant tissues.

An amusing and absurd climax fully demonstrating the protective qualities of water against heat occurred when after the full force of the full charge of this terrifying war instrument had been held on a limited area overgrown with water hyacinth, a frog, quite unharmed, emerged from the middle of the blackened debris.

The cost for fuel alone for the operation of a single standard flame thrower, for a 15-second charge, is 75 cents. This basic cost of 5 cents per second of operation would, itself, make impractical use of this method quite apart from the fact that this extremely dangerous equipment can be handled only by expertly-trained operators.

Additional experiments, using gasoline poured over the water and ignited, had been carried out by Wunderlich and yielded similar results, namely, acceleration of regrowth. Furthermore, the hope that unusually low temperatures might succeed were equally disproved by observations carried out during and following the exceptionally cold winter in Louisiana in 1939. Water hyacinth has been known to survive from winter exposure in the vicinity of Washington, D. C.

4. *Mechanical control.*—Mechanical control of the water hyacinth,

costly though it is, is thoroughly practical procedure because of the even more costly damage that this plant causes.

A long, careful and successful program of mechanical water hyacinth control has been carried out by the U. S. Engineers under the immediate supervision of William E. Wunderlich, whose inventive genius is responsible for the conception and construction of the progressively more and more efficient machines used. The machines devised range widely in design and capacity all the way from a huge, single crushing unit costing $100,000 to small portable units capable of being transported almost anywhere, each costing approximately $1,800.

Essentially, all these mechanical devices are based on the conveyor principle, whereby the water hyacinths are collected and either piled on the banks of the bodies of water or else run through terminal accessory grinders that reduce them to a nonreproducing mass.

The Louisiana Department of Wild Life and Fisheries, with the cooperation of Wunderlich, constructed machines of a special highly portable type that could be used in attempting to control water hyacinth in small bodies of water which had great recreational value but not navigational importance. Each machine consists essentially of a 20-foot long, 3-foot wide conveyor, operated at a chain speed of 60 feet per minute and with a capacity of 1,200 square yards of vegetation per hour. The power plant required for the conveyor is exceptionally weak developing only 3.8 H.P. at 2,000 R.P.M. The whole conveyor is mounted on two automobile wheels and is transported as a trailer attached to a truck. The truck is provided with a special crane for handling three sheet iron pontoons, upon which the conveyor is mounted. The machine in action has an operating load of 3,364 pounds. Each unit costs about $1,400 and requires the services of a crew of 1 mechanical operator and 10 laborers, the laborers cutting the matted water hyacinth rafts with ditch slicers and feeding them into the conveyor. An appropriate cutting pattern insures a steady feeding of the hyacinth onto the apparatus. The whole unit can be easily paddled into any position when floating. Its position is so chosen that the water hyacinths are ejected onto the bank, where, within a brief time, they lose their extremely high (95 to 98 per cent) water content, and the products of disintegration serve to fertilize the stream or lake.

A program of work involving such a mechanical attack may, at first glance, appear to be economically impractical but experimental practice has proved quite otherwise. The investment of hundreds of thousands of dollars in fish and game preserves in certain single areas of Louisiana, for example, is imperiled as far as recreational fishing facilities are concerned by the encroachment of water hyacinth. Other privately-owned areas, which the writer has investigated, whose value for sport fishing and duck hunting provide heavy annual revenues, will undoubtedly become worthless within but a few years unless this plant is controlled.

A convincing example of the complete biological damage wrought by water hyacinth may be cited. A 10-acre private lake, near the town of Chataignier (Evangeline Parish) formerly teemed with fish and provided excellent recreation. Six and six and a half pound large-mouthed black bass, *Huro salmoides* (Lacepede) were frequent. This lake, which had not been dry for 10 years, became invaded by water hyacinth, the growth of which finally covered the entire surface. Recently, the owner drained the lake into an adjacent bayou after making elaborate plans to trap all the fish by the use of wire netting equipment. The total catch secured from the 10 acres of this formerly richly productive water was exactly three white crappie (*Pomoxis annularis* Rafinesque).

It is evident that the water hyacinth is capable of dominating and ultimately destroying all other aquatic vegetation, including even that most objectionable of all our native aquatics, the American lotus (*Nelumbo pentapetala* Walt. (*N. lutea* [Willd] Pers.)).

The consolidation that, in association with other aquatics, it can accomplish is astonishing. The writer has observed a broad slow-moving stream whose complete surface, mile after mile, is blanketed with a solid growth of water hyacinth, whose individual plants attain a height of 4 feet above the water.

Two additional characteristics of the water hyacinth merit notice. These are an evidently increasing tolerance of cold and evidently increasing tolerance of salinity. During 14 years of observation, the writer has noted the steady progress of this plant northward where formerly it appeared to have been winter-killed, and a steady intrusion of the species into coastal waters of higher salinity.

SUMMARY

1. The water hyacinth (*Eichhornia crassipes*) is the number one aquatic plant problem in management of water areas in the Deep South.

2. The species has now become established across the southern part of the United States as far north as Savannah, Georgia, and Los Angeles, California.

3. There appears to be a definite development of increased tolerance by this species for lower temperatures and for higher salinities during the past 14 years in Louisiana.

4. Water hyacinth is capable of dominating and ultimately elimi-

nating all native floating and submerged aquatics, including the aggressive American lotus (*Nelumbo pentapetala* Walt. (*N. lutea* [Willd.] Pers.)).

5. Establishment of the species in stationary beds excludes light and completely destroys any useful biological pattern of plant or animal life in the waters beneath it.

6. Invasion by water hyacinth correspondingly abolishes completely any waterfowl values of the area.

7. Mechanical action of even small wind-driven rafts of water hyacinth serves to tear out and destroy natural or artificial plantings of valuable aquatics used by waterfowl.

8. Growth in initial stages interferes with the use of sport fishing gear and, if uncontrolled, renders the invaded areas impenetrable for navigation.

9. Possibilities of control investigated included the categories of:

a. Biological control by introduction of parasites. Reveals, so far, poor promise of success.

b. Control by use of flame throwers. Completely unsuccessful, and even if successful impractical economically.

c. Chemical control. Impractical because the only economically effective agents tested involved unacceptable poisoning hazards.

d. Mechanical control. The only effective, practical method in the opinion of the writer. Though expensive, this cost is justified by the results obtained and the damage thereby prevented. Mechanical control involves the use of highly differentiated equipment for the range of situations encountered in any general water hyacinth control program. Small portable units experimented with proved effective with a potential capacity per unit of clearing 1,200 square yards of water hyacinth an hour.

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Chairman: J. J. HICKEY

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PARKS, REFUGES, URBAN LANDS, AND WILDLIFE

This session arranged by the Wildlife Society

INTRODUCTORY REMARKS

J. J. HICKEY

This symposium was originally designed to discuss contemporary wildlife problems on refuge, park, and urban lands. Illness and wartime activities have decimated the ranks of the speakers, but the problems themselves remain. At a time when conservation agencies are virtually working with skeleton forces, we more than ever need to assess our position and to know where we and the wildlife of our continent stand.

Although we still have a lot of wildlife in North America, plowing, grazing, lumbering, drainage, and the growth of cities have all affected its composition—and usually for the worse. Efforts to turn game into something like a cash crop have consistently failed, and the land is strewn with the unmarked graves of farmer-sportsmen cooperatives. The indirect acknowledgment of this failure to maintain wildlife on private land is evident in the accelerated development of parks and refuges in recent years. These projects have brought with them still newer problems, although many of the old ones still remain.

In man's relationship with wildlife, these problems group themselves toward two poles. There are those who are directly connected with wildlife, how it can be understood and ultimately managed. There are also those who are directly concerned with man whose activities have long been managed (by game laws, no-trespass signs, and the like) but who, perhaps, have never been fully understood. These are the two points of view upon which Dr. Cottam and Mr. Mann focus our attention in papers that follow. It is obvious from their discussions that the modern conservation of wildlife can be no halfway effort if it is to attain its ends. Total success will only come from total effort, but that effort—if it is to be effective—must represent the coordinated and cooperative efforts of many.

RESEARCH PROBLEMS ON THE UNITED STATES NATIONAL WILDLIFE REFUGES

CLARENCE COTTAM
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On June 30, 1943, the Fish and Wildlife Service administered 275 national wildlife refuges, with an aggregate of 17,620,526 acres. Of these, 256 (9,573,551 acres) are in the United States, and 19 (8,046,975 acres) in Alaska, Hawaii, and Puerto Rico. All kinds of wildlife are protected on these refuges, but many refuges were especially established for the conservation of one or more species—188 (2,971,414 acres) for migratory waterfowl; 45 (85,850 acres) for colonial non-game birds; 16 (10,578,050 acres) for big game; and 25 (3,982,589 acres) for migratory birds other than waterfowl and miscellaneous forms of wildlife. One refuge, the Patuxent Research Refuge, Maryland (2,623 acres), is maintained for wildlife experimental purposes. During the years of drought the Service established 83 so-called "easement refuges" (144,509 acres—included above) in North and South Dakota, Montana, Colorado, and Wyoming, where conditions made impoundments advisable and where such development would help to develop suitable waterfowl nesting habitat.

In most instances these refuges are on land controlled solely by the Fish and Wildlife Service; in others, by Executive order or otherwise, refuges are established on land primarily controlled by some other agency of the Federal Government.

The Fish and Wildlife Service conducts the wildlife research and serves in an advisory capacity on management of wildlife on Indian lands and on national parks, monuments, forests, and grazing districts. On most of these areas wildlife conservation is subordinate to other primary uses of the lands, but on refuges wildlife conservation is of paramount importance.

Research problems are legion, as varied and intricate as are the problems of administration and management. Moreover, the problems vary with the seasons and the innumerable local conditions. Thus, a change in agricultural practices or other conditions adjacent to a refuge may create a serious duck depredation problem, or a flood or a drought may cause a dispersal or concentration of birds into areas where they may cause serious damage or otherwise not receive much benefit from the refuge. Provision for public hunting in portions of some refuges where there is lack of local hunting opportunities has been made in Acts authorizing their establishment; other areas are inviolate sanctuaries; others are managed as sanctuaries in conjunction with adjacent state hunting units. Some of the refuges include highly-productive land, marsh, or water; other refuges are established on submarginal or unproductive land. Research, therefore, must be so conducted under greatly diversified conditions as to enable management to secure maximum benefit for wildlife and maximum returns from the land.

Research on refuge management.—Of the more important research problems, perhaps the fundamental studies are those of refuge management and refuge ecology. In order to plan properly the development of any wildlife area, the conservation agency must have detailed knowledge of the requirements of the different wildlife species that may be expected to frequent the area. The refuge must be developed not only to supply the maximum of the most attractive foods for the entire period during which the birds or other wildlife use the area, but to be of greatest value, the refuge must also furnish the optimum nesting, brooding, molting, and resting environment in suitable size and relationship for the particular and varied species of migratory birdlife using the area. Though a particular marsh-and-water area may produce an abundance of food, the area will be little utilized during the nesting season if an appropriate type of nesting habitat and suitable protective covering during the molting period are not close at hand and readily accessible.

The requirements of closely related species are by no means identical. Even for a single species of waterfowl the resting, feeding, molting, and nesting environments differ greatly. The nesting requirements of mallard and redhead ducks, Canada geese, and coots, for example, have little in common. Likewise, their food preferences differ markedly. Each species has its own type of preferred molting and loafing territory. Consequently, a successful refuge must present a great diversity of habitat if it is to receive extensive and consistent use by the different groups of birds.

The refuge is designed not only for game species, but for wildlife in general. The problems of development and management call for specific and detailed knowledge of the requirements of the many species of ducks, geese, terns, gulls, shorebirds, herons, rails, terrestrial birds, fur-bearing animals, big game, predators, and other forms of wildlife, as well as for a detailed knowledge of the many plant associations and successions and how to develop those most favorable to wildlife. Though much progress along this line has been made during the past few years, much remains to be learned in order to develop the most effective and economical management. The magnitude of the problem may be realized when it is recalled that during the late summer and early fall almost 2 million ducks and geese and probably an equal number of shorebirds—representing nearly all the species which occur inland in the West—can be found on the Bear River Marshes of northern Utah. In addition to these groups of birds, the Bear River Migratory Bird Refuge attracts and supports a large population of gulls, pelicans, cormorants, terns, herons, coots, grebes, rails, pheasants, and many nongame land birds, as well as a considerable population of muskrats.

Control of obnoxious vegetation.—A climax type dominated by a single species of vegetation is rarely attractive to wildlife. This is as true in a marsh as in a forest area. Good management seeks, therefore, to maintain a diversified habitat in which are mixed stands of a transition type of vegetation of high food value. In the development of a marsh for waterfowl or muskrats, or in the development of an upland habitat for terrestrial wildlife, the refuge administration is often confronted with the problem of controlling dense stands of climax or subclimax vegetation and planting in their stead species more attractive to wildlife. In this development it is advisable to use the ecological or naturalistic approach whenever possible. Often the alteration of water levels or the skillfully controlled use of fire is a most efficient measure. Experience has shown that some species of perennials, for example, can be controlled if cut during the height of the flowering season; some, if cut during the period of maximum stolon growth; and others can be controlled by still different treatment. Research is making progress, but much more is needed to develop the most effective methods and procedures in controlling obnoxious vegetation and establishing more desirable forms.

Depredation and control.—It is very disconcerting to realize that ducks and geese that have been attracted to a refuge in large numbers occasionally do severe damage to adjacent agricultural crops. Birds in one rather circumscribed river valley caused the loss of more than a million dollars in a rice crop during one season. Such an economic problem, especially in wartime, demands that research workers devise ways and means of preventing or at least minimizing this loss. This problem requires that more food be produced on the refuges and in adjacent areas where the birds will cause no damage, and that at the same time more effective frightening devices be developed.

Depredations on agricultural crops may also be caused by blackbirds and many other species of birds that receive protection on the refuges. The depredation problem is more or less specific for each species of bird or animal causing damage.

Control procedures must be specific. Methods must be employed that will not only be effective against the offending species but will also be selective and cause a minimum of loss or damage to desirable forms. Under progressive management control is always held to a minimum and applied only where a proven need exists. When the problem can be solved with frightening devices, these are preferable to lethal methods. It is advisable to use the ecological method of approach whenever possible, as proper environmental adjustments may help to eliminate or "control" certain undesirable forms.

The controversial problem of predator-prey relationships is a perennial one that requires consideration on a factual rather than on a sentimental or prejudiced basis. It has been claimed that the national parks, monuments, and refuges—where control is seldom practiced—are producing large populations of coyotes and other predators which inflict serious damage upon adjacent livestock and other economic interests. Tagging studies are planned to aid in determining the movements, life histories, and habits of these predators. Economic studies are being conducted to determine the relation of these predators to other forms of wildlife and to domestic life. Research must provide many more data on the relationship of predators to rodents, game, and livestock, and their effect upon any given set of environmental conditions.

Harvest of wildlife.—Refuge areas are designed to encourage and support wildlife species, yet in the management of such areas there are often crops that can be harvested. Frequently some harvest becomes an absolute necessity. In the management of a duck marsh, muskrats, raccoons, and other fur-bearing animals may be produced in large numbers; but an overpopulation of muskrats may largely ruin the marsh even for waterfowl. Furthermore, it seems a waste of a public resource not to harvest all surplus crops. Multiple land use should always be encouraged. If properly managed, one Gulf Coast refuge is probably capable of producing 100,000 muskrats per year. On other areas considerable timber, hay, grazing, or upland or big-game species are produced and will go to waste if not utilized.

Research is necessary to determine not only the carrying capacity of each species of wildlife on an area under a given set of conditions, but also the relation of each species to every form of wild or domestic life using the refuge. Studies are needed to determine how best to manage an area, to discover under what conditions grazing privileges may be granted, to ascertain under what circumstances hay, timber, or other crops may be marketed without injury to the wildlife.

A few refuges—perhaps with insufficient food—have encouraged too large a concentration of birds, such that excessive kills have resulted in the areas adjoining. For example, 35,000 ducks are reported to have been killed during the past hunting season within a 5-mile radius of the Chautauqua National Wildlife Refuge in southern Illinois. The kill of Canada geese near the Illinois State Horseshoe Lake Refuge is a far more alarming illustration.

Restoration of goose nesting in Northern Plains States.—Application of the knowledge that research has been and is developing on our refuges would probably make possible the restoration of a breeding goose population in much of the area of the states northeast of the Rocky Mountains where the birds have been extirpated as nesters. Geese formerly were common nesters throughout the northern plains area and in many suitable habitats in the Northeastern States. Studies are now being conducted in these states to determine which refuges possess the requirements of nesting, brooding, feeding, and resting habitat suitable for geese in proper relationship, and which other refuges possess physical requirements for proper and economical development to enable the building-up of a goose population. More information on stocking, transporting, and handling of the introduced birds is needed.

In the development of some refuges it is probable that too much emphasis has been placed upon the development of expensive engineering structures and too little upon the ecological approach. Evidence sometimes indicates that more satisfactory, more effective, and more economical development would have resulted had more biology been applied and fewer expensive dikes and impoundments been constructed.

Disease research.—Of the refuge problems, disease research is one of the most important. Large numbers of wildlife are concentrated on the refuges, and this factor alone may favor the outbreak of disease. Our refuges supply an excellent opportunity to learn more of these diseases, how to control them, and what relation these diseases of wildlife bear to domestic stock and to man himself. It is probable that wildlife either directly or indirectly serves as a reservoir in carrying over a number of serious diseases that periodically afflict man or his domestic animals. Study is needed to determine the extent of this, the treatment in each case, and means of control. A study is being made to determine what relation buffalo, elk, and other species of big game on federal refuges and parks have to the spread of brucellosis or Bang's disease among range cattle.

Botulism.—As in the study of cancer and other serious human diseases, much effort has been directed to the search for a solution to the perplexing and difficult problem of botulism or western duck sickness. Though much progress has been made, many unanswered questions remain, and an annual loss of 100,000 to more than 500,000 waterfowl still plagues and harasses us. The prevention of botulism is one of the principal concerns of the Fish and Wildlife Service.

The huge Bear River Migratory Bird Refuge in northern Utah is being used primarily on a research basis during the summer season in an effort to conquer this disease, and very satisfactory progress is being made. The organism *Clostridium botulinum,* the spore-producing anaerobic bacterium that causes botulism, is well known. The present objective, therefore, is to determine the type of management that can be employed to prevent outbreak of the disease. Outbreak of botulism is apparently associated with water levels and water depths. Each of the five major units of the refuge, therefore, is being operated on a specific but different water plan to determine the conditions that may cause and prevent outbreaks of the disease. Different problems relative to this disease occur on other areas and refuges in the West. Recently a light boat with an air-thrust airplane motor has been developed that will travel over the extensive shallow water or mud flats at a rate of 25 to 35 miles per hour. With this boat, studies can be conducted in the marsh and many birds can be salvaged where it was previously almost impossible to travel. Effort is being made to determine just where in the marsh the birds are getting the botulism, what conditions favor the organism and its toxin production, and what can be done to prevent this.

Other research refuge problems.—As the name implies, the Patuxent Research Refuge is dedicated almost entirely to research and demonstration. This wildlife experiment station, with its diversified group of specialists, should become increasingly valuable as a standard by which experiments and studies elsewhere may be measured. This research station should become to wildlife what the English Rothamsted Station has been to agriculture for more than 400 years. At the Patuxent research station many types of research are conducted on many forms of wildlife to determine their relation to agriculture, horticulture, and forestry.

Among many other refuge wildlife problems, the following are extremely important:

1. Determine the requirements and procedures necessary to save vanishing species such as the ivory-billed woodpecker, whooping crane, and trumpeter swan.
2. Test the effects that new insecticides and rodenticides have upon wildlife. DDT is being studied intensively at the Patuxent Research Refuge at the present time.
3. Study big-game-livestock relationships and degree of competition, particularly on forested refuges.
4. Determine economic relationships of the so-called "pest" species such as predators, rodents, and fish-eating birds.
5. Study the management and ecological relations of wild fur-bearing animals.

6. Study the nutritional requirements of game and other wildlife species.
7. Study the ecological relationships of reptiles and other cold-blooded vertebrates.
8. Determine the efficacy of fish and game stocking programs.

CONCLUSION

True conservation of wildlife is possible only when management is based upon real understanding. The great concentrations of wildlife on our refuges have given rise to problems that must be solved in the interest of intelligent, efficient, and economical management of one of our great natural resources. Research on our refuges is directed to the discovery of means and methods whereby wildlife may be so managed as to secure the maximum benefit for wildlife and for man.

PEOPLE

ROBERTS MANN
Superintendent of Conservation, Forest Preserve District of Cook County, Illinois

The only wildlife problem in publicly-owned urban lands is *people!* City folks have no roots; they've lost their kinship with the land. A tree is just a tall wooden object with bark and leaves on it. Water is something you drink, wash with, and carry an umbrella for. Soil is either dust or mud, depending upon the weather, but equally cursed. Urban folks have not the faintest suspicion of the importance of ecological relationships: food chains, population cycles, species integration, et cetera. Shucks, they don't know that these exist.

The solution is in education—education in conservation, in good outdoor manners, in awareness and appreciation of wild things. The more people you can educate the closer you will come toward licking your problem. Educate them at all age levels from the cradle to the grave. Above all get them out of doors, out on their feet and dirt between their toes.

We urban-land managers, as a class, if we have any roots ourselves and any feeling for the land, have attacked the problem feebly and in the wrong way. We have attempted to bring the wildlife to the people rather than bring the people to the wildlife. We have failed to grasp the fact that there is an emotional factor in nature appreciation; that one deer glimpsed in the wild is worth ten thousand gawks at a herd in a fenced pasture. We have only begun to realize that people must be taught what Aldo Leopold calls "perception."

We have been classifying the public either as enemies or dolts—with provocation. We battle constantly to protect what we have from those who would hunt and destroy for lust—who regard us and our rangers as meddling fools to be eluded or defied. We battle constantly to pipe down the busy souls who would "develop" and "improve" our properties, making every nook and cranny accessible to the feeblest old lady on crutches. We battle constantly to protect what we have from the one-track minds bent on eliminating this or that: the goldenrod and ragweeds for the benefit of hay fever sufferers; the poison ivy for the protection of little Willie; the snakes; the starlings and the sparrows; that black "rascal," the crow; the hawks and owls that allegedly menace the dear little songbirds; the foxes that eat a few pheasants and chickens; the rough fish in our lakes; the marshes and ponds because they breed mosquitoes; the wet woods that breed more mosquitoes; the meanders of our streams that choke and flood back on cultivated lands; the wild gooseberry; the weed trees, the wolf trees, the dead trees, and the down trees. By the Bighorn spoon, if we eliminated all the native, living things campaigned against by pressure groups we would wind up with nothing but bluegrass, elms, and white oak—which would promptly die!

It has been proved in our Cook County forest preserves that in a county of 4 million people it is possible to build up—within a few miles of the City of Chicago and 91 suburban towns—an amazing wildlife population, both in diversity of species and numbers within those species. By management? No. It is simple if you keep the exotics out; keep the automobile out; protect rigidly against fire, against hunting and trapping, against indiscriminate intrusion beyond the fringes by heedless hordes of people. *Just leave nature alone.*

Some guy said that a child's worst hazard is its parents. Wildlife's worst hazard is its managers.

UNSOLVED PROBLEMS CONCERNING WILDLIFE IN MEXICAN NATIONAL PARKS

WILLIAM VOGT

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Mexico possesses 43 national parks. No differentiation, in the Mexican classification, is made between park areas and national monuments, but many of these include substantial areas of wild land. Some of these are so remote that they can be reached only by several hours of horseback riding. The writer has visited 26 out of 43 of these areas, including a number of wild parks such as: Ixta-Popo, Nevado de Toluca, Cumbres de Ajusco, Insurgente Miguel Hidalgo, Lagunas de Zempoala, Zoquiapan, La Maliniche, Bosencheve, and Cofre de Perote, —and in none of them has there been seen as much wildlife as may be encountered in the suburbs of Washington or New York. Mammals, even squirrels, are almost never seen. Game birds are rare, and non-game birds are much more timid than they are in the United States.

There are two reasons for the scarcity and shyness of these animals in Mexican national parks. First, hunting by all possible means, which goes on throughout the year; and second, destruction of environment.

The idea of virtual freedom to hunt in national parks may seem strange to North Americans, even to those who are proponents of controlled hunting in our own national parks. In Mexico, the hunting is illegal, but law enforcement is not strict. In no park visited was there more than one *guardabosque* (forest guard), who in some cases lived several miles from the park itself. It was not unknown in the early days of our own national park system for a park ranger to have to resort to firearms to protect the park. This is frequently the case in Mexican parks today, and the *guardabosques,* having to work alone, often risk their lives. Since hunting parties, using dogs, frequently number up to a dozen and a half people, the lone *guardabosque* can scarcely be blamed for not coming to grips with this situation. This is especially true since support is often denied enforcement efforts by the *guardabosques'* superiors.

It is important to remember that often many of the hunters are after food that is acutely needed. A very large proportion of the country people in Mexico live at a bare subsistence level. They may have meat to eat only two or three times a month. If they poach for the pot, one can scarcely censure them. No effort has been made thus far to educate them concerning the value of national parks. Some of the park areas are still wild enough so that remnants of the fauna persist, to repopulate the areas, and thus reestablish normal conditions.

In such cases the hunting does not do so much harm as destruction of the environment.

Mexico is a land-hungry country. North Americans are likely to forget that when the Spaniards arrived in the sixteenth century, they found a heavy human population already established. This decreased for a time as a result of imported diseases and atrocious working conditions imposed by the invaders, but for many years the general tendency of the population curve has been upward. In the last 15 years, the population has grown more than 30 per cent.

Mexico suffers from a scarcity of arable land. This is calculated at 12 per cent, but it is likely that this estimate is over-liberal.

Agriculture has long invaded the slopes that are characteristic of most Mexican landscapes, and land destruction has reached catastrophic levels. In most parts of Mexico it would be literally impossible to find a square mile of cultivated land that was not suffering from erosion. The high and extensive plateau on which lies Mexico City was once an important forest area. Thousands of square miles of this, such as the maguey-dominated desert in Hidalgo, Durango, etc., once carried mighty pine and hemlock forests. They are gone, as is the topsoil that sustained them. In the process of destruction, the people tilled this land, but have now had to move into other areas.

The usual complex accompanying land destruction is being extended over wider and wider areas. Important rivers that once flowed throughout the year have become intermittent and subject to destructive floods in the rainy season. More than 300 Mexicans were drowned last September. Infiltration has been reduced, springs and artesian wells have dried, and the water table is falling over great expanses of land. As a result, there is less and less area to fill even the meager demands of the Mexican peasant, and he is constantly invading such wild land as is left, with plough, cattle, and worst of all, goats. Some of this land is, of course, included in the national parks.

One of the most difficult problems to solve in Mexico is the lack of fuel. Although the country possesses some coal in the north, it has never been developed for the general use of the people. There is an abundance of petroleum but no means of distribution. Furthermore, a substantial proportion of the Mexican people are so poor that they can not buy kerosene stoves at current prices. As a result, they depend on firewood and charcoal, for cooking and heating water and houses. As living standards go up and the cultural level of the masses is brought more into line with modern concepts, they take many more hot baths. This has a direct and immediate influence on forest resources, since trees are cut to provide fuel. There is perhaps no single conservation measure that would be so effective as the invention of a *cheap* stove to get the maximum use from petroleum products or wood, as a means of reducing the drain on forest lands.

There is relatively nothing being done to replace national forests as they are cut off. Neither selective nor block cutting is commonly used so that the forests will reseed themselves. Indeed, so much of the cutting is illegal that it could scarcely be organized on a sustained yield basis.

As a result of erosion, the area of grazing lands has been enormously reduced. This tends to force cattle, horses, sheep, and goats into wild lands, which frequently means national parks. There is probably none of them free from grazing. Many are overgrazed—overgrazed to such an extent that not only is forest reproduction impossible, but erosion has got such a start that vigorous measures will be required to stop it. Mexico has a small soil conservation service that is doing an excellent job. It is, however, totally inadequate to cope with erosion, which might be compared to a raging forest fire.

The destruction of forage, browse, and cover in the national parks is an important limiting factor on wildlife. Over much of the areas, there is an important limiting factor on wildlife. Over much of the areas, there is no understory. The parks, rather than resembling national parks as we know them, have more the appearance of parklike areas on European or British estates. There is little climax forest left in Mexico and even in national parks that have been lumbered over, repeated burning (to "improve" forage), grazing, and cutting, make impossible normal successions. The effect of this situation on wildlife is too obvious to require comment.

Basic to the whole problem is the very general apathy in regard to national parks in Mexico. Such a feeling for the land as characterizes many North Europeans and North Americans, is a rare phenomenon in Latin America where anthropocentrism is even more marked than among the North Americans and North Europeans. The existence of the Mexican national park system is in great measure due to the interest and vigorous effort of Don Miguel de Quevedo who succeeded in having a number of important national parks created. A farsighted man, with a considerable understanding of problems of land use, he recognized that such preserves had a multiple purpose, and that besides protecting Mexico's great natural beauty and its interesting wildlife, they were indispensable to conserving the country's always insufficient water supplies. In November 1944, in line with the current drive to industrialize Mexico, the boundaries of Colima National Park were changed by the Mexican Congress to exclude nearly the entire forested area. Since this park was set up in part to protect the water supplies of the city of Colima, the change is likely to have far-reaching results. It will, of course, mean the destruction of an important wildlife habitat. The timber is to be used in the manufacture of celanese in a plant financed, at least in part, by North American capital. This is, unfortunately, not the first Latin American national park for whose destruction North Americans are directly or indirectly responsible. Because of the impact of such operations on our relations with the nations to the south, these activities are quite properly the concern of every American citizen. From the point of view of sound land use and long term conservation, the destruction of important watersheds can not be defended. What the citizens of Colima are going to do for drinking water, sewage disposal, and water for industrial purposes once their watershed has been denuded, seems to have occurred to no one. What the citizens of Latin America are going to think of the unrestricted destruction of their natural resources, is something that every conservation-minded citizen should consider. Because industry often sees in the forest resources of national parks a chance to make a handsome profit, the defense of these areas and the creation of an attitude that will result in their preservation, are going to be exceedingly difficult. And the areas are going so fast that only quick action can save even a remnant of them.

With them, of course, goes much habitat indispensable to wildlife. This is far more serious in Mexico than in the United States because of almost complete lack of wildlife protection outside the parks—as well as within—and the very general destruction of environment. Only prompt and vigorous measures can save a number of species of animals and plants from extirpation, in Mexico. This is, as has been indicated, of a piece with the complete land-use situation in Mexico. Unless land-use patterns are radically altered, most of Mexico will be virtually desert within a hundred years.

NATIONAL AND INTERNATIONAL CONSERVATION PROBLEMS

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Hungry people are not happy. And there are many hungry people in Central and South America. Soil is worn out, its fertility is practically gone. Forests are being ruthlessly cut down, adding to the problem of soil erosion and further cutting down the water supplies. Education is sorely needed for all classes alike; for the administrators and officers who are responsible for the adoption and carrying out of programs and for the poorer classes who crudely cultivate the land which inadequately supplies these people with food.

While we do not have such an acute land problem in the United States, we suffer from erosion and floods. The war has cut deeply into some of our natural resources. Forests have been invaded to supply lumber to make tens of thousands of items for overseas. Our farms have been called upon to produce more so that not only our Armed Forces, but our Allies might have a sufficiency of wholesome food.

These problems are only a few of the many that face conservation in its broader sense now. In the postwar era when mankind will make the effort to increase his stature and standard of living, conservation will have to invoke every facility at its command if this continent is to prevent a social upheaval such as the world has seldom seen.

The basic principles of soil conservation are essential to recovery in the Americas, particularly in Latin America. Education is necessary to inculcate these principles. It is not for me to say how the standard of living and learning is to be brought about. This is a matter for the educators and experts. Doubtless the Pan-American Union will do much in this direction.

Good soil, water and proper knowledge of planting will produce food. Food in proper amounts is necessary to insure the health of the individual and the happiness of the nation.

I believe, therefore, that the greatest conservation problem that confronts us today is that of conserving our soil. And this can only be accomplished by fundamental understanding brought about by education, both in the school and the political arena.