Wildlife Management

Introduction

Wildlife can be defined in many ways. One of the simplest and best definitions of the term includes all wild animals. In practice, some people limit the definition to include only wild vertebrates, animals with backbones. Others limit it even more, including only mammals and birds or only game species.

Game species include all species that are legally hunted or harvested. They represent a relatively small proportion of all wildlife, perhaps less than 15 percent of all birds and mammals. Non-game species includes the vast majority of wildlife, including endangered species. Management specific to game animals benefits others that share common habitats, and the funding provided by hunters pursuing game animals benefit all species.

In addition to being classified as game or non-game by those who feel the need for such divisions, wildlife can be divided into groups many other ways. Biologists may use common characteristics, like the types of food eaten or the habitats used to classify wildlife. Forest game refers to game animals commonly found in forested habitats. Farm game refers to wildlife commonly associated with agricultural land. Waterfowl describes web-footed species commonly associated with wetlands. Predators kill other animals to obtain their food, while herbivores eat primarily vegetation. Grazers eat mainly grasses; but browsers eat forbs, leaves or growing shoots of woody plants. Some wildlife, like bears or raccoons, are omnivores that eat almost anything.

Human attitudes or values can also be applied to classifying wildlife. Species that depredate crops or animals of interest to humans are often referred to as "varmints" or pests. These species are often granted little or no protection by wildlife laws. Some are subjected to active population reduction programs. Many types of classifications are based on human value judgements.

Even the terms "game" and "non-game" are classifications based on human value judgements.

Most of our wildlife species are native to North America. They developed on this continent or arrived here without the help of humans. Others are exotics, in that is they were brought to this continent by humans, either accidentally or by design. Brown rats, house mice, European starlings and fire ants are examples of accidental introductions. Ring-necked pheasants, gray partridge (Hungarian or red legged partridge), chukars and aoudads are examples of deliberately naturalized species.

Wildlife as a Resource

Two types of resources are generally accepted—renewable resources and non-renewable resources. Major differences between them are based upon their nature and upon time scales. Non-renewable resources are usually non-living components of the environment—the stuff of the universe. Minerals and fossil fuels are considered non-renewable resources because they require extremely long time periods to be replenished or recycled. The total amount of gold on the planet is limited. Although more gold may be emerging from volcanoes, the total amount available to us is, for all practical purposes, fixed. More oil or coal may be developing, but the time scale for its development is too long to be of practical use to humans.

In contrast to those non-renewable resources, renewable resources are usually living things. They can be replaced in a matter of a few seconds to a few life-times. An ancient bristlecone pine might take more than a thousand years to replace, but a new generation of mule deer can be produced every year. Some small game species can have multiple generations in a year. Renewable resources continue to produce a harvestable or useable resource over time. Because they are living things with limited life spans, they cannot be stockpiled, like the gold in Fort Knox, to be used at a later date. Wildlife resources must be used or lost each year. The annual increment cannot be saved until a later date because the capacity of the habitat is inadequate to sustain the excess population. The excess will be lost to some mortality factor.

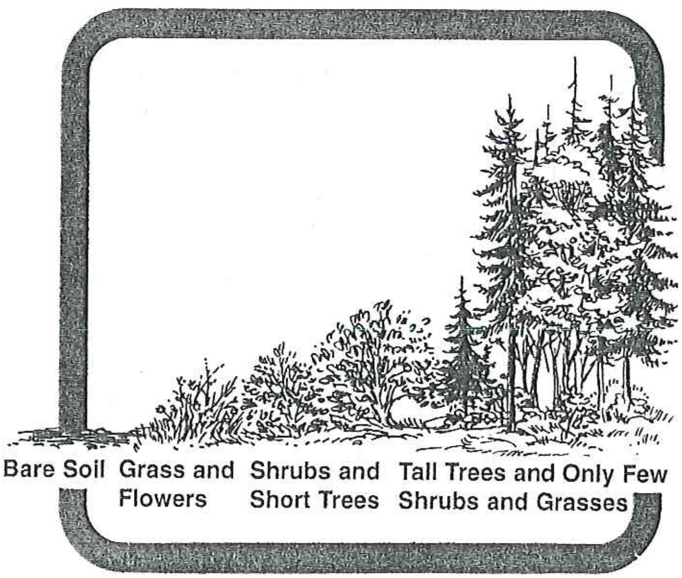
Wildlife resources produce a wide variety of human and ecological values. Sometimes those values are complementary. Sometimes they may be in sharp conflict. The same species could be a severe problem or a rich blessing to different groups of people. North American traditions make wildlife a commons resource, one held in common by all the people. This contrasts sharply with the European tradition of proprietary wildlife, where resident wildlife belonged to the land holder. Because of that difference, everyone has a stake in wildlife management. The people of the various states, provinces and nations in

North America have placed the authority for management of wildlife in the hands of professionals by creating management agencies. These professionals serve in fish and wildlife, natural resources, or conservation agencies and hold the public trust for management of resident and migratory wildlife. Federal or national agencies hold a similar trust for migratory wildlife and threatened or endangered species. They also provide both funding and technical support for state or provincial agencies. Many other agencies and organizations employ wildlife and fisheries professionals and are involved in wildlife management as part of their responsibilities.

Conservation

Aldo Leopold defined "conservation" as "wise use without waste" and promoted ecologically based management of the landscape and its wildlife. Since all people have a direct interest in management of the wildlife they hold in common, everyone needs a basic understanding of the nature of the resource and the principles of wise resource management.

"Resource" implies use, but "use" has many different meanings. Viewing wildlife or simply feeling satisfaction in knowing a species is alive is a use. Similarly, harvesting wildlife for personal use, or reducing it to possession, is a use. Although no use that involves direct or indirect contact with wildlife is truly without impact, many people distinguish between uses that have

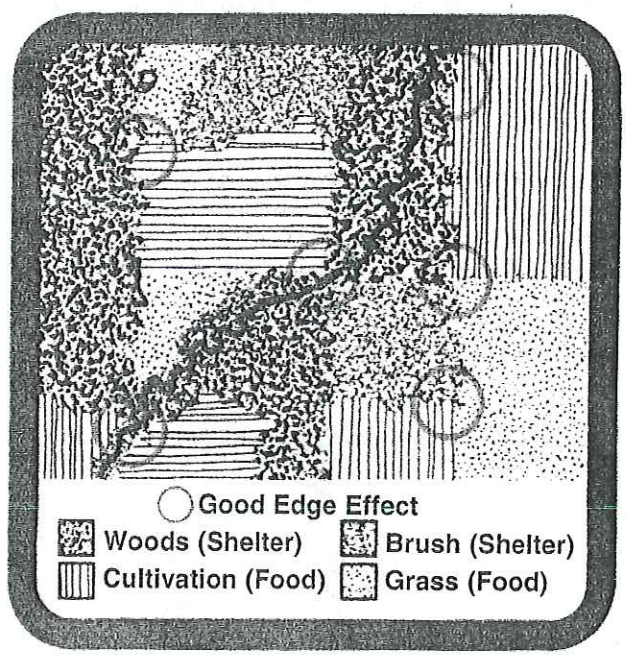


direct impacts on wildlife and those whose impacts are more subtle. "Consumptive uses" are those that result in the direct removal of individuals from the population. "Non-consumptive uses," like bird watching or wildlife photography generally are not intended to cause direct removal of individuals, even though unintentional or indirect impacts may be substantial.

Differences in orientation or perceptions may lead to conflicts among different types of users, but all uses can be compatible. The key lies in keeping the focus on species and communities or systems, rather than on individuals or competing uses. When the focus shifts to individuals the potential for confusion and conflict increases.

Although species can persist for extremely long times, the life span of any living individual is limited. Thus, all individual living things eventually must die. This is part of the normal life process. Since life is full of risks to survival, most individuals die before they reach the potential limits of that life span. In fact, each individual could be regarded as a "hopeful experiment" in solving the problems of survival and reproduction.

Since individuals die, they cannot be "preserved" beyond the constraints of their biology for use at a later time. Wildlife cannot be stockpiled. Populations change seasonally and individuals are recruited to the population or lost from it to maintain a dynamic equilibrium with their environment. This basic principle is at the core of wildlife management.



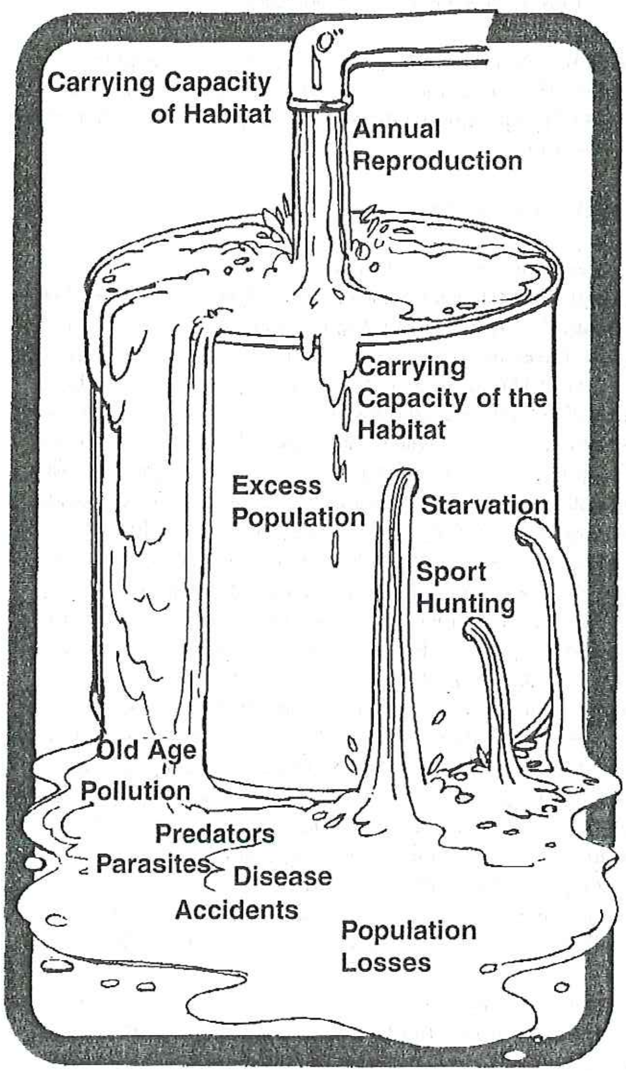
Foundations of Wildlife Management

Wildlife management has its foundation in the science of ecology. Both basic ecology and its application in wildlife management have seen explosive growth in knowledge. That growth allows professionals to continue improving their ability to manage wildlife populations, habitat and communities for the benefit of people and wildlife. That task is often made more challenging by misunderstandings, misinformation and tradition among the publics being served.

Many people feel that they are experts in wildlife, either because their activities have put them in contact with wildlife for years or because they have enjoyed media presentations on wildlife. While these activities can be helpful and meaningful to the participants, basic ecological knowledge is essential to understanding how and why wildlife management works.

Basic Principles of Ecology

Ecology is the study of living things in their home. It concentrates on the relationships of living things to each other and to the non-living components of their environment.



Some of these relationships are obvious. Others are not. In its simplest form, ecology states these basic principles.

1. Life has requirements.
2. Life has order.
3. Life is interdependent.
4. Life is change.
5. Life is energy flow.

Expansion on these simple building blocks helps us under stand how the world and the things in it operate.

Matter and Energy

Energy is the currency of living things. With very few exceptions, like bacteria that break down sulfur bonds, the energy in living systems begins with the capture of light by green plants. The highly organized form of energy in light waves is changed into stored energy in chemical bonds. It passes through systems of living things only once. Each time it is transferred, some of it is lost as disorganized energy, what scientists call "entropy." We could think of it as waste heat. Complex ecosystems are very conservative of their energy losses, holding on to the currency of life as long as possible; but constant energy inputs are essential to continued life.

Matter, the chemicals that make up the physical universe, behaves in a very different way. Healthy ecosystems recycle the vast majority of the chemical building blocks for living things. So while energy flows through the system one way, matter is constantly being cycled through the system. Elements like carbon, nitrogen, oxygen, calcium, sodium and phosphorous move through complex biogeochemical cycles.

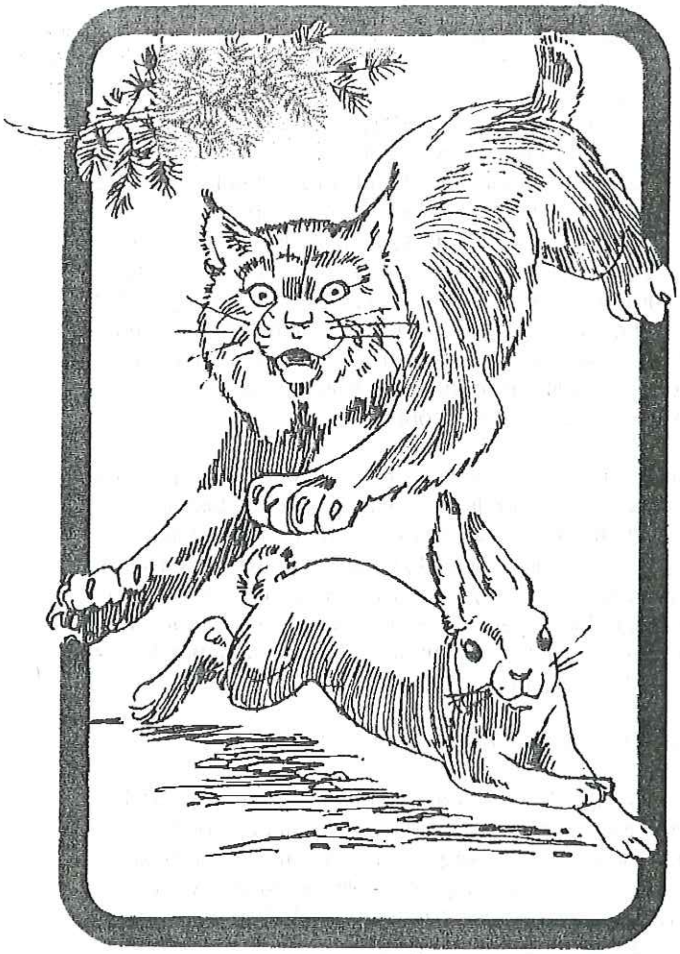
Limiting Factors

The stuff that makes up the universe exists in limited amounts. Each living thing needs certain amounts of that material and energy in order to survive, grow and reproduce. Those things are called requisites or needs. The supplies of those needs are limited on each specific site as well as in the universe as a whole. The requisite that is available at a minimum value sets the limits on populations of living things that can occupy any given site. If that resource is increased enough, another one will become the new minimum. Taken as a group, these limited resources are known as limiting factors. They can be illustrated as a wooden bucket having staves of different lengths. If the shortest stave is replaced with a longer one, another will limit the capacity of the bucket.

All the limiting factors acting on a site determine the carrying capacity of that site. This refers to the maximum number of living things that can be supported on a given site at any given time. In the wooden bucket example, carrying capacity is the maximum capacity of the bucket at any given time.

Since limiting factors can change with the conditions, the staves of the carrying capacity bucket change lengths over time. Thus, although carrying capacity is often viewed as a constant or an annual minimum, it is really a dynamic number that can change at any instant in time. Some habitats are extremely stable and predictable with respect to carrying capacity and changes in it. Others are unstable and difficult to predict.

Not only can limiting factors and carrying capacity change with seasons or other conditions, they also may be extremely difficult to identify under practical conditions. They



are a complex set of interacting factors, some living and some non-living. All of them must enter into management decisions, and often their role must be determined by highly trained observers over extended periods of time.
Some obvious factors to be included are conditions like climate, altitude, latitude and soils. Some of these factors can be altered by management practices. Others cannot. The manager is bound by the potential of sites and the species occupying them.

Habitat

The type of environment in which a living thing obtains everything it needs to survive describes its habitat. Thus, habitat can be viewed as the home or living space of a wildlife species. It can be considered as the combination of food, water, cover and space needed for survival.
Habitat quality is determined by the amounts and arrangement of these factors on a site. If quantity and quality are high, the site can support relatively large populations. If they are limited, populations of wildlife are also limited.

Although climate and local physical factors act as ultimate factors in habitat quality, it is the types and distributions of plants that immediately influence habitat quality. The types, densities and structure of the plants on a site give the habitat its structure. The structure of the habitat influences the types of wildlife that will be attracted or held on the site.

Dominant types of vegetation covering large geographic areas are called plant formations. Arctic tundra, coniferous forest, deciduous forest, tall grass prairie, chaparral and Sonoran desert are examples of plant formations. When the animal life is added to the plants, these areas are known as biomes.

One or more types of plant communities can be found in each plant formation or biome. The climax community on a site is a long-lasting and apparently stable plant community. Beech-birch-maple forest, spruce-aspen forest and creosote bush-cat-claw acacia are all types of climax plant communities. The structure of those communities attracts and supports specific types of animals.

If a climax community is disturbed by natural events or some deliberate action, it tends to regenerate through a series of stages known as seres. This process is called plant succession.

Plant Succession

Plant succession normally follows a fairly predictable pattern toward its climax community. This process can be illustrated by following the plant communities that develop after a forest fire or the abandonment of farmland in an area where hardwood forest is the climax community. The bare, mineral soil left after either event is an excellent seedbed for herbaceous plants, called forbs, and pioneer tree species, like aspen. These pioneer plants, spring up rapidly, shading the soil and trapping moisture. In the process they provide nesting sites and food for animals that live and forage on or near the surface. Grasses follow the forbs on some sites. Brambles, aspens, maples and white pines, plants that demand full sunlight begin to grow on the site, eventually shading out most of the understory cover. As these shade intolerant plants grow, they alter the conditions. Shade tolerant shrubs and seedlings begin to grow under the canopy of the developing saplings as shrubs demanding full sunlight are shaded and die. Competition for light thins the stand as the trees mature and form a closed canopy. Shade tolerant species like sugar maple and beech grow slowly under the canopy until an opening allows them to reach the canopy. Once the shade tolerant trees dominate the canopy, the structure of the community changes very little until another fire or a cut opens the forest floor to the light again.

Similar, but longer and more subtle, changes take place in other climax communities. While it may take an eastern deciduous forest only a few decades to regenerate itself, less tolerant climax communities may take centuries to regenerate if they are disturbed too much. Tracks of the pioneers are still evident in aerial and satellite images of the Great Plains, and damage to desert, tundra or alpine systems may take a very long time to repair. Sometimes the impacts on a system can be so great that a new and different type of habitat replaces the former climax community. That may be the result of local conditions that are extreme, like a pocket of excessively wet or dry soil or an avalanche scar. It could also result from extremely hot fires, severe soil compaction and heavy grazing pressure by herbivores, factors that can alter the environment to the point where it will no longer support the former climax community. These sites usually develop lasting communities that represent earlier stages of succession.

Habitat Change

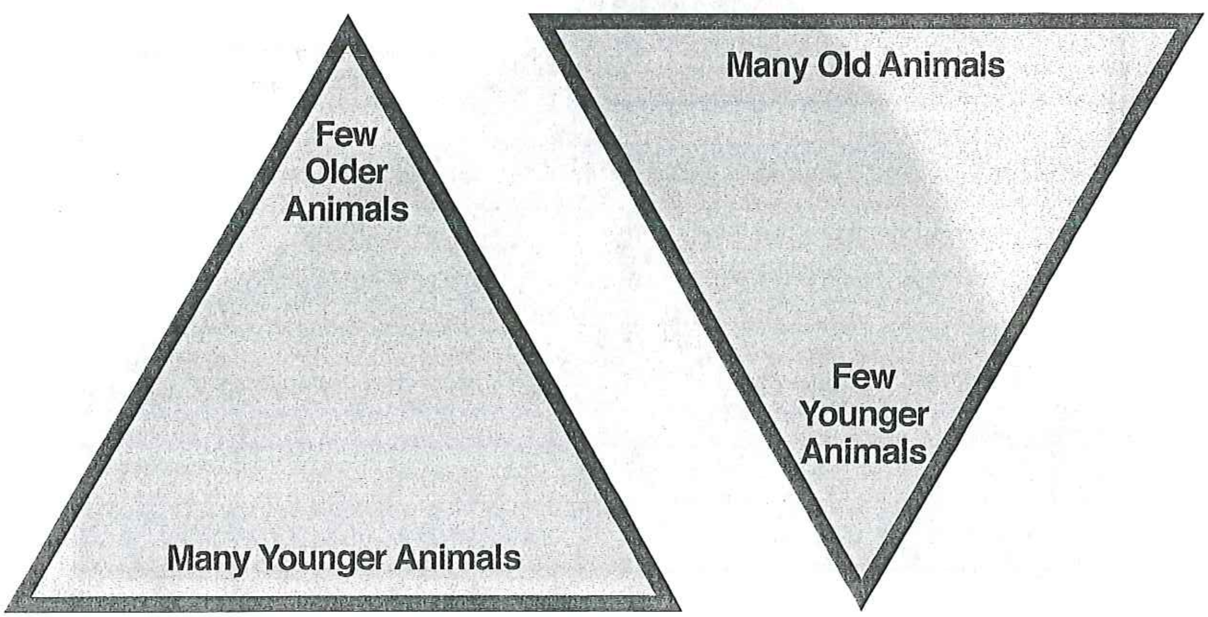
Since it is composed of both non-living factors and living components, habitat behaves like a living thing. It changes as the plant communities that determine its character change. Some changes can be rapid and obvious; but most frequently habitat changes, particularly those that are the result of plant succession, are gradual and difficult to detect without careful observation and accurate records. Animals that are associated with the plant communities increase or decrease in numbers as the amount, quality and interspersion of their preferred habitat components change.

Although some species can successfully live in a broad variety of habitat types, many others find a narrow range of habitats attractive. Some species thrive in an area dominated by bare soil. Some demand low shrubs and herbs that only persist for a decade or so following a fire. Others require closed canopy forests covering 1000 hectares (2470 acres) or more. Species that tolerate a broad range of conditions (generalists) usually are replaced by species with narrower tolerance and higher efficiency within that range of tolerance (specialists) when the appropriate habitat conditions exist. As a result, wildlife communities change with changes in habitat types.

Manipulation of habitat types and patterns of distribution is one of the main tools of wildlife managers. Sometimes that is done through habitat enhancement, increasing the amount of a limiting resource. In an area where wind and deep snows may bury escape cover or food, managers may encourage establishment of windbreaks or hedge rows to provide winter cover. In desert areas, water availability may be increased by building "guzzlers" or small ponds to provide a more dependable water source. These tasks may be done by professionals on state or national management lands, but most of it is done either by concerned private landowners or by citizens with an interest in increasing wildlife richness in an area of interest.

Many times habitat manipulation is accomplished by "set ting back succession" using a variety of tools. Prescribed fire, timber harvest, discing and similar treatments move selected patches of habitat backward in time to a stage of plant succession that is preferred by the desired collection of wildlife species. Very frequently these activities are associated with a companion use of the landscape, like forestry, agriculture or even suburban development.

Population Age Structure



Normal | Inverted

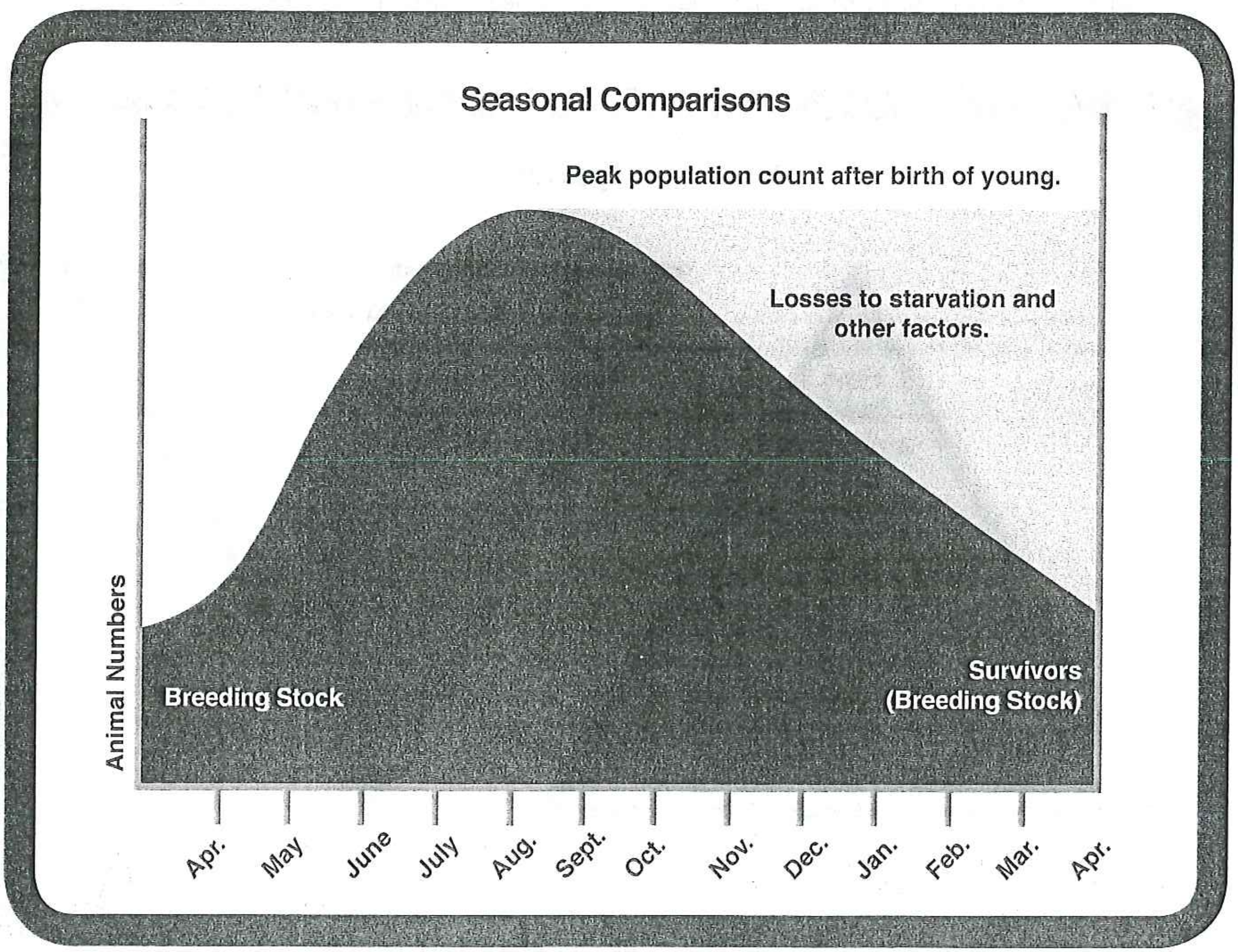
Cutting patches of mature deciduous forest, for example, has a multitude of positive effects on wildlife. It creates openings that result in greatly increased plant productivity near the ground. This makes high quality food readily available to all plant eaters and those that feed on the plant eaters. It can produce abundant insects that are essential foods for young birds. It provides specialized nesting sites for species like wild turkey, ruffed grouse, cottontail rabbit, indigo bunting, rufous-sided towhee and short-tailed shrew, as well as excellent hunting sites for broadwinged hawks and screech owls. At the same time, it may decrease habitat quality for deep forest specialists with large area requirements.

The most important feature to remember about habitat management is that no species is really managed by itself. The type and arrangement of habitat patches and the sources of species that can colonize them determine the mixture of species that will occupy the site. Each habitat type in a region supports a suite of plant and animal species that are adapted to the conditions present.
Managing for one of them results in managing for the entire group, even though the impacts on each individual species may vary for many reasons.

Pattern or Arrangement of Habitat

The type of habitat available on a site is critical, but the arrangement or pattern of the habitat patches is almost equally important. Many species require different types of habitat structures over their life cycle or in their daily activities. A red-tailed hawk may prefer to hunt for mice, rabbits or similar prey in relatively open areas, but it prefers to do its hunting from an elevated perch. A patchy mixture of wooded and open areas makes an ideal habitat.

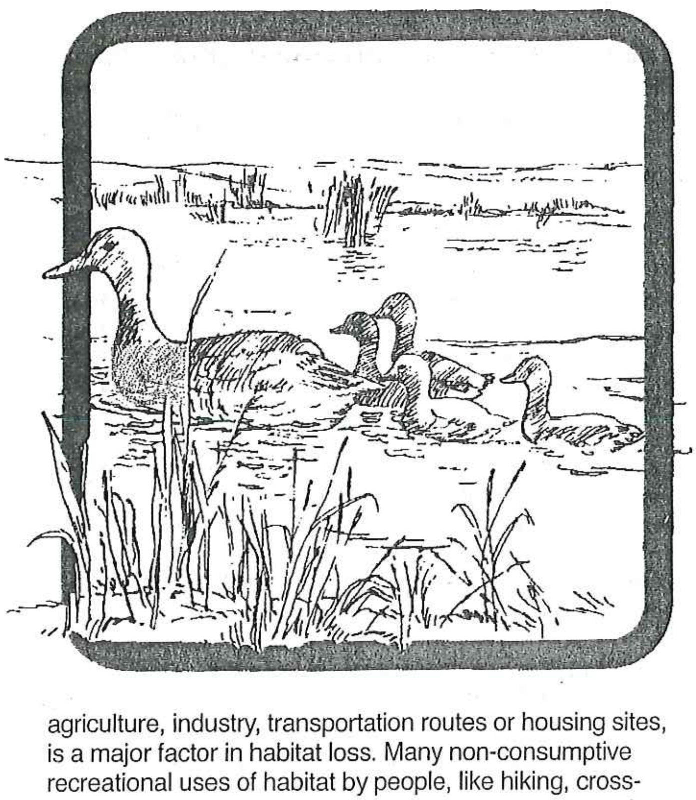
Where several types of habitat are needed by a species, the number of effective intersections of those habitat types determines the number of individuals or groups that can be supported. If only one intersection is available, only one individual or group might be able to make it. If the arrangement of the habitat is changed to increase the number of intersections, the carrying capacity of the habitat increases. An interspersion of grain fields, dense old fields and shrubby areas is excellent habitat for species like the ring-necked pheasant, while wind-swept grassland or grain fields with interspersed brushy draws may be much more attractive to sharptail grouse or prairie chickens.



The edges or interfaces of habitat types are often rich in wildlife, prompting some to refer to it as the "edge effect." Edges often hold species typical of the habitats meeting along the edge as well as species that are adapted to the special conditions on the edge itself. Those species who require both types of habitat are able to use the edge effectively as well. Since many of our game animals thrive on edges, creation of abundant edges may be part of a habitat management plan.

Seasonal differences in habitat needs often require wildlife to move. Some of those movements are relatively local, like the movements of ring-necked pheasants into marshes or shrubby cover during the winter. Some of them are primarily altitudinal, like the movement of mule deer and elk to lower elevations during the winter. Others require movement of hundreds or thousands of miles between nesting grounds and wintering grounds. Often the times when the animals are moving or migrating result in relatively high loss rates to predators (human and others) and to other mortality factors.

Of course, loss of one seasonal habitat to development or some other factor imposes a limiting factor on the species or at least that population that was directly affected.
Human activity, including competition for use of the land required to sustain wildlife, is the most significant factor in habitat loss. Development of high value human uses, like



agriculture, industry, transportation routes or housing sites, is a major factor in habitat loss. Many non-consumptive recreational uses of habitat by people, like hiking, cross-country skiing, all types of off-road vehicle use or camping, can have a profound impact as well. Development of recreational areas can also have substantial impacts. Golf courses, ski resorts, marinas and camp sites may have major impacts on wildlife without intending to do so.

Hunting provides for wildlife habitat for all species with relatively minor impacts on wildlife populations.

Population Dynamics

A population is an interbreeding group of animals of the same species. They may live together in a herd or flock for all or part of the year, or they may live alone but within a defined area. Population dynamics refers to the changes taking place within a defined population. These changes are the result of reproduction, immigration, death and emigration. The population dynamics of game species allows humans to take some members of the species for

our use while continuing to have the species for an indefinite length of time. Knowledge of population dynamics is another fundamental need for wildlife biologists and managers.

Population Growth

In a dynamic system that appears to be stable, more offspring will be produced than can be recruited into the existing population. An oak tree, for example, needs to produce only one mature tree to replace itself during its lifetime; but it sheds tons of acorns. Each of them is capable

of becoming a new tree. Very few of them make it. To a lesser scale, the same thing is true of animal species. Some species produce many more offspring than can be recruited. Others produce fewer individuals with a higher probability of survival to adulthood. But all populations have the potential to grow at an increasingly faster rate until they encounter some limiting factor.

Population growth is determined by the natality of the population and the rate of immigration into the population from other populations. Natality is based upon the age of first breeding, litter or clutch size, and the number of litters or clutches produced in a given length of time.

Some species may not reach sexual maturity for several years, while others may reach reproductive age within only a few months or weeks. Canada geese, for example, commonly do not breed until their second year or third year; but most other game birds breed in their first adult year. On the other hand, cottontail rabbits and muskrats may breed within a few weeks or months of their own birth. Some extremely large animals, like elephants, delay sexual maturity for several years or, like black bears, may breed only after reaching a certain minimum body weight. Under stressed conditions or high population densities breeding may be suppressed in young females. In other species, like black brant, breeding may not take place at all if habitat conditions are not right during a relatively brief period. These species may show "boom and bust" reproductive patterns with substantial fluctuations in numbers.

Clutch or litter size is determined by characteristics of the species as well as habitat conditions. In general, very large birds and mammals tend to produce small litters or clutches. Pregnancy or egg production demands large amounts of energy, and stressed females may resorb or abort fetal young or produce smaller clutches of eggs.
These large animals are often controlled by internal regulatory processes or by reaching the bounds of their habitat. On the other hand, very small animals frequently have relatively large litters or clutches or have them at more frequent intervals. Their populations are often controlled by predation or high juvenile mortality rates. Muskrats are a good example of a species that produces lots of young. Assume that the average female muskrat has three litters each year with about six young in each litter. In addition, assume that each litter has a balanced sex ratio, 3 males 3 females. (Litter sizes and numbers vary, but these are reasonable assumptions over portions of the muskrat's range). Females in her first litter will have one litter before the end of the breeding season. If no mortality takes place, a single female could produce 36 offspring (her 18 plus the 18 produced by her first three female offspring) in a single year. If all the adults over one year old died before the beginning of the next breeding season, the population would grow to nearly 3000 animals in only three years (see table below). After only 10 years the population would have grown to nearly 14 billion!

Table A
Muskrat Population Growth Potential

Year	number of females	population size
1	1	36
2	18	324
3	162	2,916
4	1,458	26,244
5	13,122	236,196
6	118,098	2,125,764
7	1,062,882	19,131,876
8	9,565,938	172,186,884
9	86,093,442	1,549,681,956
10	774,840,978	13,947,137,604

These numbers are similar to what might be expected of other species adapted to out-reproduce their predators, like rabbits and most upland game birds. But what about other animals, like white-tailed deer? Table B shows that the rate would be lower, but the population would still continue to rise if conditions were not limiting.

Start by making three simplifying assumptions:

1) Females live for 10 years,
2) Habitat quality is adequate for any population,
3) Yearling females and adult does produce 2 fawns per year.

Given those conditions and no mortality, the population doubles each year, reaching 2048 individuals in only 10 years. Extending those conditions, even with the loss of all 10 year old deer, the deer herd would reach about 17 billion in 33 years.

Table B
White-tailed Deer
Population Growth Potential

Year	number of females	new individuals	population size
1	1	2	4
2	2	4	8
3	4	8	16
4	8	16	32
5	16	32	64
6	32	64	128
7	64	128	256
8	128	256	512
9	256	512	1024
10	512	1024	2048

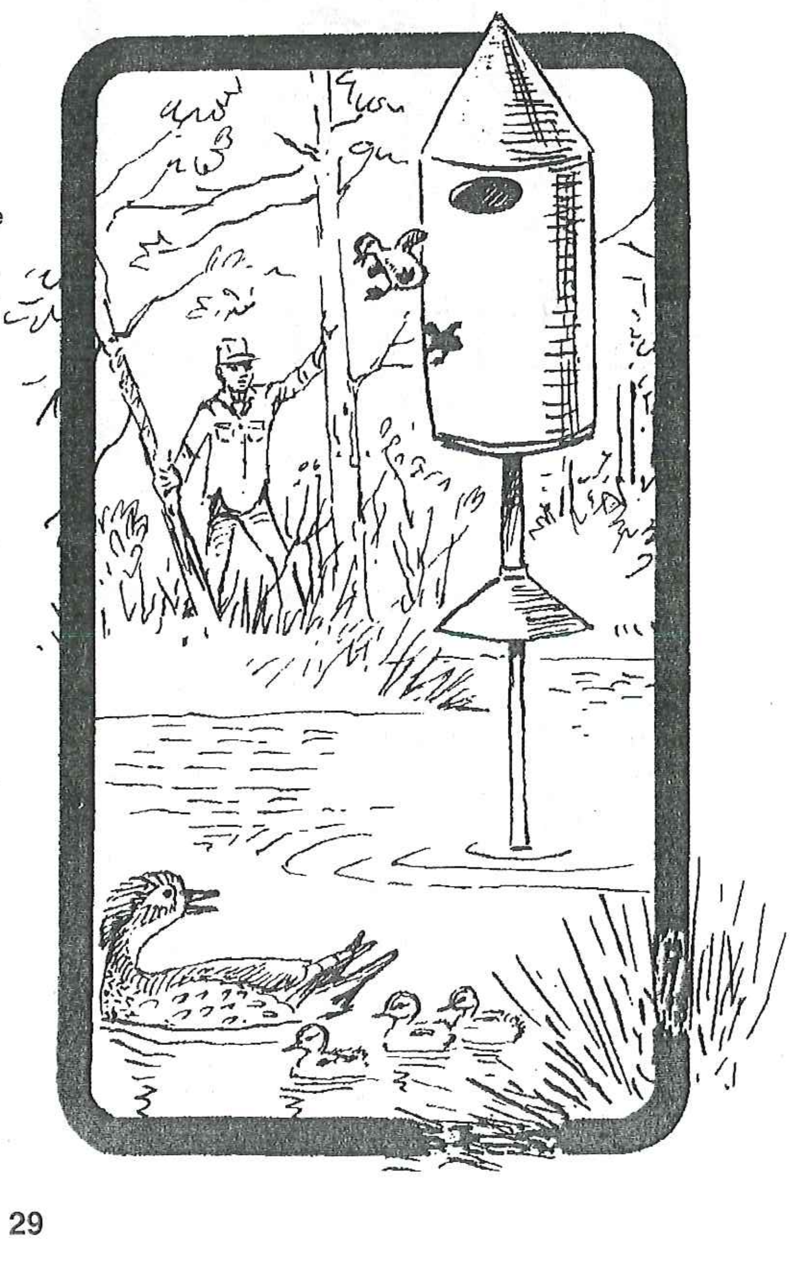
If these things are true, why are we not up to our ears in all kinds of wildlife? To see the reason, we must look at the other side of the population dynamics equation - emigration and death.

Population Reduction

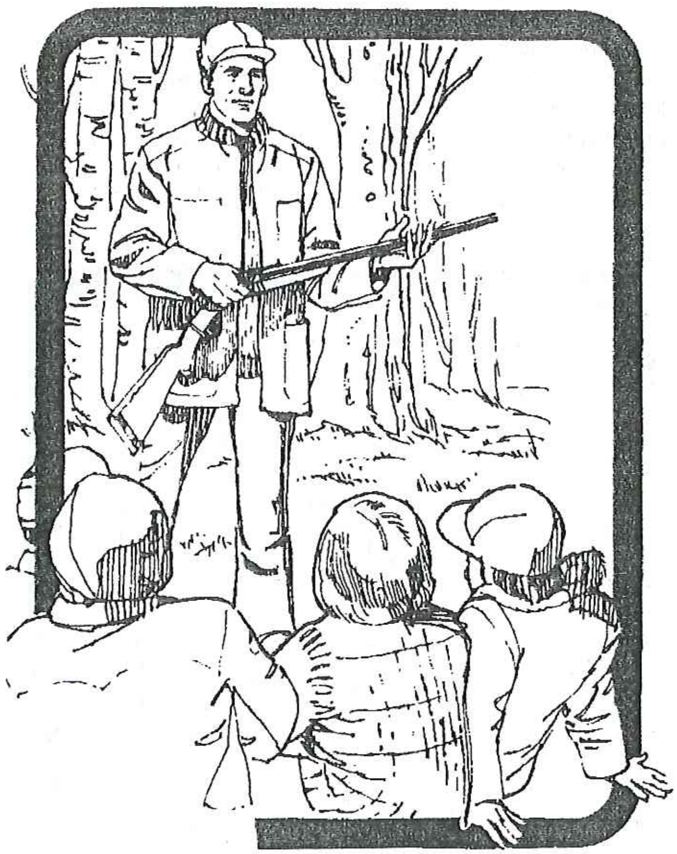
The assumptions made to show the potential for population increase simplify the situation too much. Some individuals leave the population as a result of interactions with others of the same species. If they can find suitable habitat that is not occupied, they may join or start other populations. These emigrants become immigrants to a new population. Most often, however, quality habitat is more or less saturated. Habitat is seldom uniform, even when large patches appear to be essentially the same. Differences in quality result in differences in survival potential for its occupants. Since higher quality habitat (measured as having the potential to allow an individual to survive) is commonly occupied, most immigrants become established in lower quality habitat that is temporarily adequate for their needs. When conditions become more limiting, they must move again or die. Those conditions result in the death of most immigrants during periods when carrying capacity of their new habitat is reduced. Immigrants that are successful often displace animals in the population they enter, changing who dies but not the number of ultimate survivors.

Mortality factors (things that cause death) come in many forms. Predation, fighting, starvation, weather-related deaths, accidents, disease and parasitism all take their tolls. Humans may contribute to that mortality rate as predators, participants in accidental death or by modifying habitat through other activities. Sometimes human actions are the direct cause of death, like hitting a fawn with a mowing machine or cutting a den tree while young squirrels are in the nest. At other times the human influence may be indirect. For example, a red-tailed hawk may kill a pheasant on the edge of a harvested corn field, but lack of escape cover because of the removal of a brushy hedge along the field edge may be the ultimate cause. The landowner may have removed the brushy cover to increase his crop yield in the edge rows of the field. He or she might even have considered the pheasants a valuable resource, but the indirect result of their actions was a reduction in carrying capacity for the birds. Populations must adjust to the carrying capacity of the land, and the excess population will be removed in one way or another.

Removal of any individual from the population during times of stress reduces the pressure on the remaining individuals in the population. As a result, mortality factors have a complex relationship. Changes in the rate of one mortality factor most often result in changes in the rates of other mortality factors. This is known as compensation, and these factors that remove the excess population are known as compensatory mortality factors. They tend to adjust or compensate for changes in other mortality factors. If more animals are taken by predators (human or others), fewer are likely to starve, die from diseases or parasites, or get run over by cars. The means of death or removal may change, but the amount that must take place remains fairly constant. The type of death or removal is not important to



the population but the total number is vitally important. The loss of some individuals is critical to the survival of others, and the mechanics are immaterial. Once carrying capacity reaches its annual minimum and losses have reduced the population to that size, enough resources should be available to permit the remaining individuals to live and reproduce. Among game species, those individuals in excess of the carrying capacity minimum are some times called the "harvestable surplus." Most hunting regulations are designed to maintain harvest levels within the range of compensatory mortality and the bounds of harvestable surpluses.



If populations are below the biological carrying capacity, many species respond by compensatory increases in birth rates or higher survival rates of their young. This natural response to available resources tends to increase productivity and recruitment when populations are low and decrease them when the populations are high.Intermediate population densities are normally the most productive. In fact, most populations reach their greatest productivity (addition of new individuals to the population) at a population size about one-half the biological carrying capacity.

Reducing populations below their carrying capacity requires additional or additive mortality factors to be applied. Additive mortality simply reduces the total population size. Although most wildlife management related to hunting is based upon working with a harvestable surplus and compensatory mortality factors, application of additive mortality may be required to reduce populations of some species. Managed harvest is a primary tool of wildlife managers. Harvests help to maintain some populations at desired levels. That level must be at or below the biological carrying capacity, but it is often determined by the wants and attitudes of people. This human-based population size is known as the sociological carrying capacity. It cannot exceed the biological carrying capacity, but it is often lower. Biologists also consider the interactions with other species and the habitat quality. Where other species or the habitat is subjected to damage, harvest levels usually are increased to reduce the populations creating those impacts.

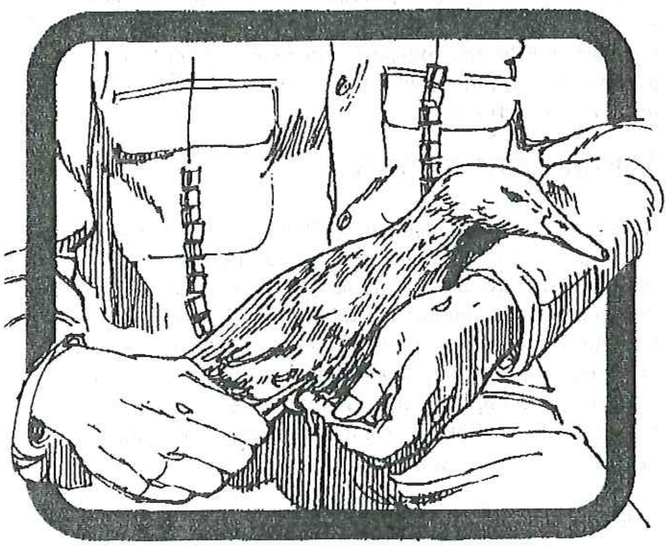
The dynamics of populations dictates a basic principle of managing renewable natural resources like wildlife. When a harvestable surplus exists, it cannot be stockpiled. It is an ephemeral resource that must be used while it exists or lost to potential use. That loss is from the human perspective - opportunity loss, recreational loss, economic loss, loss of ecological or social understanding. Natural systems do not waste anything, and the surplus individuals will find use some place in the system's energy and matter transfer processes. What is lost is the potential to enjoy the hunt and its multiple products while renewing our relationships with our ecological and social roots. Human participation or the lack of it makes little difference to the individuals actively involved in the game of survival. Their rules are the same. An upper bound exists, so the loss of the surplus is inevitable. Only the winners continue to play. Learning those rules can even help us to cope with our own mortality and place in the biological scheme of things. How the game is played influences species, populations, communities and habitats.

Necessary and Permissive Management

Some species must be managed. Others are managed because their population biology and ecology permit it. Extremely tolerant species have the potential to inflict damage on their habitat as they increase in numbers. If these species are not reduced in numbers, the habitat damage eventually will impose a new and lower carrying capacity on them. In the process, habitat for other species that are less tolerant will be damaged as well. Reducing or eliminating habitat components can severely restrict habitat for less tolerant species and influence their numbers. Many of the large herbivores, and sometimes smaller ones, require management to avoid impacts on habitat structure and quality. Elephants, white-tailed deer, wapiti and others have shown this potential. Even muskrats have some times shown the ability to "eat-out" a wetland, damaging the habitat for themselves and for all other wetland wildlife in the process. Holding these species below the level where they damage other species' habitats or their own can maintain richness and habitat quality while providing hunting or trapping opportunity for the outdoorsman and economic value to communities.

Parks often show the impacts of excessive populations of tolerant species. Elk (wapiti) populations in many western national parks and white-tailed deer populations in unmanaged parks in much of the country show the impact of their numbers on the vegetation and on less tolerant species.Elephants in some African parks show similar impacts. Management responses have differed dramatically.

Rhodesian (Zimbabwe) managers developed a complex formula to determine when they had too many elephants. Seeing old or young elephants around water holes without the rest of the herd, seeing decreases in sensitive species of plants or animals, or seeing reductions in the standing crop of preferred elephant foods signaled the need to reduce the herd. Elephants were shot, removing entire herds and using every useable part of the dead animals as a source of income to support the management process. Gradually, the balance between elephants and the rest of the park structure was found, requiring only the removal of an annual increment to maintain both the elephants and the park. This process was approved by the people when they were presented with the options as alternatives with recommendations for long-term stability and diversity in their designated parks. American park lands have been handled



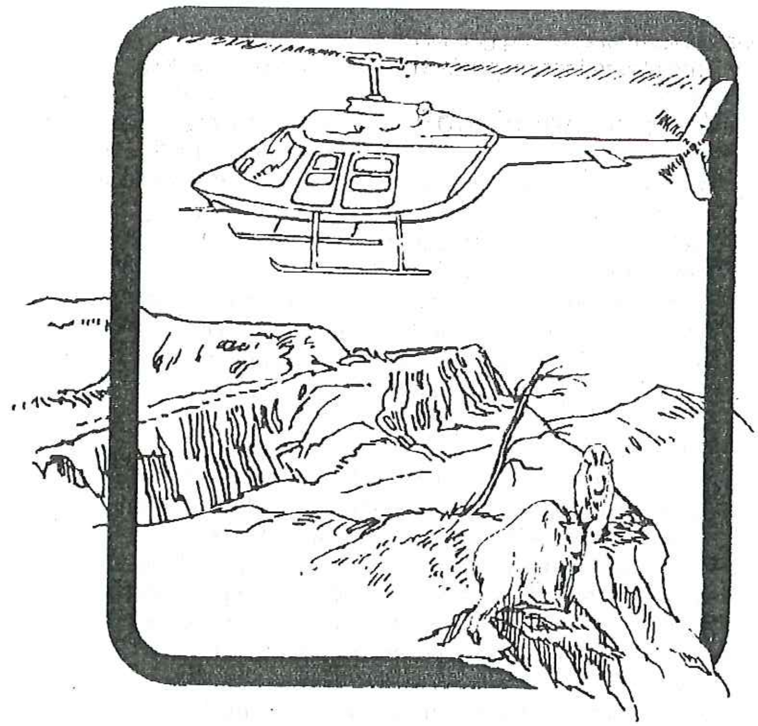
in a preserve-like manner, letting "Nature take her course" in some areas while modifying natural systems in others. Overpopulations of big game species are common. State parks and some Canadian parks have been much more flexible and successful in meeting the long term objectives than have United States national parks.They have opted for controlled hunts to keep populations within desired bounds, rather than watching damage accumulate through lack of active management. The damage, readily observable to the trained observer, is seldom seen or understood by the casual visitor, who sees the obvious and abundant big game as a mark of the system's health and well being.

Like tolerant or abundant wildlife, extremely intolerant or rare species may require management in order to survive. Often they are managed by methods that may seem severe. Kirtland's warbler, an endangered bird species, nests only in young jack pines. Patches of jack pine habitat are burned to promote growth of young pines in order to provide that habitat type. At the same time, brown headed cowbirds may be removed from the area (killed) to prevent them from parasitizing warbler nests. Cowbirds are abundant. Kirtland's warblers are extremely rare. Killing some cowbirds has little influence on their overall population size, while the loss of a warbler nest to cowbird parasitism may have a significant impact on the warbler population. Jack pine cones are opened by the heat of fire, causing them to shed their seeds and re-seed the area after fire. If we want to keep Kirtland's warbler around, we need to continue managing their habitat to encourage population growth.

Protection may not be the answer. The heath hen, an eastern prairie chicken, is an example of protection gone awry. Heath hens lived in grasslands and heaths (areas of low shrubs, like blueberries). Heavy, unregulated harvest had reduced them to remnant populations when an effort was made to save the species. One of their last populations was on an island off the Massachusetts coast. Dominated by low shrubs, the island experienced periodic wild fires. Managers, feeling these fires were a threat to the species, began to suppress the fires in order to protect the bird from extinction. We protected them into extinction. The birds needed the new growth that followed fire to survive. Whooping cranes, Attwater's prairie chicken, black-footed ferrets and others need management help to survive; and as wildlife management has grown over the last few decades, non-game and endangered species management has become a significant part of the equation.

Active management has shown its ability to bring species back from the brink of extinction. Wood ducks were endangered in the 1920s. Today they are the most common breeding duck in the United States. Trumpeter swans were endangered. Today they have been removed from the endangered species list. Bald eagles (in the lower 48 states), ospreys, peregrine falcons, brown pelicans and many other species are showing progress toward safe numbers because of active management. Wildlife management has brought many species, including white-tailed deer, elk, pronghorn antelope, beavers, wild turkeys and the giant Canada goose from very low numbers to safe numbers, sometimes even to numbers that become a nuisance to some people. The success stories with popular game animals show the beginnings of wildlife management. The growing success stories with other species show that the lessons learned with economically important species are having an impact on many others.

The species on the ends of the tolerance or abundance spectrum must be managed. This is necessary management. Those between the extremes may not require management, but their reproductive biology and other characteristics permit them to be managed. This might be termed permissive management. Cottontail rabbits are among the most popular game animals in North America. The millions of rabbits taken by sportsmen each year, however, are almost meaningless in the population



dynamics of cotton tails. Given adequate habitat, weather may be the most significant factor in rabbit abundance from one year to the next. Their reproductive strategy is to out-reproduce their predators' capability to kill and eat them. Wise management may involve the timing of hunting seasons or restrictions on the use of certain techniques that deny refuge to the rabbits. The main impact of bag limits is to provide for equitable sharing of the resource and to spread the take over a longer time frame. The same thing may be stated for most upland birds, where population turnover rates of approximately 80 percent occur whether the birds are hunted or not. Most game species (and likely most nongame species) fall into the permissive management category.

A variety of regulations can be used to reach management objectives with game species. They may restrict the sex or age of the individuals that may be taken. They may also restrict the bag limit daily or over the course of a season. The regulations may dictate the use of only specified types of equipment or place regulations on the areas that may be hunted. Spring turkey hunts, for example, permit the removal of males (toms or gobblers) but do not permit taking hens. One gobbler can breed with many hens, and most of the breeding has taken place before the season opens. Once breeding has taken place, hens rear their broods alone. These facts make it possible for hunters to enjoy the challenges of turkey hunting and the rewards of a successful hunt without jeopardizing the future of the turkey population. In areas where turkeys are being established, no harvest may be permitted for several years while that population builds. Once it has become established, hunting may be restricted to certain areas and to gobblers only until the population reaches desired levels. Bag limits are often relatively low to provide opportunity for many hunters without placing too much pressure on the resource.

Waterfowl are often managed with species specific limits. Relatively abundant species may have high limits while those that are relatively rare have much lower ones or seasons that are completely closed. Regulations limit the size and type of shot that may be used and the types of firearms that may be used in hunting. Other regulations forbid the use of techniques that offer excessive advantage to the hunter or drastically increase the vulnerability of waterfowl to gunning pressure. Hunter-requested taxes, stamps or licenses are the primary management funds for waterfowl within the states or nationally. Hunter activism is the primary source of waterfowl habitat conservation and development.

Some species are managed by prescriptive reduction in population size. Historical hunter success rates, defined boundaries and desired population reductions are used to focus hunting pressure and bags on specific areas. Special hunts may be used to reach similar goals, and management for other purposes may dictate the way those regulations or prescriptions are developed. By managing who can take which individuals by what means and at which times and places, the manager can achieve desired wildlife population objectives. In the vast majority of cases managers approach harvest prescriptions conservatively, increasing those takes until the desired impacts are achieved.

Hunting and Fitness

Confusion over the definition of "fitness" results in some false conclusions about the impacts of hunting on the genetic structure of populations. When used in the context of "survival of the fittest," fitness refers to the relative contribution of genetic material to the next generation. It is not necessarily a function of size, speed, beauty, antler mass or other factors that might convey the notion of superior physical fitness. It is based upon reproductive success and the frequency of genes.

Every individual has characteristics that were determined by the genes it carries. The realized character, or phenotype, of the individual influences its survival and reproductive performance relative to other individuals in the population. Selective factors tend to eliminate phenotypes that are passed on less frequently, favoring those that "win in the game of life." In the contest for survival and breeding success those individuals that are best equipped to survive and reproduce contribute more to the next generation than do those less well-equipped. As a result, those characteristics tend to become more common in the population, while those that are less successful tend to become relatively less abundant. Characteristics that were important to the development of the species often are protected and slow to change.

Each selective factor works independently, and those individuals which are selected "for" tend to have a suite of traits that address all the challenges they have faced. These factors normally are additive rather than competitive for space in the genetic code of the animal. Thus, the fact that American pheasants commonly run from an approaching dog or gunner does not mean that they have lost the ability to fly to escape predators. It does show how the bird has adapted to hunting pressure where the bird that is quick to take flight at the approach of dog or man is removed from the population and placed in the pot. The response to a skulking fox is still one of running then flying beyond harm.

Similarly, white-tailed deer have been selected for wariness in areas where they have been hunted hard for many generations. White-tailed deer in areas where only muzzle loading firearms and shotguns may be used to hunt them frequently use large open areas like crop fields or meadows as refuges. In contrast, those that are hunted with high powered rifles more often seek refuge in dense growth or in areas where scent, hearing and vision give them long distance warning of approaching hunters. When they do use open areas, they are normally concealed in a patch of cover.

Trophy hunting has often been condemned as taking the best animals from the population. The simple conclusion based on the truth that the animals being sought are the finest representatives of their species is that the fitness of the species must be negatively influenced. A reasonable look at the mechanics of trophy hunting reveals that this is not necessarily either simple or true. Trophy animals usually must have reached a more advanced age than the average. They are often larger, stronger or otherwise able to dominate lesser individuals in the population. Further, they must have possessed either the good fortune or the characteristics necessary to avoid human predation to that point in time. As a result, they should have contributed genetic material to several generations while becoming a trophy-sized animal. The genetic material they have

contributed to the population is well-established in both males and females of the species. Taking the trophy animal does remove a fine specimen from the population, but it does not remove the genes or the genetically determined factors that made it a trophy. Evidence in support of that argument comes from the record books themselves.

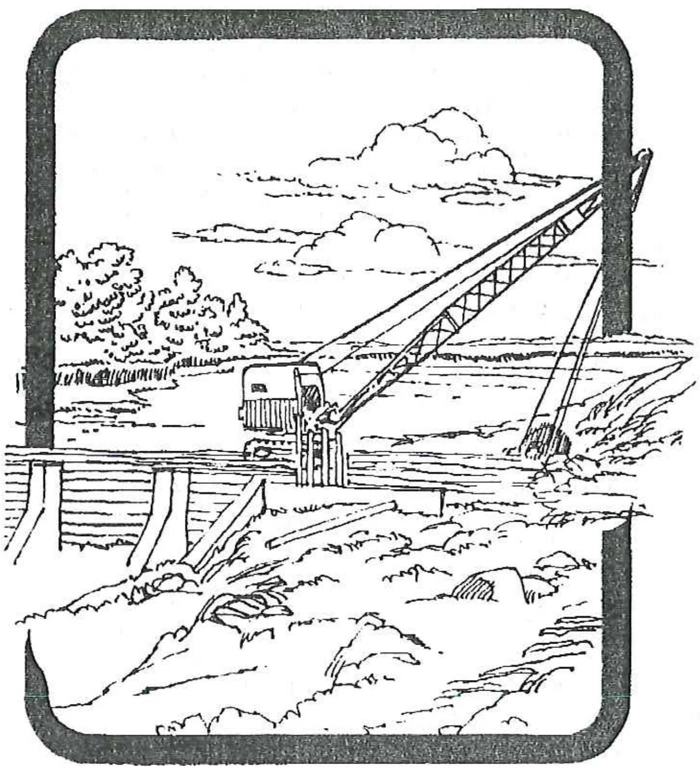
Requirements for entry have been revised upward several times for most managed species, and "book trophies" continue to come from even those areas of the continent that are heavily hunted. Those trophies are more difficult to take, but they exist - evidence of the survival of the persistent genes that produce the potential for their development. The trophy becomes a means of immortalizing an individual, at least for the duration of the hunter's life, the trophy animals' genes come as close as possible for a biological being to making it immortal in the population.

When you think of survival of the fittest, remember that fitness is in the genes. The fact that most hunters take a random sample from the population, often after the annual breeding season has been completed or nearly so, means that the influence of hunting on genetic characteristics of a population is minimal, except under very uncommon circumstances, and more likely to be positive than negative. Over time, the fittest and most alert animals will escape the human predator and the hunting process will become harder for selected animals. The "hunting-reduces-fitness" argument simply does not stand up to careful scrutiny.

Wildlife Management and Sport Hunting

Wildlife management is applied ecology coupled with understanding and managing interactions among people. The manager must be a capable scientist and technician, but they must be able to cope with political and sociological considerations as well. Managers generally agree that their task is to manage wildlife and their habitats to achieve societal objectives. That presents an extremely challenging task. Most wildlife managers have graduate degrees in one or more disciplines as well as experience in ecological or sociological research, interpretation of diverse fields of basic or applied research, and an ability to work within political boundaries. Most of them selected their careers because they had a deep regard for wildlife and a desire to do something positive about natural systems. Most of them work for modest salaries in state or federal positions. They carry the responsibility for wildlife and habitat for the entire human population of their state, province or country, taking a long-term view of wildlife values to all generations. While their title may be big-game biologist, waterfowl biologist, non-game program leader or endangered species specialist, most of them take a broad view of wildlife as a commons resource entrusted to them by the public.

Wildlife managers are constrained by the biology of the species (or suites of species) and the potential of the environment. Those characteristics limit the options available, and the manager must have information that determines those limits when he or she begins to develop a management plan for an area. Once they have determined the options available and the potential of any site, they must consider the economic and social constraints on those options. The farmlands of central Pennsylvania and New York, for example, may contain adequate prey species and large enough patches of dense cover to permit the re-introduction of gray wolves; but conflicts with an established coyote population, potential costs and attitudes of the people may make that option unacceptable. Residents of central Texas may have a strong desire to introduce moose, but the presence of a large deer herd with its potential for brainworm infestations as well as the climate makes the probability for success extremely small. On the other hand, the manager may be able to identify limiting factors and propose workable options to increase food, water, cover or suitable arrangement of needed components to enhance populations of desired species.



Very frequently, achieving management goals requires some help from interested and willing people. Both individuals and organized groups are important sources of management support and assistance. Local or state sportsmen's organizations and national organizations assist in wildlife management with funding and people. Many of these groups also participate in hearings or other meetings on wildlife management decisions. Everyone should be interested in the management of wildlife, but sportsmen have a particular responsibility to show that interest. Wildlife management decisions are often made politically after the biology and management options have been determined by professionals. Participation in that political process is vital to the success of management efforts.

Although state and federal agencies are charged with the responsibility for managing wildlife, a great deal of wildlife management takes place by individuals or corporations. Some of that management is by design. An individual or a local group might build and erect wood duck boxes along a local river or marsh. A corporation might include wildlife management plans in the development of an industrial or production site or mitigate the loss of a piece of habitat by developing a larger area on another suitable site. A farmer may elect to include wildlife habitat plantings in a Cropland Retirement Plan or even his annual rotation of crops. A school group could make living brush piles or other shelter patches on local land in cooperation with a landowner or a municipality. Volunteers, like hunter education instructors, may help the public learn about wildlife management and hunting by devoting hundreds of hours of instruction to young people and adults.

Unfortunately, too much of the wildlife management taking place on private or corporate lands is accidental and incidental to other actions. Decisions are made without wildlife being included in the decision-making process. Including wildlife in those plans may simply require education or making people aware of the impacts of their actions on wildlife. In other situations legislation or legal action may be required to protect public resources from damage. Management of some species, by their nature, requires international agreements and treaties, like the Migratory Bird Conservation Treaty among Canada, Mexico and the United States. Most wildlife issues are better settled by education and negotiation rather than by resorting to the courts to force compliance or consideration of wildlife, but litigation also has become a part of wildlife management.

Challenges and Techniques

Wildlife management is both observational and high-tech. Nothing can substitute for a personal knowledge of the animal and its biology. At the same time, biologists use computers, radio collars, aerial photography, satellite imagery, and even satellite tracking to follow tagged wildlife. Other biologists may spend thousands of hours in direct observation and laboratory analysis of samples to determine food habits, behavioral interactions, predator-prey relationships or other critical elements of wildlife biology.

Estimating numbers clearly is important. Techniques can vary from direct counts like helicopter deer or waterfowl surveys to mark-recapture techniques or the use of various indices. Road counts of calling males may be used as an index of the abundance of certain species. Cooing counts for doves, whistling counts for northern bobwhite, drumming counts for ruffed grouse or singing counts for woodcock are examples of the index approach. Using a mathematical model, the researcher can estimate the size of the population. Some indices yield population estimates that miss the true numbers by more than 200 percent, but give very stable estimators of the relative population size. Relative population sizes can be used to generate harvest regulations even though the real numbers may be several times the estimated number of individuals. One survey of white-winged dove hunters, for example, showed they had harvested twice as many birds as had been estimated to be in the population of that area by another technique.

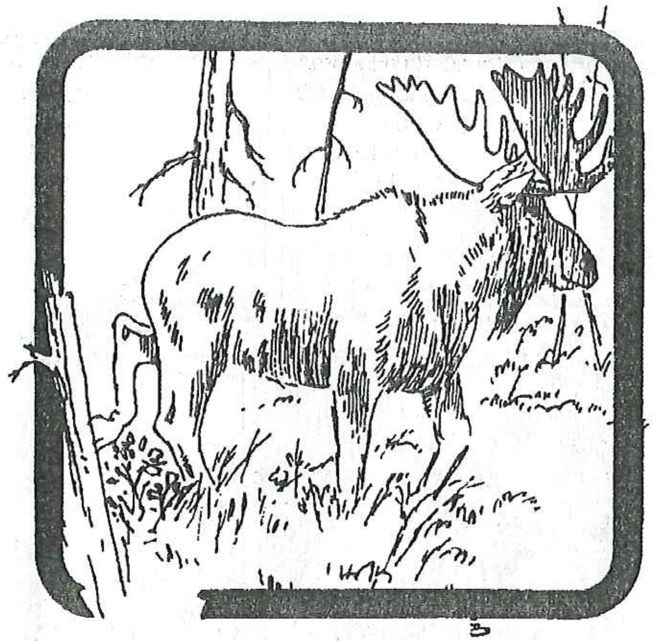
When the data were compared over several years, however, the index values predicted the harvest proportionately. Thus, the easily obtained counts were an excellent tool to judge the population size and the potential harvest level. They just needed to have a healthy correction figure added to the equation.

Banding efforts also provide evidence of population size and movements. Knowing the size of the banded population, the proportion of that population recovered and the total number of individuals taken, the biologist can calculate an estimate of the total population as a simple ratio. Banding efforts are sometimes carried out over extended periods to give estimators of births and immigrations, deaths and emigrations, longevity, and a variety of other factors. Of course, the mathematics gets a little more complicated in that type of study.

Direct counts or direct counts of samples of suitable habitat are often the most accurate types of population data obtainable. Sampling might include counting tracks, pellet piles, roadside clutches of birds or even aerial surveys of specific wintering sites for waterfowl. It could also include a strip census, like a bird survey or a spotlight survey of deer. Knowing the area of each habitat type on a site, the length of each habitat type surveyed and the average distance at which an individual could be detected in each habitat type permits the researcher to estimate a density of individuals in each habitat type. For large and obvious creatures, like deer, a helicopter count could be used to confirm the estimates if the habitat were open enough.

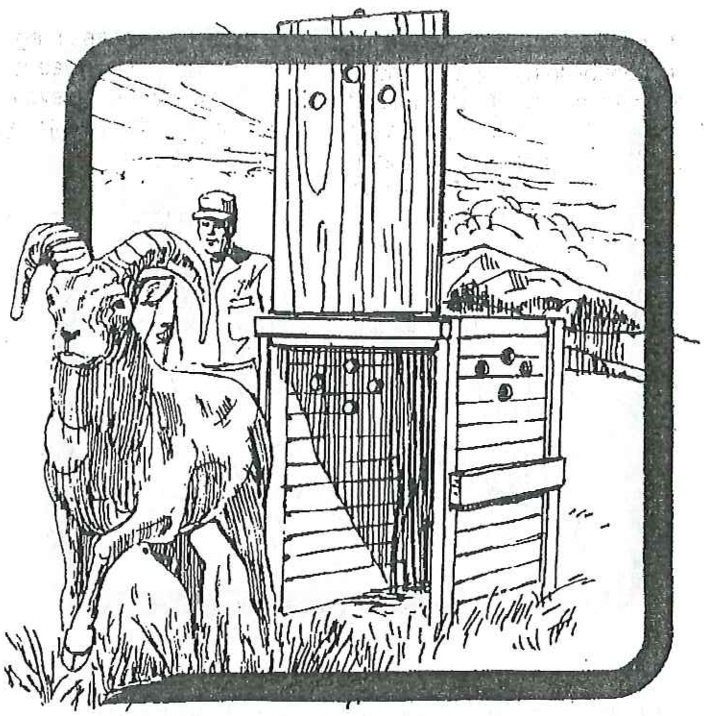
Relatively rare animals, particularly those that are active at night in dense cover, are more difficult to count by direct observations. They may require looking at tracks, trap ping, carcass analysis or bag data to determine trends in the population. Archives of data from many years of observations are often critically important to the analysis of new information. Both unpublished data and data published in various journals is useful to the manager in assessing the health of populations. New techniques may require creative thinking and long periods of testing to see if the results obtained are valid and stable.

Understanding the biology of the plants and animals in a system being managed also demands considerable study. Observations of feeding preferences, habitat preferences, daily and seasonal movements, and any indications of limiting factors take time and concentrated efforts. Once again, literature searches, direct observations and the use of sophisticated equipment are used to determine the needs, habits, preferences, potentials and interrelationships of the organisms being studied. Management plans are based upon the best available state of knowledge about the organisms and their community structure and dynamics.



Wildlife management once used a species approach, where each species of interest was managed as an entity. That quickly became a habitat approach, where the habitat of species of interest was managed to produce desired impacts on the species of interest. It is becoming a community or system approach, in which the interactions of the living components and the physical environment are treated as a complex system. Much basic work remains to be done, and integrated management remains a challenge. Neither species nor habitats are static. Some change very slowly. Others change very quickly. Change is constant and much of the management process is invested in maintaining habitat or community structures in a desired stage of development to produce the desired impacts on the wildlife resource.

Examples of the growing process in wildlife management are abundant. Predator reduction campaigns were common in the species management days. Predators of all kinds were considered competitors for game species, and programs to suppress them were frequently tried. Game animals were considered a crop, and predators were considered pests that reduced the harvest. The view of predators as furry, feathered or scaled villains gave way to a view of predators as important parts of community functioning. To some extent that resulted in a backlash that upheld them as heroes. Neither view is accurate. Predators have a place in the ecosystem and they add to the diversity and quality of wild systems. They should neither be persecuted nor treated as untouchable resources. Instead wildlife managers have learned that predators must be managed along with the rest of the wildlife in a community. They can be a problem under some circumstances, but usually the problems are individual animals that can be removed. A sheep killing coyote is a serious problem to a sheep rancher. A great horned owl that kills newly established peregrine falcons being used in a



restoration project is a serious problem to the endangered species specialist. Concentrations of predators can have a controlling influence on populations of other species of interest. In these situations, controlling the predator is warranted and desirable. In others, predators increase the diversity of local wildlife, provide a valuable economic resource and serve their ecological function without undue stress on the management of the remaining wildlife.

Nuisance wildlife are a bit like weeds, they are out of place and may cause trouble. They may cause economic damage by destroying livestock, flooding timber or highways, tunneling through dam faces, destroying crops or carrying disease. Some can pose a threat to people or pets.Others may disturb garbage or invade houses. Often these situations can be handled using non-lethal means like exclosures, shock aversion, bait crops or similar techniques to move the animal to a site where it is not a nuisance problem. At other times, the choice is to reduce the population below the sociological carrying capacity by hunting or trapping. Special deer seasons may be held in areas where wintering deer invade apple orchards, for example.

The change in the attitude toward pen-reared game animals is also evidence of the maturation of wildlife management. At one time release of pen-reared game was considered a means of increasing the breeding stock of game animals. Pheasants, turkeys and other species were raised on game farms for release to the wild. Now these animals are released primarily to enhance the availability of harvestable game. Game breeders and hunting preserves use large numbers of pheasants, chukar, quail, gray partridge and ducks on a release-for-the-gun basis. Some stock may escape to breed in the wild, but the intent is to release the birds for immediate harvest as a commercial activity.

Trapping and transferring wild birds or other game animals is a much more commonly used technique for establishing new populations now. These animals have proven survival skills. Given adequate habitat and time, they will establish populations in suitable habitat.

In a few instances exotic species have become naturalized to the wild. Pheasants, chukar, gray partridge (Hungarian partridge) and francolin have been established in one or more places across North America. Nutria were an accidental introduction that have flourished in the southern United States. Hogs have become naturalized in many parts of the country. European hares are present in a few localities. Some states, like Texas, have many naturalized species including nilgai, black buck, aoudad, axis deer, fallow deer, even kudu, giraffe and zebra. In spite of these successful introductions, most wildlife biologists agree that the emphasis of management should be on native species.

Sport Hunting

Sport hunting means different things to different people. Some feel that it means killing for the thrill of killing. Research on sport hunters shows that notion to be false. Others feel that it means the animals taken are not used. Research demonstrates that idea to be false as well. Hunters normally use what they take, and hunting law condemns wanton waste of game animals. The term comes from the end of the market hunting era. Sport hunting was used to differentiate hunting that was primarily recreational and for personal use from the commercial activity known as market hunting. It is analogous to sport fishing. Both are complex activities that range from subsistence harvest to the pursuit of trophy specimens. The motivation is primarily recreational, but it is extremely complex. The satisfactions are primarily personal. They are equally complex.

Sport hunting is a primary tool of wildlife managers in manipulating populations of game animals. It may be used to reduce nuisance problems with deer, bear, elk, geese or other species. It may be used to reduce populations to sociological carrying capacity or to limit populations of dominant species to levels that maintain a healthy and diverse community structure. It is often used to provide data on the populations being hunted - growth rates, age and sex structures, recruitment, population size, distribution and other data that can be obtained from harvest data or harvested animals. Most sport hunters are aware of the importance of hunting as a wildlife management tool. They may even over-extend the concept of population manipulation to include animals that are permissively managed.Management is not the primary reason for their participation in hunting.

Outdoor writer, Byron Dalrymple, once said that a responsible hunter could take an animal for three reasons: because it was a challenge, because the animal was causing damage, or because they planned to use it. That gets at part of the motivation. Hunters hunt to relive their social history.They hunt to renew and refresh ancient skills.

They hunt to be with friends or to be alone. They hunt to have a change of pace from the daily pressures of their lives. They hunt to simplify their lives. They hunt to challenge themselves.They hunt to feed their families directly and without the need for including the ritualized medium of exchange for time and effort. They hunt to enjoy nature and be outdoors. They hunt because they like hunting with all its complex skills and challenges and serendipity and success and failures - the act of hunting itself. Each hunter hunts for his or her own reasons, but most hunters share those reasons.They place them in different orders and express them in different ways, but hunters hunt because they love to participate in hunting. As Ortega said, they kill in order to have hunted; they do not hunt in order to kill. Killing animals is part of hunting. It is the part that most managers need to use in their management plans. To the hunter killing is an integral and necessary part of the process, but it is almost incidental to the process of hunting.

The management end of sport hunting rests with wildlife managers. They use the hunter, bag limits, seasons, permits, equipment regulations and other factors as tools to accomplish their objectives with populations of huntable species. Maintaining wildlife populations, habitats and communities for the benefit of the society is the task of the manager. They understand that wildlife cannot be stock piled, and that hunters are regulated by the law of diminishing returns. Like other prudent predators, they tend to shift to alternate prey when populations or wariness reduce the level of success. While managers may issue enough licenses to harvest more than the standing crop of a given species, they do so with a sound background in hunter success rates in order to achieve the level of control necessary. The successful use of sport hunting as a management tool is evident in the fact that no species subject to regulated harvest has become threatened or endangered since the advent of scientific wildlife management. Both the specifically directed management effort and the vested interests of a large, highly-motivated, and supportive body of hunters are responsible for that record. Wildlife management successes with turkey, deer, pronghorns, elk, wood ducks and other species also point to the success of scientific wildlife management with the support of hunters and the economic impact of hunters to fund that management. Licenses, special taxes and contributions, all of them the result of positive action by the hunting community, provide an insurance policy for all wildlife in the form of management staff and programs.

Notes