ARMY TM 5-633
NAVY NAVFAC MO-100.3
AIR FORCE AFM 126-4

TECHNICAL MANUAL

NATURAL RESOURCES

FISH WILDLIFE MANAGEMENT

DEPARTMENTS OF THE ARMY, THE NAVY, AND THE AIR FORCE

FEBRUARY 1982

FOREWORD

This manual, together with the following manuals, provides guidance, standards, and technical information to personnel concerned with the protection and management of Natural Resources at Department of Defense installations:

Land Management—TM 5-630, AFM 126-2, and NAVFAC MO-100.1

Forest Management—TM 5-631, and NAVFAC MO-100.2

Outdoor Recreation and Cultural Values—TM 5-635, AFM 126-5, and NAVFAC MO-100.4

Advice concerning any procedure within this manual may be obtained from:

a. Department of the Army—Office of the Chief of Engineers (DAEN-MPO-B)

b. Department of the Air Force—Directorate of Engineering and Services AF/LEEV.

c. Department of the Navy—Naval Facilities Engineering Command (2042) or its Geographic Engineering Field Division (243).

Recommendations or suggestions for modification, or additional information and instructions that will improve the publication and motivate its use, are invited and should be submitted through appropriate channels to the addresses listed above.

TM 5-633
AFM 126-4
NAVFAC MO-100.3

TECHNICAL MANUAL
NO. 5-633
Air Force Manual
No. 126-4
NAVFAC MO-100.3

DEPARTMENT OF THE ARMY,
THE AIR FORCE, AND THE NAVY.

WASHINGTON, DC *1 February 1982*

NATURAL RESOURCES

FISH AND WILDLIFE MANAGEMENT

Table of Contents

Appendixes

List of Illustrations

List of Tables

CHAPTER 1. FISH AND WILDLIFE RESOURCES AND THEIR HABITAT

1-1. General

1-1.1. Scope. The Department of Defense has under its control and for its use in the United States a little over 25 million acres of land and water; and area approximately the size of the State of Kentucky. Within this large area are many ecosystems of which fish and wildlife resources are component parts. This manual provides guidance to all Army, Navy and Air Force installations having fish and wildlife resources. Fish and wildlife management activities on military installations will, insofar as possible, comply with the 7 April 1978 Memorandum of Understanding (MOU) between the Department of the Interior and the Department of Defense for the Conservation and Management of Fish and Wildlife Resources on Military Installations (app F). This MOU provides for cooperative plan agreements between the installation and appropriate state and Federal authorities (app G).

1-1.2. Definitions (See Glossary).

1-1.2.1. Ecosystem. An ecosystem can be defined as an ecological community considered together with the nonliving factors of its environment as a unit. Thus, there are various types of aquatic ecosystems, terrestrial ecosystems, and combinations of the two. United States military installations encompass streams, lakes, coastal and estuarine areas, forests, agricultural lands, grasslands, and desert scrub. These areas provide habitat for numerous fish and wildlife species, including some that are threatened or endangered.

1-1.2.2. Wildlife. Wildlife can be viewed broadly to include finfish or true fish as well as shellfish, starfish, jellyfish, and other invertebrates such as insects, slugs, and earthworms which are important as food-chain organisms. In addition to birds and mammals, reptiles and amphibians are considered as wildlife.

1-1.3. Plant-Animal-Soil Relationships. All living organisms use energy to perform their life functions. Green plants are of basic importance because, through the process of photosynthesis, they capture sunlight energy and store it in a form which plant-eating animals can use. The plant-eaters or herbivores, in turn, become the source of energy for meat-eaters or carnivores. Plants are also important because they provide cover or shelter, nesting materials, and den sites and serve as roosting or resting sites. Most plants require soil in which to root and grow. They require water and certain nutrients. Their abundance and distribution, aside from man's intervention and alteration, depend upon many factors such as soil types, soil-water relationships, temperature, precipitation, exposure, light, and wind. Plant types, variety, abundance, and distribution tend to determine the distribution of animals and the kinds of living communities found in different areas. On the other hand, birds and mammals which spread seeds have a role in the distribution of some plants. Insects and other animals aid in plant pollination. The burrowing of animals results in some mixing and aeration of the soil. Certain soil bacteria, fungi, and other microorganisms have a role in nitrogen fixation and in other symbiotic relationships. Although plant-animal-soil relationships are much more complex than described here, it should be obvious that alteration of the environment by man may have far-reaching effects on any given ecosystem.

1-1.4. Indicators of Environmental Quality. To the trained ecologist, the presence or absence of certain fish and wildlife species in an area may provide an indication of environmental quality, but the type of plant and animal community present is even more indicative.In aquatic ecosystems, the presence of a preponderance of certain types of algae, tubeworms, and carp may indicate a polluted situation, whereas the presence of other algae and trout or smallmouth bass may indicate water of high quality. Similarly, an abundance of house sparrows, starlings, or pigeons around housing quarters or office buildings may indicate that construction and landscaping was done without adequate consideration for the needs of more desirable forms of wildlife which require a diversity of trees, shrubs, and other vegetation. The bird species mentioned above use ventilation holes, nooks and crannies, and ledges for nesting or roosting, and they do not require much shrubbery.

1-1.5. Nature of Fish and Wildlife Management. Wild animals, in order to survive and multiply, must have food, cover, water, and a place in which to reproduce. They are subjected not only to natural environmental factors but also to conditions imposed by man. To date, man's recognition of fish

and wildlife values has been related primarily to benefits derived from hunting and fishing. More and more, however, aesthetic, scientific, and other values are being recognized. Historically, wildlife management has concentrated to varying degrees on control of the harvest of game species, control of predators which may take some game animals, establishment of refuges which may provide protection from hunting, release or restocking of desired species, and management designed to create better habitat. Currently, the emphasis in management is on laws and enforcement to protect and regulate the taking of fish and wildlife, and management of vegetation and other features of habitat to meet the food, cover, water, and space requirements of fish and wildlife.

1-2. Why Practice Fish and Wildlife Management?

1-2.1. In Relation to Military Installations. Many installations have served as wildlife refuges for decades. They offer unique management opportunities, both in terms of land and water resources and of control over land use, user activities, and public access. On many installations, productive fish and wildlife habitat, present at the time the installation was established, has been preserved, and enhanced. Land taken out of agricultural production has been permitted to revert to wilder conditions conducive to the production and preservation of certain wildlife species. However, there are additional opportunities for enhancement of wildlife, including agricultural wildlife, in areas farmed on an outlease basis. This is true although hunting and trapping, which help control populations of certain game and fur animals, must be limited on some installations for security or safety purposes. These installations can serve as natural preserves that assist in restocking adjacent huntable lands. Fish and wildlife merit attention in natural resource management programs. What is done with land and water resources in terms of forestry, outleasing or other activities will affect fish and wildlife.

1-2.2. In Relation to the Public Good. When managing natural resources, the inherent values of the resources should be emphasized. For example, good fish and wildlife management contributes to the recreational benefits which may be derived from fishing, hunting, bird-watching, nature walks, and other outdoor activities. Fish and wildlife management can also enhance scientific values. Shrub plantings can have aesthetic as well as wildlife and erosion control value. Sound land use and natural resources management programs create good public relations. Taxpayers are interested not only in military preparedness and efficiency but also in the way natural resources are managed on installations. User fees, where collected, supplement appropriated funds to provide habitat improvements, and this helps to relieve hunting or fishing pressures for all areas.

1-2.3. In Relation to the Law. Laws such as the National Environmental Policy Act of 1969 (1 January 1970, Pub. L. 91-190. 83 Stat. 852) and the Endangered Species Act of 1973 (28 December 1973, Pub. L. 93-205, 87 Stat. 884, and as amended 10 November 1978 by Pub. L. 95-632, 92 Stat. 3751) require Federal Agencies to consider the environmental impact of their programs and to insure the welfare of threatened and endangered species.

1-3. Safety Management and Administration. Safety considerations will be included in all aspects of fish and wildlife management to insure the safety of personnel participating in the program and of the visiting public. Safety guidelines are contained in App A-7.

1-4. Proponent and User Comments. The proponent agency of this manual is the Office of the Chief of Engineers, Department of the Army. Users are invited to send comments and suggested improvements on DA Form 2028 (Recommended Changes to Publications and Blank Forms) to HQDA (DAEN-MPO-B) WASH DC 20314.

CHAPTER 2. INVENTORYING AND EVALUATING POTENTIALS OF EXISTING HABITAT

2-1. General.

2-1.1. Definition and Scope. Habitat may be defined as the place where a plant or animal species naturally lives and grows or as the environment in which the life needs of an organism, population, or biological community are supplied. Sometimes, when a component, such as food or water, is either lacking or not present in adequate quantity or quality to meet the needs of a species, it can be supplied by management. The extent to which man can supply these missing components or can manage habitat to support larger populations of a species depends, in large part, on what he has to work with and the tolerance range of a species to different factors.

2-1.2. Requirements for Different Species. Some wildlife species have much more exacting requirements than others. For example, the nesting range of the Kirtland warbler is restricted to a relatively small area in the northern part of the Lower Peninsula of Michigan. The birds nest on the ground in sandy soil areas which contain stands of young jack-pine, five to 18-feet high, with ground cover of sweet fern, bearberry, and blueberry. The presence of open grown stands of young pine with living branches near the ground appears to be a very specific habitat requirement. To keep the pine canopy from closing and the trees from growing too tall, it is necessary, in the absence of forest fires which formerly occurred in the area, to do controlled burning. Similarly, in Florida, the Everglade kite is dependent upon a certain type of snail for its food. The birds are now confined largely to the Loxahatchee National Wildlife Refuge where marsh vegetation needed for nesting and aquatic areas for snails are being protected. On the other hand, the range of some animals such as the raccoon and opossum has increased; the house sparrow, starling, and common pigeon have all adapted well to urbanization, and the creation of fish ponds and other impoundments have made it possible to produce fish where fish habitat did not previously exist.

2-1.3. Inventory and Evaluation.

2-1.3.1. Existing Conditions. Basically, a wildlife manager works with the soil, water, and vegetation in an area and with existing wildlife populations whose diversity and size reflect the carrying capacity of an area. Wildlife management should recognize the environmental limitations of an area. Fish and wildlife populations should be related to existing habitat. Then, through evaluation of the soil, water, vegetation, and other environmental factors, together with a knowledge of fish and wildlife requirement, a determination should be made as to the potentials for fish and wildlife management through habitat manipulation.

2-1.3.2. Trends and Potentials for Management. Fish and wildlife inventories, conducted as described in Chapter 3, should be indicative of habitat conditions in a given area. If an analysis of annual population estimates over a period of years shows a decline in bobwhite quail and an increase in ruffed grouse, it probably indicates a decrease in farming activity and successive vegetative growth in old fields to brush and saplings, possibly supplemented with pine plantations. Increases in squirrel and wild turkey beyond this point may mean that plant succession has reached the stage of more mature forests with large, mast-bearing trees. Creel censuses showing a decline in bass and a preponderance of pan fish in fish ponds may indicate that there is too much fishing pressure on the predatory fish and not enough on the pan fish. Thus, a wildlife manager should know not only present habitat conditions but also habitat changes or trends, and how to counteract adverse trends. Among the changes, nationwide, are: the vast acres converted to urban use and the land use for more than 3.8 million miles of roads and streets. These developments have reduced wildlife habitats on both military and nonmilitary lands. Generally, little attention has been paid to the wildlife management potential of roadside rights-of-way and other lands associated with these developments. A wildlife or natural resources manager should evaluate not only the possibilities for maintaining or improving agricultural land and land in old fields, forests, and ranges but also land around housing developments, office buildings, warehouses, roadsides, and other improved areas. Roadsides, and rights-of-ways, provide travel zones, and edge effect, for some species, especially the endangered Red Cockaded woodpecker.

2-1.3.3. Information Needed. In discussing procedures for inventory and evaluation, it is possible to provide a general framework, only, of suggested approaches. Although a well-trained and experienced wildlife ecologist can develop some valid conclusions about existing habitat and its management potentials from short periods of visual inspection, preferably at different seasons of the year, a thorough inventory and evaluation of habitat is far more conclusive. Ideally, it involves: mapping vegetation, soils, and such features as roads and water bodies; photographs; and quantitative and qualitative measurements of physical, biological, and chemical features of the area. In inventorying and evaluating habitat with a view towards improved management, knowledge of the requirements of the species to be managed are necessary. Also, the extent and intensity of habitat evaluation depends upon management goals and objectives. Finally, experience has shown that it is often desirable to use techniques designed for a specific situation; i.e., a good method for measuring forage in understory vegetation may not be as good for measuring shrub vegetation valuable to birds.

2-2. Reconnaissance-Type Evaluation with Special Reference to Terrestrial Habitat.

2-2.1. Accumulating Data. In terrestrial areas, a reconnaissance-type evaluation will suffice for many management purposes. Such an evaluation primarily involves the preparation and/or use and interpretation of vegetation and soil maps and an assessment of food availability, either as agricultural crops or wild plant species. Preliminary to mapping, an area should be inspected by a wildlife specialist to note the types of wildlife present and to identify those portions of the area which require detailed vegetation maps. Also, the literature should be surveyed to determine if any publications describe the vegetation of the area. Copies of any relevant soil maps and any available records which show present and past land use, disturbance by fire, use of pesticides, severe floods, and the like should be assembled. Sometimes, it is possible to obtain unpublished information on soil types in a specific area from the local Soil Conservation Service or the state soil conservationist at the state agricultural experiment station. They may also help interpret soil maps or analyze soil with respect to the need for liming or fertilizing for increased production of food crops or to the suitability for construction of fish ponds or other impoundments. Topographic maps from the Geological Survey (app C, No. 6) should also be obtained. In addition to topography, these maps show stream courses and other features important in evaluating habitat. Finally, aerial photographs of an area are valuable. They may be available from the U.S. Department of Agriculture (app C, No. 4), the US Department of the Interior (app C, No. 6), the National Aeronautics and Space Administration (app C, No. 2) or the Department of Defense. Otherwise, for small areas, it may be possible to take large scale photographs. Photographs, particularly at a scale of 1:8,000 or less, taken of the same area at intervals of several years provide much information on land use, vegetation, and other trends and development.

2-2.2 Information Gaps. When available information has been assembled and interpreted, a wildlife manager can better determine what information is needed to complete the inventory and habitat evaluation.

2-2.3. Mapping and Recording Information. The emphasis in mapping and recording is likely to be upon vegetation in wooded, wetland, and old field areas rather than on cultivated fields, but consideration should also be given to the vegetation of roadsides and other developed areas. Mapping and analysis should identify the physical or geographic location of these areas in relation to cropland fields and should provide information on the composition and density of vegetation comprising the overstory, the understory, and the ground vegetation of wooded areas. Streams, lakes, and wetlands should be delineated on the maps, along with roads, developed areas, and military use sites.

2-2.3.1. Agricultural Areas. Habitat evaluation should reveal: the type, distribution, and acreage of agricultural crops; the liming and fertilizing needed to increase productivity; the planting and harvesting methods employed in relation to grain available as food; and the feasibility of permitting portions of crops to remain unharvested next to good cover as a wildlife management technique. It should show also the crop rotation in the various fields in case some alteration of the rotation might provide better diversity of food and cover. In mapping, careful attention should be given to delineating the width, plant composition, density, and height of vegetation along field borders, woods, and drainage ditches. Such borders provide travel lanes for wildlife and enable many species to feed on standing grain or crop residues or to nest in areas which otherwise might not be available to them. In mapping and evaluating old fields no longer tilled, the stage of grass or woody plant invasion should be noted. If much of the cover is made up of broom-

sedge or other grasses of relatively low wildlife value, the possibility of stimulating growth of annual plants with greater food value by liming, light application of fertilizer and disking should be noted. Also, if field inspections and soil and topographic maps reveal favorable conditions for construction of a small impoundment, it should be noted as a possibility for providing greater habitat diversity. Areas of well-drained, fertile soil close to woody cover may be indicated as potential sites for wildlife food plots. Opportunities should be noted, also, for development of cover lanes which intersect old fields and connect them with other existing cover. Special note should be made of tracts of native prairie grasses. Scrutiny of past land use and the incidence of fire in an area may suggest ways of maintaining these valuable biological communities, such as prescribed burning or some grazing.

2-2.3.2. Forest and Rangeland Areas. Many of the same approaches are applicable to forest and rangeland areas. However, it may be possible in the analyses of these more permanent habitat types to measure present conditions of the vegetation and then, make later measurements of the same areas or transects to determine long-term trends. In wooded areas, in particular, it is important to note the species and their densities and distribution in the ground cover, understory, and overstory vegetation. Probably this can best be done by establishing line transects through an area and conducting periodic inventories of the vegetation. Photographs of the transects and the use of a score card to record the condition of the vegetation are helpful. From a practical standpoint, it is important to note the number, size, and distribution of openings occurring in wooded areas. Such openings provide diversity of food and cover and may serve as breeding areas for many wildlife species. Any browse lines evident in areas not subject to grazing or browsing by domestic livestock should be noted as probable evidence of too many deer (fig 2-1). Forested areas with few openings should be recorded in order that the wildlife manager may consider creation of openings to improve conditions for grouse and other wildlife. Similarly, the presence of den trees and of plant species especially valuable as wildlife food sources should be indicated in the habitat inventory. Nesting trees for species such as the endangered bald eagle should be clearly designated, and roosting trees for such species as the wild turkey should be noted. The presence of linear habitat types resulting from power line and railroad rights-of-way, ditches, and roads, including logging roads, should be indicated on maps. Information about the existing management of rights-of-way vegetation should be recorded. Possibilities for improvement, such as maintaining buffer strips of vegetation between roads and streams or planting grass mixtures or shrubs on road rights-of-way for cover and food, should be noted.

Figure2-1. Deer browsing.

2-2.3.3. Improved or Developed Areas. It is recommended that the inventory and evaluation of habitat include improved or developed areas, such as installation entrances, roadways, headquarters and office building areas, housing areas, golf courses, and other recreation areas. It is here that most personnel will have an opportunity to observe wildlife on a day-today basis. Feeding, watering, and nesting sites can be provided in cantonment areas. Habitat evaluation for these areas should note the width of grass areas along roads and the types and spacing of shrubs and trees. If roadside vegetation consists of broad strips of closely cut grass, a wildlife manager may recommend reducing the width of the mowed area and permitting the remainder to revert to more natural vegetation, or he may suggest planting shrubs valuable to wildlife. If the grounds around office buildings and living quarters have little diversity of vegetation, he may recommend planting additional species beneficial to wildlife and converting the area from tall trees and grass to several layers of vegetative cover. Less frequent mowing of grass may also be advisable.

2-2.4. ***Sampling.*** In large areas, it is impractical to measure in detail the vegetation in the entire area; hence, vegetative sampling is done, usually by means of sample plots. The size and number of plots depend upon the kind, density, and distribution of the vegetation. Larger plots, one-fifth acre or more in size, are necessary for trees; one twenty-fifth acre has been suggested for shrubs; and plots of one one hundredth acre may suffice for herbaceous ground cover. Sampling vegetation is discussed in many publications, including Wildlife Investigation Techniques which is available from the Wildlife Society (app No. 14).

2-2.5. Evaluating and Ranking. Methods of evaluating and ranking different types of habitat for different species have been developed into a Handbook for Habitat Evaluation Procedures (App A). Although written specifically for a site in Crawford County, Missouri, this handbook contains criteria that can be applied to the oak-hickory forest section of the eastern deciduous forest. Also, it can be used as a prototype for developing handbooks for other parts of the nation. The authors suggest first determining the habitat types for each region; then determining from an extensive literature search the habitat needs for each species. Evaluation elements are identified; criteria for measuring the capability of an area to support the species or groups of species in question are developed; and forms are prepared for rating the various characteristics of the area in the field. The most critical habitat factors can be given a maximum score of 10; less critical factors range only to a maximum of five. On the evaluation form, provision is made for both the possible and actual scores for the habitat characteristics and for a total habitat value. The U.S. Fish and Wildlife Service 1979 publication entitled Habitat Evaluation Procedures (HEP) provides guidelines to facilitate the evaluation of resource development project impacts on wildlife resources from a habitat approach. The Service has developed Species Criteria Handbooks to be used with their procedures. These documents are available through the Project Impact Evaluation Team Office, Division of Ecological Services, Fish and Wildlife Service, US Department of the Interior, 2625 Redwing Road, Fort Collins, Colorado 80526.

2-3. Stream Habitat Surveys. Stream habitat surveys should involve measurement and evaluation of physical, biological, and chemical characteristics.

2-3.1. Physical Data. In addition to mapping streams, information should be compiled on: the velocity, width, depth, temperatures and volume of the stream flow at different seasons of the year; the gradient; flooding frequency and extent of time; type of bottom; and areas suitable for spawning beds. Information on low flow may be crucial for different aquatic organisms. Methods for developing a physical analysis to evaluate instream flow needs are treated in considerable detail in Investigation into Methods for Developing a Physical Analysis for Evaluating Instream Flow Needs (app B, No. 81). In areas with abundant groundwater, it may be possible to improve trout streams, for example, by augmenting low flows with pumped groundwater, as described in Improvement of Trout Streams in Wisconsin by Augmenting Low Flows with Groundwater (app B, No. 78). The evaluation should indicate those streams which, because of roadbuilding or other construction, have been channelized and may need to be rehabilitated with low dams, reflectors, or other devices. Existing or planned road construction which requires culverts on streams used by anadromous fish should be noted to assure that the culverts are designed to permit stream passage of these fish. The presence of dams or other barriers should be recorded. In the case of intermittent streams, the presence or absence of deep holes which retain water during dry periods should be indicated. The stream inventory should reveal the presence of oxbow lakes, waterfalls, pools, and stretches of riffles, as well as quiet backwaters and islands which may be important to wood ducks and beaver. Descriptions of the streambank soil and its stability are also helpful. Information on the land forms or geologic formations may be useful in determining both susceptibility to erosion and the type and nature of the bottom material in the stream. Bottom materials may be categorized as sand, silt, clay, muck, fine gravel, coarse gravel, rubble, boulder, or exposed bed rock.

2-3.2. Biological Data.

2-3.2.1. Animal Populations. Biological surveys should include not only the various fish but also the organisms on which they feed. Vegetation, both within the stream and along the bank and adjacent land areas, has an important bearing on fish and wildlife using the stream habitat. Suggestions on inventorying fish populations appear in paragraph 3-14. Assistance in inventorying insects and other aquatic invertebrates may be obtained from respective state conservation departments or, perhaps, from local universities. Usually, aquatic vertebrates are collected with specifically designed equipment such as bottom samplers. Samples are taken from transects across riffles, pool areas, and elsewhere from bank to bank, are stored in a preservative, and are then sorted and analyzed in a laboratory. The population-size and diversity of species can reveal much about the quality of the aquatic habitat. Evidence of beaver activity should be recorded, including whether beaver cuttings are current or old, and whether beaver dams exist. Such dams may be of considerable importance to fish and waterfowl production.

2-3.2.2. Vegetation. Vegetation on stream banks and in adjacent areas should be noted according to principal species, height, and density. The percentage of the stream water surface that is shaded

at midday should be noted, as well as the extent to which there is vegetation overhanging the stream at different heights. It is suggested in Techniques for Conducting Stream Habitat Surveys on National Resource Land (app B, No. 29) that vegetation must be twice as high as the distance to the water's edge to be effective for shade and water temperature control. From this standpoint, higher vegetation is most effective. However, from the standpoint of aquatic cover and, presumably, the insects and other food materials falling into the water, vegetation overhanging the surface within a foot is most valuable, as suggested in A Handbook for Habitat Evaluation Procedures (app A, No. 8). Vegetation in the stream may be described as to occurence of higher plants (e.g., shrubs), algae, and mosses, or as to occurrence of submergent (pondweeds, Elodea, waterweed, water milfoil, etc.), emergent (cattails, bulrushes, etc.), and floating (duckweeds, water hyacinths, waterlilies, etc.) plants. The importance of some of these plants will be discussed later. If plant life is rare or absent, it should be noted on the inventory form. The presence of tree tops or other debris which may provide cover should also be noted.

2-3.3. Chemical and Water Quality Measurements. Water quality measurements include water temperature, turbidity, pH, dissolved oxygen, carbon dioxide, alkalinity, and conductivity or total dissolved solids. Measurements may be needed, also of nitrates-nitrites, phosphates, trace minerals and heavy metals, sulfates, sediments, detergents, and other pollutants. Note should be made of any evidence of pollution. Installations should utilize the services of military medical or environmental laboratory personnel who make field visits for the purposes of sampling and or continuous monitoring to determine environmental quality deficiencies.

2-3.4. Additional Information. Helpful suggestions for conducting stream habitat surveys appear in Techniques for Conducting Stream Habitat Surveys on National Resource Land (app B, No. 29). Also useful is "Geomorphic and Aquatic Conditions Influencing Salmonids and Stream Classification with Application to Ecosystem Classification" (App B, No. 85).

2-4. Lake and Impoundment Habitat Surveys. A map of the lake or impoundment should be obtained if one is available, or one should be made.

2-4.1. Physical Data. There should be one map showing the relation of the lake or impoundment to other features of the area, including wooded areas, agricultural fields, and other bodies of water. A more detailed map showing contours, depth, and other features such as shoreline, islands, and inlet and outlet streams is also necessary. Additional desirable information for the map includes the location of dams or other water control structures and evident beds of emergent vegetation. For ponds and larger impoundments, information on the source of water should be provided. Generally, the same types of physical, biological, and chemical information required for stream habitat surveys (para 2-3) are needed for lake and impoundment surveys. Knowledge of the fluctuation in water volume and depth can be important, as well as information on the thermocline and turnover and mixing of the water, and the potential for fish kill during winter freeze-ups. Management involving the use of chemicals in ponds or small lakes requires, for best results, that the volume of water be known. Often the volume is determined by surface area times mean depth or by the flow rate through fill pipes. In small, unstratified ponds, it is possible to obtain similar results by adding feed-mixing salt to the pond and determining the increase in chloride concentration through titration. Pond volume may be calculated by the formula $V=W/(C \times 2.718144)$, where V is the volume of the pond in acre-feet, W is the weight (in pounds) of added chlorides, and C is the change in concentration of Cl in parts per million. This formula is further discussed in "Salt Method for Determining Pond Volume" (app B, No. 86). Data on the length and type of shoreline and on bottom types can provide clues to the potential for fish spawning beds or for use by shorebirds and other wildlife.

2-4.2. Biological Surveys. The biological survey should provide information on fish in addition to floating, emergent, and submerged plants present. Plankton samples provide some indication of the productivity of a lake. The presence of abundant populations of tubeficid worms, leeches, or rat-tail maggots (the larvae of Syrphus flies or the so-called "pollution fungus", *Sphaerotilus natans*) may be indicative of pollution from domestic sewage. While emergent plants around the edges of an impoundment may provide good habitat for aquatic furbearers, they may interfere with fishing.

2-4.3. Water Quality. The same types of measurements discussed in subparagraph 2-3.3. should be part of the lake and impoundment survey. Water temperatures and dissolved oxygen content should be taken at the surface, at the bottom, and in the thermocline zone, in order to provide information as to the limitations or capabilities of deeper impoundments to support both cold and

warmwater fisheries. Turbidity may be of considerable concern in some reservoirs and lakes since it reduces photosynthesis and overall productivity and may harm fish directly. Sometimes, in shallow water, carp will cause turbidity. If fish sampling, which should be a part of the habitat evaluation procedure, indicates too many carp or other coarse or undesirable fish, the biologist may wish to remove them.

2-5. Wetland Habitat Surveys.

2-5.1. Definition. There is some overlap in wetlands with riverine habitat, with small, shallow lakes and ponds, and with the marshy vegetation which may surround larger lakes. Wetlands are covered by shallow and, sometimes, temporary or intermittent waters. They include marshes, wet meadows, bogs, swamps, potholes, dugouts, sloughs, wet river-bottom lands, and areas of waterlogged soils.

2-5.2. Importance for Wildlife. Wetland habitats are important in the production of waterfowl and aquatic mammals. They also provide food and cover for many other species such as woodcock, pheasant, raccoon, deer, heron, crane, and many song birds. Salt marshes are important components of the estuarine zone and are among the most productive of habitats, biologically.

2-5.3. Physical Data. It is desirable to have good maps showing the size and location of wetlands in relation to the overall area of concern. The area map should show general cover and land use, roads, buildings, fence rows, drainage ditches, streams, and other features. In addition, soils maps and information on soil-water conditions should be made available. A detailed map of the wetland area should also be prepared. The above information, coupled with data from wildlife population inventories and a knowledge of the requirements of individual species, should enable a wildlife manager to assess present habitat and determine its potential for further development.

2-5.4. Plant-Soil-Water Relationships.

2-5.4.1. The detailed map or maps should show the amount of open water in a wetland area in relation to areas of emergent vegetation and vegetation on the surrounding uplands. Information is needed on the depth of potholes or other open water areas and on the quality of the water. In the important duck-producing area of the Dakotas and Minnesota, it has been found that, with the mallard, a small pond will accommodate only one or two pair of mated birds during the mating period. Thus, the number of ponds or potholes is critical to the breeding requirements of this species, even if some of the ponds dry up after incubation of the eggs begins. Once the ducklings have hatched, however, the deeper potholes with permanent water are needed for brood rearing. By this time the territorial defense mechanism which prevents more mallards from utilizing the deep-water pothole during the mating season is no longer operative and several broods of mallards can occupy the deeper water body. Thus, where deeper potholes are not surrounded by shallower ponds, a wildlife manager may wish to consider creating open water areas in the surrounding emergent vegetation. Opportunities and conditions necessary for creating greentree reservoirs to attract waterfowl are treated in subparagraph 6-2.5.10.

2-5.4.2. Vegetation maps should be sufficiently detailed to indicate the major species or types of aquatic plants present and the height and density of the cover. Vegetation in the near vicinity of the water areas should be mapped also. For example, if within the breeding range of the wood duck, there are few trees on wet river-bottom lands with cavities suitable for the nesting of this species, this fact should be noted. Then, in evaluating the potential wildlife productivity of the area, the wildlife manager may wish to install nest boxes for this species. Similarly, if the habitat inventory shows soil and water conditions suitable for the growth of alders within the range of the woodcock, the manager may wish to plant or encourage the growth of alder thickets, a favorite habitat for woodcock. It should be noted that in addition to the chemical analyses of soil and water which should be a part of a comprehensive evaluation of wetland habitat, vegetation in itself can be indicative of the prevailing conditions. For example, pickerel weed, burrweed, and arrowhead may indicate moderately low pH while saltmarsh bulrush, saltgrass, and glasswort are typical of alkaline areas with a pH of 7 or above. Salt marsh cordgrass in large unbroken stands is an indicator of regularly flooded salt marshes. The Techniques Handbook of the Waterfowl Habitat Development and Management Committee (app B, No. 4) provides very helpful guidelines for habitat evaluation and its development and management in the Atlantic Flyway.

2-6. Technical Assistance. Much attention is being given to the classification, inventory, conservation, and management of fish and wildlife habitat by many Federal agencies. The Fish and Wildlife Service, in cooperation with other agencies and organizations, sponsored a symposium in 1977, on "Classification, Inventory, and Analysis of Fish and Wildlife Habitat". Proceedings of this symposium should be invaluable in developing systematic,

ecologically-based classification schemes. The Fish and Wildlife Service is also engaged in developing a classification of wetlands and aquatic habitats of the United States and procedures for evaluating water and related land resource development projects as they relate to monetary and nonmonetary fish and wildlife values. Further information can be obtained by contacting the Fish and Wildlife Service (app C, No. 6). The Bureau of Land Management (app C, No. 6) is deeply involved in developing an integrated habitat analysis system incorporating biomes described as tundra, boreal forest, coniferous forest, deciduous forest, woodland—brushland, grassland, desert, and ocean. The Bureau has also produced a series of informative "Technical Manual Supplements" dealing with the life history and habitat requirements of such species as the pronghorn antelope, mule deer, dabbling duck, mourning dove, and sage grouse. The Forest Service (app C, No. 4) is engaged in comprehensive inventories of forest and related resources, including fish and wildlife.

CHAPTER 3. METHODS AND PROCEDURES FOR INVENTORYING FISH AND WILDLIFE POPULATIONS

3-1. General.

3-1.1. Definitions. Requisite to establishment of fish and wildlife management goals and objectives is a knowledge of the species, the sizes and trends of populations in the area, and the habitat potential for these species. It is necessary to know the habitat requirements of various species and, under existing or potential habitat conditions and with current or projected supply and demand, which species warrant special attention. This section deals with some of the principles and most practical approaches for inventorying fish and wildlife. Since many of the techniques in this chapter require technical expertise, experience and special equipment, it is suggested that assistance be obtained from state Fish and Game Agencies and the US Fish and Wildlife Service. Strictly speaking, a census of a wildlife species on an area is a count of the present number of individuals of certain species but may include other vital statistics such as sex and age. Two types of census are possible: the complete census and the sample census.

3-1.1.1. Complete Census. The complete census is a complete count or tally of animals over a specified point in time or a specified interval of time at a specified point in space (area). Except under very unusual circumstances (perhaps with a threatened or endangered species confined to a small area), complete counts are impractical. Furthermore, the costs involved cannot be justified and generally are unnecessary for management purposes.

3-1.1.2. Sample Census. The sample census is a count of animals in a specified area at a specified time.

3-1.2. Needs and Problems. Inventories of wildlife populations are used to evaluate management practices, indicate potentials, determine total harvest and mortality and for public information. Indices which show the trends in the wildlife populations of an area from year to year normally are sufficient for management purposes. An index is a count or ratio which is related in some sense to the total number of animals in a specified population. Even with indices, certain problems are obvious. Generally, the animals are secretive, mobile, and not randomly distributed because they favor a particular type of habitat. They vary in number from season to season, usually reaching their highest number at the end of the reproduction season. Many are active at night or spend much of their time in ground burrows or hollow trees. Many have a very short life span, and all are subject to mortality, whether from hunting, man-caused accidents, or natural causes. For management purposes, indices should be separated according to habitat type in order to determine which types are supporting desired species. Specific harvest data, e.g. age classes, sex ratios, parasite counts, ovulation rates as well as the degree of desperation foods utilized, are positive indicators of population trends and management needs.

3-1.3. Principles and Approaches. Because of the natality (birth rate), mortality, and movement of animals, it is desirable to conduct an inventory in a short period of time at a season when mortality, ingress, and egress are negligible. Otherwise, corrections must be made in the index. Also, it is generally assumed that all members of a population have an equal probability of being counted or included in the inventory. This is not always the case because behavioral traits may differ according to age or sex of the animals, season of the year, or weather conditions. Corrections in the index for such factors can be made only on the basis of knowledge of the species gained from intensive studies or published literature. However, if inventories are made as nearly as possible under the same conditions from year to year, trends in the size or make-up of a population will be indicated sufficiently well for a manager to judge the effectiveness of his program without having all of the intricate details of population dynamics. Good reviews of the principles and approaches to wildlife inventories appear in "Estimating the Number of Animals in Wildlife Populations" (app B, No. 82), "Estimating the Numbers of Game Populations" (app B, No. 25), "Wildlife Census Methods: A Resume" (app B, No. 61), and "Ecological Evaluation of Wildlife Populations and Habitats Affected by Highway Development: Phase I" (app B, No. 1). The Handbook of Computations for Biological Statistics of

Fish Populations (app B, No. 88) deals with methods for inventorying fish populations.

3-1.3.1. Sampling Schemes. Since it is usually impractical to count all individuals in a population in large areas, sampling becomes necessary. Inventories are conducted on part of the area or time dimension of the population. The portion sampled is assumed to be representative of the total population. Every effort should be made to develop a statistically sound sampling plan and to properly analyze the data collected. This can best be done with the help of a biometrician or statistician familiar with biological sampling. Several sampling schemes and many census or inventory techniques may be used, according to the particular species, time, place, area, and purpose for making the estimate. Basically, there are two steps in inventorying an animal population: obtaining the data and calculating the result or ratio of animals seen or heard per unit of time, area, trap, etc., to a known ratio of animals per unit. Inventories of wild animal populations usually are based upon counting animals directly, counting animal signs such as tracks or calls, or using index counts or ratios (i.e., counting some object which is related in some numerical way to the animal, such as estimating the number of whistling males.)

3-1.3.1.1. Harvest Check Stations. The game bag and creel census represents the best sample of wildlife on military installations. A complete sample can normally be checked because of the security and safety requirements on most installations. Operation of check stations to determine weight, number of points, general condition, etc., by nontechnical personnel is an expensive operation of no value to scientific management. Any game or creel check should be accomplished by technically qualified people. Physical, biological, and chemical data which can be collected includes weight corrected for extent of field dressing, sex, age, parasites, injuries, ovulation rates, sexual maturity, blood and tissue samples, specific physical measurements, and stomach/craw record.

3-1.3.1.2. Transect Method. One of the most versatile and useful methods for inventorying wildlife populations is the transect method of sampling. This method can be utilized after a cover map has been prepared (subpara 2-2.3.). The cover map can be used to select representative habitats for establishing transect count routes. The intensity of sampling of each habitat type depends upon available manpower (and other associated costs) and upon the inherent biological variability of the population to be sampled. The greater the variability, the greater the number of samples needed to obtain a given level of precision. In many cases, an estimate of the variability can be obtained by consulting with local biologists. If this is not possible, then the first year's data collection effort should yield such an estimate, and the sampling intensity for following years can be adjusted accordingly. The transect method is discussed in relation to various inventory techniques below. Further details regarding the line transect approach can be found in Guidelines for Line Transect Sampling of Biological Populations (App B, No. 3). However, transect lines are designed and located as follows:

3-1.3.1.2.1. A grid system should be overlaid on the cover-type map. The grid should consist of lines running North to South and East to West at 100-yard intervals. A cover-type description can then be assigned to any of the 100-yard segments. The transect line used for wildlife inventories should consist of a number of contiguous 100-yard segments. The manager must systematically and/or randomly select the starting point of each transect line. For example, he could randomly select the first point and systematically select the rest. It may be necessary to locate the beginning points of some transect lines close to a road to facilitate access. If an installation is too large for the grid technique, sample locations can be selected by the coordinate system or by an expansion of the grid technique, such as a grid based on 200-yard segments.

3-1.3.1.2.2. Upon determining the point at which the transect line will be initiated, two flips of a coin can be made to decide whether the transect line will run North, South, East, or West. Each transect line should consist of at least twenty 100-yard segments. These can be arranged in the most efficient configuration. Remember, each cover type should be sampled in a representative way. The basic sample plot will be 100 yards × 100 yards, bisected by a central transect line. The series of segments should be continuous, if possible, for maximum efficiency. Other alterations of this suggested scheme may be necessary, depending upon specific circumstances. However, some form of randomness must be built into the sampling scheme. This should be done even if a systematic sampling plan is used (by randomly selecting the first point, for example).

3-1.3.1.3. Size of Sample for Randomized Sampling Scheme. A manager needs some idea of the magnitude of error he can accept. Generally, wildlife biologists will accept an error of plus or minus 10 to 20 percent of the mean value (mean number of

animals per plot, etc.). A manager must also decide what chance he can take that the error will exceed 10 to 20 percent. A five percent chance is accepted in many cases.

Then $$n = \frac{t(0.05)^2 S^2}{(0.2\bar{x})^2}$$

where
- n = required sample size
- $t(0.05)$ = t value from t-distribution
- s^2 = sample variance
- 0.2 = an acceptable error of 20 percent of the mean
- $\bar{x}$ = sample mean.

3-1.3.2. Determining Trends by Using Indices. Upon completion of the field aspects of an inventory, all data should be edited according to rigorous standards, transcribed to punch cards, and subjected to a series of computer programs to verify, summarize, and analyze the current year's inventory data and to estimate probabilities associated with changes in the indices from previous years. In this computation, the test statistic should be:

$$z = \frac{\bar{D}}{\sqrt{\widehat{Var}\ (\bar{D})}}$$

where $$\widehat{Var}\ (\bar{D}) = \frac{2}{N^2} \sum_{i=1}^{N} \widehat{Var}\ (X_{i,p}),$$

where $$\widehat{Var}\ (X_{i,p}) = \frac{\sum_{j=1}^{p} (X_{i,j} - \bar{X}_i)^2}{p-1},$$

and $$\bar{X}_i = \frac{\sum_{j=1}^{p} X_{i,j}}{p},$$

where D denotes the mean change from year p–1 to year p in index value for all lines compared,
- p denotes the present year,
- N denotes the total number of lines run in both year p and year p–1,
- i denotes line i,
- j denotes year j, and
- $X_{i,j}$ denotes the index value for line i in year j.

The above formula requires the assumptions that the lines are independent of each other, and that the variance for a given line is homogeneous from year to year. Data should be summarized in tabular form as follows:

Years compared	Number of comparable lines	Average index for comparable lines	Percent change	Probability

Comparable lines are those lines run in each of the two years being compared. Probability can be obtained from a z table of normal curve areas using z values calculated from the above formula. This table and a description of its use appear in Manual of Experimental Statistics (app B, No. 36).

3–2. Big Game.

3-2.1. Scope. Big game described herein include: deer (mule deer, white-tailed deer, elk, moose, caribou), sheep, mountain goat, pronghorn antelope, collared peccary, and bear (fig 3–1).

Figure 3-1. White-tailed deer.

3-2.2. Pellet-Group Counts. Systematic pellet-group counts, as described in "The Pellet-Group Count Technique for Big Game Trend, Census, and Distribution: A Review" (app B, No. 76) have been used for a variety of research and management objectives. The chief advantage is that pellet groups can be sampled by standard field plot techniques. Most pellet-group plots are circles or long, narrow rectangles, distributed in some form of stratified-random design. This means that plots are grouped together on the basis of similarity of some characteristic such as habitat type. Each group or stratum is then sampled, and the group estimates are combined to give an index. Sampling intensity estimates can be made on the basis of mean and variance derived from preliminary sample counts. For determining sample size needed to produce a desired degree of sampling precision, a manager should refer to the formula described in sub paragraph 3-1.3.1.2. Pellet counts should be made within permanently marked, 0.02-acre, circular plots (diameter 33.3 feet) which are periodically cleared of old pellets. Two 0.02-acre units should be sampled within each 100x100-yard plot and located along the central transect line. Circular plots should be randomly located on the transect line in such a way that they do not overlap. Within each 0.02-acre unit, the observer should record the number of big-game pellet groups by species. Identification of pellets to species can be made by consulting A Field Guide to Animal Tracks (app B, No. 75). Observer bias may arise mainly from

ferences in interpretation and from missed groups. Therefore, all observers should carefully adhere to standards for interpretation of pellet-group identity. Observer error can be avoided by continuously using the same observers. However, if observers change with time and area, observer correction factors should be developed. The "confidence limits" on such correction factors will necessarily be wide, and periodic rechecks will be needed. Optimal time for pellet-group sampling is in early spring (March 1 to April 1), prior to new vegetation growth. Relative pellet-group density on an installation over a period of years can be calculated as described in "Estimating the Numbers of Animals in Wildlife Populations" (app B, No. 82). An index to big-game use can be determined for each big-game species by counting the number of pellet groups in each plot.

Then, let $t = \left(\frac{1}{n\acute{a}}\right) \Sigma y = \frac{1}{a} \Sigma y$

Where Σy = the sum of groups counted over all n plots
$\acute{a}$ = The area of one plot
$a = n\acute{a}$

then t is expressed as pellet groups per unit area.

3-2.3. Track Counts. Big-game track and trails which cross the pellet group plots should be recorded during the pellet-group surveys, as described in "Estimating the Numbers of Animals in Wildlife Populations" (App B, No. 82). A Field Guide to Animals Tracks (app B, No. 75) is useful for these counts.

3-2.4. Drive Counts. Drive counts are often possible for such populations as deer. The technique is variable and is usually modified by the particular area. Two crews of observers are required: one crew to drive the area, the other stationed around the area to monitor animals entering or leaving. A suitable area is one that can be monitored on the boundaries. Well-defined and cleared boundaries are desirable since monitors must be able to clearly observe the boundary at least to the next observer. This technique is further described in "Estimating the Numbers of Animals in Wildlife Populations" (app B, No. 82). Drive counts may be desirable as a method to compare with the pellet-group count technique. A sufficient number of observers must be available to cover the area properly and to insure that no animals are uncounted. The total number of animals can be calculated as the sum of animals leaving the area ahead of the drive crew plus the sum of animals passing back through the drive line. The sum of animals passing forward through the drive line is then subtracted from the total count to yield the net count.

3-2.5. Aerial Surveys and Photographs. Aerial surveys can be used as a census approximating a total count on terrain of moderate relief in prairie areas, as described in "Aerial Census of Big Game in North Dakota" (app B, No. 96), and in coastal marshes, as described in The Everglades Deer Herd Life History and Management (App B, No. 65). Surveys should be done early in the morning and late evening. Aerial photographs can be valuable checks on aerial surveys. Large-scale photographs taken along the flight line of the survey aircraft and examined carefully can provide more accurate counts of big game which are partially hidden under trees. Photographs also form a permanent record of the condition and occupied areas of the range. Additional information about aerial surveys appears in "Aerial Photographs, Their Interpretation and Suggested Uses in Wildlife Management" (app B, No. 59).

3-2.6. Harvest Records. Daily bag checks of harvested game should be made during the hunting season in order to determine trends in game populations and to determine how many hunters should be permitted on an installation while maintaining a reasonable rate of hunter success. Other factors such as safety, installation size, terrain, and location also dictate how many hunters should be allowed. Data on age and sex composition of game can be obtained from harvest records. The techniques of aging and sexing of game animals are described in "Estimating the Numbers of Animals in Wildlife Populations" (app B, No. 82). It is also important to locate where animals examined were actually killed. This requires good maps, an interviewer familiar with the installation, and much patience. If it is not possible to interview each hunter in person, game-kill surveys can be made by contacting hunters by mail. Accurate records should be kept on the following: date, location, weather conditions during the hunt, man-hours hunted, kill or harvest per day or per man-hour hunted, and game observed. The restricted nature of most installations should permit virtually all hunters to be surveyed. Records of harvest should be kept for all game species, predators, and nuisance animals.

3-2.7. Browse Surveys: For all animals that browse and/or graze, a browse survey should be run to determine the relation of these animals to their food supply. This is far more important than the total number of animals and will provide information the manager can use.

One method for taking data on browse use which has found wide application was developed by

Aldous (1944). This is a plot system along transect lines by which use of food species as browse is compared with the amounts available. In addition to measuring degree of use, the method also indicates relative palatabilities among the species present. Aldous, S.E., 1944, A Deer Browse Survey Method, J. Mammal. 25: 130–136.

3-2.8. Petersen or Lincoln Index: This method is well suited to work with hunter bag check or creel census where all animals taken by hunters and fishermen are checked by base personnel. It involves first capture and marking a segment of the population. The assumption has to be made that the trapped, tagged and released animals are an unbiased sample of the total population. The second sample of captured, killed or bagged animals is also an unbiased sample. Refer to the book Wildlife Management Techniques by the Wildlife Society, 1971, for details.

3-2.9. Other Methods. Other methods range from direct counts of congregating deer and elk to rather complex techniques involving marked animals. While these may be of value in some cases, they can be unreliable, very expensive in terms of time and effort, or just not necessary for inventorying on military installations.

3-3. Terrestrial Furbearers and Mammalian Predators.

3-3.1. Scope. Terrestrial furbearers described herein include: opposum, porcupine, skunk, raccoon, ringtail, weasel, badger, fisher, pine marten, wolverine, mink, fox, coyote, wolf, bobcat, lynx, cougar, and bear.

3-3.2. Scent Stations and Track Counts. The presence of tracks at scent stations should be the principal method for sampling terrestrial furbearers. A flexible wire hoop, 39 inches in diameter, is an easily handled template. A thin layer (0.25–0.50 inches) of fine-textured soil over a hard surface produces tracks of the highest quality. Where proper soil conditions do not exist, it may be necessary to import soil. A two and one-half-gallon pail holds sufficient soil to prepare one station. A small mason trowel works well for smoothing the soil. A small watering can may be used to moisten soil under dry conditions. Scent stations should be located 100 yards apart on the centerline of the transect. The following are effective baits: a paste made from canned sardines, commercially prepared fox lure, and egg attractant which should be readily available from the Fish and Wildlife Service Animal Damage Control Office (app C, No. 6.c.(1)) or Denver Wildlife Research Center (app C, No. 6.c.(4)). Bait is placed in the center of a station. Then, all tracks present at the station are counted and identified as to species by consulting a field guide such as "A Field Guide to Animal Tracks" (app B, No. 75). After checking, the area should be cleared of tracks for the following night's operation. Stations should be operated for three consecutive nights. Scent station sampling should coincide with small mammal trapping. Good references on the scent station method include "Determining the Relative Abundance of Coyotes by Scent Station Lines" (app B, No. 64) and "Scent Station Index of Black Bear Abundance" (app B, No. 63).

3-3.3. Indices. Visitation indices can be obtained for each survey line by totaling the number of stations visited by each species for three nights. The total number of scent-station nights is derived by subtracting from the total number of station nights all nights that were inoperable because of weather, human interference, or animal interference (e.g., by cattle). In this context, an "inoperable" station is one for which predator tracks, if present, could not be distinguished. The index is calculated for each species of interest as follows:

$$\frac{\text{Total Number of Visits}}{\text{Total Number of Operable Station Nights}} \times 1{,}000 = \text{Index}$$

For example, a line with 20 coyote visits and 120 operable scent-station nights results in an index of 167 (i.e., $\frac{20}{120} \times 1{,}000 = 167$).

3-4. Aquatic Furbearers and Woodchucks.

3-4.1. Scope. Species described herein include muskrat, beaver, nutria, otter, and woodchuck.

3-4.2. House and Trail Counts and Indices. Indices should be obtained by counting active lodges, dens, houses, and trails which occur within 100 yard × 100-yard transect segments, linear segments of stream, or point counts in a defined radius. An active house is determined by signs of activity. The number of individuals per house will vary within and between species. An index to relative abundance for each species can be obtained by using the following formula:

$$\frac{\text{Total Number of Active Houses or Trails}}{\text{Total Number of Transect Segments}} = \text{Index}$$

These counts should be made annually during the summer. Methods for inventorying muskrat and beavers are described in "Estimating Muskrat Populations by House Counts" (app. B, No. 28) and "Beaver Census Methods in the Rocky Mountain Region" (app. B, No. 44).

3-5. Rabbits and Hares. Pellet counts for rabbits and hares should be a subsample of the circular, 0.02-acre plots used for big-game mammals. The subsample plot should be 0.01-acre. Records of pellets within these plots should be treated as in big-game pellet counts (subpara 3-2.2.).

3-6. Tree Squirrels and Chipmunks. Observations of diurnal mammals should be made while sampling birds and small mammals. See paragraphs 3-7. and 3-9. for details on transect counts of animals (by the strip transect method).

3-7. Small Mammals.

3-7.1. Scope. Small mammals described herein include: mouse, vole, rat, shrew, mole, chipmunk, tree and ground squirrel. Species and trend data can be obtained by transects and trapping. Numerous methods and techniques have been developed.

3-7.2. Snap Traps. Small mammals should be sampled with snap traps at stations located at five-yard intervals along the centerline of each 100 × 100-yard plot. There should be one snap-style mouse trap placed at each station and one snap-style rat trap placed at every fifth station. When the trap line is set, there should be 20 mouse traps and five rat traps within each 100-yard transect. Peanut butter, rolled oats paste, or a mixture of the two have been successful as bait. Trap lines should be run three consecutive days and nights. The ground should be scuffed up in order to set traps flush to the ground on bare soil; do not set traps on top of grass or leaf litter. If possible, a vegetation "overhang" should be left over the trap to break rain and thus avoid accidental tripping. When checking traps, remove animals and put all animals from each trap line into a plastic bag. Label as to line and date. Also note on the label the number of traps in each transect that have been tripped by rain or other animals. Record the presence of tails, legs, feet, etc., and attempt to identify as to species. Count "fragments" in totals if no animal is caught later with these parts missing. Replace broken or inoperative traps and reset traps for the next night's session. Trapping should be done in late winter to May. Data collected can be used to determine small mammal species composition and to obtain an index to small mammals present on an installation.

3-7.3. Indices. An index to small mammals can be obtained for each species by using the following formula:

$$\frac{\text{Total Number of Animals Trapped}}{\text{Total Number of Trap Nights}} \times 1{,}000 = \text{Index}$$

The total number of trap nights per transect segment is derived by subtracting from the maximum 75 trap nights (25 traps × 3 nights) all traps that were accidentally tripped.

3-8. Bats.

3-8.1. Visual Estimates. Visual estimates can be made as bats leave a cave entrance at dusk.

3-8.2. Systematic-Timed Photographs. Taking systematic-timed photographs of a column of bats as it leaves a cave and then counting individuals in the print is a more refined method of bat inventory. For roosting bats, the entire surface area of a roost can be determined; then portions of the surface can be photographed and individuals counted. The photographic method is suitable for bats that hang from a ceiling in a single layer. This method is further described in "Photographic Estimation of Population Size in the Mexican Free-Tailed Bat, *Tadarida brasiliensis*" (app B, No. 46).

3-8.3. Nets. Some species of bats hang in clusters composed of several layers. For these, it is necessary to take a sample of the surface area with a net and actually count the number of bats.

3-8.4. Other Methods. Counting bat pellets in trays, estimating numbers of roosting bats, using recapture ratios, and trapping bats are four other methods described in Activity Patterns of the Mexican Freetailed Bat (app B, No. 20). When working with mammals, care should be taken since rabies can be contracted through human-mammal contact.

3-9. Songbirds.

3-9.1. Scope and Approaches. Songbirds described herein include perching birds and birds with similar habits. Bird inventories should be carried out in both breeding and wintering periods when avian populations are relatively stable and most accurately reflect habitat conditions. Numerous techniques have been developed to measure the absolute and relative abundance of bird populations. These methods vary widely in both accuracy and efficiency. Methods generally considered to be among the most accurate include: mapping territories of singing males or the "spot-map" method; locating all nests; and marking and recapturing a fraction of a population to get a Lincoln index. The "spot-map" method is described in "The Composition and Dynamics of a Beech-Maple Climax Community" (app B, No. 114), "On the Determination of the Size and Composition of a Passerine Bird Population during the Breeding Season" (app B, No. 32), and

"Recommendations for an International Standard for a Mapping Method in Bird Census Work" (app B, No. 91). The time required to use these methods is extensive. Less time-consuming techniques are described below.

3-9.2. Strip Transect Method. This technique has been modified for use on military installations. In this method, the regular 100 yard × 100-yard transect segment is used as a defined area. The observer walks slowly down the centerline of the transect, covering the 100 yards in five minutes. Each bird noted within the transect segment is recorded by species on a data coding form. Whether the bird was noted by sight or sound should also be recorded. If a bird is heard first and subsequently seen, it should be recorded as seen. Only birds actually in the plot or judged by trajectory to be either taking off or landing within the plot during the survey interval should be counted. Birds flying over the plot should not be counted. No birds observed either behind or more than 50 yards in front of the observer should be counted. Data from these counts can be used to calculate an index to bird use for a defined area (100 X 100-yard segment) for each species or for total birds by using the following formula:

$$\frac{\text{Total Number of Birds}}{\text{Total Number of Segments}} = \text{Index}$$

This technique is effective for both breeding bird and winter counts. Breeding bird counts should be made in June (this period may vary somewhat according to geographic location; contact the state wildlife agency for exact dates) and should be made within the first five hours after sunrise. Winter bird counts should be made in January and can be run throughout the daylight hours. Observers must be able to identify common birds of the area by sight and sound. The few, unfamiliar songs can be learned in a few days of preliminary field work by an experienced birder. Surveys should be repeated at least five times for proper coverage. When using the technique, the observer should record all other animals (including mammals, reptiles, and amphibians). This data should be treated similarly to bird data and used to supplement other inventory techniques.

3-9.3. Roadside Breeding Bird Surveys. This method may be used on installations which cannot be inventoried by the Strip Transect Method, and which have an extensive road system traversing the installation in a representative way. The method provides an index of birds observed or heard at fifty, three-minute stops along a 24 and 1/2-mile route. Each survey begins one-half hour before local sunrise and continues along a predetermined route, stopping at one-half-mile intervals. This method can be used to survey nearly all bird groups (found along a road) and to cover a large area in a short period of time. However, crepuscular species may be missed, and specific habitat types may be omitted if the habitats are not crossed by roads. The technique has been described in detail by the Fish and Wildlife Service in connection with the Cooperative Breeding Bird Survey of North America. Details of field procedures and data analysis can be obtained by writing to the Service's Migratory Bird and Habitat Research Laboratory (app C, No.6.c.(5)).

3-10. Waterfowl, Wading Birds, and Shorebirds.

3-10.1 Ecologically Stratified Ground Surveys. It may be desirable to inventory these birds on small water areas by using an ecologically stratified ground survey. This term refers to selecting sample areas which include all significant habitat types for these birds and sampling some of the habitats more intensely than others. Observation points should have a good view of areas likely to be used by the birds. These sites can be chosen to allow complete coverage without overlap. The sites should be surveyed for a definite period of time (i.e., one-half hour). Counts should be made early in the morning (near sunrise) or late in the evening (near sunset). Counts at all sites should be repeated 10 to 15 different days during each breeding and wintering season to obtain an index to use of the area. An index to relative bird use for each species can be calculated using the following formula:

$$\frac{\text{Total Number of Birds}}{\text{Total Number of Observation Periods}} = \text{Index}$$

Experience has indicated that ground surveys are cheaper and more accurate than aerial surveys.

3-10.2. Roadside Transects. Roadside transects can be used to obtain indices of breeding waterfowl populations. Since the number of pairs fluctuate with time of day and from day to day, several counts of transects should be averaged to improve the reliability of the indices. Short transects of 7 miles may require as many as 25 counts between first light and 10:00 A.M. in order to obtain a meaningful index. Roadside transects are further described in "An Evaluation of the Roadside Technique for Censusing Breeding Waterfowl" (app B, No. 95). An index to bird use for each species can be obtained using the following formula:

$$\frac{\text{Total Number of Birds}}{\text{Total Number of Miles Driven}} = \text{Index}$$

The Fish and Wildlife Service (app C, No. 6.c.) should be contacted regarding waterfowl inventories since the Service conducts on an annual basis aerial waterfowl surveys which may be pertinent to some installations.

3-11. Upland Game Birds.

3-11.1. Auditory Indices. Upland game birds are often surveyed by state divisions of wildlife with the auditory index technique which has been developed for each species. One example of the index is the quail call index described in "Regression Coefficients Used to Adjust Bobwhite Quail Whistle Count Data" (app B, No. 92), "A Summer Whistling Cock Count of Bobwhite as an Index to Wintering Populations" (app B, No. 93), "Whistling Cock Indices and Bobwhite Populations in Autumn" (app B, No. 77), "Estimation of Fall Quail Populations in Iowa" (app B, No. 54), and Some Aspects of Missouri Quail and Quail Hunting, 1939-1948 (app B, No. 8). In this technique, stops are made every one-half mile along a route. Since many variables can affect the number of calls heard, correction formulae have been developed to improve the index. Another auditory index is the ring-necked pheasant crowing count described in "The Crowing Count Pheasant Census" (app B, No. 51). It is conducted along a 20-mile route, beginning about 40 minutes before sunrise. It yields an index based on the average number of calls heard during each two-minute stop. All of these techniques must consider variables such as time of day, time of year, weather, ability of the observer, etc. The index should be standardized as much as possible, or correction formulae must be developed for variables which are not standardized. Migratory game birds, excluding ducks and geese, include rails, coots, gallinules, shorebirds, pigeons, and doves. One shorebird, the American woodcock, is censused by an auditory count at the singing grounds, as described in "An Analysis of Woodcock Singing Ground Counts 1948-1952" (app B, No. 53). This bird is found only in the eastern United States. The mourning dove is found all across the United States. More of these birds are killed annually than all waterfowl combined. This bird is censused on a cooperative, nationwide basis by a randomized call-count census. The route consists of 20 stations at one-mile intervals, with counts beginning 30 minutes before sunrise. Calling doves are counted during each three-minute stop. This technique is discussed in "The Call Count as a Census Method for Breeding Mourning Doves in Georgia" (app B, No. 69), "Breeding Density and Productivity of Mourning Doves on a Countywide Basis in Georgia" (app B, No. 66), and Mourning Dove Status Report (app B, No. 113).

3-11.2. Strip Transect Method. This method is described in subparagraph 3-9.2.

3-12. Raptors.

3-12.1. Aerial Surveys. This method is suitable for nesting surveys in inaccessible areas. Advantages and Disadvantages of the Use of Rotor-winged Aircraft in Raptor Studies (app B, No. 112) provides information on using helicopters to locate nests of large raptors. It is suggested that searches be made between the hatching and fledging period when adult raptors are less likely to desert the young. Aerial surveys of golden eagles wintering in the Southwest are described in "Winter Golden Eagle Populations in the Southwest" (app B, No. 11).

3-12.2. Car Census. A car census is frequently used to survey wintering hawk populations. For this survey, the route should be limited as much as possible to dirt roads. Counts are made by two observers driving the road at 13 miles per hour. One observer drives, and the other records data on form sheets and maps. Buteos, marsh hawks, and American kestrels are recorded within a quarter-mile of each side of the road. Surveys should be conducted between 1:00 and 4:00 P.M., sun time. It has been determined that an accurate total of winter hawks can normally be found by making three or four closely-spaced car censuses and supplementing these with random observations on Cooper's hawks and American kestrels.

3-12.3. Hiking Survey. A foot-census of diurnal raptors (hawks) is described in Hawks, Owls and Wildlife (app B, No. 23). Individual surveys of species of crepuscular and nocturnal raptors (owls) have been attempted, but they require considerable time. Owls have also been surveyed by counting hoots as described in "Territory and Population in the Great Horned Owl" (app B, No. 6).

3-13. Amphibians and Reptiles.

3-13.1. Intensive Searches. Amphibians and reptiles are difficult to inventory. Temperature, precipitation, soil moisture, humidity, light intensity, wind, and season control their activity patterns. However, intensive, systematic searches of the 0.02-acre, circular plots described in subparagraph 3-2.2. should produce data adequate to determine population trends. Intensive searches involve careful examination of the ground surface, rocks, logs, tree trunks and stumps, and other objects within the plots. All rocks, logs, bark, and

other objects lying on the ground should be moved in order to inspect the ground surface beneath them. Loose bark on logs and stumps must be removed. Rotten logs and stumps must be torn apart. Areas containing loose gravel or rock should be raked or dug to a four to six-inch depth. Streams or pools should also be examined carefully. Rocks, logs, etc., should be placed in their original position after inspection in order to minimize habitat degradation. An index to reptile and amphibian use can be determined for each species by counting the number of animals in each plot.

Then, let $t = \frac{1}{n\acute{a}} \Sigma y = \frac{1}{a} \Sigma y$

Where Σy = the sum of animals counted over all n plots

$\acute{a}$ = the area of one plot

$a = n\acute{a}$

then, t is expressed as animals per unit area.

3-13.2. Strip Transect Method. This method is described in subparagraph 3-9.2. Audio observations of frogs and toads should be recorded while sampling birds. Reptile and amphibian surveys should be conducted in April, May, and June.

3-14. Fish

3-14.1. Scope. The composition of a fish population in terms of numbers, sizes, and kinds at any instant is the result of the interaction of many factors, as discussed in Freshwater Fishery Biology (app B, No. 58). The factors are of two kinds: those stemming from the genetics and physiology of the fish and those stemming from the total environment of each species. The interaction of organism and environment determines the population composition by species and numbers and, within a species, the rate of growth and condition of the individuals. The first step in population analysis is to learn its makeup by species (a discussion of freshwater fish identification appears in "Identification of Freshwater Fishes" (app B, No. 67) and, within any species, the constituency by numbers (relative or absolute) and age groups. When the makeup and constituency are known, mortality and turn-over can be computed, and the future composition of a species-stock predicted. If a random sample of the total size range of a species-stock is obtained, if the age of each individual is assessed, and if the age-group composition of the stock is charted from youngest to oldest, the rate of mortality will be shown. If, in addition, the relative abundance at any moment can be learned, rational management becomes possible. Methods for fish inventories in inland lakes and streams are very similar. Procedures for enumeration of fish populations in inland waters are of two kinds: direct (actual counts) and indirect (estimations). These procedures are summarized in "The Measurement of Fish Population Size" (app B, No. 21). On installations, indirect methods should be used primarily.

3-14.2. Mark and Recapture Methods. There are several methods of indirect, numerical approximation, most involving mark and recapture means. These methods have been used extensively in inland water as described in "The Standing Crop of Fish in Lakes" (app B, No. 17). For example, a fish population in all streams and lakes on an installation can be sampled by mark and recapture means based upon the occurrence of previously marked fish in the catch. This is largely an outgrowth of the simple, direct-proportion estimation device proposed in The Yearly Immigration of Young Plaice into the Limfjord from the German Sea (app B, No. 83). Estimation of population by mark and recapture means involves: 1. the capture and release of a number of marked fish (m) into the population; 2. the subsequent recapture of marked fish (r) along with the capture of unmarked fish (u) from the population; and 3. the computation of the population using the equation $P = m(\frac{u + r}{r})$. Workers must obtain any information needed to make required adjustments in the estimates.

3-14.2.1. Collecting or Capturing. Techniques for collecting fish include seining, trapping, electrofishing, poisoning, netting, and draining ponds or pools (fig. 3-2). Indirect methods of population survey (subpara 3-14.2.) have been used in streams with seining and with electrical shocking. They have also been employed for salmon populations where fish to be counted could be readily seen. Single, large sections or sample sections of streams can be used satisfactorily. The study portion can be either blocked off at both ends or left open. When a shocker is used, repeated passes are made through the sample section, marking and returning fish and recording the numbers of both those caught once and those caught repeatedly. An excellent discussion of electroshocking techniques appears in Fishing with Electricity—Its Application to Biology and Management (app B, No. 111). In standing waters, hoop, fyke, and trap nets, described in "Capture, Sampling, and Examination of Fishes" (app B, No. 57), can be used. In practice, the nets are

run daily and the unmarked fish are marked and returned to the water, as are those which have been previously marked and recaptured. Days of such sampling are repeated, in practice, until estimates have become relatively constant as the basis of the formula in use. There are variations in the procedures for selecting the location for nets and the site for returning marked fish Because of the differences in response to netting among species and among different size groups within species, any given method of collecting may be more efficient for some kinds and sizes of fish than for others. Care must be taken to recognize such differences and adjust to them.

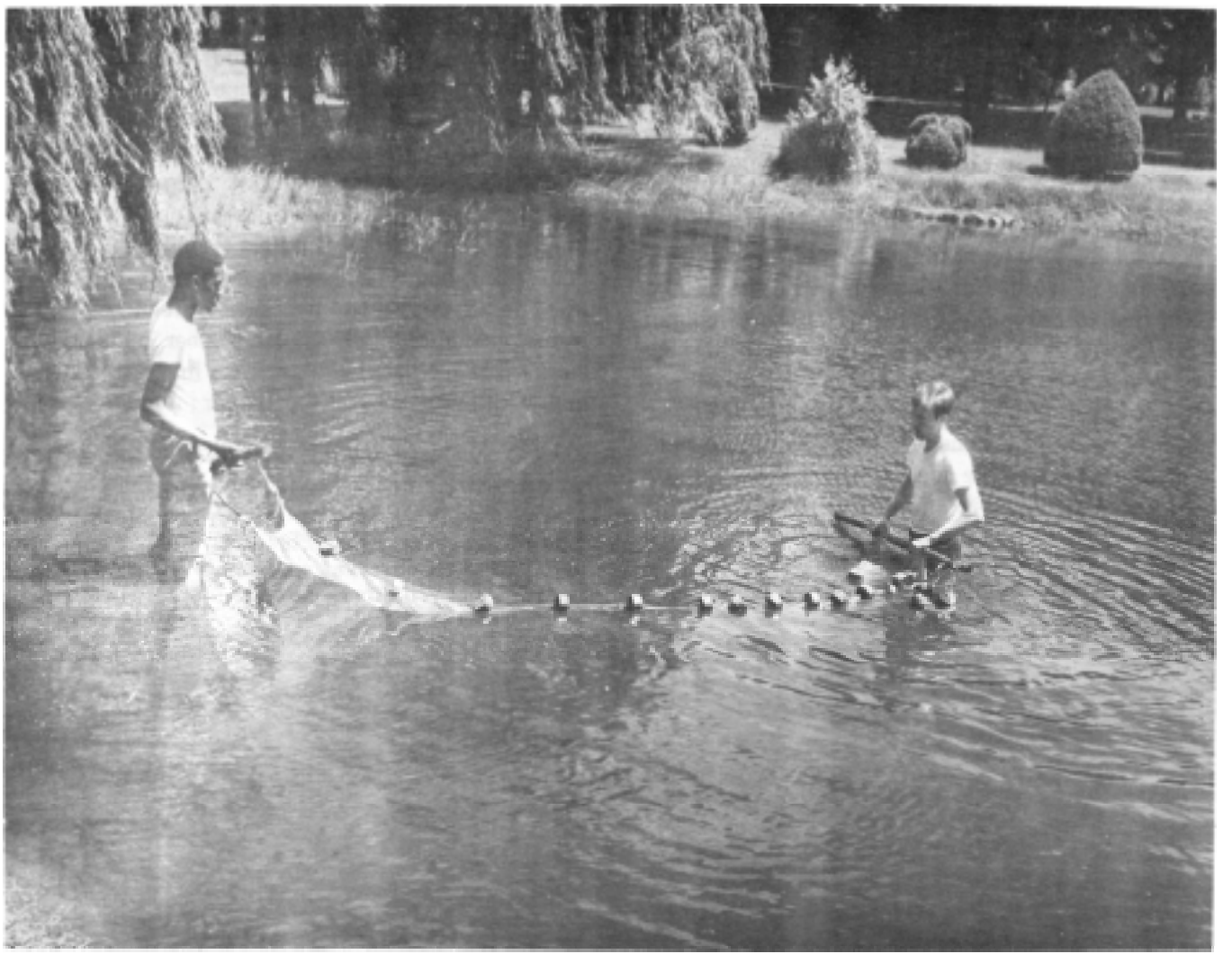


Figure 3-2. Seining.

3-14.2.2. Marking. Many different methods are described in "Marking and Tagging" (app B, No: 103) but basically, the means for marking fish are mutilating the fish or attaching a tag. Mutilation includes fin-clipping, which is the most common technique for short-term population studies. This method is fast and requires no special equipment. Often fish can be marked more readily, doing less harm to them or the handler, if they are anaesthetized. The use of anaesthetics on fish is discussed in "A Guide to the Properties, Characteristics and Uses of Some General Anaesthetics for Fish" (app B, No. 7). Care should be taken to follow the directions on the container when working with anaesthetics since humans can be harmed by repeateduse.

3-14.3. Creel Census. Creel censuses can be valuable for obtaining broad information on trends in kinds of fishing, times of fishing, time spent, species and sizes caught, and the catch per unit of fishing effort

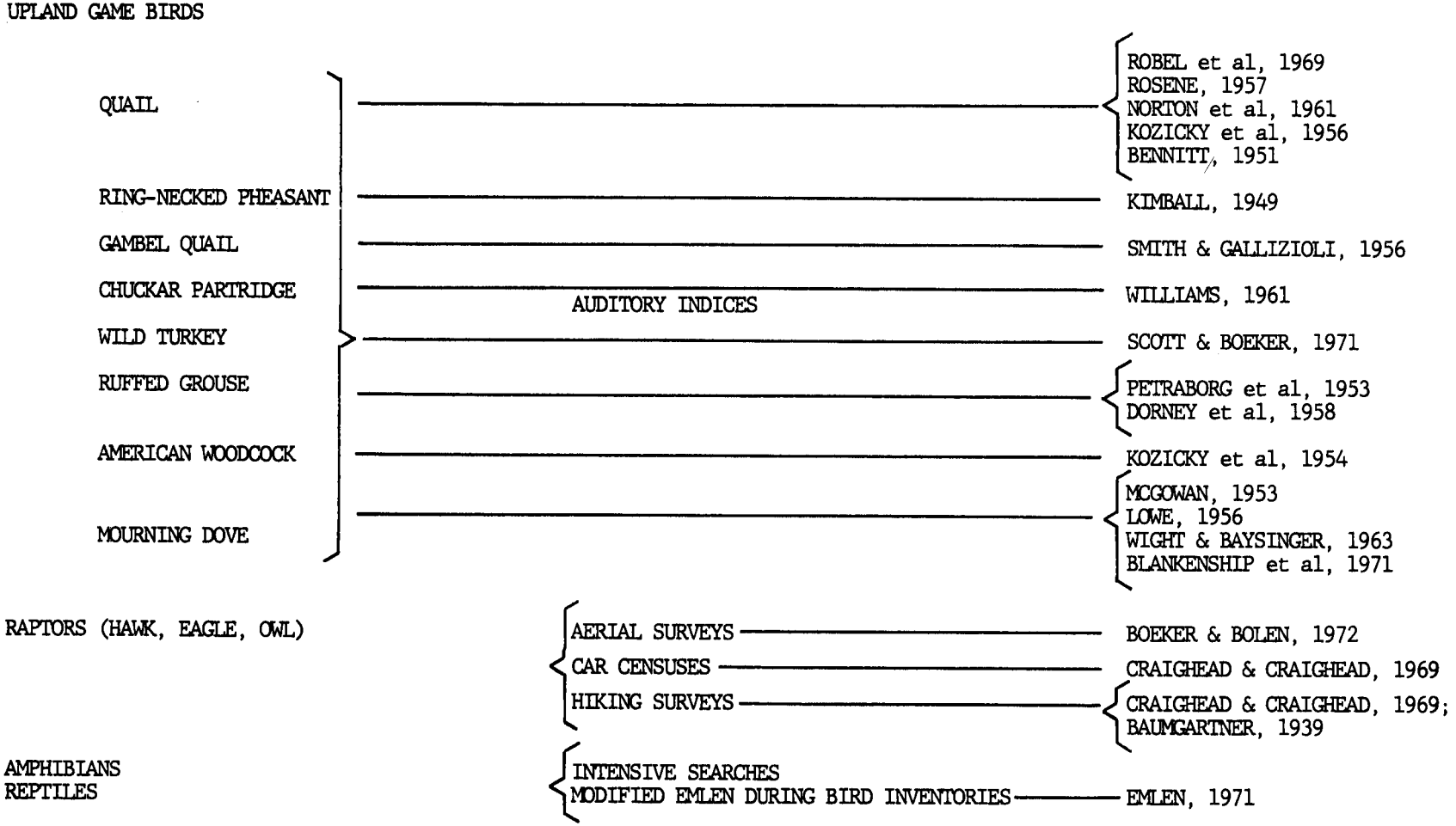
(usually in terms of the numbers of legal fish per fisherman-hour). Complete censuses aim at highly individualized information on fishing type, time, effort, success, etc. They further seek complete information on the fishing pressure and yield for individual bodies of water or parts thereof. Although the creel census requires considerable time from competent persons, the resultant data may be of high quality and value. Where checking stations are maintained and manned by trained personnel, excellent results can be obtained. The restricted nature of installations may make a complete creel census attainable. Where a complete census is not feasible, a stratified random sample technique may yield desirable results. Such a scheme can be accomplished by distributing the sample among days according to the amount of fishing and the degree of variability of catch-effort data for each type of day. According to Sampling Problems in the Michigan Creel Census (app B, No. 105), greater efficiency may be achieved in this way than if an equal census effort is given by each day. The number of angler contacts made in a schedule including three half-days each week may be adequate for estimating the mean catch per hour in a season with considerable fishing effort. By comparing population estimates with creel censuses, a direct relationship may be shown to the size of fish populations and fishing success. US Fish and Wildlife Service (app C, No. 6 c) and state fish and game departments often can provide assistance in determining fish populations and stocking needs.

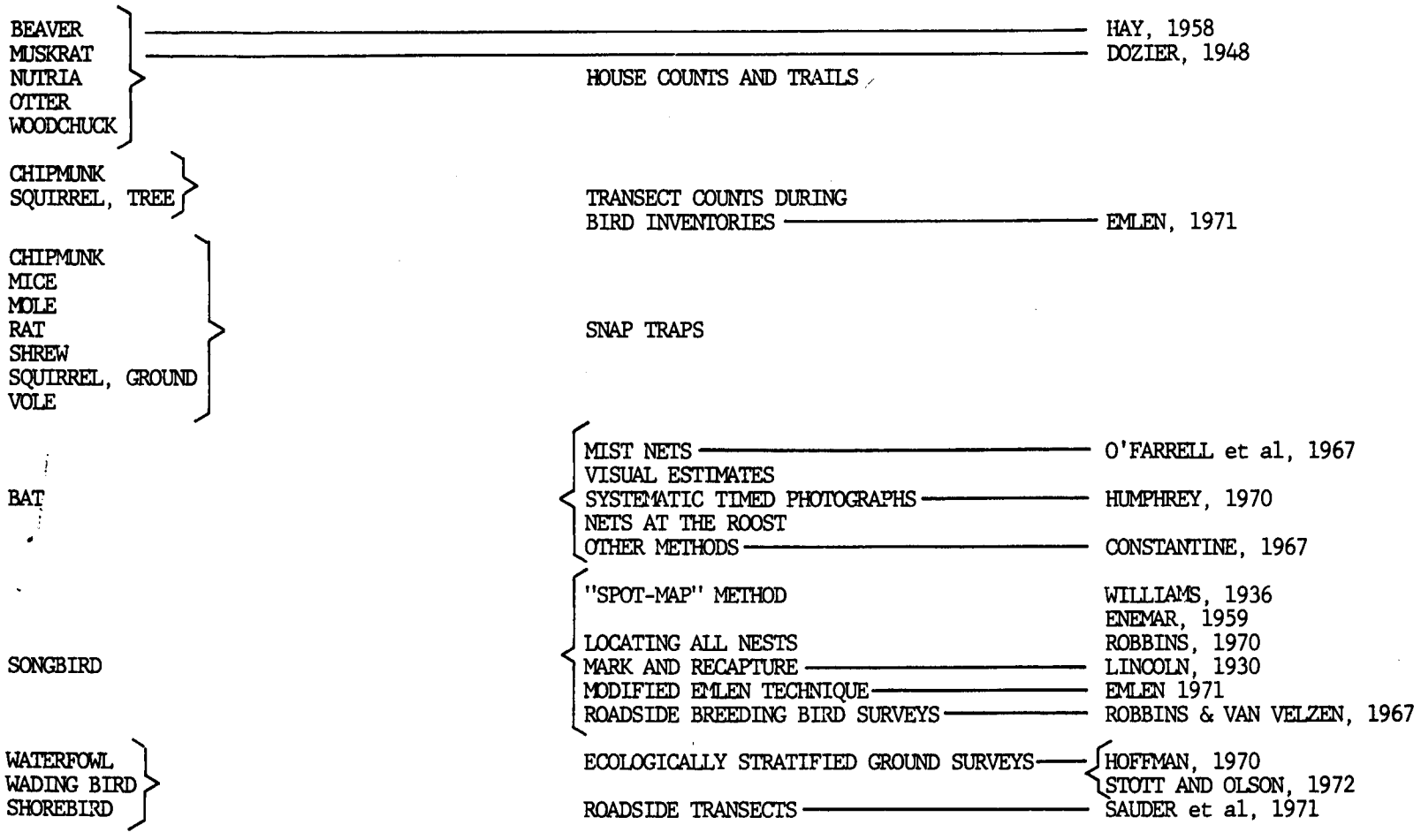
3-15. Threatened and Endangered Species. The Fish and Wildlife Service (app C, No. 6c) and state fish and game departments should be contacted for information on threatened and endangered species. These agencies can provide a list of sensitive animals by geographic distribution and habitat preference. Installation personnel should be aware of these species when making inventories. Particular attention should be paid to their habitat preferences. If similar habitat occurs on an installation, a more intensive inventory of that area may be warranted. Special techniques for inventorying some of these species have been compiled and described by the Bureau of Land Management (app C, No. 6a) and other Federal agencies. Table 3-1 lists techniques for inventorying fish and wildlife and sources for further information.

3-16. Technical Assistance. Additional information on inventories can be obtained from the National Marine Fisheries Service (app C, No. 5) and state wildlife agencies. Other helpful organizations are listed in the Conservation Directory published by the National Wildlife Federation (app C, No. 8).

Table 1. Procedures for Inventorying Fish and Wildlife Populations.

SPECIES	INVENTORY TECHNIQUE	SOURCE OF INFORMATION
CARIBOU, DEER, MULE, DEER, WHITE-TAILED, ELK, MOOSE, PRONGHORN ANTELOPE	DRIVE COUNTS	MORSE, 1943 OVERTON, 1969
	PELLET GROUP COUNTS	NEFF, 1968
	TRACK COUNTS	OVERTON, 1969
	AERIAL SURVEYS	SAUGSTAD, 1942 (Prairies) LOVELESS, 1959 (Coastal Marshes) BENSON, 1962 (Canada) GROON et al, 1969 (Infrared scanning devices)
BEAR, COLLARED PECCARY, MOUNTAIN GOAT, SHEEP	AERIAL PHOTOGRAPHS	LEEDY, 1949
	RECORDS OF HARVEST	OVERTON, 1969
BADGER, BEAR, BOBCAT, COUGAR, COYOTE, FISHER, FOX, LYNX, MINK, OPOSSUM, PINE MARTEN, PORCUPINE, RACCOON, SKUNK, WEASEL, WOLF, WOLVERINE		LINDSEY et al, 1977
		LINHART & KNOWLTON, 1975 ROUGHTON, 1976
	SCENT STATION AND TRACK COUNTS	
HARE, RABBIT	PELLET GROUP COUNTS	SEE LARGE MAMMAL PELLET GROUP COUNTS


UPLAND GAME BIRDS
QUAIL
ROBEL et al, 1969
ROSENE, 1957
NORTON et al, 1961
KOZICKY et al, 1956
BENNITT, 1951
RING-NECKED PHEASANT
KIMBALL, 1949
GAMBEL QUAIL
SMITH & GALLIZIOLI, 1956
CHUCKAR PARTRIDGE
WILLIAMS, 1961
AUDITORY INDICES
WILD TURKEY
SCOTT & BOEKER, 1971
RUFFED GROUSE
PETRABORG et al, 1953
DORNEY et al, 1958
AMERICAN WOODCOCK
KOZICKY et al, 1954
MOURNING DOVE
MCGOWAN, 1953
LOWE, 1956
WIGHT & BAYSINGER, 1963
BLANKENSHIP et al, 1971
RAPTORS (HAWK, EAGLE, OWL)
AERIAL SURVEYS
BOEKER & BOLEN, 1972
CAR CENSUSES
CRAIGHEAD & CRAIGHEAD, 1969
HIKING SURVEYS
CRAIGHEAD & CRAIGHEAD, 1969;
BAUMGARTNER, 1939
AMPHIBIANS
REPTILES
INTENSIVE SEARCHES
MODIFIED EMLEN DURING BIRD INVENTORIES
EMLEN, 1971


BEAVER
MUSKRAT
NUTRIA
OTTER
WOODCHUCK
HOUSE COUNTS AND TRAILS
HAY, 1958
DOZIER, 1948
CHIPMUNK
SQUIRREL, TREE
TRANSECT COUNTS DURING
BIRD INVENTORIES
EMLEN, 1971
CHIPMUNK
MICE
MOLE
RAT
SHREW
SQUIRREL, GROUND
VOLE
SNAP TRAPS
BAT
MIST NETS
O'FARRELL et al, 1967
VISUAL ESTIMATES
SYSTEMATIC TIMED PHOTOGRAPHS
HUMPHREY, 1970
NETS AT THE ROOST
OTHER METHODS
CONSTANTINE, 1967
SONGBIRD
"SPOT-MAP" METHOD
WILLIAMS, 1936
ENEMAR, 1959
LOCATING ALL NESTS
ROBBINS, 1970
MARK AND RECAPTURE
LINCOLN, 1930
MODIFIED EMLEN TECHNIQUE
EMLEN 1971
ROADSIDE BREEDING BIRD SURVEYS
ROBBINS & VAN VELZEN, 1967
WATERFOWL
WADING BIRD
SHOREBIRD
ECOLOGICALLY STRATIFIED GROUND SURVEYS
HOFFMAN, 1970
STOTT AND OLSON, 1972
ROADSIDE TRANSECTS
SAUDER et al, 1971

FISH

- MARK AND RECAPTURE
  - RICKER, 1975
  - CARLANDER, 1955
  - LAGLER, 1956
  - STOTT, 1968
  - GULLAND, 1966
- CREEL CENSUSES
  - TAIT, 1953

ENDANGERED SPECIES

<u>CONTACT</u>: U.S. DEPARTMENT OF AGRICULTURE
U.S. DEPARTMENT OF THE INTERIOR
FISH AND WILDLIFE SERVICE
BUREAU OF LAND MANAGEMENT
STATE FISH AND GAME DEPARTMENTS

CHAPTER 4. ESTABLISHING MANAGEMENT GOALS AND OBJECTIVES

4-1. Responsibility for Control and Administration of Natural Resources.

Control and administration of natural resources, including fish and wildlife, on military lands and waters generally is considered to be the responsibility of the respective installation. However, technical assistance and cooperation should be sought, when necessary, from appropriate public agencies and institutions. Cooperation with state and Federal agencies is handled through execution of cooperative agreements (DA Pam 420-7/AFR 126-1/NAVFAC INST. 11015.4/MCO P11000.8, app. A). These agreements can be brief but should state the purpose of cooperation, legal authority, responsibilities, and what each cooperator agrees to do. In general, natural resources will be managed in the public interest under the principles of multiple-use-sustained-yield, within the limitations of the overriding military mission.

4-2. Establishment of Priorities.

4-2.1. Military Mission. The establishment of management goals and objectives for a specific installation should be based upon its habitat potentials and the species found on the installation. Public access to available natural resources should be controlled and managed so as not to interfere with the military mission or result in security risks or safety hazards.

4-2.2. Endangered and Threatened Species. Within the limitations of the military mission, first priority should be given to the protection and preservation of habitat containing or used by endangered and threatened species. These resources are irreplacable and should be protected and managed to enhance their value.

4-2.2.1. Fish and Wildlife Service and National Marine Fisheries Service. Federal agencies are required by law to insure that their actions do not jeopardize the survival or adversely affect the "critical habitat" of endangered and threatened species. The Fish and Wildlife Service is delineating critical habitat areas. Also, the Fish and Wildlife Service and the National Marine Fisheries Service have developed guidelines to assist Federal Departments and agencies in meeting their responsibilities under the Endangered Species Act of 1973, (28 December 1973, Pub. L. 93-205, 87 Stat. 884, and as amended 10 November 1978 by Pub L. 95-632, 92 Stat. 3751). These Services have been delegated the responsibilities of the Departments of the Interior and Commerce for implementing the Act. Jurisdiction over endangered and threatened flora is divided among the Secretaries of Agriculture, Commerce, and the Interior.

4-2.2.2. Critical Habitat. "Critical habitat", is any air, land, or water area, including any elements thereof, which the Secretary of the Interior has determined essential to the survival of wild populations of a listed species. Critical habitat has a strong meaning under the law, and no Federal agency may take any action which will modify this habitat. In the same context, to "jeopardize the continued existence of" relates to any action which reasonably would be expected to result in the reduction of the reproductive ability, numbers, or distribution of a listed species to the extent that the loss would pose a threat to the continued survival or recovery of the species in the wild. "Destruction or (adverse) modification" relates to any action which would have a detrimental effect upon any of the constituent elements of critical habitat which are necessary to the survival or recovery of such species. Constituent elements of critical habitat include, but are not limited to: land, air, and water areas; physical structures; topography; flora; fauna; climate; human activity; and the quality and chemical content of soil, water, and air. The requirements for survival or recovery of listed species include: space for normal growth, movement, or territorial behavior; nutritional requirements such as food, water, and minerals; sites for breeding, reproduction, or rearing of offspring; cover shelter; or other biological, physical, or behavioral requirements.

4-2.2.3. Consultation and Assistance. It is the responsibility of the Secretary of the Interior to make the final determination of critical habitat for listed species, or to amend or terminate such determinations. The Fish and Wildlife Service and the National Marine Fisheries Service will seek consultation, as appropriate, with the states in which the listed species habitat occurs. Essentially, the consultation and assistance procedures relative to

endangered and threatened species are handled through the regional offices of these Services.

4-2.3. Recreational Benefits. The next priority in natural resources management should be given to the management and conservation of those areas capable of providing recreation use, such as fishing, hunting, nature walks, camping, winter sports, and water sports. Although recreational values are emphasized in the management of such areas, the overall welfare of fish and wildlife as a vital resource base should be given high priority.

4-2.4. Greatest Net Public Benefit. The remaining areas on an installation should be managed to provide for the greatest net public benefit. This determination should be based upon an analysis of the supply-and-demand relationship of the various resources, the relationship of the various resources and uses to each other, and the ecological factors involved. In determining the greatest net public benefit, full consideration should be given to tangible, intangible, social, historical, aesthetic, cultural, and economic values.

4-3. Establishment of Goals and Objectives. Generally, the goals in fish and wildlife management are to further the enhancement or development of fish and wildlife resources by protecting, restoring, developing, and managing land and other habitat for the reasonable production of the species. Another goal should be to allow public enjoyment and utilization of fish and wildlife through nature-oriented recreation. Possible conflicts with mission safety, such as might occur in management that would permit the use of areas adjacent to runways by birds or other wildlife, resulting in animal-aircraft strikes, should be avoided. The emphasis should be on game and nongame, native or indigenous species, except such exotic species as the ring-necked pheasant, chukar partridge, and various fish which have become well-established in the wild and are generally considered desirable. Introduction and release of exotic species should be avoided or done only under conditions approved by Federal and state conservation agencies. As previously indicated, the first priority should be to protect and preserve threatened and endangered species and their habitat. A deliberate effort should be made to prevent the reduction of such species. At the same time, an objective should be to maintain an optimum balance within the fish and wildlife populations. For example, game species should not be managed to the exclusion of nongame species, and predators should not be killed unnecessarily.

4-3.1. Wildlife Management.

4-3.1.1. Land and Water Base. Wildlife management goals and objectives should be based upon a realistic appraisal of what there is to work with in the form of current wildlife, soils, acreage, vegetation, climate, and other environmental conditions. Practical Wildlife Management (app B, No. 15) suggests that if what you have does not lend itself easily to what you hope to have, you can either spend a lot of work, money, and time to change things, with no guaranteed success, or re-think your situation, find substitute but nearly equivalent goals, and build on what is present.

4-3.1.2. Wildlife Populations as Indicators of Habitat Conditions. The presence and numbers of native species in an area constitute one of the best indications of habitat conditions since these species tend to occupy habitat, including newly created or altered habitat, in numbers which the area can support. An area with suitable cover and plenty of agricultural crops and associated weeds for food is likely to be occupied by farm game and other seed-eating species. An area with a mixture of large nut-producing trees and conifers is likely to have squirrels and, if the area is large enough and has suitable openings, wild turkey. The presence of woodcock in an area probably indicates the presence of alder thickets and a good population of earthworms. Thus, if pheasant hunting is desired on an installation, but there are no pheasants within 100 miles, and the soil is too sandy or infertile to support the crops pheasants thrive on, it is probably best to consider quail, grouse, or doves instead. About the only way to have pheasant shooting in such situation is put-and-take hunting, which does not contribute substantially to sustained natural resource management. One of the best approaches in establishing goals is to determine which species are present and to improve conditions for those species.

4-3.1.3. Habitat Management Potentials for Selected Species. Although much is known about habitat requirements for many wildlife species, there is still much to learn. What is known, however, should be used and related to careful analyses of the information developed from soil, water, vegetation, wildlife, and other natural resources inventories conducted on the installation to establish wildlife goals. Development of comprehensive plans using a featured species approach opens the way to decision-making based upon long-range goals, strategies, and objectives. The featured species approach matches wildlife species to the most ap-

propriate habitats available, taking into consideration public interest and all other natural resources involved. In this or other approaches, a management objective should be to maintain a diversity of vegetation and other habitat conditions on a sustained-yield basis. In featured species management, consideration should be given to maintaining a good balance among game and nongame animals and to conserving endangered or threatened species. For game species, one objective should be to provide for proper harvesting and control, consistent with the carrying capacity of existing or improved habitat. For nongame species, the objective should be to provide for or enhance nonconsumptive recreational, educational, and other values of the animals. Fish and wildlife management practices should be integrated with the overall natural resources management of the installation.

4-3.2. Fish Management.

4-3.2.1. Water and Related Resources Base. The same general principles described in subparagraph 4-3.1. apply to fish in relation to habitat conditions and carrying capacity. Although the immediate environment for fish and other aquatic organisms is flowing, impounded, or, perhaps, coastal water, the land use and other practices or activities within the watershed affect water quality and, sometimes, the supply of water; hence, they affect the aquatic habitat. As examples: farming and construction may cause accelerated erosion, excessive turbidity, and siltation; pesticides used for agriculture, forestry, or urban lawns and gardens may cause pollution; and the use of water for irrigation and domestic or industrial purposes may cause low flow problems in streams or low water levels in reservoirs.

4-3.2.2. Fish Resources. The presence of cold-water or warm-water fish should be a guide in deciding which species to manage. Put-and-take fishing (the release of hatchery-reared fish in waters for fishing purposes) may be justified, but on a sustained basis, where fish populations depend upon reproduction in the wild, the fish species must be adapted to its habitat. Habitat management potentials for selected species are discussed in chapters 2. and 6. Another management objective should be to maintain a good balance between piscivorous or fish-eating fish and forage fish.

4-4. Technical Assistance. Good sources for pertinent references to literature are Sports Fishery Abstracts and Wildlife Review. These periodicals are in most large libraries or can be obtained through the Editorial Office of the US Fish and Wildlife Service (app C, No. 6c). Types of assistance should be designated by all parties to any cooperative agreement.

CHAPTER 5. PLANNING REQUIREMENTS.

5-1. Planning Process. Planning for fish and wildlife has four basic stages: a clear statement of goals and objectives; collection and analyses of data on which to base a plan, often including the preparation of various maps; preparation of the plan which involves updating, organizing, and synthesizing available information to solve or meet specific problems; and implementation of the plan. If general information on the nature of an area, including the presence or absence of certain species of wildlife, is not available, it may not be possible to state specific goals and objectives. The planning process starts with information gathering to understand the situation; proceeds to analysis, identification of specific problems and requirements, and establishment of goals; then, after synthesis, recommends a solution or model for action; and finally, begins implementation of the plan.

5-1.1. Requirements. Fundamentally, a wildlife management plan, as described in Practical Wildlife Management (app B, No. 15), should:

5-1.1.1. Be feasible, biologically. It should depend on improvement of existing natural resources.

5-1.1.2. Aim to increase the basic productivity of the area. It should not incorporate features that encourage erosion, deplete soils, or create situations which can be maintained only by constant artificial treatment, such as pesticides, herbicides, and the like.

5-1.1.3. Make sense economically. It should be capable of being completed in a reasonable length of time, and, preferably, without acquisition of additional equipment.

5-1.1.4. Aim, whenever possible, at monitoring and increasing plants and animals already native to the area and at complementing existing terrain, watercourses, etc.

5-1.1.5. Contain numerical priorities, proposed methods of accomplishment (i.e., whether by contract or in-house), estimated costs, and costs if action is deferred.

5-1.2. Methods. Guidelines for Developing a Comprehensive Plan for the Management of Fish and Wildlife Resources (app B, No. 12) may be helpful in developing fish and wildlife plans. (Air Force installations should use the format prescribed by AFR 126-1.) The Wildland Resources Allocation Procedure (WRAP), developed by the Tennessee Valley Authority (app C, No. 3), may also be useful. The WRAP system consteucts a tember-harvest method which should provide a number of benefits. It produces a computer printout that includes a management plan and harvesting schedule based specifically on a landowner's objectives, consistent with the resource potential of his property. This method would appear to have potential use in fish and wildlife planning. An Outline for a Fish and Wildlife Management Plan has been prepared (app. E) to assist installations in preparing new plans, or in revising current plans. See annex I to appendix E for a suggested format for an annual work plan.

5-2. Information Needed.

5-2.1. Scope. Before planning, it is necessary to know what exists in an area, and what features may either lend themselves to or prohibit certain types of improvements. Necessary information includes:

5-2.1.1. Data on the various populations of fish and wildlife currently in the area, and whether they are increasing, decreasing, or essentially stable.

5-2.1.2. Detailed data on the types, extent, and distribution of the habitat and its potential for improvement through management.

5-2.1.3. Knowledge of species requirements, their geographic ranges, and factors such as climate, temperature extremes, or inadequate precipitation which would limit populations or prevent their occurrence in an area.

5-2.1.4. Data on past and current land use, including methods of vegetation management, types and extent of agricultural crops grown, herbicides and insecticides used, and sources of pollution.

5-2.1.5. Demands for fish and wildlife, described in such a way that it is clear whether unsatisfied, current demand should be included in projected demand estimates.

5-2.1.6. Knowledge of current or potential impacts of wildlife on the military mission.

5-2.1.7. Goals and objectives of the installation with respect to natural resources management and, particularly, with respect to fish and wildlife, as related to military and other agency responsibilities.

5-2.1.8. Time period available for attaining the objectives.

5-2.1.9. Availability of manpower and funds and identification of in-house versus contractual capabilities for implementing the plan.

5-2.2. Sources of Information. Much information may already be available on an installation and need only be compiled and presented in the form of maps,

charts, and tables. Other information should be obtained through in-house surveys and research, through secondary sources such as Federal and state agencies, or through contractual arrangements. Table 5-1 indicates the information needed and suggested sources for obtaining it.

Table 5-1. Planning Information: Needs and Sources

	Information needed	Suggested sources
1.	Fish and wildlife inventories[a]	See Chapter 3
2.	Habitat inventories	See Chapter 2
	Soils, including pH, fertilizing needs, etc.	Soil Conservation Service (SCS), county agents, universities
	Vegetation	Literature, U.S. Department of Agriculture (USDA), U.S. Department of Interior (USDI), universities
	Water, quantity and quality and flooding	USDA, USDI, Environmental Protection Agency (EPA), Tennessee Valley Authority (TVA), Corps of Engineers, respective state agencies
	Topography (maps)	U.S. Geological Survey (USGS)
	Geology	USGS and respective state agency
	Soil and land capability maps	USGS, SCS
	Aerial photographs	SCS, National Air and Space Administration (NASA), USGS, in-house
	Climate and weather	National Oceanic and Atmospheric Administration (NOAA) in the U.S. Department of Commerce
3.	Species requirements	Literature, USDA, USDI
4.	Land use[b]	In-house, literature
5.	Demands for fish and wildlife	In-house, USDI, respective state agencies
6.	Impacts of wildlife on military mission	In-house, USDI
7.	Goals and objectives	In-house
8.	Time available for attaining objective	In-house
9.	Man-power and funds	In-house

[a]In connection with fish and wildlife inventories, it is suggested that, where possible, creel censuses be conducted and checking stations be operated to obtain needed data on ratios of bucks to does and of adults to young in deer herds and comparable data for other wildlife species. If the checking stations are manned by trained biologists, information collected on degree of parasitism may provide clues to the condition of the habitat and indicate needed changes in management.

[b]It is suggested that land use records include: history of land use, including timber cutting, forest inventories, forest fires, prescribed burns, etc.; types and extent of agricultural crops grown and information on lime, fertilizers, and pesticides used; grazing intensity over time; maps of physical and cultural features such as roads and airfields; and number of acres used or available for each activity or use.

CHAPTER 6. HABITAT MANAGEMENT PRACTICES.

6-1. General

6-1.1. Definition and Scope. Habitat, the place where a plant or animal species lives and grows, may include buildings and other man-made structures. The emphasis here, however, is upon more natural areas where vegetation, soil, and water are important features, but where man's influence is usually felt.

6-1.2. Nature and Purpose. A primary objective of wildlife management is to manipulate vegetation and other components of the habitat to meet the food, cover, water, and space requirements of desired species and to eliminate the habitat for undesired species. Fish and wildlife populations are affected by man's alteration of the environment, whether done deliberately to increase or decrease populations or accidentally, in connection with agriculture, timber-cutting, urbanization, industrialization, etc. Habitat management for specific wildlife species may effect other species and other natural resources. Management of forest land for maximum production of lumber or other wood products is not necessarily the best management for wildlife; neither are agricultural practices designed to produce the highest yields of agricultural crops per acre. Yet, forest land can be managed to produce both timber and wildlife, promote water conservation, and provide recreation benefits; and agricultural land can be managed to produce both crops of grain and wildlife. Where to place the emphasis and what management techniques to use depend upon the goals and objectives of natural resources management and upon current and potential habitat conditions. Management techniques should be determined by utilizing the multiple use concept.

6-1.3. Principles. After surveys have been made of existing wildlife populations and their habitat, and the potentials for habitat development have been determined, goals and objectives for management should be established, including whether the preferred species system (successfully used by the U.S. Forest Service in the Southeast) is to be used, and whether management should be directed towards attaining the maximum multiple-use carrying capacity of the installation. If certain preferred or featured species are selected for special attention, the usefulness or potential of the range available for each species should be estimated. This requires knowledge of the requirements of the selected species. Attention should be given to modifying or removing critical limiting factors; for example, suitable wintering areas might be such a factor for deer in the Northeast. Decisions on management approaches should involve consideration of the effects of management on other species and natural resources and should be biologically and economically feasible.

6-1.3.1. Cover Diversity and Interspersion. To increase diversity in wildlife populations, management should be designed to promote diversity or interspersion of food, cover, and water or wetlands of suitable quality and quantity. This involves creating edges where two types of cover join; the "edge effect" is beneficial to many kinds of wildlife (fig. 6-1).

Figure 6-1. Lespedeza bicolor edge planting for wildlife.

6-1.3.2. Requirements of Wild Animals. Meeting these requirements is basic to habitat management. Insofar as possible, natural or close to natural conditions should be maintained, and native flora and fauna should be perpetuated.

6-1.3.3. Featured Species or Unit Management. Habitat management on small units may emphasize practices known to be of particular value to certain selected or featured species. Thus: living, mature pine trees with heart rot may be preserved along roadsides or in forested areas within the range of the red-cockaded woodpecker to retain populations of this endangered species; within the range of the American woodcock, alder thickets may be encouraged in moist soil areas in the East;controlled burning may be done in Michigan pine forests to maintain conditions needed for the breeding of the rare Kirtland warbler; and brushy cover intermixed with clumps of evergreens may be maintained for the benefit of ruffed grouse. Management that stresses habitat diversity, even though directed at certain species, usually benefits other species as well.

6-1.3.4. Periodic Evaluation Periodic evaluation of management projects should be made to determine accomplishment of objectives. This involves, primarily, the evaluation of wildlife population and habitat inventory information in relation to stated management objectives.

6-1.4. Tools and Approaches. Among the many management tools and approaches are: creation of new impoundments or wetlands, natural vegetation control, land use regulation, water level control, food and cover planting, erection of nesting

tures, waste disposal, and nutrient supplements. Generally, these are mentioned in connection with habitat management on various types of areas, rather than in connection with particular species of fish and wildlife. In habitat management, it is necessary to work within the environmental constraints for each ecological area or physiographic region. A management technique suitable for one installation may not be equally applicable for another in a different region.

6-2. Wetland Habitat.

6-2.1. Definition and Scope. Wetlands are areas with high soil moisture, in which the ground surface is covered with water at least part of the year. Examples of wetlands are marshes, bogs, and potholes. Streams and lakes, although often associated with wetlands, and man-made fish ponds and larger reservoirs are treated separately. Beaver ponds are discussed in paragraph 6-5.

6-2.2. Animals Which May Benefit. Many wetlands, including those in estuarine zones, are highly productive biologically. Coastal salt marshes are extremely important in the lives of many fish valuable for commercial and sport fishing. They also provide habitat for muskrats and other mammals; for many species of birds including waterfowl, herons, and shorebirds; and for numerous other wildlife species. Freshwater marshes and potholes, along with surrounding uplands, constitute the primary waterfowl breeding areas of the country and are utilized by a great number of other species of fish and wildlife. The nation's wetlands have been reduced markedly from their former extent and quality by draining, filling, pollution, and other causes. Wetlands on installations warrant careful maintenance and management. Any actions which affect wetlands must comply with Executive Order 11999, "Protection of Wetland".

6-2.3. Objectives. Management objectives should include: (1) optimizing the abundance and diversity of fish and wildlife in the area; (2) assuring the continued availability of habitat capable of supporting fish and wildlife populations at desired levels; (3) helping to assure the survival of the area's natural plant and animal species; and (4) optimizing the kinds, amount, and quality of wildlife and wet-lands-oriented recreation possible in the area.

6-2.4. Maintenance of Existing Habitat. If a wetland area is in good condition, every effort should be made to maintain it. This may mean no management, at least temporarily, except to avoid filling it, draining it, grazing it extensively, altering the water level by diversion or consumptive water uses, or permitting pollution. Fencing and posting against trespass may help keep the area intact and reduce disturbance. After a period of years, however, natural plant succession and eutrophication tend to fill in a marsh or change its character, so some rehabilitation measures may be required to keep it productive.

6-2.5. Rehabilitation and Development. Among the possible measures for opening up densely vegetated marshes, especially those choked by emergent-type plants, and thus improving conditions for waterfowl utilization, are pothole blasting, level ditching, biological control, chemical control, and drainage ditch plugging.

6-2.5.1. Potholes. Blasting to create potholes or open water in marshes is accomplished by using a mixture of ammonium nitrate mixed with fuel oil. Blasting should be done only by qualified personnel or by a licensed and bonded contractor employing strict safety measures. The holes may be five feet or so in depth and perhaps 1,500 square feet in surface area. Small blastouts or potholes are useful in wetlands too thick with vegetation or too dry in summer to maintain waterfowl since they may serve as loafing or feeding sites even though they may not contribute much to waterfowl production (fig. 6-2). Blasting may be warranted in small areas where other means for creating water-holding openings are not feasible. Pothole blasting is further described in Practical Wildlife Management (app B, No. 15).

Figure 6-2. Shallow-water facility for wildlife, created by blasting.

6-2.5.2. Ditches. Ditching with a dragline or bulldozer may be cheaper than blasting for larger projects and has the added advantage of leaving exposed soil banks useful for ducks, minks, and muskrats. Ditches four to five feet deep with surface areas of 2,000 to 10,000 square feet and spaced so that there is one opening for approximately each two to four acres of marsh are recommended in Practical Wildlife Management (app B, No. 15).

6-2.5.3. Biological Control The introduction of muskrats can help create open water areas in densely vegetated marshes. However, unless their populations are controlled, muskrats may cause damage to dikes or create vegetative eat-outs greater than desired. Furthermore, in suitable marshes, muskrats are probably already present in numbers attuned to the available habitat. In the north-central United States, a marsh full of cattails, bulrushes, and duck potatoes and with the right amount of water may support thousands of muskrats per square mile, as described in Of Predation and Life (app B, No. 33).

6-2.5.4. ***Chemical Control*** From the standpoint of waterfowl management, dense stands of cattail and other emergent plants are not desirable. The broad-leaved cattail is, however, a prime food of muskrats. Treatment of alternate strips of a marsh with herbicides will create some openings. Thus, it may be possible to manage a marsh both for waterfowl and muskrats. Use of any herbicides should be in accordance with applicable state and Federal regulations.

6-2.5.5. ***Plugging.*** If coordinated with the mission of the installation and not contrary to water district

or other regulations, the plugging of drainage ditches and tile lines can restore marshes to productive status. In the experience of the Fish and Wildlife Service, this is best accomplished when site renovations are underway, and a bulldozer is available. Ditch plugs can be compacted in layers by the bulldozer, and tile plugs can be made by excavating a 15-foot section of tile, cementing the ends, and compacting dirt in the excavation.

6-2.5.6. Burning. Controlled or prescribed burning may be used to combat or promote specific types of marsh vegetation. Burning has been done in Louisiana to promote Olney bulrush, an important muskrat food in that area, as described in The Muskrat in the Louisiana Coastal Marshes (app B, No. 80). Burning in marsh areas usually is done before birds start to nest in the spring. Additional information on fire ecology may be obtained from publications of the Tall Timbers Research Station (app C, No. 12).

6-2.5.7. Impoundments. Some marshes can be improved for wildlife production by the creation of impoundments (i.e., the development of more open water areas). Artificial impoundments can be constructed in wetlands or other lowland areas, both inland and coastal, through the use of bulldozers and draglines and the construction of dams or dikes. Dugouts or dams across small coulees, as in the northern Great Plains area, receive much use by waterfowl pairs and broods and may be beneficial also to mourning doves and other wildlife. When new wetlands and larger impoundments are created, the capability of controlling water levels is very important from a management standpoint (fig. 6-3). Control of water levels facilitates vegetation management since drawdowns can encourage plant growth or permit the seeding of food plants attractive to birds in the fall and winter. Partial drawdowns can encourage growth of plants suitable for brood and nesting cover for waterfowl. If cover is too abundant in relation to open water, raising water levels can kill cattails and other emergent plants.

Figure 6-3. A flashboard riser for controlling water levels.

6-2.5.8 Flooding. Flooding a marsh, either through natural causes or deliberately, so that water depths exceed three or four feet, may kill cattails and other plants beneficial to muskrats. Once the cattail growths are gone, one means of restoring them is through partial or complete exposure of the marsh bottom in late summer. Drawdowns which expose bottom soil to sunlight and air can, especially when combined with disking, result in more rapid decomposition of organic materials in the bottom of reservoirs and aid in the rejuvenation of reservoirs which tend to lose fertility or decline in productivity after a few years. Reflooding of the exposed bottom areas, after food plants have become established, facilitates feeding for both waterfowl and muskrats.

6-2.5.9. Islands. When there is too much open water in a marsh, in addition to water level manipluation and control, construction of floating nests sites, rafts, or artificial islands may help. Islands can be constructed most conveniently in connection with new pond or wetland development by leaving higher sections exposed or by dredging and dumping material so it rests above the water level. Islands increase edges and provide for diversification. They are used by waterfowl for loafing and nesting sites and by other animals. Practical Wildlife Management (app B, No. 15) recommends small, circular islands of 10 feet or more in diameter, for ground-nesting ducks.

6-2.5.10. Greentree Reservoirs. With water-control devices, a good supply of water, and a dike, waterfowl can be attracted in the fall or winter to lowland grain fields with heavy soils or to woodlands of oak or other nut-producing trees by flooding them to a

depth of one to 12 inches. These "greentree" reservoirs should be drained before tree growth begins in the spring. It should be determined whether state and local laws permit diversion of natural waters for this purpose.

6-2.5.11. Planting. It may be possible to increase or optimize wildlife use of wetlands through the introduction of aquatic plants or the control of land use in adjacent uplands. As in the introduction of muskrats, water plants tend to establish naturally in areas suitable for them, even in new impoundments. The planting of perennial aquatic plants, therefore, is usually unnecessary and, often, the survival of the introduced plants is poor. Under the proper conditions, however, perennial plantings can hasten the establishment of vegetation in new waters and improve conditions in older or natural areas. Such plantings should be done with the advice or assistance of biologists familiar with wildlife values and the requirements of the plants. Generally, in stable impoundments, submerged aquatics such as pondweeds or true emergent plants such as bulrushes do best. In areas with fluctuating waters, annual food plants such as millets and woody emergent plants such as buttonbush and willows may be more suitable. Along the shorelines of impoundments and marshes, wild millet, smartweed, sedges, panic grasses, and rice cutgrass may do well. Additional suggestions regarding aquatic plantings can be found in Practical Wildlife Management (app B, No. 15), Waterfowl Tomorrow (app B, No. 62), and Wildfowl Food Plants (app B, No. 68). Some species utilizing wetland areas also use crops or other vegetation in the surrounding uplands for cover or food. Thus, green grain crops such as wheat or perennial pastures or crop residues remaining from the harvest of corn or soybeans provide valuable food for geese. Crop residues, particularly in harvested corn fields, also serve as a food source for ducks. Pheasants, which find marshes suitable for winter cover, may need alfalfa or other crop fields for nesting and grain fields for feeding sites.

6-2.5.12. Buildings and Roads. It is desirable to avoid construction of buildings and roads in wetland areas. If unavoidable, the structures, particularly in estuarine areas, should be designed to permit the natural flow of water. Permits are necessary under Section 404 of the Federal Water Pollution Control Act of 1972 as Amended (33 U.S.C. 1344, 86 Stat. 816). Any activities which may affect wetland must comply with Executive Order 11990 "Protection of Wetlands".

6-2.6. Technical Assistance. Among Federal agencies, the Fish and Wildlife Service has had much experience in wetland habitat management. Its "Wetland Management Guidelines", although intended for in-house use and under revision, may be used as a reference by installations in the North-Central States. The Bureau of Land Management published "Dabbling Ducks-Tribe Anatini" (BLM Manual Technical Supplement 6601-5, Release 6-27, 3 March 1972) which provides useful information on the management of these ducks. The Forest Service has developed a rather comprehensive Wildlife Habitat Improvement Handbook (app A, No. 9) in which Chapter 30 deals with wetland improvement. The Soil Conservation Service (app C) can provide useful information on water-control structures and other aspects of wetland habitat management. There are also a few wild game food nurseries which can supply seed, roots, tubers, or growing stock for wildlife plantings.

6-3. Upland Agricultural Habitat.

6-3.1. Animals which May Benefit. Agricultural land provides habitat for many kinds of wildlife, particularly if shelterbelts, small farm woodlots next to cultivated land, old fields which have not reverted to forest, and pasture fields are included. Many game species, small mammals, fur animals, and some songbirds which use such areas are non-migratory or resident species. Migratory birds, as well, frequent agricultural habitats of various kinds. The upland plover which winters in South America may still be seen locally in the spring and summer in pastures or grass fields of the northern United States, and the farm woodlot may be alive with wood warblers during migration periods. Farm game species, particularly the cottontail rabbit and the bobwhite, have small home ranges. Other important farm game species are the ring-necked pheasant, the Hungarian partridge (not now as common in the United States as formerly), and the fox squirrel of which optimum populations are often found in woodlots adjacent to corn fields. The mourning dove, a species which may be seen in large numbers during migration and which nests widely in the country, is included in the discussion of agricultural habitat since waste grain and weed seeds on cultivated land constitute much of its food.

6-3.2. Objectives. Management objectives for agricultural land are: meeting the requirements of wildlife for food, water, cover, and breeding space; ensuring survival of the species; maintaining needed habitat; and promoting recreational and other

values of the resources. As in the management of other habitats, consideration should be given to other natural resources and activities (primarily farming, agricultural crops, and small woodlots) and if management is directed towards selected or preferred species, to the effects on other species.

6-3.3. Maintenance of Existing Habitat. If optimum habitat exists, or if a unique biological community is present, every possible effort should be made to maintain it. In some agricultural areas, for example, there may be remnants of native prairie grasses vital to certain prairie wildlife. As a rule, such remnant communities cannot be maintained over a long period of time without management. Agricultural land is usually fertile and capable of producing large wildlife populations if managed for that purpose. On flood plains where the flooding frequency is such that agriculture cannot be practiced economically or without great risk, more of the land could be devoted to wildlife. Often, flood plains contain woody cover along streams and lend themselves to wildlife management.

6-3.4. Management and Development.

6-3.4.1. Edges and Cover Interspersion. Due to the small home range of many farm wildlife species, development of good interspersion of food and cover is particularly important. A diversity of cover types adjoining one another as edges or in an interspersed manner enables wildlife to secure food close to the cover it requires for nesting, loafing, or escaping predators. Edges can be created by keeping field sizes small and developing good strips of cover between fields (for example, along fencerows, drainage ditches, or diversion ditches) or between woodlots and fields. Information on the development of edge cover is available from the Soil Conservation Service. The Service can also provide information on shelterbelt plantings which help diversify cover, particularly in the Plains states, and which are important nesting sites for mourning doves and other wildlife.

6-3.4.2. Cover for Agricultural Wildlife. Diversification of cover can be increased by planning crop rotations so that adjoining fields contain different crops harvested at different times. Many small woodlots in the East and Midwest are grazed by livestock to the extent that little undergrowth remains. For many types of wildlife, including songbirds, cessation of grazing will, after a few years, result in the growth of ground cover, shrubs, and saplings which constitute three additional layers of cover, each one preferred by certain species or used, in combination, by other species. Where woodlot cover is too dense or uniform, the creation of small openings results in more edges and more diversity of food and cover. Species such as the cottontail frequently use brush piles constructed in such a manner that there are entrances and space left beneath the piles (fig. 6-4). Also, brush piles can provide escape cover in open spaces between tracts of living, woody cover, thus forming a sort of travel lane. Vegetation management, whether through outlease agriculture, woodlot management, or practices more specifically aimed to enhance wildlife, is a principal approach to wildlife management on agricultural land. Agricultural crops, or portions thereof, in fields adjacent to wildlife cover may be left unharvested as food for wildlife or as nesting cover in the case of alfalfa or sweet clovers which are particularly valuable for nesting pheasants. Sweet clover, if left standing until fully mature and then harvested with a combine for seed, provides excellent nesting cover for pheasants. The harvest can be late enough that nesting is not disrupted with loss of birds and eggs, as occurs in regular hay-cutting operations. Controlled or prescribed burning may be needed to maintain stands of native prairie grasses. Disking stands of bunch grass in old fields can stimulate the growth of herbaceous plants more valuable as wildlife food. Cutting is another method of controlling vegetation. Freeing or releasing old apple trees at the site of previous farm residences so that there is less competition with other trees can increase the production of fruit attractive to many kinds of wildlife. Selective herbicide treatments can be used to help establish shrubs and maintain vegetation in the successional stage most desirable for certain types of wildlife. Plantings, whether annuals in wildlife food plots or shrubs and trees in border plantings, can help diversify habitat. Such plantings also control erosion and add beauty to the area. The importance of travel lanes or corridors connecting one area of cover with another and providing access to feeding areas should be kept in mind. Finally, in the interest of diversity, wetland areas within agricultural areas should be maintained whenever possible. Development of water catchments, small ponds, and other water areas can be very beneficial to doves, muskrats, fish, reptiles, amphibians, and other wildlife.

Figure 6-4. A brush pile for wildlife.

6-3.5. Technical Assistance. Technical assistance can be obtained by contacting the Federal agencies listed in subparagraph 6-2.6. Many good suggestions on managing agricultural habitat appear in Practical Wildlife Management (app B, No. 15).

6-4. Forest and Range Habitat.

6-4.1. Animals Which May Benefit. Forest and range habitat, literally and figuratively, covers a great deal of territory and involves many species of fish and wildlife, from the endangered spotted bat to the bighorn sheep or moose to the burrowing owl to the golden eagle or California condor. Included are hundreds of species of nongame birds (songbirds, predators, etc.) and many species of game birds (grouse or various types, wild turkey, woodcock, Chukar partridge, and various species of quail and dove). In addition to a host of bats, small mammals (mice, shrews, moles, ground squirrels, and other rodents), predators (coyotes and foxes), and fur animals (beavers, pine martens, skunks, opossums, and raccoons), many game mammals are found in forest and range habitat. Among the latter are tree squirrels, deer, other ungulates, and bears.

6-4.2. Objectives. Management objectives include: optimizing the abundance and diversity of fish and wildlife in an area; maintaining areas of high wildlife productivity which already exist on an installation; improving for fish and wildlife other areas on an installation consistent with other natural resource management objectives and needs; optimizing the kinds, amount, and quality of wildlife and wildlands-oriented recreation; and helping to assure survival of an area's plant and animal species including, particularly, threatened and endangered species. As an

example of the latter, living, mature pine trees with heart rot are being retained for the benefit of the red-cockaded woodpecker at Eglin Air Force Base, Florida, Fort Benning, Georgia, and other installations in the South.

6-4.3. Rehabilitation and Development. Rehabilitation and development practices for forest and range habitat are similar to those recommended for other habitats. Although major attention is given to vegetation management, provision of water may be quite important. Also, the relationship of livestock grazing to wildlife may be of concern. The same principles of cover diversity, cover interspersion, and edges apply to forest and rangeland areas as elsewhere.

6-4.3.1. Provision of Water. Where water is limited, as in much of the Southwest, the carrying capacity of some forms of wildlife can be increased by developing or providing additional water. Various types of watering devices, frequently called "guzzlers", are used in the Southwest for quail, deer, bighorn sheep, and other wildlife. Instructions for making these guzzlers and criteria for spacing them appear in the Wildlife Habitat Improvement Handbook (app A, No. 9). Spacing depends upon food and cover conditions and the daily cruising radius of the species. Thus, the California Valley quail may range from one-half to one mile, the Mountain quail may range two miles, and the Gambel quail, three to five miles. For deer, development of waters is suggested at one-mile intervals at sites with suitable food and cover. Guzzlers basically consist of a hard-surface apron to collect maximum rain and runoff and to carry water to a storage tank. In addition, waterholes can be constructed, windmills installed and springs developed in some areas. Often, fences are necessary around such developments to keep out livestock. Adequate cover should be provided around a watering area. The Forest Service, Bureau of Land Management, Fish and Wildlife Service, and state conservation departments can advise on watering facilities.

6-4.3.2. Control of Grazing. Overgrazing and overutilization by livestock can result in serious degradation of forest and rangeland and can lead to accelerated erosion and siltation of streams and lakes. Grazing tends to remove much of the ground cover and shrub layer and thus reduce the diversity of vegetation. When overgrazed areas are protected from grazing, or when grazing is reduced, vegetation comes back, and so does a greater variety of wildlife. Regulated grazing can help keep vegetation at the stages preferred by some wildlife species; for example, species which utilize seeds of annual weeds as food.

6-4.3.3. Forest Management. The methods, extent, and frequency or timing of timber harvests are of prime importance in determining food and cover conditions for wildlife. Solid stands of timber of fairly uniform size or large plantations of a single species often are not particularly productive of or attractive to wildlife. In stands with a dense canopy, most photosynthesis occurs high above ground level, and the stored energy is concentrated where deer and other ground-dwelling animals are unable to use it. Opening the canopy permits more sunlight to reach the ground and results in the growth of more plants for food and cover. Following are recommendations for the creation of openings:

6-4.3.3.1. Forest openings may occur naturally as a result of fire, storm, insects, disease, or site conditions. Other openings are caused by man in building roads, firebreaks, and utility line rights-of-way or as a result of fires. In many forest areas, there are abandoned farm homesites or old orchards. All openings in otherwise closed canopy forests are valuable to wildlife. If well-scattered openings do not make up about five percent of the forest area, such openings should be created if increased wildlife is an objective. Clear-cutting in blocks or strips creates openings and increases the edge effect. For maximum diversity, there should be various successional stages and mixtures of tree species close to forest openings or borders. The clovers, lespedeza, and other legumes often found in forest clearings are used as a source of green vegetable matter by grouse and turkeys. Insects found on the vegetation in clearings supply a source of high-protein food for young birds. Clearings also provide forage for elk, deer, rabbit, woodchuck, and other species.

6-4.3.3.2. With respect to the number and size of openings recommended, the Forest Service suggests one-half to one-acre openings at one-quarter-mile intervals for quail and grouse and larger openings, two to five acres at one-half-mile intervals, for wider-ranging birds such as turkey and for deer. More openings are needed in large stands of small pole timber than in sparse sawtimber stands. Wildlife travel lane areas adjacent to streams, ponds and lakes and on ridges or in valleys, are desirable site locations for openings.

6-4.3.3.3. In addition to timber harvesting, openings can be created by bulldozers or herbicides. They can be maintained with prescribed burns, cultivation, cutting, herbicides, or the use of heavy disks, rotary choppers, mowers, heavy chain drags,

and rollers. Clones of some shrubs, once well-established, resist tree invasion for many years, and perennial grass stands can hold brush reinvasion to a minimum. There should be close coordination and cooperation between the wildlife manager and the forester. In constructing logging roads and harvesting timber, erosion should be minimized to avoid unnecessary turbidity and siltation in streams. Logging debris should be kept out of streams and lakes. Leaving buffer strips of uncut timber and shrubby vegetation along streams is also recommended.

6-4.3.4. Cover-Type Conversion on Rangeland. Attempts to convert extensive areas on one major vegetation type to another, such as sagebrush to grasses, can be detrimental to species like the sage grouse if proper care is not taken. The Wildlife Habitat Improvement Handbook (app A, No. 9) contains specific guidelines to providing for the sage grouse by leaving corridors, islands, and blocks of sagebrush intact. It is indicated, for example, that a sagebrush-control project should affect no more than 50 percent of the sagebrush stand concerned. Similarly, guidelines have been developed for avoiding damage to deer and elk habitat in juniper-pinyon clearing projects in the Southwest. These guidelines involve the principles of diversity and interspersion of cover types in various stages of plant succession.

6-4.3.5. Prescribed Burning. Prescribed burning can be a valuable tool for improving habitat. It is used widely in the South in quail management. The Michigan Department of Natural Resources and the Forest Service employ controlled burning as a vital part of a cooperative program in Michigan to conserve the Kirtland warbler.

6-4.3.6. Other Approaches. Other approaches to wildlife management include: special wildlife plantings; construction of brush piles; top-pruning of trees to provide slash and promote bushy tree growth for roosting cover; preservation of den trees or trees with natural cavities used by various squirrels, wood ducks, some woodpeckers, and other species; preservation of nesting trees used by such species as the bald eagle and osprey; retention of known roost trees of turkeys and rookeries for other important species; retention of standing dead trees for woodpeckers, flying squirrels, and other hole nesters and as perches for raptors; and use of salt or other nutrient supplements for deer.

6-4.4. Technical Assistance. Assistance on wildlife management in forest and rangeland habitats can be obtained from the Forest Service and the Bureau of Land Management (app C). The Bureau has published a series of Technical Notes, titled "Habitat Management Series for Unique or Endangered Species", which provides a description of the species; summarizes information on its status and population trend, distribution, life history, habitat requirements, and limiting factors; lists protective measures instituted; provides species and habitat management recommendations; lists authorities on the species; and cites references. Useful information on prescribed burning, fire ecology, and ecological control by habitat management is available from the Tall Timbers Research Station (app c, 12). This information applies not only to the South but also to other parts of the country.

6-5. Stream Habitat.

6-5.1. Scope. Streams and rivers transect other habitat types and are affected by the land use within their respective watershed. Varying in size from mere trickles at the head to large, tide-influenced rivers at the outlet to the sea, they provide habitat for myriads of aquatic organisms, both plant and animal, and for other species which use flowing waters as part of their environment. Streams and rivers are used by many birds and mammals in addition to fish, ranging from small darters to sturgeons, and by amphibians, reptiles, and a host of invertebrates and microscopic forms of plants and animals. Thus, the water ouzel may be seen diving into swift Rocky Mountain streams, and pelicans and gulls may be seen using tidal river areas. Beaver may occupy mountain streams and build dams while the large, plant-eating manatee may be found in some Florida rivers and canals. Some species of fish, like salmon, come from the ocean and swim up streams for spawning; they are designated as anadromous. Other species, like the eel, which swim from freshwater streams to the ocean for breeding are called catadromous. Dams and other structures, such as culverts, built by man may obstruct the movement from sea to inland stream. Also, timber harvesting, agriculture, industrialization, and urbanization may affect the quality or quantity of water needed in streams or rivers for certain animals. Consumptive use of water from streams may result in a minimum flow too little to support certain species. Dams, which back up water, may so change habitat conditions that some species are extirpated or endangered. Use of water for irrigation may result in water so degraded in the return flow, due to increased salt content or chemical fertilizers and pesticides, that it will not satisfy the requirements of certain species. Many

aquatic species suffer also as a result of stream channelization.

6-5.2. Objectives. Management in stream or riverine habitat is designed to ensure survival of the animal species involved and to enhance their recreational and other values. In some instances, this may mean keeping conditions as they are; in others, it may mean practicing rehabilitation or development measures equated with other land use practices and natural resource values. State and Federal agencies concerned with water management should be consulted in advance of improvement projects in order to coordinate work with other programs and needs. It is expected that emphasis in management will be on endangered and threatened fish species and on various featured species, depending upon the aquatic environment and its potential. The upper reaches of streams are smaller and likely to have clearer, cooler, less fertile waters than downstream. In the eastern United States, they may contain brook trout, the transplanted rainbow or brown trout, or smallmouth bass. Downstream, the smallmouth bass and other species less tolerant of siltation and changes occurring as a result of agriculture and other land uses may give way to catfish, carp, and suckers. In larger rivers, most of the common game and panfish characteristic of the area are likely to be found either in the main channel or in backwaters, sloughs, oxbows, bayous, and overflow ponds. These species include largemouth bass, crappies, other sunfish, and bullheads. In the tidal or estuarine reaches of rivers, special consideration should be given to flounder and striped bass. In addition to fish, management of stream and river habitat, involves consideration of plankton, invertebrates such as crustaceans, birds, and mammals, all of which are affected by land use in the watershed any by any other activities which may alter the stream habitat.

6-5.3. Relation of Stream Conditions to Watershed. Plan the land use of the watershed to minimize soil erosion, sedimentation, pollution, channelization and regulation of stream flow.

6-5.3.1. Soil Erosion. Products of soil erosion can fill pools, cover food-rich areas with barren materials, increase turbidity, destroy cover, cover spawning areas, and cause serious mortalities (for example, among salmonid embroyos, alevins, and fry still in the gravel). Mention has been made of the need to control erosion in construction of roads in forested areas. Care needs to be exercised, elsewhere, in road and other construction activities; and in connection with agriculture and range management, with respect to grazing intensities to avoid accelerated erosion. Settling ponds, used in connection with gravel washing and mining operations, can help reduce siltation in streams.

6-5.3.2. Pollution. Care in the use of pesticides on agricultural land, forest, rangeland or developed areas can reduce stream pollution. Abandoned mine tunnels, a source of acid waste, sometimes can be plugged. State water quality standards required by the Water Quality Act of 1965 should be reviewed. When stream pollutants exceed the tolerances defined by these standards, an effort should be made to take corrective abatement action.

6-5.3.3. Channelization. Stream channelization should be kept to a minimum. Additional bridges or the careful routing of roads sometimes can lessen the amount of channelization. Following channelization, rehabilitation measures can help restore a channel to conditions approaching the original if the length of the stream has not been too greatly reduced. Maintaining buffer strips of native vegetation along streams or planting and managing riparian vegetation provides insect food and cover, reduces erosion, and controls water temperature. If stream banks are well stabilized by vegetation, there can be some undercutting of the banks by erosion which will provide shade and hiding places for fish or mink without sloughing off the upper part of the bank. Various species of willow are often used for streambank planting. Planting fresh cuttings in permanently moist soil, while the willows are dormant, has proven successful, provided populations of hungry muskrat, beaver, or deer are not too high. If they are a problem, other native trees or shrubs might be tried. Fencing, with water gaps for livestock, can be used to protect riparian vegetation from livestock.

6-5.4. Regulation of Stream Flow. Regulation of stream flow can best be attained by headwater improvements on streams, creating controlled storage and releases, or by adequate releases from existing structures. This requires coordination with other interests. Advice on the timing and amounts of release should be sought from biologists knowledgeable about the requirements of stream biota.

6-5.5. Stream Improvement Practices.

6-5.5.1. Improving Channelized Areas. Channelized portions of a river can be developed with the installation of instream rehabilitation structures, such as deflectors and check dams, so that the hydrological features resemble unchannelized streams. This is described in "Rehabilitation of a Channelized River in Utah" (app B, No. 5). Conditions for fish and the aquatic organisms on which

they depend can be improved in channelized streams by such measures. In some cases, these measures can improve unchannelized, but otherwise degraded streams, as well. The Wildlife Habitat Improvement Handbook (app A, No. 9) provides details on the construction and use of various types of dams, deflectors, and other devices or approaches for direct channel improvement. The Forest Service recommends, for stream improvement, that dams be restricted to streams whose maximum flood volumes do not exceed 100 cubic feet per second; the Service suggests that deflectors may be installed in larger streams.

6-5.5.2. Creating Cover and Resting Places. The creation of pools for resting places and shelter for fish is one of the principal objectives of stream improvement. The deeper pools found in intermittent streams also have value for muskrats if located in food-rich places (for example, near a corn field). Large boulders, two-thirds of a cubic yard or larger, placed in broad, shallow, fast-velocity channels with gravel or rubble bottoms can produce resting places for fish. Brush and trees carefully secured by cables to stumps or trees along the banks of small streams can be used to provide cover for fish. They should not be used in situations that would block fish passage or cover known gravel spawning beds.

6-5.5.3. Improving Spawning Conditions. Although most egg-laying fish deposit their eggs above the bottom, species such as salmon and trout bury their eggs below the bottom on gravels of different sizes. When the spaces between the gravels are filled in with sand or silt, conditions are unsuitable for spawning and survival of the eggs and young fish. When the gravels have become cemented by fine sands and silt, they may be loosened mechanically by raking, harrowing, disking, plowing, spading, or dozing. Such work should be done when eggs and larvae are not in the gravels, and the effect on downstream conditions should be evaluated. Another method used by the Forest Service is gravel cleaning. In this operation, a mobile machine drags harrow-like teeth through stream gravels to a depth of 14 inches; high-pressure jets of water are released into the gravel through the teeth; a vacuum-cleaner device above the disturbed gravel sucks up the finer materials; and the slurry of fines is pumped through a high-pressure nozzle 100 feet back of the stream bank.

6-5.5.4. Creating New Spawning Beds. New spawning beds can be created by trapping gravels in a stream with low dams or right-angle deflectors or by introducing graded gravels in excavations designed to hold them. Larger species of salmon may use spawning gravels up to six inches in diameter while trout and fish of similar size use gravel up to two inches in diameter. Special artificial spawning and hatching channels can be constructed in cooperation with state or other agencies under cooperative agreements or special use permits. Details on these approaches are contained in the Wildlife Habitat Improvement Handbook (app A, No. 9).

6-5.5.5. Facilitating Fish Passage. With anadromous species (which move up river from the sea to spawn), in particular, consideration should be given to facilitating fish passage. Although complex fish ladders and other approaches are needed for high dams, blockage of fish passage on installations is more likely to be caused by culverts or low dams which require less sophisticated approaches. The Wildlife Habitat Improvement Handbook treats this problem in considerable detail. Fish Migration and Fish Passage—A Practical Guide to Solving Fish Passage Problems (app B, No. 34) contains a series of graphs to aid biologists and engineers in determining velocity and water depth (of critical importance in fish passage) for the most common types of culverts.

6-5.5.6. Improving Conditions for Warm-water Fish. Many warm-water fish need resting and holding areas protected from fast currents. Spawning areas for sunfish, black bass, channel catfish, and other warm-water fish should be protected from strong currents. Lagoons, side channels, and large eddies that contain logs, brush, and deep holes for cover and feeding sites should be protected, improved, or constructed. Ponds or oxbow areas connected to the main stream channel during floods can be very productive for small fish. Abandoned dredge ponds and gravel pits adjacent to streams can also be good fish-rearing locations, especially if temperature and water conditions can be improved by diverting some stream flow through them.

6-5.5.7. Adding Nutrients. There may be situations in headwaters where nutrients are low, or in other stream stretches where water chemistry conditions are extreme. In these situations, adding chemicals or nutrients will help support fish. Food supplies in upstream waters may be augmented temporarily by placing porous sacks of agricultural fertilizer (e.g., a 4-12-16 analysis) in the waters.

6-5.5.8 Considering Birds and Mammals. Other wildlife can benefit from the management suggested for fish. If beaver is selected as a featured species in stream management, preferred foods, such as willow, aspen, and serviceberry, should be retained adjacent to the stream. Dams built by beaver may

benefit muskrat, raccoon, mink, woodcock, and waterfowl such as woodducks, but they may also reduce much needed winter cover for deer in protected valleys. Beaver ponds may increase water acreage for trout for a couple of years; but thereafter, when the stream bank cover has been consumed, resulting in rising water temperatures, and when populations of competing species of fish such as the creek chub and dace develop, the effects on trout may be detrimental. On the other hand, beaver ponds may increase the carrying capacity of streams for warm-water fish. Beaver dams and the beavers' tendency to plug culverts may lead to the flooding of roads. The pros and cons are controversial, but if kept under control, the beaver can be a valuable asset. Waterfowl use rivers as resting areas during migration in the fall, and some species nest in riparian vegetation. River hunting for waterfowl is important from a recreation standpoint. On the other hand, portions of some rivers can serve as sanctuaries if areas having concentrations of waterfowl are posted against hunting.

6-6. Lake and Impoundment Habitat.

6-6.1. Definitions. There is no rule that states how large or how deep a body of water must be to be called a lake, nor is there a clearly defined distinction between a lake and a pond. The origin of natural lakes is associated with glacial action, volcanic action, warping of the earth's crust, and other natural phenomena. Ponds, usually regarded as bodies of water too small to be called lakes, may have a natural origin or be man-made. A water body large enough to be considered a lake in one part of the country may be considered a pond or pothole in another. Reservoirs, also varying greatly in size, are man-made impoundments or controlled lakes in which water is collected or stored. There are important distinctions between artificial reservoirs and natural lakes. Reservoirs are so constructed that they contain very little dead storage (i.e., most of the water is above the level of the lowest outlet and can be released if necessary); on the other hand, almost all water in natural lakes is below the level of the natural outlet. Another difference is that, as compared with their total contents, reservoirs generally have larger inflow than lakes. Principal Lakes of the United States (app B, No. 14) further discusses these distinctions. From the standpoint of fish and wildlife, a lake, reservoir, or pond with water-level control facilities provides more flexibility for management. However, if fish and wildlife values are not given adequate consideration, a reservoir may not be as productive biologically as it could be.

6-6.2. Animals which May Benefit. Ponds, lakes, artificial impoundments, and the land adjacent to them provide habitat for a great variety of warm-water and cold-water fish and the organisms on which they feed. They provide suitable habitat for numerous other wildlife species, including amphibians, reptiles, birds, and mammals.

6-6.3. Objectives. Management objectives include preservation of threatened and endangered species and their habitat, enhancement of fish and wildlife in general, management for preferred species, and conservation for the public benefit, including outdoor recreation and aesthetic and scientific values.

6-6.4. Scope. Considered herein are large, multipurpose impoundments built on rivers and smaller impoundments, ranging from 20 acres to one acre or less, constructed for fishing and recreation. Lakes, ponds, and reservoirs are all bodies of water surrounded by land and affected by its uses and activities. Each has a biological community dependent, in part, on the physical and chemical characteristics of the area. Around the shores of many impoundments, particularly at the upper end or where tributary streams enter reservoirs, there are usually wetland or marshy areas. Management of these areas should be much the same as discussed in paragraph 6-2. Larger lakes and reservoirs may have extensive sandy or gravelly shorelines and, during drought periods or drawdowns, mud flats frequented by shorebirds. During the fall and until frozen over in winter, many of the larger reservoirs also serve as resting places or sanctuaries for large numbers of geese and ducks. Reservoirs affect the distribution and migration patterns of waterfowl which use them as resting sites and surrounding grain fields as feeding grounds.

6-6.4.1. Sedimentation and Eutrophication. In a geological sense, natural lakes are relatively short-lived, and reservoirs are likely to fill quickly with sediment as a result of accelerated erosion and siltation. Small, shallow ponds, whether natural or man-made, also shrink in size from invasion of vegetation and may become eutrophic or over-enriched with nutrients, resulting in the rapid growth of algae. With decomposition of these plants, dissolved oxygen may be used up, resulting, in turn, in fish kills. In shallow, northern ponds and lakes, snow covered ice may also cause winter kills due to lack of sufficient oxygen.

6-6.4.2. Pollution. Although subjected generally to the same types of pollutants as rivers, the problem in lakes is compounded because of the relatively slow replacement of water. Whereas pollutants in rivers tend to be carried downstream and diluted, those in lakes are more confined over longer periods of time. Large reservoirs, if completely drained, may require two years or so to refill, but in Principal Lakes of the United States (app B, No. 14), it is suggested that Senaca Lake in New York might require 10 years and Lake Tahoe, as much as 300 years, to refill.

6-6.4.3. Thermal Stratification. Another important characteristic of larger and deeper lakes and reservoirs is the mixing and thermal stratification of water. In most natural lakes and reservoirs, wind and wave circulation maintains fairly uniform temperatures from top to bottom. With the approach of summer, wind velocities decrease, and the sun warms the surface water, causing it to become less dense than the colder water below. The warm surface waters may mix to a depth of 15 to 40 feet. Below the warmer waters is a transition zone called the thermocline, which may vary from five to 50 feet (usually, the water temperature drops about 0.6°F. per foot), and below the thermocline, the water temperature is cold (ranging in big, fertile reservoirs from 46° to 60°F.). In the fall, the surface water cools and becomes denser and heavier than the lower water. Coupled with wind action, this results in the so-called fall turnover. During the fall and spring periods of mixing, the oxygen which has been added to the upper level by wave action and photosynthesis is distributed throughout the lake. Thermal stratification is further described in "Big Reservoirs" (app B, No. 50).

6-6.5. Management Implications of Thermoclines. The fact that many larger reservoirs have thermoclines with cold water beneath and warm water above enables biologists to manage for the combined production of warm-water fish and trout. Also, in the case of hydropower dams with outlets at the bottom, the release of cold water permits trout fisheries to be established downstream.

6-6.6. Fish Production Potentials. A study by the Fish and Wildlife Service's National Reservoir Research Program, described in "Big Reservoirs" (app B, No. 50), revealed that the impoundment producing the highest angler catches hypothetically would be two to six years old and would have a dissolved solids content of 200 parts per million, an average depth of 20 feet, a relatively long and irregular shoreline, a low water exchange rate, and a long growing season. Fish and Wildlife Service studies also indicate that the average reservoir supports approximately 80 pounds of sport-type fish per acre. At least 50 percent of that crop can be harvested by anglers each year without jeopardizing future production. This means that the current average yield of 17 pounds per acre could be doubled without endangering the population. Among the species produced in reservoirs and lakes are largemouth bass, crappie, rainbow trout, white bass, northern pike, walleye, yellow perch, carp, and suckers. Threadfin and gizzard shad serve as forage fish in many impoundments.

6-6.7. Reservoir Management. Drawdowns which expose parts of the reservoir bottom in the fall or winter tend to increase nutrients for plankton when the bottom is reinundated in the spring. Also, when fish are concentrated by extreme drawdown, unbalanced populations can be eliminated more economically with selective chemicals. Increased fishing can be promoted by providing fishing piers and docks. The construction and annual maintenance or refurbishing of submerged brush shelters concentrate crappie and other species for the angler, as does the winter discharge of warm water from steam power plants.

6-6.8. Cold-water Ponds. Cold-water ponds where water seldom gets above 70°F. in summer are best suited for trout. Trout do not spawn in these ponds; therefore, the ponds should be restocked at least every two or three years. Rainbow trout are the most commonly available species for stocking. Brown trout will grow in slightly warmer water than that required for rainbow, brook, or cutthroat. Food supplies naturally available in ponds usually are sufficient to grow and support 50 pounds of trout or more per acre; however, a pond's carrying capacity can be increased by using manufactured fish foods in pellet form. Stocking cold-water ponds is further discussed in "Farm Ponds" (app B, No. 26).

6-6.9. Warm-water Ponds. In warm-water ponds, water temperatures rise to 60° or 70°F. early in the spring and remain above 70°F. throughout the summer. The most successful combination of fish for stocking warm-water ponds is bluegills and largemouth bass. Channel catfish stocked in warm-water ponds and fed commercial pelleted fish feeds may produce up to 1,000 pounds or more per surface-acre, but they do not reproduce successfully in small ponds. Channel catfish grow best in water with temperatures between 70° and 90°F. Black, brown, and yellow bullhead catfish prosper in warm-water ponds, but they spawn repeatedly and usually overpopulate the water seriously. Stocking warm-

water ponds is further discussed in "Farm Ponds" (app B, No. 26). Information on maintaining a good balance between largemouth bass and bluegills or other forage fish and on managing small impoundments to permit optimum harvests is available in "Symposium on Overharvest and Management of Largemouth Bass in Small Impoundments" (app B, No. 37). Fish pond management is not a simple operation, and guidance from experts in state conservation departments, universities, or Federal agencies such as the Fish and Wildlife Service (app C, No. 6c) and the Soil Conservation Service (app C, No. 4c) should be sought. They can provide helpful information on pond construction, stocking, fertilization, weed control, and elimination of undesirable fish.

6-6.10. Pond and Lake Improvement.

6-6.10.1. Coordination and Legal Aspects. When planning improvement projects, many factors must be considered, including: determination of water rights and prior uses that would conflict with the project purpose; coordination with other resources and land uses; coordination with the state fish and game agency to avoid conflicts with state management plans; evaluation of physical and biological features; checking the quality of the water with Federal and/or state water quality standards for possible detrimental effects of the impoundment upon downstream water, especially its temperature; and careful planning, design, construction, operation, and maintenance of the project.

6-6.10.2. Improvement of Habitat. Many existing ponds or small lakes could be improved by enlarging and deepening. In the case of natural lakes, this could possibly be accomplished through construction of a dam across the outlet, which may result in increased productivity and eliminate winterkill. Addition of brushy cover in the water may provide needed shelter. From the standpoint of birds and mammals, borders of shrubs and herbaceous marsh plants, such as cattails, burreeds, arrowheads, wild millet, wild rice, bulrushes, smartweeds, and reed canary grass, around a pond or lake may be beneficial. Dense growths of such cover, however, may render bank-fishing very difficult and may promote the survival of too many young fish.

6-6.10.3. Water Level Control. It is recommended that facilities for controlling water levels be included in new water development projects. For example, the ability to drop the water level in an impoundment overpopulated with stunted panfish will force many of these forage fish out of the weed beds and into areas where predator fish can get them. Drawdowns are reported to have been used to control carp by leaving carp eggs stranded on an exposed shoreline shortly after spawning and to control bullheads and mudminnows in northern impoundments through winterkill. On the other hand, by raising the water level, additional marshy areas which may improve conditions for northern pike spawning and for waterfowl can be created. In most cases, water control systems should be designed for bottom draw of water to provide better oxygen distribution.

6-6.10.4. Improvement of Conditions for Spawning. Other means of improving conditions for spawning in lakes include the introduction of gravel or crushed stone and the installation of various artificial spawning structures. The natural reproduction of some large catfish, especially channel catfish, can be encouraged by installing drain or flue tiles in new reservoirs before filling the impoundment. The tiles, with one end filled with concrete, should be laid almost horizontally in a small trench on the lake bottom three to five feet below the conservation pool level where they can serve as holes in which catfish spawn. This structure is further described in the Wildlife Habitat Improvement Handbook (app A, No. 9).

6-6.10.5. Improvement of Cover. In clear-water lakes, provision of cover attracts fish. Brush can serve as egg-attachment sites for some minnows and insects as well as escape cover for forage fish. In new impoundments, some brush or standing timber can be left in place; in existing, northern impoundments, brush and log shelters can be constructed, weighted, and placed on the ice to sink when it melts. These structures should be placed in areas of 10 to 15-foot depths but above the zone of summer and winter stagnation. Construction of islands and floating nest boxes is also useful for waterfowl and other wildlife.

6-6.10.6. Vegetation Management. Plants are an essential part of the natural aquatic habitat. They increase the oxygen content of the water during photosynthesis and serve in various ways for food and cover. The microscopic phytoplankton and so-called algae bloom aid in maintaining clear and fertile water with their metabolic and decomposition products. However, aquatic plants can become detrimental to fish, and dense stands of vegetation can make fishing and other water-based recreation next to impossible. The subject of aquatic plant control is complex but among the approaches are:

6-6.10.6.1. Pulling or cutting plants by hand on very small areas or by specially designed machines on larger areas.

6-6.10.6.2. Reducing photosynthesis through dyes

or plastic sheeting which cut down the light penetrating the water.

6-6.10.6.3. Biologically controlling the plants. There have been experiments with the manatee, some herbivorous fish, and certain plant diseases.

6-6.10.6.4. Chemically controlling plants which, while probably the most effective, practical method, has limitations. Any state or Federal regulations on the use of algacides or other chemical weed killers must be adhered to, the applicator must be qualified or licensed, and the work must be coordinated with other concerned agencies. The right chemical should be used at the right time in the life cycle or growth stage of the plant and in accordance with the label on the chemical container.

6-6.10.6.5. Fertilizing certain types of submersed aquatic plants, particularly in the Southeast. Fertilization increases the organic turbidity of the surface water by increasing plankton composed of tiny plant and animal organisms. These suspended organisms reflect the sunlight from the water surface and impede light penetration necessary for plants in deeper waters. The use of organic fertilizers in the waters of northern states, however, tends to increase the growth of objectional forms of algae rather than plankton algae, thus compounding the problem.

6-6.10.7. Increase of Biological Productivity. Since plankton are at the bottom of the food chain, their increase by fertilization theoretically should result in more fish. Many impounded waters are sufficiently fertile so that further chemical enrichment is neither needed nor desirable. Preferably, fertilization should be undertaken only after a complete water chemistry analysis has been made. The advice of biologists should be sought on the need for fertilization and on the kinds, amounts, timing, and manner. Application of inorganic fertilizers may also cause clay particles to settle, thereby reducing turbidity in muddy ponds. Clay turbidity, has been treated in some detail in "Physiochemical Nature of Clay Turbidity with Special Reference to Clarification and Productivity of Impounded Waters" (app B, No. 48).

6-7. Technical Assistance. Many helpful publications can be identified by examining, Sport Fishery Abstracts and Wildlife Review, published by the Fish and Wildlife Service. In addition, the Conservation Directory, published by the National Wildlife Federation (app C, No. 8), contains the annually updated names and addresses of most national and international natural resources conservation agencies and organizations, as well as many professional and scientific societies. The Wildlife Management Institute (app C, No. 13) publishes the transactions of the annual North American Wildlife and Natural Resources Conference; and Stackpole Books (app C, No. 11) publishes a series of authoritative books on the life history and management of many of the nation's large mammalian predators, big game, upland game birds, and waterfowl.

CHAPTER 7. OTHER MANAGEMENT PRACTICES

7-1. General. This section deals with such tools of fish and wildlife management as laws; refuges and sanctuaries; population control, including predators other than those discussed in chapter 8.; winter feeding; stocking and restocking; introduction of exotics; and put-and-take hunting and fishing. This section considers nongame species and nonconsumptive uses of fish and wildlife as well as game species. The positive values of the above tools in complementing and supplementing habitat management are discussed along with their limitations. Means of enhancing the recreational and other values of fish and wildlife are discussed also.

7-2. Laws and Regulations. Laws for protecting and controlling fish and wildlife are discussed in chapters 8. and 9. In this section, the emphasis is on regulating the harvest of game species and protecting nongame species to enhance their recreational and other values and to protect the public interest. Regulations on military installations are within the limitations of the laws passed by respective states or the Federal government. The commander may further restrict the fish and wildlife to be harvested, but cannot extend the season or liberalize the bag or creel limits without approval of the responsible state or Federal authorities. On installations, one problem may be an inability to obtain the legally or biologically permitted game harvest due to security and safety restrictions. Other problems may be distributing the harvest as equitably as possible and assuring that hunting does not interfere unnecessarily with nonconsumptive benefits derived by birdwatchers, hikers, campers, and others. Installation regulations should seek to prevent habitat damage and undue disturbance and harassment of nongame species.

7-2.1. Hunting Harvests. Harvest by hunters is often much less than what is biologically feasible. For example, in Our Wildlife Legacy (app B, No. 2) it is reported that studies in Michigan indicated up to 90 percent of the cock pheasants could be harvested without endangering the following year's production, and in suitable habitat with a reasonable amount of escape cover, legal hunting practically never results in overshooting of the cocks. Although the percentages of game populations considered biologically safe to harvest vary with species and location, studies have indicated that up to two-thirds of the fall population of cottontails and up to approximately one-half of the squirrels may be harvested without harm to succeeding crops of these animals. Other studies have indicated that annual populations of bobwhites on similar areas, whether hunted or not, were much the same, and that in the case of ruffed grouse, there often would be an allowable kill twice the 15 to 20 percent likely to be taken by hunters. In the case of deer, it has been found that in many areas it is necessary to shoot both bucks and does or to have special doe hunting seasons to keep the herds under control.

7-2.2. Trapping Harvests. It is necessary to control populations of coyotes, fox and feral animals that spread rabies. These animals have no natural enemies preying upon them throughout their life span, as many other species do. The fox preys upon ground nesting species such as quail and rabbits. The coyote preys upon deer fawns and thereby affect hunting success. The beaver and muskrat damage or disrupt, drainage facilities by burrowing into impoundments and by blocking outlet structures causing excessive loss of timberland and damage to roads. Trapping should be considered as a source of income and recreational activity in addition to providing population control. The trapping on military lands is accomplished in accordance with state regulations.

7-2.3. Fishing Harvests. Although not applicable to put-and-take fishing, sport fishing with hook and line is so ineffective that ample brood stock generally is present regardless of the fishing intensity. However, fishing regulations do help provide a fair distribution of the fishing and fish crop and may be necessary for limiting the type of gear used. A major problem on installations is likely to be maintaining a proper balance between pan, rough, or forage fish and the carnivores like bass, trout, and pike. In addition to fish population control measures, it may be possible to make the annual surplus of pan fish more available to youths through fishing derbies and modified regulations. For predatory or carnivorous game fish, it may be necessary to impose stricter limitations in order to avoid excessive harvest in small ponds. Regulations covering allowable take, within the limitations of the military mission, and provision of access by roads, piers, boat-launching sites, etc., may help maintain fish population balance and increase recreational benefits.

7-3. Refuges and Sanctuaries.

7-3.1. Definitions. Wildlife refuges may be defined as areas designated for the protection of wildlife and within which hunting and fishing are either prohibited or strictly controlled. They may protect wildlife habitat that might otherwise be used and altered. When properly selected and administered, refuges insure the perpetuation of breeding stocks of the animals they seek to protect. Also, they may constitute areas from which game or other animals can disperse to restock and to be hunted or enjoyed in surrounding areas. Wildlife sanctuaries are similar to refuges but usually afford more protection from man. Hunting, fishing, and collecting specimens may be prohibited. The term, "hunting preserve", may be applied to land or water managed primarily for hunting.

7-3.2. Management. Refuges and sanctuaries may have a place in wildlife management on some installations. Often, refuges are the sites of large concentrations of waterfowl or other wildlife populations which can provide recreational benefits for bird-watchers or other non-consumptive users without harming fish and wildlife resources. On the other hand, too many visitors, without proper control, can negate the purpose of a refuge. Snowmobile and other off-road vehicle trails should be kept away from winter deer yards and other sensitive areas, such as marshes, to avoid disturbing deer, ducks and marsh birds. Installations must coordinate the possible establishment of refuges and sanctuaries with the appropriate military command and the Fish and Wildlife Service.

7-3.2.1. Waterfowl Refuges. Refuges within the breeding ranges of waterfowl can provide good nesting and brood-rearing areas. Refuges within the primary flyways or within waterfowl wintering areas provide resting sites during migration or wintering sites. Additionally, however, if waterfowl populations and other circumstances permit, they provide a source of birds for hunters when the birds fly to surrounding areas to feed. Wild waterfowl will not tolerate harassment for long and will leave abundant feed and attractive water behind if disturbed too often by shooting, people, vehicles, or dogs. On the other hand, an attractive site, free of disturbances, can be the focal point for concentrations of ducks and geese which return year after year. As described in Practical Wildlife Management (app B, No. 15) a 9-acre pond and a few acres of surrounding fields, fenced against trespass by both people and animals, attract and hold thousands of Canada geese every winter at Remington Farms, Maryland. The sanctuary principle applies not only to areas where bird-watching is a goal but also to areas where improved hunting is a primary objective.

7-3.2.2. Other Refuges. Often, in refuges established primarily for waterfowl, other species of wildlife become abundant. For nonmigratory wildlife with a small home range, refuges may not be particularly valuable in providing breeding stock for the surrounding countryside; therefore, excess populations of deer, rabbits, squirrels, upland game birds, or fur animals can be harvested by hunting or trapping. Aside from the restrictions on land use or hunting which may be in effect in refuges, the habitat management or predator control favoring certain species may be more intensive than elsewhere. The bald eagle now gone or threatened in some regions where it once occurred in substantial numbers, can be afforded necessary protection in wildlife sanctuaries (fig 7-1).

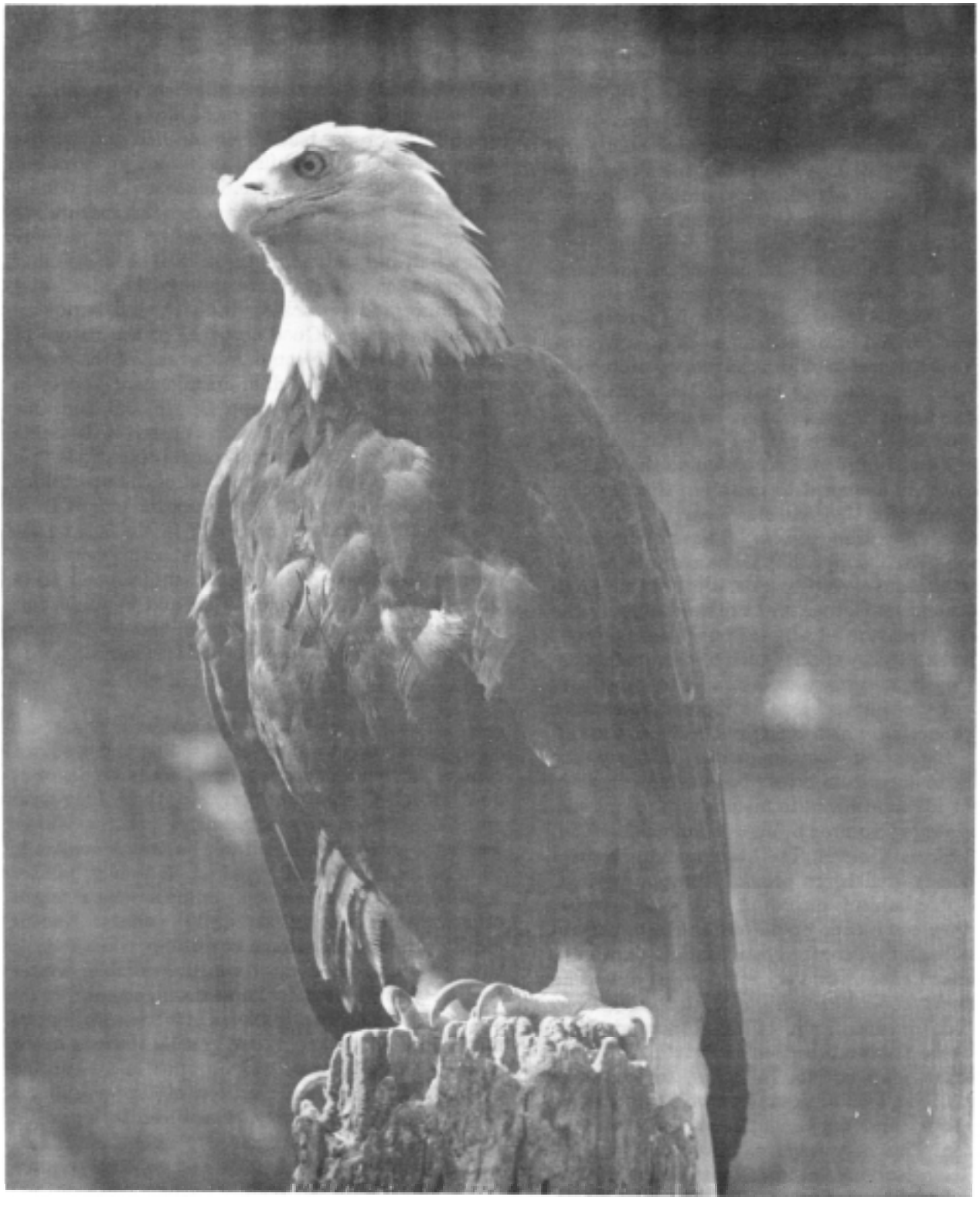


Figure 7-1. Bald eagle.

7-4. Population Control.

7-4.1. Natural regulation of Animal Numbers. Wild animal populations are regulated by both natural and man-contrived means. The Natural Regulation of Animal Numbers (app B, No. 56) develops the following principles: reproductive rates in wild animals are a product of natural selection and are as efficient as possible; reproductive rates may vary with population density, but the main density-dependent control of numbers probably comes through variations in the death rate; critical mortality factors are food shortage, predation, and disease, one of which may be paramount although they often react together; preservation of rare and attractive animals is achieved either by preventing human destruction or by setting aside an area containing their natural habitat as a reserve; protection of animals from shooting may, in the absence of predators, result later in huge losses from starvation; and certain rare species are confined to a temporary stage in plant succession so that unless their habitat is managed to maintain that specific stage of succession they will disappear.

7-4.2. Need for Management. The principles in paragraph 7-4.1. imply that if man wants to preserve certain endangered species, it is not enough to set aside areas and let nature take its course. In the absence of predators which previously were present and helped keep prey species such as deer under control, it may be necessary or desirable to substitute harvest by the hunter. Due to modern forest fire control programs, which keep fires in check, thus affecting vegetation development, it may be necessary to substitute prescribed burning or selective herbicide treatments to maintain the plant successional stages required by certain animals.

7-4.3. Predator Control. The best predator control program may well be to provide the prey species with suitable habitat, including good escape cover, so that they can escape predators. Predator control on a continuing, year-after-year basis is expensive and, in many cases, not very effective as a wildlife management tool. There are situations, however, where predator control is justified, at least on a temporary basis. Studies described in Practical Wildlife Management (app B, No. 15) show, for example, that drastic removal of predators which take eggs, nesting hens, and ducklings increases waterfowl production. This may require, therefore, removing skunks from land-nesting areas and snapping turtles from brood-rearing areas. Trapping can be used to control skunks, while large fish hooks that are baited with chunks of meat or fish and rigged on lengths of heavy cord tied to a stake can be used to capture turtles.

7-4.4. Selective Animal Control. Animal control to reduce competition from nuisance species, carried on with skill, can result in a higher production of more desirable species, especially fish. With fish, the problem on installations is most likely to be either keeping the proper balance of pan fish and bass or other predatory game fish, or removing so-called rough fish, such as carp, from lakes and fish ponds. Approaches toward removing rough fish include: encouraging more fishing pressure on pan fish or rough fish and restricting the take of bass; draining the pond or reservoir; removing the fish, and reclaiming and restocking the site; and removing fish by poisoning. Good accounts of the nature of predation in wildlife communities and of the role of predator control in wildlife management appear in Of Predation and Life (app B, No. 33) and Our Wildlife Legacy (app B, No. 2). When it is desirable to engage in selective animal control operations, it is recommended that both approval of the operations and technical advice or assistance be sought from the Fish and Wildlife Service (app C, No. 6c) and the respective state fish and game or conservation department. Cooperative agreements among state conservation agencies, the Fish and Wildlife Service, and military installations should describe arrangements for such advice and assistance.

7-5. Winter Feeding.

7-5.1. Relation to Other Approaches. There are many parallels between winter feeding and predator control for wildlife management. Less credence is now attached than formerly to their long-term value. As in the case of predator control, winter feeding is expensive. If suitable habitat is available, usually feeding is not required. However, winter feeding may enable a few animals which might otherwise starve to get through the winter. Except locally and under extreme conditions when food is covered with ice or snow and unavailable, winter feeding is not feasible for game management.

7-5.2. Problems. The problems of winter feeding are manifold. In addition to cost, getting the feed to the animals in large areas and in time is almost impossible. Also, animals concentrating around artificial feeding sites may be subject to increased predation and may become dependent upon continued handouts which may not be forthcoming. Many animals cannot readily change types of food due to the lack of enzymes to fully digest the food.

Deer have died near winter feeding stations with stomachs full of undigested foods.

7-6. Restocking Fish and Wildlife.

7-6.1. Carrying Capacity. Another management approach is restocking areas which once supported certain fish and wildlife species or stocking areas which are suitable for species not currently present or in the desired numbers. Although some restocking efforts have been effective, as in the cases of beaver and wild turkey, many attempts have not been. Stocking or restocking should occur only after careful studies have been made of habitat conditions. If a remnant population of a species appears in an area, the existing population is probably all the area will support. When a species native or endemic to one area of the United States is considered for release in another part of the country, detailed investigation of the habitat requirements of that species should be made and related to the habitat into which it is to be released. Consideration should be given to possible conflicts with other species, damage which may be inflicted on crops, and possible introduction of wildlife diseases. Although there are instances of notable success in releasing species from one part of the country into another, as in the cases of brook trout from the East to the West or of rainbow trout and coho salmon from the Pacific drainages to the East, most attempts have failed.

7-6.2. Stocking Fish Ponds and Streams. Stocking fish is a common practice on military installations, usually in cooperation with or upon the advice and approval of the respective state conservation department and regional office of the Fish and Wildlife Service (app C, No. 6c). Rearing channel catfish is also common on installations in the South. Technical advice and approval should be sought even when stocking native species. The roles of the Fish and Wildlife Service, the state conservation department, and the installation should be outlined in a cooperative agreement.

7-7. Introduction of Exotic Species.

7-7.1. Potential Problems. The same general principles governing the stocking or release of native species apply to the introduction of exotic species. Even more care must be taken to avoid dire consequences, such as crowding out native species, introducing new diseases or parasites, causing economic losses to crops, or creating unfavorable effects on the habitat. Recently, there has been considerable interest in the introduction into United States waters of grass carp or white amur as a biological means to control aquatic vegetation. This has proven unsuccessful in most situations however, and by 1977, has been restricted or outlawed in 35 states. Introduction of exotics generally should be discouraged.

7-7.2. Established Exotics. Most attempts to introduce desirable game species have failed. However, some species, such as the ring-necked pheasant, the Hungarian or gray partridge, and Chukar partridge, have been relatively successful. These species can be treated much like native species if the stock is obtained from populations already existing in the United States.

7-7.3. Legal Restrictions. Introduction of exotic animals is strictly controlled by the Federal Government. The animals must be held in quarantine before release as a protection against introduction of disease. No fish, wild mammal, or bird should be introduced on an installation without prior written approval of both the military and the Fish and Wildlife Service. A statement to this effect should be included in any fish and wildlife management cooperative agreement.

7-8. Put-and-take-Hunting and Fishing. In the absence of habitat sufficient to provide populations large enough to meet the demand for fishing and hunting, put-and-take programs may be implemented. Put-and-take programs involve the release of fish or wildlife into designated areas shortly before they are to be harvested. Usually, there is little holdover of wildlife after the harvest season due to a lack of suitable habitat or cover. Therefore, where suitable, management activities should be directed toward improvement of habitat, rather than toward put-and-take programs. To simulate fishing or hunting under anything like natural conditions is not easy, and technical advice should be sought. Information on shooting preserve management appears in Shooting Preserve Management—The Nilo System (app B, No. 55). Additional information can be obtained from the North American Game Breeders and Shooting Preserve Operators Association (app C. No. 9).

7-9. Nonharvest Aspects of Wildlife Management.

7-9.1. Need for Attention. Although the emphasis has been on game species management, there is a growing interest in the nonconsumptive aspects of wildlife management, including the welfare of and the recreational benefits from songbirds and other nongame species. Although habitat management for game species often benefits nongame species,

there are many opportunities to do more, especially within developed areas.

7-9.2. Opportunities for Management.

7-9.2.1. Building Areas. The areas of installations used for dwellings and office quarters could be improved for wildlife by maintaining a greater diversity of vegetation, less short-clipped grass, more shrubs with special food and cover value for wildlife, and where possible, mixtures of coniferous and deciduous trees. Even a few weeds or unharvested crops left along fences or in gardens can be useful. Backyard pools or other sources of water help attract wildlife, and birdhouses may attract bluebirds, wrens, or other species. Additional guidance and suggestions can be found in "Invite Wildlife to Your Backyard" (app B, No. 107), Landscaping for Birds (app B, No. 13), Homes for Birds (app B, No. 22), and Songbirds in Your Garden (app B, No. 106). Information on attracting birds and other wildlife to developed areas can be obtained from the Fish and Wildlife Service (app C, No. 6c) National Wildlife Federation (app C, No. 8), National Audubon Society (app C, No. 7), and local Audubon and natural history organizations. Preserving open space, saving wetlands from drainage, creating wetlands or ponds, and avoiding unnecessary channelization of streams in developed areas of installations benefit wildlife, including fish, reptiles, and amphibians.

7-9.2.2. Road Areas. Roadways should be planned and maintained with more consideration of wildlife. Construction can be accomplished with less impact on the environment if routes are selected which do not necessitate wetland drainage or stream channelization. Vegetation along roads, including landscape planting and mowed areas (in terms of mowing frequency and width), can be managed to enhance conditions for small birds and other wildlife that do not constitute a hazard to vehicular traffic and are enjoyed by travellers. For example, leaving some dead trees along roadways to serve as perching sites for hawks can contribute to recreational benefits. Both ponds created from borrow pits for sand and gravel and wetlands formed by fills across drainage during highway construction can be maintained as fish and wildlife areas.

7-9.3. Additional Benefits. Increased enjoyment and appreciation of wildlife may result from the construction of observation blinds, viewing towers, or pull-off parking sites which overlook marshes or other areas of wildlife concentration. Well-designed nature trails, with appropriate informational signs, can serve as educational tools and arouse interest in conservation. The entrance to a nature trail should be conspicuous enough to attract attention. The route should vary as much as possible and should be designed as a loop or figure-eight so that the user returns near the starting point after walking approximately one-half mile. Trails should avoid steep grades that are tiring and result in erosion; they should be laid out along existing contour lines if possible. Raised footpaths should be used across wet spots or areas that may be flooded. Persons well-versed in natural history should be invited to go over the area during trail selection to identify interesting features. Their assistance can ensure factual information for signs, labels, and interpretive leaflets and can assist in conservation of the resource. For example, signs explaining why box turtles, which frequently are collected in large numbers along nature trails by children, should not be collected, help conserve this species for others to enjoy. How to Build a Nature Trail (app B, No. 70) provides additional information.

7-10. Funding and Equipment.

7-10.1. Need. In some instances, habitat management for wildlife is accomplished in connection with forest management or grounds maintenance operations. Equipment obtained for other activities on an installation may be used occasionally for habitat management work. Although, with good planning, coordination, and cooperation, much can be accomplished in this way, the extent and effectiveness of habitat management will be increased as more funds are made available for fish and wildlife programs specifically, and when certain types of equipment such as brush hogs, heavy discs, plows, tractors, drills, and chain saws are available when needed.

7-10.2. Use Permits. The sale of permits for fishing and hunting and other recreation activities is an excellent means of providing funds for expanding these programs. Reference AR 420-74/DA PAM 420-7/AFR 126-1/NAVFAC INST. 11015.4/MCO P11000.8 (app A) for guidelines relating to permits, fees and licenses.

CHAPTER 8. REGULATION OF WILD ANIMAL POPULATIONS AND REDUCTION OF INTERFERENCE WITH MISSION ACTIVITIES AND LIVING CONDITIONS

8-1. Regulation of Animal Populations.

8-1.1. Scope. If animal mortality did not approximate reproduction, the earth soon would be overflowing with animals. Animal populations, if kept free of man's impact, would be regulated by natural means. However, there are probably few, if any, places in the United States where animals or their habitat are not affected by mankind. The effects may be beneficial or detrimental, deliberate or incidental. Many situations in which man now feels it necessary to regulate populations of wild animals have been created inadvertently. Conflicts with desirable wildlife species have developed when airfields have been sited in desirable wildlife habitat.

8-1.2. Justification for Control. Regulation or control, in addition to that imposed by nature, is often justified by economics, health, and safety. Wildlife can cause loss of crops, stored grains or food, damage to property, and interference with man's activities. Bird-aircraft strikes can result in damage to an airplane and injury or loss of life to its occupants. Also, birds such as gulls in the vicinity of an airport or deer along a runway may create hazards to aircrews and passengers. Certain diseases can be transmitted from wildlife to man. There has been some concern that bubonic plague may be contracted from the large numbers of ground squirrels on some installations. Histoplasmosis, an airborne fungal disease which attacks the lungs of man, is spread through bird dropping buildup. Therefore, bird roosts constitute a definite health hazard. Large roosts of blackbirds, starlings, house sparrows, and pigeons in or near housing, hangars, or other buildings can cause unsanitary conditions, economic losses and constitute a nuisance. Other situations where control is needed include highways flooded due to culverts blocked by beavers, and fish ponds drained by burrowing muskrats. An example of yet another reason for regulatory control is that uncontrolled deer populations may overbrowse their habitat causing starvation, emaciation, heavy parasitism and disease.

8-1.3. Approaches. Although man has exercised considerable control over wild animal populations, his influence probably has been greatest through land use changes and environmental impacts unrelated to wildlife management. However, deliberate management efforts, including those intended to control or regulate animal damage or interference, have been based, in part, on habitat management. In such instances, the approach has been to render a site unattractive to offending animals. Other approaches to control include: deliberate removal of offending animals by shooting, poisoning, or trapping (in the latter case, the animals are killed or released elsewhere); biological control by natural predators; chemical control by either killing animals or keeping them away with chemical repellents; physical control by scaring animals with various noise and distress call devices or excluding them from a site with fences; bird proof designed building construction; cultural control by selecting varieties of crops resistant to damage; and by planning the timing and methods of planting and harvesting.

8-2. Regulation As a Function of Management. The regulation of wild animal populations is a function of wildlife management. Habitat management, regulation enforcement, and predator control are three approaches of wildlife management.

8-2.1. Habitat Management. When developing management programs, possible conflicts with the military mission should be kept in mind at all times. Installation areas where wildlife may pose a hazard, or interfere with the military mission, should be managed in such a way that they are not attractive to wildlife. At installations with airfields, for example, precautions should be taken to avoid water, attractive cover or sources of food near or along runways or approaches to the airport. Fish ponds or reservoirs, which attract birds, and food plots, which tend to concentrate wildlife, should be separated from areas where wildlife is not wanted. Habitat management practices to enhance wildlife should be avoided in such areas.

8-2.2. Regulations. Animal populations can be controlled to some degree by regulating fishing, hunting, and trapping seasons and daily bag or creel limits. However, the setting of seasons and daily

limits must be coordinated with appropriate state game and fish agencies and correspond with Federal regulations for migratory species.

8-2.2.1. Hunting. There are limitations to hunting as a control method since too many hunters can create safety problems. A "safe" ratio of acres per hunter depends in large part upon cover type, terrain, type of weapons and ammunition, hunter discipline, hunter visibility, and type of clothing worn. Many states require deer hunters to wear some fluorescent orange or red material. With the use of shotguns and buckshot, a ratio of one hunter per 50 acres is considered a reasonable safe hunter density. The number of hunters can be increased for small upland game hunting. Special doe seasons designed to cut the annual production of deer may be arranged with the approval of the respective state fish and game department, or the length of hunting season may be extended to take more deer. In areas where firearms cannot be permitted for safety reasons, bow-and-arrow hunting may be feasible. In other areas, muskets or primitive weapons may be used, contributing to the recreational value.

8-2.2.2. Trapping. Beaver, nutria, and muskrats which are causing problems should be trapped. Trapping for fur production must be conducted in accordance with state regulations. Nuisance animal trapping must be coordinated with state wildlife officials.

8-2.3. Predator Control. Predators and certain rodents merit special attention in connection with population control.

8-2.3.1. Predators. Predators are meat-eaters and feed largely upon foraging species. They are a part of natural ecosystems and help maintain a balance among the thousands of species making up animal populations. If a wildlife management program requires intensive management for endangered or newly reintroduced species, some predator control may be justified. Normally with suitable habitat conditions, good populations of game species along with the predators can be maintained without predator control. The esthetic and recreational values of many predators should not be overlooked.

8-2.3.2. Rodents. Often, certain rodents, such as the woodchuck or groundhog, are classified as "vermin" or nongame animals and are subjected to unregulated hunting. The woodchuck, a burrowing animal, digs holes valuable to other wildlife, such as skunks and rabbits, which take refuge in ground dens. Ammunition storage sites involving soil-covered bunkers are particularly attractive to woodchucks. The burrows can be detrimental in some cases causing culvert maintenance problems and soil erosion. From the standpoint of wildlife management, hunting these animals should be controlled.

8-2.3.3. Predator Harvest. It is fortunate that the productivity of many game species, as well as that of predators and rodents, can withstand heavy mortality from hunting or trapping. Studies have indicated that up to three-fourths of many animal populations existing after the reproduction period can be harvested without interfering with the annual population levels. Both game species and predators can be harvested in reasonable numbers, but harvesters should not discriminate against so-called predators. Should there be a rabies outbreak involving fox, skunk, or other animals, assistance and advice from the state conservation department or health authorities should be sought. Usually, there is no valid justification for special control of predators.

8-2.3.4. Dogs and Cats. Free-roaming dogs and cats are predators in a slightly different category. From the standpoint of management to enhance wildlife populations, they should be controlled. Dog and cat owners should keep their pets on leash or under control at all times to avoid undue harassment and killing of wildlife on an installation. Regulations to this effect should be strictly enforced.

8-3. Deliberate Reduction of Mammal and Bird Interference. There are situations which require prevention or control of animal damage to, or interference with, the military mission. Control may be based upon environmental, physical, biological, chemical, or cultural conditions.

8-3.1. Environmental Control. Environmental management is a major approach to controlling animal damage at airports. Although much of the interference or damage and most of the potential hazard to human life is caused by birds, either resident or transient, other animals are involved. Information concerning means of reducing bird-aircraft strikes appears in Airport Services Manual: Part 3 (app B, No. 47). While detailed analyses of bird problems and control methodologies are not possible here, the general approaches (which also apply to other types of military facilities) are as follows.

8-3.1.1. Development and Maintenance. Birds occur on or over airports to obtain food, water, cover, and a place to breed, nest, roost, or find safety. They may fly over an airport runway or across airplane approaches during migration or in daily flights to and from feeding, roosting, or resting sites. Their

food may be: edible garbage, aquatic organisms from ponds or other wetland or water areas, insects from vegetation or the air space above the airport, earthworms which crawl on the surface of the ground or runways after a heavy rain, seeds of crops or grass, grass itself, and small mammals such as voles, lemmings, and ground squirrels which are consumed by owls, hawks, and other birds of prey. Environmental management for existing airports should be directed towards making the airport unattractive to birds and other wildlife. Methods include: better garbage disposal; filling of borrow pits, ponds, and wetland areas; restrictions on farming and other agricultural pursuits; and vegetation management resulting in the least attractive food or cover. Pine or other coniferous plantations or thickets of deciduous vegetation conducive to large roosts of starlings and blackbirds may need to be thinned. Care should be taken in landscape planting to select, in so far as possible, species or spacings which are unattractive to birds and other wildlife. Depending upon the problem species of bird, the maintenance of grass at heights from seven to nine inches may reduce their occurrence on grass-covered areas near runways.

8-3.1.2. Construction. New buildings should be well constructed, with a minimum of decorative ventilation openings, ledges, and I-beams covered by sheltering eaves which provide nesting or roosting sites for such species as the house sparrow, starling, and pigeon. Informational and directional signs should be designed with sharp points or trim along the upper surface to discourage birds from perching.

8-3.1.3. Sanitation. Good sanitation, including retrieval and disposal of waste paper, may be helpful. Waste paper blowing across a surface may attract gulls, presumably because the gulls associate garbage with a food source.

8-3.2. Physical Control. Wires stretched across drainage ditches or canals tend to keep birds away. Various pyrotechnic devices, such as firecrackers, rockets, flares, shellcrackers, and carbide cannons scare birds away, but they involve some fire hazard. Tape recordings of bird distress calls have been used to repel birds with some success, as have dead or model birds placed along the sides of airport runways or in other areas such as crop fields. No single scaring device is effective for long term control. A combination of techniques is necessary to prevent habituation. Fences may be used to keep deer and other large mammals from areas where they are not wanted. Some animals can be killed by live ammunition or removed by trapping. Information on trapping methods and necessary permits is obtainable from the regional offices of the Fish and Wildlife Service (app C, No. 6c).

8-3.3. Biological Control. Biological control by predators has already been mentioned. From the standpoint of animal damage control, using insects or diseases probably has been more successful to control noxious insects than to control larger animals. Although peregrine falcons have been used with some success to drive away or kill birds at airports, the falcons must be trained and have specialized personnel to handle them. Falcons cannot be used in adverse weather and the protected status of birds of prey complicates their use.

8-3.4. Chemical Control. Many kinds of chemicals have been used to kill or repel birds and mammals. Environmental Assessments and, if necessary, Environmental Impact Statements must be prepared so that undesirable environmental impacts, killing or damaging of desirable species, and hazards to people applying chemicals are avoided. Chemical control action must comply with "Environmental Safeguards in Activities for Animal Damage Control on Federal Lands" (E.O. 11870, 18 July 1975), the National Environmental Policy Act of 1969 (1 January 1970, Pub. L. 91-191, 83 Stat. 852), and the Endangered Species Act of 1973 (28 December 1973,Pub. L. 93-205, 87 Stat. 884). Although some of the methods of chemical control advocated in Animal Control in Field, Farm and Forest (app B, No. 30) are outdated, this book still offers useful information on the characteristics and control of mammals.

8-3.4.1. Birds. Surfactants or detergents have had considerable success in reducing populations of starlings and blackbirds in large roosts. Surfactants when mixed with water lower the surface tension of water. When the solution is sprayed on birds, the chemical action of the surfactant breaks down the oil in the feathers, removing the birds' natural waterproofing. The insulating effect of the birds' feathers is lost, and if temperatures are low enough, the birds die. This approach has limitations and should be attempted only in cooperation with the Fish and Wildlife Service and in compliance with the directives referenced in subparagraph 8-3.4. Responsibility for the protection, conservation, and management of migratory birds, including blackbirds, and for the control of significant conflicts between migratory birds and man in the United States lies with the U.S. Department of the Interior under the protection of the Migratory Game and Insectivorous Birds Act (16 U.S.C. 701-718h) and the Animal Damage Control Act of 1931 (2 March 1931, 7 U.S.C. 426-426b, 47 Stat. 1468). Additional in-

formation on the potential use of surfactants can be obtained from the Fish and Wildlife Service.

8-3.4.2. Mammals. Chemicals to kill or repel offending mammals have a place in the control arsenal under certain conditions. The regulatory action cited in subparagraph 8-3.4. must be complied with prior to application of any chemical control program. Chemicals developed to kill rodents or other mammals may produce secondary effects, such as insecticides which kill or damage nontarget wildlife species. Thus, while use of Compound 1080 may be effective in the control of ground squirrels, a suspected source of bubonic plague, it may result in the death of other animals which consume the poisoned animals. Compound 1080 cannot be used on Federal lands except under unusual circumstances. Other poisons such as zinc phosphide, which is not passed up the food chain, are effective. The real need for extensive poisoning campaigns should be evaluated carefully.

8-3.5. Cultural Control. Cultural methods apply to installations particularly in connection with outleasing land for agricultural purposes and with landscaping programs. Planting corn with adequate cover, harvesting promptly upon ripening, controlling corn borers, and using varieties in which the stalks tend to stand erect rather than lodging can reduce damage by pheasants. Waterfowl damage to wheat in the north-central United States may be reduced similarly by prompt harvesting. When landscaping living quarters and office buildings, shrub species unattractive to wildlife should be selected if wildlife populations are considered undesirable.

8-4. Technical Assistance. The Fish and Wildlife Service, the Agricultural Research Service (app C, No. 4 a), and the Wildlife Society (app C, No. 14) produce numerous publications on animal control. The Fish and Wildlife Service can also provide the names and addresses of its Animal Damage Control State Supervisors. Other sources of information include state agricultural experiment stations, agricultural extension services, and departments of zoology and entomology in state and local universities.

CHAPTER 9. PROTECTION OF FISH AND WILDLIFE AND THEIR HABITAT

9-1. General

9-1.1. Means of Protection. Protection, preservation, and conservation of fish and wildlife are afforded by preserving, maintaining, and developing (i.e., managing) habitat and by regulating the take of fish and wildlife and the activities of man which affect them.

9-1.2. Wildlife Ownership. Within the United States, the common law of the land provides that all wildlife is the property of the people, the sovereignty of which is vested with the states. State laws, therefore, are the primary means of protecting fish and wildlife through regulations. The Federal Government also has certain protective responsibilities. The Migratory Bird Treaty Act of 1918 as Amended (3 July 1918, 16 U.S.C. 703-711, 40 Stat. 755) authorizes and directs the Secretary of the Department of the Interior to exercise control over migratory birds. The Federal Government has responsibility for protecting threatened or endangered species of native plants and wildlife under the Endangered Species Act of 1973 (P.L. 93-205 as amended by P.L. 94-235, 94-359 and 95-632). In public lands, when there is conflict between the objectives of a state and the Federal Government, the supremacy clause of the United States Constitution (Article VI, clause 2) precludes state control over authorized Federal activity in furtherance of Federal public land programs. In addition, other Federal laws apply to various marine fish and mammals and their habitat. A military installation may also impose regulations, for safety or other reasons, which are more restrictive than Federal or state regulations. An installation may develop programs to instill strict discipline and responsibility in the hunting and fishing activities of its personnel.

9-2. Habitat Preservation and Management for Threatened and Endangered Species. The habitat of threatened and endangered species may be very restricted in area, or it may contain certain nesting trees, water quality or supplies, specific food items, or other components essential to the continued existence of a species. Special care is needed in managing or protecting such habitat and the threatened or endangered species population occupying the habitat.

9-2.1. Critical Habitat. All Federal land managing agencies have been directed to survey their lands and make critical habitat recommendations to the Secretary of the Interior. The definition of critical habitat was revised by the 10 November 78 amendment to the Endangered Species Act of 1973.

9-2.2. Critical Habitat Management. The existence of threatened or endangered species should be determined from literature and from consultation with biologists or ecologists of the Fish and Wildlife Service (app C, No. 6c) and the National Marine Fisheries Service (app C, No. 5) and state fish and game agencies who have made special studies of such species. Critical habitat has a strong meaning in the Endangered Species Act, and no Federal agency may take any action which will modify this habitat. The probable environmental impact of an action on threatened and endangered species must be assessed. If required, the Federal agency must initiate consultation with the Fish and Wildlife Service in accordance with Section 7 of the Endangered Species Act. Specific management practices may be required to maintain the critical habitat. Nest trees used by such species as red-cockaded woodpeckers, bald eagles, and ospreys should remain, along with replacement trees, in any forest management operation. For threatened and endangered species, the best management may be no management (i.e., no disturbance of the critical habitat). Management for endangered species usually benefits other species as well.

9-3. Regulations.

9-3.1. Hunting, Fishing, and Other Outdoor Recreation Activities. Hunting, fishing, and trapping laws effective on installations are expected to be within the limits established by the respective state fish and wildlife agencies and the Federal Government. Threatened and endangered species should be subject neither to fishing, hunting, and trapping nor to undue disturbance from camping, boating, swimming, and other recreational or military activities.

9-3.1.1. Law Enforcement. Usually, the Provost Marshal/Security Officer is charged with the enforcement of hunting, fishing, and trapping regulations. Enforcement is provided as directed by

DOD instructions and is in compliance with applicable state laws. Officers of the Fish and Wildlife Service are primarily responsible for enforcing laws dealing with waterfowl and other migratory birds and with threatened and endangered species and certain laws dealing with fish. State conservation officers may hold a dual commission to act as Federal agents to enforce wildlife regulations on Federal land normally as specified under a cooperative agreement.

9-3.1.2. Harvest Regulations. Laws or regulations governing the harvest of fish, game animals, and furbearers are based primarily upon trends in wild animal populations in view of previous harvests and upon habitat conditions, current populations, and management objectives of an installation. For migratory game birds, the surveys and inventories by the Fish and Wildlife Service provide the best general and nationwide or regional indications of population trends. State wildlife agencies can provide information on population trends for resident game species and fur animals. The Fish and Wildlife Service can render technical assistance in determining fish populations in streams and the population and balance of fish species in ponds and lakes. State conservation agency personnel can provide similar assistance.

9-3.1.3. Permits and Licenses. Reference AR 420-74/DA PAM 420-7/AFR 126-1/NAVFAC INST. 11015.4/MCO P11000.8 (app A) for guidelines relating to permits, fees and licenses.

9-3.1.4. Special or Extended Seasons. When regulations more restrictive than those of a state or the Fish and Wildlife Service are needed to protect certain species, harvests can be regulated by reducing the daily or annual limit of fish or game or by reducing the number of days or restricting the way in which fish or wildlife may be harvested. To ensure that deer do not degrade their habitat through excessive population, it may be desirable to extend the hunting season beyond that authorized statewide. Due to the military mission or security, hunting cannot be permitted on some installations during much of the season (e.g., daily hunting). If, for example, hunting can occur on an installation only on Saturdays, and the state deer season is two weeks, it may be possible to obtain approval from the state wildlife agency to extend the season or to obtain permission for a special any-sex-or-doe season to keep the deer herd under control. Deviations from the seasonal regulations of state or Federal agencies must be made with the consent and advice of the agencies. The need for special or extended seasons should be addressed in the Cooperative Plan Agreement: a commitment from the state to recognize and consider such a need upon request should be incorporated in the agreement.

9-3.1.5. Record-keeping. As a means of determining trends in the annual fish catch or game harvest, it is recommended that fishermen and hunters be required to complete forms recording the animals taken. In the cases of deer and wild turkey, hunters should bring the killed animals to a checking station for examination by qualified biologists so that they can obtain information on sex and age ratios, condition of the animals, etc., for use in wildlife management plans.

9-3.1.6. Safety Practices. Installations should adhere to the safety devices and practices required by respective states. Establishment of safety zones and danger areas for hunting is the responsibility of the installation Safety Officer, or equivalent, in cooperation with personnel from the fish and wildlife section. Each hunter and fisherman should be requested to report accidents and the location of unsafe conditions, such as unexploded munitions, to the appropriate office. Many states require attendance at a hunter safety lecture prior to issuance of an installation hunting permit.

9-3.2. Environmental Protection. Congress has enacted several laws oriented toward environmental protection and requiring an appraisal of the effect of proposed military construction activities on wildlife habitat in general and on protected plant and animal species and their habitats specifically.

9-3.2.1. Fish and Wildlife Coordination Act of 1934 as Amended (10 March 1934, 16 U.S.C. 661-666c, 48 Stat. 401). The Act is intended to provide for more effective integration of fish and wildlife conservation with Federal water-resource developments, such as stream channelization, impoundment, water diversion, and other control facilities, in order to prevent loss of and damage to fish and wildlife resources and to provide for the development and improvement thereof.

9-3.2.2. Sikes Act of 1960 (15 September 1960, Pub.L. 86-797, 74 Stat. 1052). Section 1 of the Act states that: ". . . the Secretary of Defense is hereby authorized to carry out a program of planning, development, maintenance, and coordination of wildlife and fish and game conservation, and rehabilitation in military reservations in accordance with a cooperative plan mutually agreed upon by the Secretary of Defense, the Secretary of the Interior, and the appropriate state agency designated by the state in which the reservation is located. Such cooperative plan may stipulate the issuance of special state hunting and fishing permits to in-

dividuals and require the payment of a nominal fee therefore, which fees shall be utilized for the protection, conservation, and management of fish and wildlife, including habitat improvement and related activities in accordance with the cooperative plan."

9-3.2.3. National Wildlife Refuge System Administration Act of 1966 as Amended (15 October 1966, 16 U.S.C. 668dd-668ee, 80 Stat. 927). The purpose of the Act is to provide for the conservation, protection, restoration, and propagation of selected native fish and wildlife species, including migratory birds threatened with extinction, and to consolidate the present authorities (i.e., the legal framework) relating to the administration of the National Wildlife Refuge System by the Secretary of the Interior.

9-3.2.4. National Environmental Policy Act of 1969 (1 January 1970, Pub. L. 91-190, 83 Stat. 852). The purposes of the Act, as stated in Section 2, are to:

9-3.2.4.1. Declare a national policy that will encourage productive and enjoyable harmony between man and his environment.

9-3.2.4.2. Promote efforts that will prevent or eliminate damage to the environment and biosphere and will stimulate the health and welfare of man.

9-3.2.4.3. Enrich the understanding of the ecological systems and natural resources important to the Nation.

9-3.2.4.4. Establish a Council on Environmental Quality and provide guidelines for preparation of Environmental Assessments (EA) and Environmental Impact Statements (EIS).

9-3.2.5. Marine Mammal Protection Act of 1972 as Amended (21 October 1972, Pub. L. 92-522, 86 Stat. 1027). The purposes of the Act are to protect marine mammals and establish a Marine Mammal Commission. Section 2(2) states: ". . . in particular, efforts should be made to protect the rookeries, mating grounds, and areas of similar significance for each species of marine mammals from the adverse effect of man's actions." The Act gives the Secretaries of Commerce and the Interior authority to protect specific marine mammals.

9-3.2.6. Marine Protection, Research, and Sanctuaries Act of 1972 as Amended (23 October 1972, Pub. L. 92-532, 86 Stat. 1052). The purpose of the Act is to regulate the transportation of material from the United States intended for dumping in ocean waters. The Act also regulates, under accepted principles in international law, dumping in ocean waters over which the United States has jurisdiction or may exercise control in order to protect its territory or territorial waters. The Act specifically prohibits any person from transporting and dumping into ocean waters any radiological, chemical, or biological warfare agent or any high-level radioactive waste or any other material except by permit; either an Environmental Protection Agency Permit or a U.S. Corps of Engineers Permit (possibly both) must be obtained before either transportation or dumping can take place and then, only when certain criteria are considered.

9-3.2.7. Endangered Species Act of 1973 (28 December 1973, Pub. L. 93-205, 87 Stat. 884). Section 2(b) states that: ". . . the purposes of this Act are to provide a means whereby the ecosystems upon which endangered species and threatened species depend may be conserved, to provide a program for the conservation of such endangered species and threatened species, and to take such steps as may be appropriate to achieve the purposes of the treaties and conventions set forth in subsection (a) of this section." Section 7 of the Act provides that all Federal Departments and agencies: ". . . shall, in consultation with and with the assistance of the Secretary of the Interior, utilize their authorities in furtherance of the purposes of this Act by carrying out programs for the conservation of endangered species and threatened species listed pursuant to Section 4 of this Act and by taking such action necessary to insure that actions authorized, funded, or carried out by them do not jeopardize the continued existence of such endangered species and threatened species or result in the destruction or modification of habitat of such species which is determined by the Secretary, after consultation as appropriate with the affected States, to be critical." The Act also gives the Secretary of the Interior authority to protect specific animals. The Department of the Interiors Federal list of threatened and endangered species is published annually in the Federal Register and is updated as required.

9-3.3. Executive Orders and DOD Documents. Various Executive Orders and DOD documents relate to environmental quality and, at least indirectly, to protection of fish and wildlife. The Council on Environmental Quality published in 1978 the final regulation for the implementation of National Environmental Policy Act of 1969. In "Protection and Enhancement of Environmental Quality" (E.O. 11514, 5 March 1970) and "Provisions, Control, Abatement of Environmental Pollution at Federal Facilities" (E.O. 11752, 17 December 1973), the President directed that all Federal agencies set the example for the rest of the Nation by demonstrating initiative and leadership in the formulation and execution of an imaginative environmental program. In a memorandum from the Deputy

Assistant Secretary of Defense (Installations and Housing) to the Assistant Secretary of the Army (Installations and Logistics) and to all Military Departments, reference is made to Section 7 of the Endangered Species Act of 1973 (28 December 1973, Pub. L. 93-205, 87 Stat. 884). The memorandum states, in part, that the Department of Defense, because of the protective or security nature of many of its installations, has provided vital sanctuaries for threatened species of fauna in the past and can make further unique contributions to the protection of such species. The memorandum further states that an Endangered Species Protection Program will be initiated and carried out at all military installations and activities. Steps for carrying out this program are included in the directive. Two related Executive Orders "Floodplain management" (E.O. 11988) and "Wetlands Protection" (E.O. 11990) were issued 24 May 1977. The Orders tie together the need to protect lives and property with the need to restore and preserve natural and beneficial floodplain and wetland values. To implement these policies E.O. 11988 requires that each agency provide leadership and take action to reduce the risk of flood loss, to minimize the impact of floods on human safety, health and welfare, and to restore and preserve the natural and beneficial values served by floodplains. E.O. 11990 requires each agency to provide leadership and take action to minimize the destruction of wetlands, and to preserve and enhance the natural and beneficial values of wetland. This involves maintenance of natural systems including: conservation and long-term productivity of existing flora and fauna: species and habitat diversity and stability; hydrologic utility; fish, wildlife, timber, and food and fiber resources; and other uses of wetlands in the public interest including scientific, recreational, and cultural uses.

CHAPTER 10. PERSONNEL REQUIREMENTS

10-1. General. Personnel requirements for fish and wildlife management depend upon: the geographic location, size, and nature of an installation; the fish and wildlife habitat potentials of an area; and the fish and wildlife management objectives of the installation. Fish and wildlife managers should have both a broad knowledge of and specialized capabilities in one or more of the areas of ecology, natural resources management, outdoor recreation, or fish and wildlife. They should be able to evaluate habitat, including vegetation, water quantity and quality, and soils, in terms of wild animals' needs. They should also be able to identify factors limiting populations of desired species. They should have an appreciation of ecosystems analysis and an ability to synthesize data. Personnel requirements and staffing patterns vary at different levels or echelons of the military establishment in a manner similar to that of other federal land-managing agencies.

10-2. Staffing. The GS-grade level and type of fish and wildlife managers required on individual installations may vary greatly. Installations with no agricultural, forest, or wild lands may not require a wildlife manager, although consideration should be given by grounds maintenance personnel to wildlife enhancement in developed areas through selection of landscaping plants and management of existing vegetation. On some installations with considerable agricultural, forest, or undeveloped land, one person at the GS-11 level, assisted by technicians, should be able to handle the entire natural resources management program including forestry, fish and wildlife, and recreation. On larger installations a GS-12 natural resources manager and a fish and wildlife biologist at the GS-9/11 level can do an adequate job if they have a staff of technical assistants at the GS-5/7 level. Such technicians are needed to develop wildlife food plots, inventory wildlife, operate deer-checking stations, and handle numerous other assignments. Some technicians can be employed on a seasonal basis. Good help also can be obtained by employing students during summers. Close liaison with universities may lead to assistance by professors and other qualified personnel on many technical problems.

10-3. Qualification Standards and Civil Service Registers.

10-3.1. US Fish and Wildlife Service. As a principal Federal agency concerned with fish and wildlife, the Fish and Wildlife Service has worked with the Civil Service Commission (now Office of Personnel Management) to develop qualification standards for fish and wildlife research and management positions. Applications for employment are received and rated by procedures established and approved by these two agencies, and registers of applicants eligible for consideration for certain types of positions are compiled. Whether a position is filled by a civilian or by military person, the qualification standards developed by the Civil Service Commission will be helpful. The "single agency" qualification standards for the wildlife refuge management series (GS-485) developed by the Fish and Wildlife Service can aid in setting standards for wildlife managers on military installations. Suggestions for other GS series applicable to installations can be obtained from the Fish and Wildlife Service (app C, No. 6c).

10-3.2. The Office of Personnel Management. The Office of Personnel Management (app C, No. 1) can provide qualification standards and register of eligible applicants in a broad range of fish and wildlife management positions. The standards vary according to GS grade levels, duties of the incumbent, and specific areas of concern. Usually, the minimum requirements are a full, 4 year course of study in an accredited college or university leading to a bachelor's degree or higher in the area of wildlife biology, wildlife management or the equivalent in formal training and experience. For position where duties involve a considerable amount of cooperative work, applicants must show that they have the ability to establish sound, effective working relations with others, including the general public.

10-4. Law Enforcement Personnel.

10-4.1. Law Enforcement as Part of Management. Enforcement personnel often are the principal contacts that fishermen and hunters have with the fish and wildlife management unit. They not only enforce the law but also are public relations agents and educators. They are engaged in a wide variety of tasks, ranging from fish and wildlife management to first aid or rescue for lost hunters.

10-4.2. Type and Number. The number and type of law enforcement personnel needed on an installation

depend upon the size of the area, the type and extent of fishing and hunting, the extent of public participation and the number of access points available to participants, particularly the public. With limited access and fishing and hunting checkpoint requirements, the number of enforcement personnel can be held to a minimum. In nationwide surveys, described in Wildlife Law Enforcement (app B, No. 73) the number of hunters and fishermen per state conservation officer averaged 7,160 in 1968, and the number of arrests per conservation officer averaged 55 per year.

10-4.3. Qualification Standards. In 1976, 13 of the state conservation departments required a college wildlife degree for their conservation officers, and six additional states required two years of college. Orientation towards education and public relations is an important aspect of law enforcement work, as cited in Law Enforcement—A Tool of Management in a Manual of Wildlife Conservation (app B, No. 72). If possible, law enforcement personnel should be selected from individuals with training and experience both in fish or wildlife management and in law enforcement. Law enforcement officers should be able to identify the common plants and animals on an installation and explain to hunters and anglers what is being done to promote the installation's natural resources management program. U.S. Civil Service Announcement 432, Series Code-1812, or subsequent announcements describe minimum requirements, general experience, and qualifying specialized experience for Special Agent (Wildlife) at the GS-5 and GS-7 levels for law enforcement positions in the Fish and Wildlife Service. It is recommended that, in addition to some university training in fish and wildlife management, military personnel or civilian security police assigned to fish and wildlife law enforcement attend a short course in law enforcement. Such courses are conducted by some state fish and game departments and universities. Texts or references for such courses are available in Manual for the Conservation Officer (app B, No. 49) and Wildlife Law Enforcement (app B, No. 101).

10-5. Technical Assistance. The Office of Personnel Management collaborates in developing new job series as needed. Assistance may also be obtained from the Fish and Wildlife Service or respective state conservation departments on fish and wildlife law enforcement, fish and wildlife inventories, fish stocking, noxious plant control, predator control, use of herbicides and pesticides, and similar matters, thereby reducing manpower needs on installations. The Cooperative Plan Agreement should specify the type and extent of technical assistance that will be provided by the state and Federal agencies involved. Experts at universities, the Fish and Wildlife Service, the Smithsonian Institution, and state conservation departments can assist in the identification of fish and wildlife species that may be involved in law enforcement cases.

CHAPTER 11. PUBLIC RELATIONS.

11-1. Definition and Purpose. The purpose of a public relations program is to promote good will between an installation and the public and to assess public reaction. The military services and installations should maintain a good public relations program concerning fishing, hunting, nonconsumptive use and the environment. The public relations program should be presented as an information service.

11-2. Involvement of Personnel. Public relations involve all employees who are in contact with the public. Maintenance of good public relations is a continuous process. A noncommissioned officer or security police officer may be the primary contact with fisherman and hunters on an installation. Such personnel may become aware of public relations problems which, in turn, should be considered by the installation Natural Resources Conservation and Beautification Committee, working in cooperation with local communities.

11-3. Need for Public Relations Programs. To be most effective, a public relations program must be understood and accepted by each segment of the general public. Whether the problem is reducing an overpopulated deer herd or one which involves controlling black birds or ground squirrels which may endanger human lives, congressional inquiry is likely to occur. Answering congressional inquiries requires considerable time and might be avoided by good, on-going public relations programs. Such programs keep the local community outside the installation employees, informed about natural resources management efforts. These programs also encourage citizen participation in decision-making and support of the natural resources management program. For example, an explanation of reasons why deer cannot be harvested on certain areas of an installation because of safety or security reasons, might quell a storm of protest. The Installation Natural Resources Conservation and Beautification Committee is an excellent forum for involving representatives of the local community, as well as assisting conservation agencies in the decision-making process.

11-4. Principles and Approaches.

11-4.1. Principles. Natural resources and public relations should be oriented directly towards making the public aware of the necessity of having a well balanced natural resources program for the benefit of all concerned, consistent with the military mission. To further good public relations a series of complex, integrated steps are recommended (Natural Resources and Public Relations, app B, No. 41):

11-4.1.1. Define the problem or situation.
11-4.1.2. Be sure the solution or decision is good for the people and the resource.
11-4.1.3. Establish definite goals.
11-4.1.4. Collect facts in relation to the situation and the specific segment of the public involved.
11-4.1.5. Develop a plan.
11-4.1.6. Gather necessary items and materials.
11-4.1.7. Indoctrinate and organize personnel.
11-4.1.8. Communicate with the public (talks, tours, meetings with the press, etc.).
11-4.1.9. Conduct the operation.
11-4.1.10. Constantly evaluate the entire process.
11-4.1.11. Publicize the good job that was done.
11-4.1.12. Organize and file materials and data for future reference.

11-4.2. Approaches. Many installations work with youth groups, providing educational and recreational opportunities and, at the same time, developing a better understanding of installation operations by the parents and other adults of the community (fig 11-1). Public field trips or "show me" trips may be used advantageously with both youth and adults, including teachers and civic leaders. Self-guided nature trails with informative signs or recorded messages along the trail can help clarify and promote good conservation and natural resources management principles and practices.

Figure 11-1. Working with a youth group.

11-5. Information and Materials. Many Federal natural resources agencies, such as the Forest Service, Soil Conservation Service, and Fish and Wildlife Service have film libraries and other source materials which are helpful in mounting effective public relations programs. Films can be borrowed for use at public meetings. Similarly, state conservation departments and many private conservation organizations, such as the National Audubon Society and the National Wildlife Federation (app C, No. 7 and No. 8) have excellent films and materials.

APPENDIX A. REFERENCES

Fish and Wildlife Management

1. AR 420-74 — Natural Resources-Land, Forest and Wildlife Management, July 1977

2. DA PAM 420-7 — Natural Resources-Land, Forest and Wildlife Management, May 1977

3. MCO P11000.8 — Real Property Facilities Manual, Volume V, Environmental Management

4. NAVFAC INST. 11015.4 — Natural Resources-Fish and Wildlife Conservation Program and Annual Conservation Award

5. AFM 126-1 — Conservation and Management of Natural Resources

6. TM 5-629
AFM 91-19
NAVFAC MO-314 — Herbicide Manual for Noncropland Weeds

7. TM 5-630
AFM-126-2
NAVFAC MO-100.1 — Natural Resources-Land Management

8. Flood, Bettina S., Sangster, Mary E., Sparrowe, Rollin D., and Baskett, Thomas S., *A Handbook for Habitat Evaluation Procedures,* U.S. Department of the Interior, Resource Publication 132, Washington, DC, 1977.

9. U.S. Department of Agriculture, *Wildlife Habitat Improvement Handbook,* Forest Service, Forest Service Handbook 2609.11, Washington, DC, 1969.

APPENDIX B. BIBLIOGRAPHY

Fish and Wildlife Management

1. Adams, Lowell W. and Geis, A. D., ed.s, "Ecological Evaluation of Wildlife Populations and Habitats. Affected by Highway Development: Phase I", U.S. Department of Transportation, Federal Highway Administration, Offices of Research and Development, Washington, D.C., 1978.

2. Allen, Durward L., *Our Wildlife Legacy,* Funk and Wagnalls Company, New York, New York, 1954.

3. Anderson, D. R., Laake, J. L., Crain, B. R. and Burnham, K. P., *Guidelines for Line Transect Sampling of Biological Populations,* Utah State University, Utah Cooperative Wildlife Research Unit, Logan, Utah, 1976.

4. Atlantic Waterfowl Council, *Techniques Handbook of the Waterfowl Habitat Development and Management Committee,* Atlantic Flyway Council, Bethany Beach, Delaware, 1972.

5. Barton, J. R. and Winger, P. V., "Rehabilitation of a Channelized River in Utah", *Hydraulic Engineering and the Environment: Proceedings of the Hydraulic Specialty Conference,* Bozeman, Montana, 1973, pp 1-10.

6. Baumgartner, F. M., "Territory and Population in the Great Horned Owl", *The Auk,* Vol 56, 1939, pp 274-282.

7. Bell, G. R., "A Guide to the Properties, Characteristics and Uses of Some General Anaesthetics for Fish", Fisheries Resources Board of Canada, Bulletin No. 148, Ottawa, Canada, 1964.

8. Bennitt, R., *Some Aspects of Missouri Quail and Quail Hunting, 1939-1948,* Missouri Conservation Commission, Technical Bulletin 2, 1951.

9. Benson, D. A., *Use of Aerial Surveys by the Canadian Wildlife Service,* Canadian Wildlife Service, Occasional Papers No. 3, 1962.

10. Blankenship, L. H., Humphrey, A. B. and MacDonald, D., "A New Stratification for Mourning Dove Call-Count Routes", *Journal of Wildlife Management,* Vol 35, No. 2, 1971, pp 319-326.

11. Boeker, E. L. and Bolen, E. B., "Winter Golden Eagle Populations in the Southwest", *Journal of Wildlife Management,* Vol 36, No. 2, 1972, pp 477-484.

12. Booz, Allen, Public Administration Services, Inc. (BASYS Division), *Guidelines for Developing a Comprehensive Plan for the Management of Fish and Wildlife Resources,* U.S. Department of the Interior, Fish and Wildlife Service, Washington, D.C., 1973.

13. Briggs, Shirley A., ed., *Landscaping for Birds,* Audubon Naturalist Society of the Central Atlantic States, Inc., Washington, D.C., 1973.

14. Bue, Conrad D., *Principal Lakes of the United States,* U.S. Department of the Interior, Geological Survey, Geological Survey Circular 476, Washington, D.C., 1963.

15. Burger, George V., *Practical Wildlife Management,* 2d ed., Winchester Press, New York, 1975.

16. Bystrak, Danny, Robbins, C. S., Drennan, S. R. and Arbib, Robert, ed.s, *Wintering Areas of Bird Species Potentially Hazardous to Aircraft,* U.S. Department of the Interior, Fish and Wildlife Service, and National Audubon Society, Washington, D.C., 1974.

17. Carlander, K. D., "*The Standing Crop of Fish in Lakes*", *Journal Fisheries Resources Board of Canada*, Vol 12, No. 4, 1955, pp 543-570.

18. Chaplin, Bryant R., "Public Relations and the Wildlife Administrator", *A Manual of Wildlife Conservation*, The Wildlife Society, Washington, D.C., 1971, pp 18-21.

19. Chapman, D. G., "Some Properties of the Hypergeometric Distribution with Applications to Zoological Sample Censuses", *University of California Public Statistics*, Vol 1, No. 7, 1951, pp 131-160.

20. Constantine, D. G., *Activity Patterns of the Mexican Freetailed Bat*, University of New Mexico, Publication in Biology, No. 7, 1967.

21. Cooper, G. P. and Lagler, Karl F., The Measurement of Fish Population Size", *Transactions of 21st North American Wildlife Conference*, 1956.

22. Courtsal, F. R. and Ivers, R. E., *Homes for Birds*, U.S. Department of the Interior, Fish and Wildlife Service, Washington, D.C., 1969.

23. Craighead, J. J. and Graighead, F. C., *Hawks, Owls and Wildlife*, Dover Publications, Inc., New York, New York, 1969.

24. Croon, G. W., McCullough, D. R., Olsen, C. E. Jr., and Queal, L. M., "Infrared Scanning Techniques for Big-Game Censusing", *Journal of Wildlife Management*, Vol 32, No. 4, 1968, pp 751-759.

25. Davis, David E., "Estimating the Numbers of Game Populations", *Wildlife Investigational Techniques*, 2nd ed., The Wildlife Society, Washington, D.C., 1963, pp 89-118.

26. Davison, Verne E., "Farm Ponds", *Sport Fishing USA*, U.S. Department of the Interior,Fish and Wildlife Service, 1971, pp 267-275.

27. DeGraff, Richard M., Coordinator, Proceedings of the Workshop, MANAGEMENT OF SOUTHERN FORESTS FOR NON—GAME BIRDS, USDA Forest Service General Technical Report SE-14, 1978.

28. Dozier, H. L., "Estimating Muskrat Populations by House Counts", *Transactions of the 13th North American Wildlife Conference*, Wildlife Management Institute, Washington, D.C., 1948, pp 372-389.

29. Duff, Donald A. and Cooper, James L., *Techniques for Conducting Stream Habitat Surveys on National Resource Land*, U.S. Department of the Interior, Bureau of Land Management, Technical Note 283, Filing Code 6671, 1976.

30. Eadie, W. Robert, *Animal Control in Field, Farm and Forest*, The MacMillan Company, New York, New York, 1954.

31. Emlen, J. T., "Population Densities of Birds Derived from Transect Counts", *The Auk*, Vol 88, 1971, pp 323-342.

32. Enemar, A., "On the Determination of the Size and Composition of a Passerine Bird Population during the Breeding Season", *Var Fagelvarld*, Supplement 2, 1959, pp 1-114.

33. Errington, Paul L., *Of Predation and Life*, Iowa State University Press, Ames, Iowa, 1967.

34. Evans, W. A. and Johnston, F. B., *Fish Migration and Fish Passage—A Practical Guide to Solving Fish Passage Problems*, U.S. Department of Agriculture, Forest Service, Region 5, 1974.

35. Falk, John H., "The Frenetic Life Forms that Flourish in Suburban Lawns", *Smithsonian*, Smithsonian Institution, Vol 8, No. 1, Washington, D.C., 1977, pp 90–96.

36. Freund, John E., Livermore, Paul E. and Miller, Irwin, *Manual of Experimental Statistics*, Prentis-Hall, Inc., Englewood Cliffs, New Jersey, 1960, pp 120–121.

37. Funk, John L., ed., "Symposium on Overharvest and Management of Largemouth Bass in Small Impoundments", American Fisheries Society, North Central Division, Special Publication No. 3, 1974, pp 1–116.

38. Gabrielson, Ira N., *Wildlife Conservation*, The MacMillan Company, New York, New York, 1941.

39. Gabrielson, Ira N., *Wildlife Management*, The MacMillan Company, New York New York, 1951, pp 81–82.

40. Gerking, S. D., "Urethane (Ethyl carbamate) in Some Fishery Procedures", *Progressive Fish Culturist*, Vol 11, No. 1, 1949, pp 73–74.

41. Gilbert, Douglas L., *Natural Resources and Public Relations*, 2d ed., The Wildlife Society, Washington, D.C., 1971.

42. Gulland, J. A., *Manual of Sampling and Statistical Methods for Fisheries Biology: Part I, Sampling Methods*, FAO Manuals in Fisheries Science No. 3, The Whitefriars Press, Ltd., London and Tonbridge, England, and UNIPUB, Inc., New York, New York, 1966.

43. Halls, Lowell K., et al., SOUTHERN FRUIT-PRODUCING WOODY PLANTS USED BY WILDLIFE, SUDA Forest Service General Technical Report SO–16, 1977.

44. Hay, K. G., "Beaver Census Methods in the Rocky Mountain Region", *Journal of Wildlife Management*, Vol 22, 1958, pp 395–402.

45. Hoffman, R. H., "Waterfowl Utilization of Ponds Blasted at Delta Manitoba", *Journal of Wildlife Management*, Vol 34, No. 3, 1970, pp 586–593.

46. Humphrey, S. R., "Photographic Estimation of Population Size in the Mexican Free-Tailed Bat, *Tadarida brasiliensis*", 50th Annual Meeting, American Society of Mammalogists, College Station, Texas, 1970.

47. International Civil Aviation Organization, "Bird Control and Reduction", *Airport Services Manual, Part 3*, 1st ed., Document 9137–AN/898, P.O. Box 400, 100 Sherbrooke Street West Montreal, Quebec, Canada H3A 2R2, 1975.

48. Irwin, W. H. and Stevenson, J. H., "Physiochemical Nature of Clay Turbidity with Special Reference to Clarification and Productivity of Impounded Waters", *Bulletin of Oklahoma Agricultural and Mechanical College*, Vol 48, No. 4, Stillwater, Oklahoma, 1951, pp 1–54.

49. Isaacson, Irving, *Manual for the Conservation Officer*, 2d ed., Legal Publications, Lewiston, Maine, 1969.

50. Jenkins, Robert M., "Big Reservoirs", *Sport Fishing USA*, U.S. Department of the Interior, Fish and Wildlife Service, 1971, pp 233–243.

51. Kimball, J. W., "The Crowing Count Pheasant Census" *Journal of Wildlife Management*, Vol 13, 1949, pp 101–120.

52. Kornman, W. M., "Fish and Wildlife Management Manual for Military Lands", Louisiana State University, *School of Forestry and Wildlife Management*, Master of Science Thesis, Baton Rouge, Louisiana, 1968.

53. Kozicky, E. L., Bancroft, T. A. and Homeyer, P. G., "An Analysis of Woodcock Singing Ground Counts, 1948-1952", *Journal of Wildlife Management,* Vol 18, 1954, pp 259-266.

54. Kozicky, E. L., Jessen, R. J., Hendrickson, G. O. and Speaker, E. B., "Estimation of Fall Quail Populations in Iowa", *Journal of Wildlife Management,* Vol 20, No. 2, 1956, pp 97-104.

55. Kozicky, E. L. and Madson, John, *Shooting Preserve Management—the Nilo System,* Winchester Western Press, East Alton, Illinois, 1966.

56. Lack, David, F. R. S., *The Natural Regulation of Animal Numbers,* Oxford at the Clarendon Press, London, England, 1954.

57. Lagler, Karl F., "Capture, Sampling, and Examination of Fishes", *Methods of Assessment of Fish Production in Fresh Waters,* Wilmer Brothers Ltd., Birkenhead, England, 1968, pp 7-45.

58. Lagler, Karl F., *Freshwater Fishery Biology,* 2d ed., William C. Brown Company, Dubuque, Iowa, 1956.

59. Leedy, D.L., "Aerial Photographs, Their Interpretation and Suggested Uses in Wildlife Management", *Journal of Wildlife Management,* vol 12, No. 2, 1948.

60. Leopold, A., *Game Management,* Charles Scribner's Sons, New York, New York, 1933.

61. Lewis, James C., "Wildlife Census Methods: A Resume", *Proceedings of the Annual Wildlife Disease Association Conference, Journal of Wildlife Diseases,* Vol 6, No. 4, 1970, pp 356-364.

62. Linduska, Joseph P. and Nelson, Arnold L., ed.s, *Waterfowl Tomorrow,* U.S. Department of the Interior, Fish and Wildlife Service, Washington, D.C., 1964.

63. Lindzey, F. G., Thompson, S. K. and Hodges, J. I., "Scent Station Index of Black Bear Abundance", *Journal of Wildlife Management,* Vol 41, No. 1, 1977, pp 151-153.

64. Linhart, S. B. and Knowlton, F. F., "Determining the Relative Abundance of Coyotes by Scent Station Lines", *Wildlife Society Bulletin,* Vol 3, No. 3, 1975, pp 119-124.

65. Loveless, C. M., *The Everglades Deer Herd Life History and Management,* Florida Game and Fresh Water Fish Commission, Technical Bulletin 6, 1959.

66. Lowe, J. I., "Breeding Density and Productivity of Mourning Doves on a Countywide Basis in Georgia", *Journal of Wildlife Management,* Vol 20, 1956, pp 428-433.

67. Lowe-McConnell, R. H., "Identification of Freshwater Fishes", *Methods of Assessment of Fish Production in Fresh Waters,* Wilmer Brothers Ltd., Birkenhead, England, 1968, pp 46-47.

68. McAtee, W.L., *Wildfowl Food Plants,* Collegiate Press, Inc., Ames, Iowa, 1939.

69. McGowan, T. A., "The Call Count as a Census Method for Breeding Mourning Doves in Georgia", *Journal of Wildlife Management,* Vol 17, 1953, pp 437-445.

70. Mohr, Charles E., *How to Build a Nature Trail,* National Audubon Society, Audubon Aids, Set NB 12, New York, New York, 1953.

71. Morse, M. A., "Technique for Reducing Man-Power in Deer Drive Census", *Journal of Wildlife Management,* Vol 7, No. 2, 1943, pp 217-220.

72. Morse, William B., *Law Enforcement—A Tool of Management in a Manual of Wildlife Conservation,* The Wildlife Society, Washington, D.C., 1971, pp 120-123.

73. Morse, William B., *Wildlife Law Enforcement,* Western Association of State Fish and Conservation Commissioners, Sun Valley, Idaho, 1976.

74. Mosby, Henry S., ed., *Wildlife Investigational Techniques,* 2d ed., The Wildlife Society, Washington, D.C., 1963.

75. Murie, O. J., *A Field Guide to Animal Tracks, 2d ed.,* Houghton-Mifflin Company, Boston, Massachusetts, 1974, pp xiii and 375.

76. Neff, D. J., "The Pellet-Group Count Technique for Big Game Trend, Census, and Distribution: A Review", *Journal of Wildlife Management,* Vol 32, No. 3, 1968, pp 597–614.

77. Norton, H. W., Scott, T. B., Hanson, W. R. and Klimstra, W. D., "Whistling Cock Indices and Bobwhite Populations in Autumn", *Journal of Wildlife Management,* Vol 25, No. 4, 1961, pp 398–403.

78. Novitzski, R. P., *Improvement of Trout Streams in Wisconsin by Augmenting Low Flows with Ground Water,* U.S. Department of the Interior, Geological Survey, in cooperation with Wisconsin Department of Natural Resources, Geological Survey Water-Supply Paper 2017, Washington, D.C., 1973.

79. O'Farrell, M. J., Bradley, W. G. and Jones, G. W., "Fall and Winter Bat Activity at a Desert Spring in Southern Nevada", *The Southwestern Naturalist,* Vol 12, No. 2, 1967, pp 163–171.

80. O'Neil, Ted, *The Muskrat in the Louisiana Coastal Marshes,* Louisiana Department of Wildlife and Fisheries, New Orleans, Louisiana, 1949.

81. Orsborn, John F. and Deane, F. David, *Investigation into Methods for Developing a Physical Analysis for Evaluating Instream Flow Needs,* Washington State University, Project Completion Report, Project A-084-WASH 1976, Pullman, Washington, 1976.

82. Overton, W. S., "Estimating the Numbers of Animals in Wildlife Populations", *Wild life Management Techniques,* 3d ed., The Wildlife Society, Washington, D.C., 1971. pp 403–455.

83. Peterson, C. G. J., *The Yearly Immigration of Young Plaice Into the Limfjord from the German Sea,. . .,* Report of Danish Biology Station, Vol 6, 1896, pp 1–77. (Original not seen).

84. Petraborg, W. H., Wellein, E. G. and Gunvalson, V. E., "Roadside Drumming Counts: A Spring Census Method for Ruffed Grouse", *Journal of Wildlife Management,* Vol 17, 1953, pp 292–295.

85. Platts, W. S., "Geomorphic and Aquatic Conditions Influencing Salmonids and Stream Classification with Application to Ecosystem Classification", U.S. Department of Agriculture, Forest Service, Surface Environment and Mining, Billings, Montana, 1974.

86. Provine, William C., "Salt Method for Determining Pond Volume", *The Progressive Fish Culturist,* U.S. Department of the Interior, Fish and Wildlife Service, 38(3): 135–137, 1976.

87. Ricker, W. E., *Computation and Interpretation of Biological Statistics of Fish Populations,* Fisheries Research Board of Canada, Ottawa, Canada, 1975.

88. Ricker, W. E., *Handbook of Computations for Biological Statistics of Fish Populations,* Fisheries Research Board of Canada, Ottawa, Canada, 1958.

89. Ricker, W. E., ed., *Methods for Assessment of Fish Production in Fresh Waters,* International Biological Programme Handbook No. 3, 7 Marylebone Road, London, England, NWJ, 1968.

90. Robbins, C. S. and Van Velzen, W. T., *The Breeding Bird Survey, 1966,* Special Scientific Report, Wildlife No. 102, Washington, D.C., 1967, pp iv and 43.

91. Robbins, C. S., "Recommendations for an International Standard for a Mapping Method in Bird Census Work", *Audubon Field Notes,* Vol 24, No. 6, 1970, pp 723-726.

92. Robel, R. J., Dick, D. J. and Krause, G. F., "Regression Coefficients Used to Adjust Bobwhite Quail Whistle Count Data", *Journal of Wildlife Management,* Vol 33, No. 3, 1969, pp 662-668.

93. Rosene, W. J., "A Summer Whistling Cock Count of Bobwhite as an Index to Wintering Populations", *Journal of Wildlife Management,* Vol 21, 1957, pp 153-158.

94. Rounsefell, G. A. and Kask, J. L., "How to Mark Fish", *Transactions of the American Fisheries Society,* Vol 73, 1946, pp 320-363.

95. Sauder, D. W., Linder, R. L., Dahlgreen, R. B. and Tucker, W. L., "An Evaluation of the Roadside Technique for Censusing Breeding Waterfowl", *Journal of Wildlife Management,* Vol 35, No. 3, 1971, pp 538-543.

96. Saugstad, S., "Aerial Census of Big Game in North Dakota", *Transactions, North American Wildlife Conference,* Vol 7, 1942, pp 343-356.

97. Schnabel, Zoe E., "The Estimation of the Total Fish Population of a Lake", *American Mathematics Monthly,* Vol 45, No. 6, 1938, pp 348-352.

98. Schultz, V., Eberhardt, L. L., Thomas, J. M. and Cochran, M. I., *A Bibliography of Quantitative Ecology,* Halsted Press, John Wiley & Sons, Inc., New York, New York, 1976.

99. Schumacher, F. X. and Eschmeyer, R. W., "The Estimate of Fish Population in Lakes or Ponds", *Journal of Tennessee Academy of Science,* Vol 18, No. 3, 1943, pp 228-249.

100. Scott, V. E. and Boeker, E. L., "An Evaluation of Wild Turkey Call Counts in Arizona", *Journal of Wildlife Management,* Vol 36, No. 2, 1972, pp 628-630.

101. Sigler, W. F., *Wildlife Law Enforcement,* William C. Brown Company, Dubuque, Iowa, 1956.

102. Smith, R. H. and Gallizioli, S., "Predicting Hunter Success by Means of a Spring Call Count of Gambel Quail", *Journal of Wildlife Management,* Vol 29, 1965, pp 806-813.

103. Stott, B., "Marking and Tagging", *Methods of Assessment of Fish Production in Fresh Waters,* Wilman Brothers Ltd., Birkenhead, England, 1968, pp 78-92.

104. Stott, R. S. and Olson, D. P., "An Evaluation of Waterfowl Surveys on the New Hampshire Coastline", *Journal of Wildlife Management,* Vol 36, No. 2, 1972, pp 468-471.

105. Tait, H.D., *Sampling Problems in the Michigan Creel Census,* University of Michigan, Ph.D. Thesis, 1953.

106. Terres, John K., *Songbirds in Your Garden,* Thomas V. Crowell Company, New York, New York, 1953.

107. Thomas, J W., Brush, R. O., and De Graaf, R. M., "Invite Wildlife to Your Backyard", *National Wildlife Magazine,* National Wildlife Federation, Vol 11, Washington, D.C., 1973.

108. Transport Canada, "Wildlife Control—Birds", Field Maintenance Technical Circular FMTC No. 4-13-1.

109. U.S. Department of Agriculture, "Controlling Erosion on Construction Sites", Soil Conservation Service, Agriculture Information Bulletin 347, Washington, D.C., 1970.

110. United States Department of Agriculture, WILDLIFE HABITAT MANAGEMENT HANDBOOK, FSH 2609.23 R, USFS Southern Region, Atlanta, 1971.

111. Vibert, R., ed., *Fishing With Electricity—Its Application to Biology and Management,* Whitefriars Press Ltd., London and Tonbridge, England, 1967.

112. White, C.M. and Sherrod, S.K. *Advantages and Disadvantages of the Use of Rotor-Winged Aircraft in Raptor Studies,* Brigham Young University, unpublished manuscript, Provo, Utah, 1973.

113. Wight, H.M. and Baysinger, E. B., *Mourning Dove Status Report,* U.S. Department of the Interior, Fish and Wildlife Service, Special Scientific Report No. 73, 1963.

114. Williams, A. B., "The Composition and Dynamics of a Beech-Maple Climax Community", *Ecological Monograph,* Vol 6, 1936, pp 317-408.

115. Williams, H. W., "The Influence of Physical and Biological Factors on the Rally Call of the Chukar Partridge (*Alectoris graeca*) with Regard to the Use Call as a Census Method", Western Association of State Game and Fish Commissioners, Vol 41, 1961, pp 117-129.

APPENDIX C. SOURCES OF TECHNICAL ASSISTANCE

FEDERAL:

1. Civil Service Commission (now Office of Personnel Management)
   1900 E Street, N.W.
   Washington, D.C. 20415

2. National Aeronautics and Space Administration
   Washington, D.C. 20546

3. Tennessee Valley Authority
   Division of Forestry, Fisheries and Wildlife Development
   Norris, Tennessee 37828

4. U.S. Department of Agriculture
   12th Street and Independence Avenue, S.W.
   Washington, D.C. 20250
   a. Agricultural Research Service
   Beltsville Agricultural Research Center
   Beltsville, Maryland 20705
   b. Forest Service
   P.O. Box 2417
   Washington, D.C. 20013
   c. Soil Conservation Service
   P.O. Box 2890
   Washington, D.C. 20013

5. U.S. Department of Commerce
   14th Street and Constitution Avenue, N.W.
   Washington, D.C. 20230
   a. National Marine Fisheries Service
   Public Affairs Officer, PA 13
   National Oceanic and Atmospheric Administration
   Washington, D.C. 20235

6. U.S. Department of the Interior
   18th and C Streets, N.W.
   Washington, D.C. 20240
   a. Bureau of Land Management
   Office of Public Affairs
   18th and C Streets, N.W.
   Washington, D.C. 20240
   b. Bureau of Reclamation
   Public Affairs Office
   18th and C Streets, N.W.
   Washington, D.C. 20240
   c. Fish and Wildlife Service
   Public Affairs Office
   18th and C Streets, N.W.
   Washington, D.C. 20240
   (1) Animal Damage Control Office
   Utah State University, UMC 52
   Logan, Utah 84321

(2) Editorial Office
Aylesworth Hall
Colorado State University
Fort Collins, Colorado 80523
(3) Office of Endangered Species
1000 N. Glebe Road,
Arlington, Va.
(4) Denver Wildlife Research Center
Denver Federal Center, Building 16
Denver, Colorado 80225
(5) Chief, Migratory Nongame Bird Studies
Migratory Bird and Habitat Research Laboratory
Patuxent Wildlife Research Center
Laurel, Maryland 20811

d. Geological Survey
12201 Sunrise Valley Drive
Reston, Virginia 22092

e. Heritage Conservation and Recreation Service
(1) Division of Federal Programs
Room 134, Interior Building, South
1951 Constitution Avenue
Washington, D.C. 20240
(2) Office of Archeology and Preservation
U.S. Department of the Interior
Washington, D.C. 20240
(3) National Natural Landmarks Program
Denver Service Center
755 Parfet Street
P.O. Box 25287
Denver, Colorado 80225

f. National Park Service
Office of Communications
18th and C Streets, N.W.
Washington, D.C. 20240

OTHER:

7. National Audubon Society
950 Third Avenue
New York, New York 10022

8. National Wildlife Federation
1412 16th Street, N.W.
Washington, D.C. 20036

9. North American Game Breeders and Shooting Preserve Operators Association, Inc.
Route 2, Box 74
Prairie City, Iowa 50228

10. Sport Fishing Institute
608 13th Street, N.W., Suite 801
Washington, D.C. 20005

11. Stackpole Books
Cameron and Keller Streets
Harrisburg, Pennsylvania 17105

12. Tall Timbers Research Station
Route 1, Box 160
Tallahassee, Florida 32303

13. Wildlife Management Institute
709 Wire Building
1000 Vermont Avenue, N.W.
Washington, D.C. 20005

14. Wildlife Society
7101 Wisconsin Avenue, N.W.
Suite 611
Washington, D.C. 20014

APPENDIX D. GLOSSARY

Alevin: A newly hatched salmon when still attached to the yolk mass of the egg.

Carrying Capacity: The maximum density of wildlife which a particular area or habitat is capable of carrying on a sustained basis without deterioration of the habitat.

Census: A counting of the numbers of a wildlife species or group of animals on an area at a point in time, which may involve other vital statistics such as the sex and age of individual animals. Complete counts usually are impossible or impractical for wildlife management purposes.

Ecological community: A community of organisms, together with its environment, which constitutes an interacting system. Synonym: *ecosystem.*

Ecosystem: A community, including all the component organisms together with the environment, forming an interacting system.

Edge effect: The effect, generally favorable to wildlife, produced by the conditions existing where one habitat or cover type ends, and another one begins.

Estuary: That part of a stream which is influenced by the tide of the body of water into which it flows, usually where fresh and salt or marine waters mix.

Exotic species: A species that is not native to the region in which it is found; generally, the term is used for species introduced from a foreign country.

Habitat: The place where a plant or animal species naturally lives and grows, or the environment in which the life needs of an organism, population, or biological community are supplied.

Habitat management: The act of controlling or regulating the components of the habitat (vegetation, soil, and water, in particular) to attain a human goal.

Interspersion: The degree of insertion of one cover or habitat type into another; i.e., the distribution of heterogeneous cover types (plant species) in a limited area.

Inventory, wildlife: Estimates of the populations of wild animals, by species, on an area at a given time, usually based upon some type of sampling procedure.

Limiting Factor: A factor whose absence or excessive concentration exerts some restraining influence upon a population through incompatibility with species requirements or tolerance. Thus, absence of a certain snail may keep the Florida kite from existing in areas similar to where it does live.

Mast: Plant fruit (e.g., acorns, beechnuts, walnuts, and the seeds of conifers rather than fleshy fruits) used as food by animals; a collective term.

Open space: Usually, a relatively undeveloped green or wooded area within an urban community. Often the open space is communal or public property.

Range, wildlife: The geographic area in which a wild animal may be expected to be found; home range is that area which the individual animal traverses in its normal activities of food gathering, resting, mating, or caring for its young.

Refuge, wildlife: An area designated for wildlife management, in which hunting either is prohibited to protect the wild animals or is strictly controlled.

Riparian, land: Land situated along the bank of a stream or other body of water.

Tolerance: As applied to fish and wildlife, the relative ability of a species to survive where there is a deficiency or overabundance of essential growth requirements or site factors such as pH, moisture, temperature, light, or excessive water and toxic materials.

Wildlife: Broadly defined, all nondomesticated animals, including fish. More narrowly defined, wild vertebrates, other than fish, and particularly those in which man has a management interest, and which are covered by various Federal and state laws.

Wildlife management: The art of producing sustained annual crops of wildlife to achieve human goals, whether for recreation, aesthetic and environmental enhancement, economic or scientific reasons, or conservation of an endangered species. To a large extent, wildlife management is applied ecology.

APPENDIX E

NATURAL RESOURCES MANAGEMENT PLAN

OUTLINE FOR PART IV—FISH AND WILDLIFE MANAGEMENT*

E-1. General.

E-1.1. Objectives. Specific objectives of this plan are to provide, compatible with the military mission, the following:

E-1.1.1. Long-range and annual plans of work for fish and wildlife habitat, development and maintenance. (see Annex I)

E-1.1.2. Integration of fish and wildlife management practices with other natural resources management work, with emphasis on multiple use concept.

E-1.1.3. Preservation, where possible, of wetlands valuable for waterfowl and other wildlife.

E-1.1.4. Protection and preservation of existing important fish and wildlife species and those threatened by extinction.

E-1.1.5. Optimum ecological development of land and water areas.

E-1.1.6. Recommendations for fish and wildlife harvest designed to adjust fish and game populations to the capacity of available habitat.

E-1.1.7. Natural beauty protection, improvement and enhancement associated with the fish and wildlife management program.

E-1.1.8. Additional recreational benefits for both installation personnel and the general public.

E-1.2. Description of the fish and wildlife areas.

E-1.2.1. Indicate on small scale installation map the land and water areas available for fish and wildlife management.

E-1.2.2. Make a tabulation of native species of wildlife food and cover plants by common and scientific names.

E-1.2.3. Discuss military use of areas within the fish and wildlife management areas.

E-1.3. History of fish and wildlife management.

E-1.3.1. General

E-1.3.2. Indicate degree of cooperation with State and Federal agencies, with local organizations (conservation clubs, sportsmen clubs, etc.) and other groups.

E-1.3.3. Describe extent of public use for hunting and fishing. (Give logical and substantial reasons if access is denied.)

E-1.4. Fish and wildlife resources.

E-1.4.1. Denote fish species and the estimated numbers (table form) of game species.

E-1.4.2. Denote non-game birds common to the area.

E-1.4.3. Indicate endangered and threatened species found on or in the vicinity of the installation.

E-1.5. Fish and wildlife potentials.

E-1.5.1. Describe habitat trends (vegetation transition important to wildlife).

E-1.5.2. Describe population trends.

E-1.5.3. Game responses to past land use and management programs.

E-1.5.4. Potential days of hunting and fishing; include past history.

E-1.6. Responsibilities. Include responsibilities (Facilities Engineer, Provost Marshal, Special Services Officer, State, Federal, other Cooperative Agency)

E-1.6.1. Fish and wildlife management and habitat improvement.

E-1.6.2. Establishing harvest quotas.

E-1.6.3. Law enforcement and policing the harvest.

E-1.6.4. Organized Hunts.

*Plan outline is not applicable to Air Force installations. Air Force installations should use the format prescribed in AFR 126-1.

E-1.6.5. Issuing special licenses and permits.
E-1.6.6. Maintaining records of take and hours of fishing and hunting.
E-1.6.7. Census taking and operation of check points.
E-1.7. Objectives of management.
E-1.7.1. Hunting within goals of optimum population.
E-1.7.2. Provide satisfactory fishing within resource capabilities.
E-1.7.3. Protection of endangered and threatened fish and wildlife species.
E-1.7.4. Bird and animal watching.

E-2. Management.

E-2.1. Wildlife habitat management and maintenance.
E-2.1.1. Treatment of existing habitat.
E-2.1.1.1. Disking, timely mowing or other cultural practices that will encourage the development of native game food plants.
E-2.1.1.2. Brush cutting for habitat improvement.
E-2.1.1.3. Use of control burning as a game management tool.
E-2.1.1.4. Other methods and treatments such as cutting saplings for emergency deer browse and the retention of mast and den trees.
E-2.1.2. Establishment and maintenance of game food areas (annual and perennial plants).
E-2.1.2.1. Species to be planted or maintained and the intended use. Give number, size, and distribution of plots.
E-2.1.2.2. Seeding and maintenance practices, seeding rates, methods, dates, frequencies, fertilization and cultural practices for each species.
E-2.1.3. Establishment and maintenance of water facilities for wildlife.
E-2.1.3.1. Give number and location of existing water facilities (tanks, ponds, windmills, springs).
E-2.1.3.2. Give number and location of proposed new water facilities.
E-2.1.4. Predator control.
E-2.1.4.1. Known predators, estimated populations and problems.
E-2.1.4.2. Control methods and extent.
E-2.1.4.3. Coordination with appropriate State and Department of the Interior personnel.
E-2.1.5. Harvest management.
E-2.1.5.1. Establishment of quotas by species to maintain a balance between game and available food.
E-2.1.5.2. Census data, harvest recommendations, policing the harvest, check points, maintenance or records of take.
E-2.1.6. Wetlands management.
E-2.1.6.1. Waterfowl impoundments.
E-2.1.6.2. Waterfowl nesting areas and structures.
E-2.1.6.3. Marshland improvements, such as constructing open waterways, small islands for waterfowl use and pot-hole development.
E-2.2. Fish management.
E-2.2.1. Fish species to be managed.
E-2.2.2. Management practices and facilities improvements.
E-2.2.2.1. Fishing facilities available and needed (docks, piers, marinas, boats, motors) and responsibilities for each.
E-2.2.2.2. Shoreline development (stabilization, access areas, etc.).
E-2.2.2.3. Fertilization.
E-2.2.2.4. Aquatic weed control.
E-2.2.2.5. Rough fish control.
E-2.2.2.6. Stocking and restocking.
E-2.2.2.7. Fish farming.
E-2.2.2.8. Pollution control.
E-2.2.2.9. New lakes or ponds proposed.
E-2.2.2.10. Other.

E-2.3. Exploration and studies in cooperation with Federal, State and local agencies.
E-2.3.1. Populations.
E-2.3.2. Mortality studies.
E-2.3.3. Disease, pests and insects.
E-2.3.4. Browse studies
E-2.3.5. Habitat improvement

ANNUAL WORK PLAN—FISH & WILDLIFE MANAGEMENT—MAJOR REQUIREMENTS & ESTIMATED COSTS (Suggested Format)

ANNEX I to Appendix E

TO: FROM: For Fiscal Year

Line	Job Description	unit	amount	WORK BY POST FORCES				WORK BY CONTRACT		Work by others	Equipment acquisition (dollars)	Estimated total cost	Type of funding
				man days	labor cost	material cost	equipment rental cost	amount	cost				
	a	b	c	d	e	f	g	h	i	j	k	l	m
	WILDLIFE MANAGEMENT:												
1.	Cultural practices on existing plants	ac											
2.	Annual plantings	ac											
3.	Perennial plantings	ac											
4.	Marsh or wet land development	ac											
5.	Vegetation control	ac											
6.	Nest boxes (duck, squirrel etc)	no.											
7.	Other habitat improvements												
	FISH MANAGEMENT:												
8.	Pond or lake construction	ac											
9.	Pond or lake renovation	ac											
10.	Shoreline development	lin ft.											
11.	Pond fertilization	ac											
12.	Fish "farms" (feeding)	no.											
13.	Aquatic weed control	ac											
14.	Rough fish control	ac											
15.	Other												
	MISCELLANEOUS												
16.	Fish & game stocking	no.											
17.	Fish & game inventory												
18.	Sampling & growth surveys	no.											
19.	Inspection (bag, creel etc check)	no.											
20.	Regulatory (licenses, tags, enforcement etc)												
21.	Predator control												
22.	Special watering devices	no.											
23.	Fish & game feeding												
24.	Training classes/conferences	no.											
25.	Administration												
26.	Other												
27.	TOTAL												

Footnotes:

5. Chemical and/or mechanical
8. Including docks, piers, launching facilities, water control structures, etc.
10. Stabilization, access areas, etc.

j. Use as desired to record work items by others either at a cost or gratuitously

m. Use digit symbols as follows: (1) O&MA (2) 21X5095 (3) Other non-appr. (welfare, sundry, private assoc. etc) (4) Troop labor (5) State & Fed. Grants. Report costs to the nearest dollar and amounts (c.d.h.) to the nearest whole number.

APPENDIX F

Memorandum of Understanding

between

THE DEPARTMENT OF THE INTERIOR

and

THE DEPARTMENT OF DEFENSE

for the

Conservation and Management of Fish and Wildlife Resources on Military Installations

WHEREAS the Department of Defense has jurisdiction over all military installations and facilities, and therefore has been entrusted with the responsibility to restore, improve and conserve and manage the renewable natural resources thereon in the public interest;

WHEREAS the Department of the Interior, functioning through the United States Fish and Wildlife Service, is charged with the responsibility for the management and wise use of fish and wildlife resources throughout the United States, its territories and possessions;

WHEREAS Public Law 93-280, May 10, 1975, authorizes certain Federal agencies, including the Department of Defense, to detail personnel and loan equipment to the Fish and Wildlife Service of the U.S. Department of the Interior;

WHEREAS the Sikes Act (P.L. 86-797), Sikes Act Amendment (P.L. 90-465) and Sikes Act extension (P.L. 93-452)(16 US 670) authorize fish and wildlife conservation and rehabilitation and outdoor recreation programs on military reservations;

WHEREAS the Department of Defense recognizes fish and wildlife as important renewable natural resources which are found on most military installations and which must be managed properly to insure their availability for the enjoyment of future generations; it is therefore mutually agreed that:

THE Department of Defense will, with assistance from the Department of the Interior, and with cooperation from the various State fish and game agencies, manage the fish and wildlife resources on military reservations.

To effect this understanding:

THE Fish and Wildlife Service will, when required and as budgetary allocations permit, assist the Department of Defense, working with its Military Departments, by conducting investigations and providing technical assistance and services in fish and wildlife management on military reservations. Such services may include:

(a) Development of a management plan for fish and wildlife on military reservations. The plan to be mutually agreed to by the military installation, the appropriate State fish and game agency and the Fish and Wildlife Service.

(b) Conducting surveys of fish and wildlife and their habitat on military installations.

(c) Providing technical assistance for the protection, restoration and control of fish and wildlife populations on military installations.

(d) Providing guidance and assistance to the Department of Defense in carrying out the Marine Mammal Protection Act, the Endangered Species Act of 1973 and other Federal laws as they apply to fish and wildlife populations found on military installations.

(e) Making available as requested the services of a Law Enforcement Officer to aid in enforcing Federal fish and game regulations.

THE Department of Defense will, as budgetary allocations permit, have a fish and wildlife management plan developed for each military installation where there is suitable habitat for management and where management of fish and wildlife resources is consistent with the mission of the installation. Management practices and procedures will provide for the protection, restoration and control of all species and for harmonious interaction with other conservation goals and beneficial land uses. Hunting and fishing may be permitted on installations where sound management policies dictate and where these activities will not interfere with the mission of the installation. Fish and wildlife management and land use policies will be reviewed annually at the Service and Department level.

IMPLEMENTATION of Section 1 of PL 90-465 which authorizes the Secretary of Defense to carry out a program for the development of public outdoor recreation resources at military reservations will be by a separate cooperative plan mutually agreed upon by the Secretary of Defense and the Secretary of the Interior.

THE management of fish and wildlife resources on military reservations requires the exchange of information between the coordinating agencies. Representatives from the Department of Defense and the Fish and Wildlife Service will meet annually, as near as possible to the anniversary of the signing of this document unless otherwise requested by either agency, to review progress and/or suggested revisions to this agreement.

THIS Memorandum of Understanding supersedes the Memorandum of Understanding between the Departments of the Interior and Defense for the conservation of fish and wildlife on military installations dated July 11, 1960.

THIS Memorandum of Understanding shall become effective when approved by the Secretary of the Interior and the Secretary of Defense and shall continue in force and effect until terminated by either party.

Harold Brown
Secretary of Defense

Cecil D. Andrus
Secretary of the Interior

APPENDIX G

FORMAT TO BE FOLLOWED IN PREPARATION OF A COOPERATIVE PLAN AGREEMENT FOR CONSERVATION AND DEVELOPMENT OF FISH AND WILDLIFE RESOURCES

1. In accordance with the authority contained in Title 10, U.S. Code, Section 2671, and Title 16, U.S. Code, Section 670 the Department of Defense, the Department of Interior, and the State of _____, through their duly designated representatives whose signatures appear below, approved the following cooperative plan for the protection, development, and management of fish and wildlife resources on _____.
(military base)

2. The cooperative plan will include the following features and provisions: *a.* Provide for a general inventory review of fish and wildlife resources to be made at the earliest practical time with representatives of all three agencies participating and when completed to be attached and made a part of this agreement. (Objectives: Such an inventory should locate principal land and water areas suitable for fish and wildlife. The inventory should list the principal species of wildlife, condition of their range, and include any data on population numbers. Water areas should be described briefly as to location, types, and acreage, with principal fish species known to be present, and with general observations on the quality of the aquatic habitat. The inventory will identify endangered and threatened species of fish and wildlife. The inventory should provide information on restricted and public use areas existing at that time. It should set forth the potential for the development of fish and wildlife resources.)

b. The cooperative plan should set forth, where applicable, a program for development and management of fish and wildlife resources to include the following:

(1) Development and improvement of habitats for optimum conditions and in keeping with installation objectives.
(2) Need for a means of accomplishing stocking of desired species.
(3) Need for and means of accomplishing control of plant and animal species, as may be indicated.
(4) Plans for the protection of fish and wildlife resources including endangered and threatened species.

c. The cooperative plan will describe the extent of public participation in the harvest of fish and game commensurate with military objectives and should outline general procedures for the operation of such programs. When public access must be withheld, the reasons must be substantiated by a statement incorporated in the cooperative plan.

d. The cooperative plan should specify under what circumstances special State fishing and hunting permits are to be required, the fees to be charged, and procedure for their issue. The plan should specify the fish and game management items for which the money may be spent, the method of relating this income to expenditures.

e. The cooperative plan will specify the State and/or Federal agency or agencies to provide technical advice and assistance to the installation in fishery management and in wildlife management, either separately or together, and to what extent.

f. The cooperative plan will specify circumstances permitting use of off-road vehicles where such vehicles are authorized in the conduct of the installation fish and wildlife management program.

g. The cooperative plan will be in full force upon its adoption, and subject to later amendment or revision as agreed upon by all parties represented. Request for amendment or change of the plan may originate with any one of the parties concerned.

h. All cooperative plans will be reviewed by a judge advocate or legal advisor, prior to signature by commanders empowered to execute such documents.

i. Signers of the cooperative plan will be the installation commander, the Regional Director, U.S. Fish and Wildlife Service, and the Director of the State Fish and Game Department, or other official designated by the Governor of the State concerned.

By Order of the Secretaries of the Army, the Navy, and the Air Force:

E. C. MEYER
General, United States Army
Chief of Staff

Official:

ROBERT M. JOYCE
Brigadier General, United States Army
The Adjutant General

W. M. ZOBEL
Rear Admiral, CEC, US Navy Commander
Naval Facilities Engineering Command

LEW ALLEN, JR., *General USAF*
Chief of Staff

Official:

JAMES L. WYATT, JR., *Colonel, USAF*
Director of Administration

DISTRIBUTION:

Army: To be distributed in accordance with DA Form 12-34B, requirements for TM 5-600 Series: Facilities Engineering: Maintenance and Operation of Facilities.

Navy: (1 copy each except as noted)

SNDL:		
	A1 (SO-4)	ASN (S&L)
	A3	CNO (OP-45)
	A4A	CHNAVMAT (044)
	FKA1G	COMNAVSEASYSCOM
	FKA1F	COMNAVSUPSYSCOM
	FKA1B	COMNAVELEXSYSCOM
	FKA1A	COMNAVAIRSYSCOM
	FKA1C	COMNAVFACENGCOM (FAC-204) 20 copies each
	A6	CMC (LFF-2) 45 copies each
	FKN5	PWCs (less Yokosuka) 5 copies each
	FKN1	CHESNAVFACENGCOM (243) 6 copies each, SOUTHNAVFACENGCOM (243) 5 copies each, NORTHNAVFACENGCOM (243) 20 copies each, WESTNAVFACENGCOM (243) 25 copies each, PACNAVFACENGCOM (243) 5 copies each, LANTNAVFACENGCOM (243) 35 copies each

Additional copies may be obtained from: US Naval Publications and Forms Center
5801 Tabor Avenue
Philadelphia, PA 19120

Air Force: F

☆U.S. GOVERNMENT PRINTING OFFICE: 1993 - 342-421/63395

PIN : 050364-000