

**Florida Envirothon Study Packet
Wildlife Section**

CONTENTS

INTRODUCTION	1
WILDLIFE BIOLOGY	3
General Biology Rules and Principles.....	3
Ethology	5
Genetics	6
MANAGEMENT AND RESEARCH.....	11
Management Techniques	11
Research Techniques.....	17
NATURAL HISTORIES	21
Sign.....	21
American Alligator	23
Florida Black Bear	24
Bowfin.....	27
Brown Pelican	27
Cotton Mouse	29
Coyote.....	29
Eastern Diamondback Rattlesnake.....	31
Florida Scrub Jay	32
Gopher Tortoise.....	34
Greater Yellow-Legs.....	35
Gulf Sturgeon.....	36
Mosquito.....	37
Osprey.....	39
River Otter.....	39
White-Tailed Deer	41
Wild Hog	42
DISEASES.....	45
Canine Distemper	45
Lyme Disease	46
Rabies.....	46
HUMAN CAUSES AND EFFECTS.....	49

REGULATORY PROTECTION OF THE ENVIRONMENT..... 51

REFERENCES..... 55

GLOSSARY 59

INTRODUCTION

Each portion of the **wildlife** section is designed to build a more complete understanding of wildlife biology as a whole. The packet will be the most useful if students first focus on grasping the general principles of wildlife science, then apply these principles to specific problems related to individual **species** and situations.

The section on natural histories depicts the unique needs of individual species. Some wildlife species are generalists, while others are specialists. The specialist has a smaller range of acceptable living situations. A species may preferentially select a **habitat** to meet its needs. Natural histories provide a basis of understanding and the means for anticipating impacts, which can help biologists in making **management** decisions.

There are a wide range of wildlife diseases, some of which are species-specific. Others can affect multiple wildlife species and may also affect domestic livestock and/or humans. A basic understanding of diseases, including how they are carried and transmitted, is important for making management decisions.

The greatest threat to wildlife **populations** in Florida is loss or fragmentation of habitat. Fragmentation results in both direct and indirect negative impacts. Both types of impacts should be considered when assessing the cost to wildlife. For example, roads can cause negative impacts — construction fragments the habitat and vehicles kill wildlife individuals.

The section addressing the potential impacts that human recreational activities may have on wildlife is intended to complete the learning process by moving from understanding to action. All impacts have effects — some positive and some negative. Negative effects can be minimized or avoided by combining knowledge of species, management techniques, and biological principles. The challenges wildlife biologists face continue to evolve, as do the solutions. You can become part of the solution!

WILDLIFE BIOLOGY

GENERAL BIOLOGY RULES AND PRINCIPLES

Bergmann's Rule — **Homeotherms** living in cold climates are often larger than those from warmer regions (reduced surface:air ratio for warmth). The assumed advantage is that the surface:air ratio is reduced, allowing for better heat retention.

Gloger's Rule — Animals from dry, hot areas tend to be paler in color than those from colder, wetter areas.

Allen's Rule — Appendages and/or extremities of homeotherms are either longer or have a larger area in warmer climates. The assumed advantage is that larger appendages have a greater relative surface area which enhances heat dissipation.

Natural selection — Natural selection is a subtle process, where one organism leaves more offspring than another. In time, its genes will come to dominate the gene pool. Natural selection operates only by differential reproductive success.

Law of the Minimum — Ecological events and their outcomes are often regulated by the availability of one or a few factors or requisites in short supply while other resources present in excess may go unused. The factors in short supply are called **limiting factors**.

Law of Tolerance — Too much or too little of anything can be detrimental to an organism.

Competitive Exclusion Principle — The more the **niches** of two species overlap, the more intense the competition will be between them and the less likely that they will coexist in any area.

Logistics curve — This curve demonstrates how the population growth of a wildlife species can be dependent upon its population density. As a population nears its **carrying capacity**, the growth rate slows. The decreased growth rate can be attributed to several factors, among which are increased mortality, emigration, and reduced reproductive rates.

Habitat preferences — Many wildlife species are capable of living in a variety of habitats, although there is usually a small number of optimal habitats for a species. An optimal habitat has everything required for living at a limited expense to the animal.

These optimal habitats are those of preference. Due to territorial ranges, dominance, density constraints, etc., some individuals can be forced to live in marginal habitats. The animals in the marginal areas tend to be less-dominant animals, often dispersing young.

If a species is absent from what appears to be good habitat, it is important to determine why the species is absent. Has the habitat become isolated from other habitats? Have the animals been extirpated? Is there an environmental hazard which renders the area uninhabitable? These questions need to be addressed before successful mitigation/restoration can occur.

Dispersal — Dispersal is a common phenomenon in wildlife populations. The young tend to move away from the population centers. In some species, this is done in an early phase, for example, shellfish larvae. Other species disperse only after they are forced out of their natal ranges by parents or other dominant animals.

Migration — Migration occurs in some mammal, fish, insect, and bird species. Generally, migration takes an animal from a place where it carries out one stage of its **life cycle** to a place where it carries out one or more other stages of its life cycle. Migration routes stay basically the same from year to year. A migration route is a general pathway followed by individuals of a particular species.

The migrations of birds are perhaps the most astounding journeys. Approximately 350 North American bird species annually migrate to the tropical regions of Mexico, Latin America, and the Caribbean. Some examples of migratory feats: ruby-throated hummingbirds — which weigh less than an eighth of an ounce — fly 500 miles across the Gulf of Mexico in about one day; bobolinks fly 6,000 miles from the Canadian prairies to Argentina; and the blackpoll warbler flies nonstop over water for 2,300 miles, with a total annual mileage of 10,000 miles during migration.

Photoperiod, or the length of the day, seems to trigger migration. There are several theories on how animals navigate during migration. Daytime migrants are thought to use the sun, nighttime migrants to use the stars. Landforms (e.g., coastlines and mountains) are thought to help orient their direction and course. It is also possible that at least some birds use the earth's magnetic field in combination with gravity to navigate.

There are many threats to migratory species including oil spills, weather, power lines, and habitat loss (both winter and summer habitat as well as habitat along the migration route). Additionally, large aggregates of animals provide the potential for over-harvesting a population. Limited populations which all migrate along the same route

and live in the same area are much more prone to catastrophic disasters which could lead to extinction. The whooping crane is an excellent example of this problem. Wildlife biologists are concerned about the overall populations of migrating birds. Most studies show a decline in population numbers. Many of these declines are attributed to loss and fragmentation of habitat.

ETHOLOGY

All animals have species-specific behavior. By observing a species, an **ethogram** can be created of that species' behaviors. There can be similarities between closely related species.

It is important to get the sequence of behaviors accurate. Fixed action patterns (a behavior performed in the same way each time) can usually be distinguished quickly. Fixed action patterns may vary somewhat with the sex or the age of individuals.

There are two main groups of behaviors: maintenance behaviors and social behaviors. There are also several individual behavior groups.

Maintenance behaviors can be divided into nine groups:

- General postures and movements (particularly locomotion)
- Resting behavior
- Comfort behavior (cleaning and grooming)
- Feeding and drinking behavior
- Urination and defecation
- Marking behavior (particularly gland marking)
- Behavior of building
- Rhythms of activity (**circadian rhythms**)
- Orientation and migration

Social behavior groups fall into six categories:

- Intraspecific aggression
- Sexual behavior
- Parent-offspring relationships
- Social groupings and organization
- Territorial and home range behavior
- Play behavior

Additional individual behavior groups include the following:

- Interspecific interactions (including domestication)
- **Predator-prey** relationships
- Communications and expressive behavior
- Vocalizations

One way to assess recreational impacts is to study or watch the divergence from normal behavior patterns (or lack thereof) in the presence of a particular recreational activity. The first indications of **disturbance** are called displacement behavior. For example, a deer is feeding. A hiker slowly approaches. When the hiker begins to get too close, the deer may start grooming instead of eating. The grooming behavior is not normal in the context of the previous behavior and the approaching hiker. This is displacement behavior. The hiker continues to approach. The deer can no longer tolerate the approach. It is left with two options: fight or flight. This scenario could be recreated for other species, perhaps with different displacement behaviors and different distances when the behavior changes. There can even be seasonal variations in distances due to **forage** availability, protection of young, recreational intensity, etc.

GENETICS

Genetics is the study of heredity — the transmission of characteristics from one generation to the next — as well as the changes that frequently occur in heritable characteristics — variation. The modern science of genetics began with the discovery that many characteristics observed in living organisms could be transmitted from one generation to the next, that is, many characteristics are heritable. Any recognizable characteristic or property of an organism is called a trait. For a trait to be heritable, organisms must have some innate mechanism that directs the development of that characteristic.

The term genetics is based on gene, which is the basic unit of heritable information. Each gene directs the development of one or more traits. Today it is recognized that each gene represents one discrete section of one chromosome; that is, one section of a strand of DNA. Much variation is based on the fact that there can be more than one form or version of a gene. Each different version of a gene is called an allele. Each allele of a gene directs the development of the trait to occur in a different way. For example, color often is a heritable trait that results from the action of a single gene. One allele of a gene may direct the development of pink color while another allele of that gene causes development of white color.

Population genetics is the study of how genetic principles apply to entire populations. The study of population genetics must take into account such ecological and evolutionary factors as population size, how individuals select mates, how individuals are distributed across the geographic range of the population, patterns of migration, and natural selection. To understand the genetic processes that may act within a population, it is necessary to understand the different genes as well as the types of alleles for any given gene that may be present and how frequently they occur. As changes occur from one generation to the next in the kinds and frequencies of genes that occur in a population, evolution results.

A series of genetic processes can occur within a population, that is, at the population level. Processes that can cause changes in the relative frequencies of genes or alleles present in a population include mutation, natural selection, and migration. Other processes that can occur include the following:

- Random genetic drift — Changes in allele frequencies within a population that occur at random and not as a result of mutation, selection, or the migration of individuals. The process typically occurs within small, isolated populations. The gene pool in unusually small populations may not be representative of the overall species' gene pool. Breeding individuals in the population may have lower genetic variance or different allele frequencies than expected. Such differences would then be passed on to the next generation and could lead to a significant deviation in allele frequencies from other populations of that species. Often measured as a rate of change in heterozygosity.
- Gene pool — The total genetic information present in all members of a population or a species.
- Gene flow — The exchange of genetic information (i.e., genes or alleles) among populations as a result of migration of individuals. Gene flow often helps to maintain similar levels of genetic variance among populations of a species.
- Inbreeding — Sexual reproduction between individuals who are more closely related than would be expected given the effective population size, which would determine an average probability of selecting two individuals at random. This process can lead to a decrease in heterozygosity in a population and thus a decrease in the genetic variance.
- Genetic variance — Variance in allele frequency among samples taken from a population or among subpopulations.
- Heterozygosity — For a population, a measure of the average probability that an individual will have two different alleles for any gene, or the average probability of heterozygous alleles for any gene, per individual, within a population.

- Population bottleneck — A severe reduction in the size of, or number of individuals in, a population. Such reductions often are temporary, with numbers of individuals in a population subsequently increasing.
- Founder effect — When a new population is founded by a few individuals who possess only part of the full genetic variation of that species. The new population often has a much more limited amount of genetic variation than other populations of the species and the new population may have much different allele frequencies. Sometimes considered an extreme form of genetic drift.
- Effective population size — Essentially, the number of individuals in a population with the possibility of contributing genes to the next generation. In more generalized terms, it can be thought of as the number of mature, reproducing individuals in a population.

One aspect of population genetics is predicting how observed population characteristics are regulated by genetic processes. Such predictions can result from understanding the answers to questions such as What genetic processes are important in affecting changes in gene frequencies within a population? In what ways do those processes affect gene frequencies? If changes in gene frequencies occur, how can they affect wildlife populations? What gene frequencies have occurred historically in a population? What conservation strategies may be necessary for maintaining important genetic processes?

Observing the genetic makeup of populations can provide insight to the underlying genetic processes. Understanding the genetic processes acting within populations can provide more clear direction for management actions necessary for target populations to maintain or restore expected genetic characteristics. Changes in the genetic characteristics of populations can affect population viability. Population viability means, in effect, the probability that a population will not only remain extant (in existence), but will also remain capable of successfully reproducing and maintaining its characteristic genetic diversity for a long-term period of time. This 'long-term period' has been defined in different ways in different situations but generally covers a time period of 100 generations to 1,000 years. By definition then, if a viable population is not expected to go extinct, it will remain capable of successfully reproducing from one generation to the next and it will not lose its inherent genetic variability.

Among other factors, population viability is dependent upon the genetic fitness of the individuals that compose the population. Genetic fitness is the relative competitive ability of a given genotype (the genetic makeup of an individual) as determined by the individual's innate body form (morphological characters), bodily processes (physiological characters), and behaviors (behavioral characters). That is, the process of natural selection can only act on an individual's phenotypic characters, but if those

characters are inheritable, then they must be determined by the action of genes or genetic processes. Competition for food, nest sites, or other critical resources can determine which individuals will leave the most offspring in the next generation. It is expected that good competitors have characters that make them better adapted to the **environment** in which they exist (environment in the broad sense of competitors and predators, as well as the physical environment). In a stable environment, individuals can become adapted to relatively constant, often predictable conditions. However, the natural world frequently is not predictable.

The occurrence of random events in an environment often favors populations with inherent genetic variance that can enable populations to evolve to accommodate such changes. The level of genetic variance in a population can represent a trade-off between the acquisition of characters that provide a competitive advantage under existing conditions and the maintenance of characters that may provide an advantage under randomly occurring, unpredictable conditions. Genetic variance often does not remain constant over the entire distribution of a species. Localized differences in the conditions experienced by different populations can cause differences in allele frequencies and genetic variance among populations. Differences in allele frequencies among populations often result when gene flow is low and can provide some populations' greater fitness under localized environmental conditions.

It is important for natural resource managers to understand the genetic processes potentially existing within a given population. Managers who do not recognize the existence of local variation in allele frequencies or other genetic processes could implement management activities that actually cause reductions in the genetic fitness of populations and ultimately reduce the viability of those populations. The planning of effective management strategies requires consideration of population genetics and an understanding of the genetic processes known or expected to occur both at the species and the population level.

MANAGEMENT AND RESEARCH

MANAGEMENT TECHNIQUES

Food Plots

Food plots are plantings meant to supplement an animal's natural food sources or attract animals for viewing. The validity of using plots for management is, at best, questionable. Food plots are certainly no substitute for management programs based on a thorough knowledge of wildlife ecology and the culture of native vegetation. However, if they are used, some researchers indicate a minimum of 10% coverage of wooded lands in food plots to make a difference in populations. This is expensive in materials, equipment, and manpower. Once established, they need to be maintained.

If plots are used for attracting wildlife for viewing, attention needs to be directed to the design. Locations of animal travel ways, power lines, etc., need to be considered to ensure that the animals will not experience indirect negative impacts from use of the food plots.

Food plots are also used in association with recreational hunting. They can successfully assist in luring prey into areas which can increase hunter success rates. States frequently regulate this type of activity. **Note:** Taking wildlife on or over baited fields (fields where food items have been placed for wildlife) is illegal.

Mitigation

Mitigation is a concept used when negative impacts to the environment caused by development in a sensitive area cannot be avoided or minimized. Mitigation strives to offset the destructive nature of development on wildlife habitats by improving a degraded habitat or creating a new one to replace the habitat destroyed. Common areas that require mitigation from impacts are **wetlands** or habitat supporting listed species.

The success of a mitigation project is measured by comparing it to the initial function of the habitat (**community**) destroyed. Compensation is considered complete when the functions meet or exceed the initial habitat assessment.

Mitigation Banking

Mitigation banking means that landowners needing to **mitigate** for authorized impacts associated with development activities have the option of purchasing credits from an approved mitigation bank rather than restoring or creating habitat on or near the development site. Mitigation banking has the benefits of providing potentially more cost-effective mitigation; being likely to preserve viable communities or **ecosystems**; limiting temporal losses associated with on-site mitigation initiated after or during development; and consolidating small, fragmented mitigation projects into a single large parcel with greater ecological benefits.

Minimization of Impacts

Careful planning and evaluating the design of facilities and activities can minimize development and recreational impacts on wildlife. Often a critical look at project design can reveal areas that can be used to reduce impacts to wildlife, for example, for relocating trails, planting vegetative buffers, and providing nesting structures. Landscaping with native plant species around buildings and other developed sites may create habitat islands that would facilitate the movement of individuals of some species between undeveloped areas.

Openings

Areas typically at earlier successional stages than the surrounding habitats. For example, areas where trees are expected to dominate the natural vegetative cover, but shrubs or herbaceous plants are the dominant species. Openings may occur naturally (e.g., when trees fall or are killed by disease or insects) or they may occur as unmaintained agricultural plots not yet reverted to closed stands of trees (old field). In an ecological sense, these openings are not permanent. Openings may be maintained by management activities in an early **seral** stage for a longer period of time than would be the case with normal **succession**. Openings created by silvicultural practices are more transient and are not considered in this classification.

Openings are important for wildlife species as they allow for forage production closer to the ground where there is more access for eating, and provide cover for nesting and refuge from predators. Opening sizes vary; however, the recommended size is between one and five acres. The U.S. Forest Service recommends 20 acres of opening for each 640 wooded acres where no major silvicultural cuts are occurring. Four common methods of maintaining these openings are burning, hand clearing, mowing, and bush hogging. Cattle grazing and herbicides may also be used to control vegetative growth in special

cases but introduce additional management problems which must be taken into account during planning (e.g., potential loss of listed plant species).

The overall management cost of maintaining openings is low to moderate with a high return on increased wildlife accessibility, forage quality and quantity, and wildlife cover.

Corridors

Wildlife corridors can connect isolated patches of habitat. Corridors linking fragmented patches of habitat will be important for the perpetuation of large-ranging wildlife species. These linkages are important to allow animals access to additional habitats they may require for survival. Corridors may link otherwise isolated wildlife populations and thereby prevent genetic isolation of those groups of individuals.

One example of a corridor is the habitat along a river and the land immediately adjacent to the river. This may be land specifically set aside for wildlife or passive recreation. One aspect of corridors being researched in Florida is the use of highway underpasses specifically designed for panthers and bears to move more effectively among habitat patches.

Potential risks associated with corridors include the increased probability of transmitting diseases among populations and easier access for predators. Introduction of foreign **pathogens** to a species could alter long-term survival rates. Easier access for predators could also affect species survival. Therefore, both the benefits and the risks that can result from corridors should be carefully examined during planning.

Restoration

This is a process whereby actions are taken to counter conditions in an altered community or ecosystem and return that area to a state as close as possible to its natural form. This may require extensive alterations including rebuilding the soil profile, land contouring, plantings, removal of domestic or **feral** species, and temporary exclusion of wildlife species, if feasible. Essential development components include mimicking historic soil, drainage, and foliage characteristics. Hopefully, natural processes in the ecosystem will act as a type of self-restoration process once the initial work is done (succession). It is common to require a maintenance program to eradicate **exotic** or weedy species until the desired plant community takes hold. As the habitat is restored, many wildlife species will migrate into the area without expensive relocation programs.

Restoration projects will vary in terms of the number and extent of activities that must be undertaken. Some restoration projects are low-key and may utilize management techniques like control burning and timber harvesting to reduce stand basal area that would open the canopy and allow for understory restoration. As a result, the costs of restoration projects are vastly different. Restoration projects requiring soil alteration and contouring, projects where “immediate” results are required, and projects on steep slopes are all costly endeavors. Projects that deal with stimulating an existing seed source are less time-consuming and expensive, but still require maintenance practices to ensure site conversion.

One key to successful restoration is knowledge of the biology of organisms in the system and interactions among those organisms. Given the complexity of most systems, there are few (if any) systems that are fully understood. Consequently, it is difficult to restore a system to its original form or to guarantee the success of any project.

Exotic Species Control

Exotic refers to a species that is not **indigenous** to an area and whose introduction is usually caused by human activity, such as accidental release, intentional dumping, or being moved with agricultural products. Exotic species can be either plant or animal. The control of exotic species is very important to native wildlife prosperity. Exotic plants may out-compete native species while providing limited or no value to native wildlife species. Establishment of exotic plants can significantly alter the resources available in natural systems. Exotic animals introduce diseases to which native species have no immunity and compete with native wildlife for available, and often limited, resources. Exotic species may have no natural predators in the systems they invade, which can result in exponential growth patterns. Exponential growth rates are unsustainable and can initiate or accelerate declines in numbers of native species competing with or being preyed upon by the exotics.

Exotic species released into the wild need to be controlled or removed as quickly as possible to minimize damage. Control methods for animals include trapping, shooting, and sterilization (often effective with insect populations). Control methods for plants include herbicides, manual removal, and/or control burning. Treatment may require a combination of management techniques over time to achieve control or eradication. No method is cheap; however, left uncontrolled, the ecological and economic problem will only increase.

Control Burning

Control burning (management-ignited fire) is an important management tool for wildlife managers because it helps maintain or improve the quality of habitat for wildlife species. Most of Florida's natural communities are fire-dependent. This means that the communities of plants and animals have adapted to and require fire.

Control burning benefits wildlife by setting back succession and stimulating new plant growth. Generally, the yield and quality of herbage, legumes, and browse are increased. Openings may be created that are necessary for feeding, movements (migration), and maintenance and social behaviors.

The timing of a control burn and the methods used to conduct the burn are dependent upon the present conditions of the habitat and the desired outcome. An area which has not undergone any burn for a long period of time should be burned to reduce fuel loads, then burned again later to begin to restore community integrity.

Population Estimates

Population estimation methods are important tools for understanding population growth and tracking population trends. There are a variety of techniques to estimate populations, most of which are species-specific. Each method is based on a set of assumptions. For an estimate to be valid, all assumptions of the method used to generate that estimate must be met.

Call Counts. Used to estimate dove and quail populations, call count estimates are based on a knowledge of home range size and the assumption that only male birds are calling. This method requires a set route to be monitored with listening points established for a set period of time. Some species of non-game birds can also be studied using their response to a taped call.

Track Counts. Track counts can be useful in following trends in deer and to a lesser degree, turkey. An established trail is cleared of all tracks, then left alone for a set period of time. The tracker then follows the trail, recording the number of times a particular animal species crosses the trail. A population estimate can then be calculated with factors such as known area covered, total area, and number viewed.

Aerial Surveys. A method used to count the number of eggs or chicks in eagle nests, this type of survey is also used during the winter for counting manatees. In areas where

the overstory is not dense, deer, antelope, and other **herbivores** can be counted. Aerial surveillance of transect lines is also used in estimating waterfowl numbers.

Spotlight Counts. This is a technique using the eye shine of animals spotted with a light at night to estimate population trends with known coverage and total acreage. Spotlight counts are used primarily with deer and alligators.

Area estimates. Transects can be used to assess population trends and estimates, recording either the animal or the sign. This may include flushing number and distance from birds, and gopher tortoise burrow counts. Quadrats are generally used to count a specific type of sign, like pellet groups for deer or rabbits.

Mark-Recapture Studies. See Research Techniques.

Bait Site Surveys and/or Scent Stations. These methods require baiting the desired species to a location and counting the number of individuals visiting the site. The counting can be done manually or with the use of cameras. This technique has been used with a variety of species including deer, bear, mink, bobcat, and turkey.

Sex and Age

This information can be gathered during either management or research activities and is very important to the management of wildlife populations. Certain cases can make it even more valuable, for example, if a population is isolated or a species is listed. The ability to perpetuate a wildlife species requires both sexes at a viable reproductive age, in numbers great enough to ensure genetic viability (effective population size).

There are a variety of ways to age wildlife species. Many require that the animals be captured; most work for only specific species.

Most birds can be aged until they obtain adult plumage through molt changes. Some species, like deer, can be aged by tooth replacement and wear. Gray squirrels can be aged by color variations in the tail. Bear can be aged by counting the annual growth rings in their eye teeth.

Fish can be aged by counting annual growth rings present in the **otolith**. The rings are caused by a protein buildup as growth slows for a year. When the bone is thin, the whole bone may be observed under a dissecting microscope; however, if the fish is older and the total fish growth has slowed, or if the otolith is thick, a thin slice from the nucleus of the bone can be mounted on a slide and the rings counted using an oil immersion lens. Fish in more northern climates are sometimes aged by counting the

annual rings on their scales. This method is not as accurate, although it can be done without sacrificing the fish.

RESEARCH TECHNIQUES

Capture and Marking

Capture is the act of getting an animal in one's possession for research or management purposes, while marking is the act of giving that animal a unique, identifiable feature. These techniques are important, as many research and management projects concerned with animal transplants and population studies are dependent upon following the fates of individuals to determine any factors affecting those fates. The successful trapping (capture) operations depend on a suitable bait or lure to attract animals into traps. These attractants can be baits (food), scents, decoys, or enticement lures (tapes with calls). Once the animals have been attracted, they can be captured with non-lethal methods including, but not limited to, steel and snap traps, box traps, nest traps, drive or drift traps, corral traps, net traps, mist nets, wire or rope snares, and the use of drugs.

With the study animal in hand, it can then be marked. Marking techniques need to be safe and reliable (i.e., certain to be retained for the duration of the study) and should not affect probability of mortality. There are three main categories of marks — permanent, semipermanent, and temporary. Some methods of permanent markings include branding, tattooing, toe-clipping, tail-docking, and ear-cropping. Semipermanent marks include tags, bands, collars (these may just be used for identification or may include a radio for movement monitoring), and fluorescing chemicals administered to mark bones and teeth. Temporary markers include dyes, paints, colored streamers, and colored adhesive tape. With some temporary markers, the animal doesn't actually need to be captured, just attracted close enough to be marked or to mark themselves (by rubbing against something with paint or dye).

Costs associated with marking and monitoring the marked animals must be considered during design of the study. Costs must be evaluated in terms of both monetary and time requirements. A comparison of some potential costs follows.

Cost	Permanent Mark	Semipermanent Mark	Temporary Mark
Initial equipment	Moderate	Moderate to high	Low
Monitoring	High	Low (high with radio)	Moderate
Capturing	High	High	High; moderate if self-marking
Manpower	Moderate	Moderate (high with radio)	Moderate
Wildlife stress	High	High	High; low if self-marking

Sampling Methods

Research projects are designed around a hypothesis and the testing of the validity of that hypothesis through investigative questioning. Sampling methods provide a means to quantify and/or qualify existing plant and/or animal populations. Sampling methods are directly correlated to the questions asked in the research. A variety of sampling methods are available, and the ones selected are dependent upon research or management goals and objectives, time, and money.

Population Sampling. In wildlife management, it is often necessary to know how many individuals are present in a population (and numbers by age and sex). A census is the most accurate method of determining a population since it requires counting each individual. Often it is the most impractical method. Methods to establish population estimates are more practical, yet less accurate and often lacking in precision. An estimate can be made directly from the population or by measuring an attribute which is related to the population. Some actual techniques include transect sampling, quadrant sampling, indices (drumming or call count indices), signs (tracks, pellet counts, etc.), captures, and recaptures. Often, several estimates are used together to help eliminate individual technique bias. Associated costs are shown in the following table.

Cost	Estimate	Census	Capture	Recapture
Manpower	Moderate	High	High	High
Equipment	Low (if no aircraft are used)	High	Moderate to high	High
Statistical validity	Variable	High	Low to moderate	Moderate to high
Wildlife stress	Low	Low to moderate	High	High

Vegetative Sampling. There are numerous variations of vegetative sampling, which is used to evaluate the variation in the quality of available habitat. Some methods concentrate on a particular class of vegetation (e.g., harvestable timber); however, the

actual number of methods is not great. The basic vegetative sampling techniques include line transects, plots, and plotless techniques. With both plots and plotless techniques, different records can be sampled (e.g., number of individuals, dry weight of shoots, canopy coverage, etc.). Additional techniques may be applied at plots, for example, the use of a density board or clipping. (Density boards assist in quantifying vegetation thickness and height-cover, while clipping is used to quantify biomass.) Techniques may also be combined to increase accuracy. Methods used are dictated by the goals and objectives of the study as well as by cost and manpower. Associated costs are shown in the following table.

Cost	Transects	Plots	Plotless
Manpower	Moderate	High	Moderate
Equipment	Low to moderate	Moderate	Moderate
Reproducibility	Moderate	High	Low
Statistical validity	Moderate	High	Low

Ethological studies. Time budgeting is one of the more popular methods for studying wildlife behavior. Information is collected in time intervals, showing the amount of time an animal spends in a particular activity and the sequence in which behaviors are performed. Additional information collected is dependent on the study goals and can include items like time of day, season, and age. Ethological studies are usually expensive in terms of manpower and time.

There are several other important fields of wildlife research. Pathology (the study of diseases) provides valuable links to and an understanding of population health, **population dynamics**, and human health risks. The fields of genetics and cytology are providing insights into evolutionary links and new avenues for species recovery and maintenance.

NATURAL HISTORIES

Summaries of the biology or life history of some of Florida's wildlife species are given in this section. Natural histories provide basic information pertinent to an animal's life and its living requirements. Some species are restricted to particular communities or ecosystems within Florida, while other species may be found in a variety of habitats throughout the United States.

Knowledge of life histories allows for the planning of recreational activities in a manner which will be the least disruptive to wildlife species. Sometimes management decisions are determined by requirements of laws or rules. For example, **threatened** and **endangered** species and their associated habitats are protected by law from destruction, molestation, and disturbances.

Understanding the habitat or resource requirements and behaviors of wildlife provide for more compatible uses with the resources. Knowledge and understanding must come from education. The education phase may be difficult at times, but it is critical to limiting human impacts.

SIGN

An important aspect of understanding wildlife and their use of habitats is identification of the animal and the signs they leave. Most wild animals tend to avoid humans. This makes them appear shy or sly and elusive. This appearance is augmented by the fact that many animals are **crepuscular** or **nocturnal**. Fortunately, wildlife leave a variety of signs indicating their use of an area. These signs can be used to determine wildlife presence in an area.

The most common sign left is **tracks**. Clear tracks can be found after a rain or in moist soil along wetlands. Most mammals and some reptiles can be accurately identified from clear tracks. Tracks left in dry sand can be deceptive, as the loose sand tends to spread out more than the foot and often does not give a clear view of pad shapes, hooves, or claws. The presence or absence of claws is extremely important in separating canines (with nails) from felines (with retractable claws). Presence of other groups of wildlife can be recognized from tracks, but their individual identification is usually impossible. Most snakes cannot be identified to the species from their track, although information can be obtained on their size and direction of movement.

Scat is another common sign. It varies in size, shape, content and manner of deposition. Cats use excrement to mark territories and usually attempt to cover it by scraping dirt over it. Some species of wildlife develop dung piles or latrines. These are also used as territorial markers.

Scat can be used to study the feeding habits of wildlife. This information can be used to better manage wildlife habitat and understand interspecies relationships.

Owls can pass only liquids completely through their bodies. Any undigested parts of their prey (e.g., bone, hair, feathers, exoskeleton) are regurgitated in a dry pellet form. These pellets can be used to evaluate prey species changes over time by examining the skulls, bones, hair, etc., in each pellet. The prey species can be identified by features unique to each species.

Wildlife trails provide information on travel routes. Many species will repeatedly follow a trail, especially through dense vegetation. The series of soil mounds left by pocket gophers as they tunnel beneath the soil surface also forms a trail. Mounds alone do not signal the presence of pocket gophers though, since moles and some insects also create mounds; however, the mounds are distinctive and species presence can be identified by the type of mound.

Burrows are excellent indicators of wildlife use. The shape, size, and location of a burrow give clues to determine which species uses a particular hole. Some of the most common burrow makers/dwellers are gopher tortoises, foxes, and armadillos.

Nests, like burrows, indicate when an area is used by individuals of a species. Many nests are unique (especially in combination with the eggs), making identification possible. Birds are the most common nest builders; however, muskrats and golden mice also build nests. Beavers construct a modified nest complete with dam and water control structures.

Signs of feeding also can be found and used as indicators. These signs included snapped twigs (the angle of cut is indicative), rooting, peeled pine cones or other fruits, holes in trees, and stripped plants. Deer cut twigs at a 90 degree angle, while rabbits nip twigs at a 45 degree angle. Squirrels and birds use pine cones, although only the squirrel strips them. Woodpeckers are the most common species making holes in trees.

Several other types of signs are used as marks or to mark territories. These include deer scrapes, bear-chewed trees, beaver-stripped trees, and tree spot or bark loss on trees from deer rubbing the velvet off their antlers.

AMERICAN ALLIGATOR (*Alligator mississippiensis*)

The alligator is a true relic of the Cretaceous era, having changed little since the age of the dinosaurs. The alligator is a large, rough-backed reptile with a broad, rounded snout and dark brown or black coloration. Young alligators (usually less than three feet in length) are striped with yellow and white bands between the brown. Adult alligators will grow to 10 feet in length; males may reach lengths between 12 and 16 feet. The tail is highly compressed and crested with pointed scales. The tail is used for power swimming and as a defense mechanism.

Alligators are found in the southeastern United States, from North Carolina to Texas and extending north in the Mississippi basin to southeastern Oklahoma. They are adaptable to broad ranges of conditions. They primarily occupy freshwater wetlands, but some occasionally use brackish or saltwater areas.

Alligators may become inactive during winter in the northern part of the range, although they may still be seen basking in the sun on warm days. Their activity period increases as spring approaches. Courtship begins in mid-March. The males emit a loud, deep roar which probably serves to mark their **territory** and announce their presence to receptive females. Females answer with a bellow slightly lower in pitch and intensity. (The bellows are also used after the breeding season, probably as territorial signals.)

The actual mechanism used for pair location is thought to be a combination of bellowing and scent. Alligators have a well-developed sense of smell, with two sets of scent glands — one near the vent and one near the base of the lower jaw. Approximately two months after mating, the female builds her nest. She does this by scraping together a mound of earth and plant debris. The nest averages 1.8 meters wide and 0.7 meter high and is near to the water. The female then uses a hind foot to dig a cavity in the top of the nest and deposits between 20 and 50 eggs in the cavity. Humidity in the nest is always high, and the fermenting plant material helps keep the temperature at the proper level for incubation. The females often remain near the nest and protect it during incubation.

After about nine weeks, the young become vocal while still in their shells. This seems to stimulate the female to open the nest. This act allows hatched young to leave the nest. They are about nine inches long at hatching, and head straight for the water. The female may remain with the young for awhile; however, the young alligators will remain together as a pod for up to several years.

Alligator growth rates vary, but are quickest in young animals. Juvenile alligators eat insects, mollusks, and crustaceans while older animals consume fish, turtles, snakes, birds, mammals, and crustaceans. Juvenile alligators are preyed upon by birds, snakes, otters, raccoons, and bass, but adult alligators are preyed upon only by man.

Adult alligators construct dens and/or holes. These holes may resemble small ponds or be a tunneled area away from a shoreline. Alligators create these wallows by aggressively moving vegetation and soil with both their mouth and their tail. An underground passage leads back into an enlarged cave or den not far from the hole. These holes are extremely important to many wildlife species as they often provide the only surface water available during droughts; they also provide thick vegetative growth along the shoreline for avian species.

Alligators use these dens as home sites. Females have been shown to stay within 450 meters of the den. The males have larger home ranges and move around more, especially in the spring.

Alligators were hunted heavily until the late 1960s. At that point, it is estimated that over 10 million animals were harvested. Alligators were effectively eliminated in most parts of their historic range. Legal protection, management, and research have reversed this trend and restored animals to many parts of their range. Louisiana and Florida are two of the first states to reduce their listing status. Conflicts between man and alligator have also increased with rising population numbers of both species. Some states are now beginning to manage populations through controlled hunts.

FLORIDA BLACK BEAR (*URSUS AMERICANUS FLORIDANUS*)

The Florida black bear is a subspecies of the American black bear. The historic distribution of this species included all forested areas of the United States, northern Mexico, and Canada. The present range of black bears is drastically fragmented and is restricted to remaining large forested tracts. In the eastern United States, it is estimated that bears inhabit only half of their historic range and in the southeastern United States, only 10%. Habitat loss is the major reason for the species decline.

Merriam first described the Florida black bear (*Ursus floridanus*) in 1896, calling it the Everglades bear. Hall and Kelson relegated it to subspecies status (*U. americanus floridanus*) in 1959. At present, there are 16 subspecies of black bears, three in the southeastern United States. Based on new data, the number of subspecies can change either up or down.

Adult male bears are larger than adult females. Males typically weigh between 250 and 450 pounds; females' weight generally ranges between 125 and 250 pounds. The largest male recorded weighed 624; the largest female weighed 342 pounds.

The Florida black bear's color varies less than species color in other parts of the United States. Florida females may have a blonde "V" strip on their chests. Some bears in southwestern Florida exhibit a unique pelage characteristic which makes them appear woolly brown. They actually shed their black guard hairs (the shiny black coat), exposing their underfur (a brown color) and their skin.

Black bears exhibit seasonal shifts in habitat use caused by food availability and cover. Throughout the year, they will utilize a variety of habitats including bayheads, swamps, flatwoods, **scrub** oak ridges, and hammock areas. Bears in central Florida tend to spend the summer and fall months in scrub and hammock areas and winter and spring in pine flatwoods. The bears in north Florida prefer hardwood swamps year-round, periodically utilizing surrounding flatwoods.

Bears are omnivorous. Approximately 80% of their diet consists of plant material. The animal component is largely insects, with a few armadillos and wild hogs thrown in. Their food preferences, like their habitat use, are also cyclic. Bears tend to eat new plant growth of wetland plants, hearts of palms, and the basal ends of palmetto shoots in the spring. They shift to fruits as they ripen in the summer. Favorite fruits include blueberry, blackberry, and gallberry. Fall foods include acorns, saw palmetto fruit, and tupelo gum fruit. During this period, the bears are foraging heavily in order to put on extra stores of fat for winter. The winter diet consists of remaining fruits and berries — often those which are more bitter. Insects are eaten throughout the year whenever they are found.

Florida black bears do go through a winter slow-down. They form ground beds or nests in hardwood swamps or dense thickets. Males and non-pregnant females do not appear to enter into a true state of **hibernation**. Instead, they enter a physiological state known as walking hibernation or denning. These animals will bed down for a few days, weeks, or even months; however, they can be awakened and may get up on warm winter days to forage. Pregnant females enter into a hibernation state in mid-December to early January and don't awaken until late April or early May. Whether denning or in a true hibernation, the bear's body temperature and metabolic and heart rates decrease. They may lose up to 25% of their body weight while hibernating.

The young are born in January or February, after a seven- to eight-month gestation period. Litter sizes are two or three cubs. The cubs only weigh about 12 ounces at birth.

They remain denning with their mother and grow quickly during the next several months. The cubs are large enough to begin foraging for themselves by the end of the denning period. They will remain with the female until they are about 1.5 years old.

Black bears have few enemies besides man after they are about a year old. Male bears have large home ranges (42,000 acres) and do not tolerate other males within their ranges. This leads to a dispersal period for young males when they search for a home. Female bears have smaller home ranges (6,900 acres) and will allow other bears to overlap into their area. In fact, many females grow up and reproduce near their natal range.

Bears are difficult to actually observe in the wild; however, they do leave distinctive signs. One sign is tracks. Bears have five toes and a front foot that is about as long as it is wide. The back foot is long and narrow, resembling a human footprint. Because of their size, they are difficult to confuse with anything else.

Rolled rocks and logs are another good sign. Few animals besides man will turn over rocks and logs, and only bears and man have the strength to roll large ones. The number of overturned rocks depends on how hard the bear was foraging. Signs from rolled rocks are visible for a long time. The age of the sign can be estimated by the presence of twigs and leaves in the print or any dried leaves.

Another excellent indicator of bear presence in an area is bear scat, which consists of a large pile with both plant and animal parts evident. Since organic matter biodegrades quickly in Florida, scat indicates recent use of an area.

Bears will mark their territory by clawing trees. These marking posts are usually along a trail. Sometimes they will also rub against the tree, possibly leaving a scent marker as well as the visual marker. When bears mark trees, they will usually stand or sit at the base of a tree, reach up and drag their paws down the side of the tree for about a foot or two before reaching up to repeat the procedure. Bears will often mark the same tree year after year, leaving a dish-shaped imprint and eventually killing the tree.

Day beds are another excellent sign that bears are using an area. Day beds usually occur in areas of dense cover and are usually up against large trees, logs, or rocks. The bears dig out a depression that looks much like a large ground nest. They will use this for sleeping, especially during the winter months.

BOWFIN (*Amia calva*)

The bowfin is a relatively large fish commonly measuring between two and three feet and weighing 5–10 pounds. The bowfin is a relic species of a prehistoric fish family; fossil remains have been found throughout Europe and North America. The bowfin looks rather like an eel with long fins and has undulating swimming patterns. Today, bowfins are found in the eastern United States, frequently in **sloughs** and back waters, east of the Mississippi basin and from Minnesota through the Great Lakes, south to the Gulf of Mexico.

The bowfin has unique **adaptations** for life in warm, stagnant waters. Although they prefer clear water with abundant vegetation, they are tolerant of silt, mud, and higher water temperatures. The bowfin uses its gas bladder for buoyancy (as other fish do) and to inhale atmospheric oxygen. This allows the bowfin to rise to the water surface and gulp air to augment the oxygen intake from the gills. This feature allows the fish to live in water where dissolved oxygen is reduced by high water temperatures or vegetative decomposition.

The bowfin, or dogfish, is a predator, feeding primarily on other fish. It is classified as a sport fish and is known to be a hard-hitting, excellent fighter. It is not pursued as often as some of the more popular species, however, because it is hard to cook palatably.

The male bowfin roots a shallow nest in weedy swamp or slough bottom in late spring. The female then deposits the eggs. The male fertilizes them and guards the nest and fry (the recently hatched fish) until the fingerlings can fend for themselves.

BROWN PELICAN (*Pelecanus occidentalis*)

The brown pelican is a large, stocky bird with a brown body and a massive bill and throat pouch. The head is whitish yellow in adults and brown in juveniles. Pelicans are coastal birds, ranging from North Carolina south to Venezuela and on the Pacific coast from British Columbia to Chile. They are non-migratory.

Pelicans nest on coastal islands in colonies. Some birds nest in low trees like mangroves, while others nest on the ground. They construct the nests of branches, twigs, and grasses, often stealing nesting materials from neighbors. Some pelicans which nest on the ground have greatly reduced nests.

They lay two or three whitish eggs which hatch after about 4 weeks. The young are blind and featherless when hatched. They open their eyes after several days, and their

skin turns from a red to gray. They begin getting white down feathers after about two weeks, and pin feathers start emerging when they're half grown. Young raised in tree nests stay in the nests until fledging; however, young raised in ground nests begin wandering around almost as soon as they can walk.

Pelicans eat a diet of fish. The parents regurgitate partially digested fish for the young. As the young grow, they begin to reach into the parent's pouch to retrieve fish. They will be ready to fledge and fish on their own at about 12 weeks of age.

Brown pelicans have several adaptations which allow them to dive for fish. Their skulls have reinforced sutures, and they have air sacs in their breasts. Both features buffer them from the shock of crashing into the water. The birds dive from 10 to 50 feet above the water when prey is sighted. The impact of the bird hitting the water actually stuns the fish, allowing the pelican to scoop it up. After catching their prey, they tilt their bills forward to drain off water, then back to swallow the fish. Their usual fare are small to medium fish. Other birds, like gulls, will try to steal fish from the pelicans.

Pelicans frequently fly together in long lines only a few inches off the water or between the waves. This is thought to reduce drag and enable them to take advantage of small updrafts as air passes over the waves.

Pelicans take off from the water with an assist from their feet. Both feet are kicked together to boost the large body into the air. Landings in the water are accomplished with both feet out front, skidding against the water as brakes.

Brown pelicans seem common along the Florida coast, but they are listed as a species of special concern by the state of Florida. Their numbers were, and still are, greatly reduced in many parts of their range due to pesticide buildup in prey species. Birds eating pesticide-laden fish were affected by the thinning of their eggshells and could not effectively incubate their eggs. As a result, species numbers plummeted.

After federal laws banned DDT in 1972, pelicans began to make a slow comeback. Florida is the only area of the country where the pelican had not suffered heavily from the poison. However, the species still faces problems from loss of habitat and conflicts with humans. For example, if boaters passing close to pelicans nesting in the mangroves don't use extreme caution, the chicks become excited and fall from the nest; the parents will not retrieve them, and the chicks perish.

Another human impact is from pelicans getting tangled in hooks and fishing line. If the line is cut by the fisherman and remains dangling from the bird, it can get caught in

mangrove tree roots and the bird will starve. If it gets wrapped around a foot or a wing, circulation can be stopped and the limb lost.

COTTON MOUSE (*Peromyscus gossypinus*)

The cotton mouse is a medium-sized, heavy-bodied, white-footed mouse with a brown back and creamy white underparts. One of the most abundant mammals in Florida, it is found throughout the state. There is one rare subspecies found only on Key Largo. The Key Largo cotton mouse is found in the same areas as the endangered Key Largo wood rat, including the Crocodile Lake National Wildlife Refuge and a few other uncut tropical hammocks remaining in northern Key Largo.

Cotton mice are typically woodland dwellers and occur along water courses where stumps, downed logs, and tangles of brush and vines offer suitable retreats. Frequently, they are in woodland areas which border open fields and may also move into an old barn or a house. They are good swimmers as well as climbers.

Their feeding habits are not well known; however, animals observed in captivity seem to prefer small grains and seeds and eat green foods sparingly.

Cotton mice have a long breeding season, from late August until early May. Litter sizes average three to four young, and a female may raise four or more litters a year. The young are naked and blind at birth. Their ears open in five or six days at the same time as their teeth are beginning to erupt. Their eyes open in about 13 days, and shortly after that they begin to eat solid foods. They are weaned by 20–25 days.

Like the Florida mouse, the cotton mouse has a distinct smell. It has six tubercles on each rear foot which helps to distinguish it from the Florida mouse, which only has five tubercles.

COYOTE (*Canis latrans*)

The coyote is one of the most adaptable native mammals in North America. It is a medium-sized, dog-like **carnivore**. The upper parts of a coyote's coat are a grizzled buff and grayish overlaid with black. The muzzle, ears, and outer sides of the legs are yellowish buff, and the tail has a black tip.

Historically, the coyote was a western mammal ranging from sea level to over 10,000 feet in communities from desert scrub through grasslands and into timberlands. As man settled into these areas, it seems to have forced the coyotes to expand their range. They

were not reported east of the Mississippi River until the 1950s. Several additional factors may have increased the rate of range expansion, including the extermination of wolves in the eastern United States (creating a vacant niche) and human relocations for hunting purposes. Additionally, as humans have settled areas in the eastern United States, they may have caused changes to available habitats that favor the expansion of coyotes.

Coyotes are known from Native American folklore and ancient pictographs. They are noted for their baying (howling). Their eerie vocalizations are most frequent at dusk or dawn and are often answered by another coyote miles away.

Coyotes can live in a family unit or alone. They are not gregarious, although several family groups have been recorded hunting antelope together. After the kill, the group then disbanded. Coyotes have a relatively small home range, probably only several miles in diameter. They do tolerate other coyotes in close vicinity though, which may lead to a high population density in a small area.

Food habits of the coyote are varied. They seem to be opportunistic and utilize anything that can be eaten — carrion, garbage, insects, frogs, snakes, fruits, and fresh meat (wild or domestic). Their most common natural foods are rabbits, rodents, and carrion. They use their acute sense of hearing and smell to locate and capture prey items.

Females pick a mate in spring. The pair are known to stay together until the young are raised, and there is some indications they may mate for life. The pair will dig a nursery den in a hillside, usurp and enlarge an abandoned burrow, or use a shallow cave or crevice between rocks. The breeding season begins in January and terminates by the middle of May. Five or six young are born after a 60-day gestation period. The young are blind and helpless at birth. Their eyes open at about nine days of age. Both parents begin feeding the pups regurgitated food at about two weeks of age. The male and the previous year's offspring often hunt as a unit to feed the female and the newborns until the pups start hunting on their own. They are indistinguishable from their parents by October or November.

Wolves were coyotes' only natural predators. Their extermination leaves the coyotes with no natural predators except man. Coyotes are sly, though, and have adapted well to man, especially in suburban areas.

Coyotes have moved into Florida and are expanding down the peninsula. Ranchers in various areas of Florida are having predation problems with the coyotes, and this trend is moving south with the animals. Some of the coyotes in the state have been illegally

brought in to run in fox pens. This situation is creating a health problem for domestic stock, humans, and wildlife. The threat is from two diseases. One is a strain of rabies common in the western United States in fox and coyotes. It was previously unknown in Florida. The other is a tapeworm known only from the northwestern United States and Canada. It is transmittable to other wildlife and people. When humans become infected, the death rate is greater than 50%.

EASTERN DIAMONDBACK RATTLESNAKE (*Crotalus adamanteus*)

The eastern diamondback rattlesnake is recognized by its distinctive diamond pattern with yellow borders. It has an arrow-shaped head which is much larger than its neck, and a set of rattles at the end of its tail. They have a pit in front of each eye and an elliptical eye pupil. The diamondback is the largest and potentially most dangerous of the North American snakes. They can grow in excess of eight feet in length, though six feet and less is more common. Their average weight is four to five pounds.

The diamondback ranges from southeastern North Carolina to eastern Texas and south. It has been reported in every county and many of the islands in Florida.

Diamondbacks are an upland snake frequently living in hollow logs, underneath palmetto roots, or in gopher tortoise or armadillo burrows. They will occasionally forage in swamps and marshes when water levels are low. Diamondbacks are excellent swimmers and are known to swim between islands. Rattlesnakes typically feed on warm-blooded animals, mainly rabbits, squirrels, rats, mice, and birds. They are an ambush predator, waiting in a coil for suitable prey to come within striking distance. They have been known to wait motionless for a week before taking a victim.

Eastern diamondbacks have several adaptive features. The first is the needle-like fangs and the poison sacs. The fangs normally lie back until they open their mouths, which causes the fangs to self erect. When they bite a victim the pressure from the victim on the upper surface of the snake's mouth pushes the venom from the sacs into the fangs, thus injecting the victim. The venom is a complex of proteins — some neurotoxins and some hemotoxins.

A second feature is the rattle. The rattle is a series of interlocking segments that knock against each other when the tail is vibrated. The rattle increases by one each time the skin is shed. (Rattlesnakes will shed one to five times each year depending on their diet.) Rattles also break and/or rub off with wear. Consequently, they cannot be used to age a snake.

The diamondback generally sounds a warning rattle when disturbed. They do not have to be coiled to strike and can strike in any direction from any position, with an effective striking distance of a third to more than a half of their body length.

Eastern diamondbacks give birth to 9–15 live young between July and October. August is the most common month for diamondbacks to have young in Florida. The young are 12–15 inches long and fully capable of hunting on their own. Females may not breed every year. Rattlesnakes may live to the age of 20.

Eastern diamondbacks have large home ranges. Male home ranges are known to encompass as much as 500 acres. Females have smaller home ranges. During winter, rattlesnake movements decrease. In the northern part of their range, they may stay in a burrow, often grouping together for warmth. But in the southern part of their range, they will still remain on the surface at least half of the time.

Many herpetologists believe the diamondback rattlesnake's population numbers are declining due to a combination of habitat loss, habitat fragmentation, and both indiscriminate and discriminate killings. Some snakes are taken for their skin and/or meat. Others are taken because of the perceived threat to the public. The real threat to public safety is low. For whatever reason, more research is needed into the population status of this species.

FLORIDA SCRUB JAY (*Aphelocoma coerulescens coerulescens*)

The Florida scrub jay is closely related to scrub jays of the southwestern United States. The range of their western cousins extends eastward into Texas, leaving the Florida scrub jay regionally isolated from the other western scrub jays by over 1,000 miles. Within Florida, they are restricted to oak-dominated scrub habitats associated with old coastal dunes or paleodunes. The blue jay is also a close relative of the scrub jay.

Historically, the Florida scrub jay ranged throughout peninsular Florida in all counties south of Duval, Clay, Alachua, Levy, and Gilchrist with the exception of Monroe County. Their populations were patchy, being dependent upon the oak scrub community. Since the early 1900s, they have been extirpated from seven counties and are nearing **extirpation** in several others. Cox (1987) estimated that the scrub jay population in Florida has decreased by at least 50% in the past 100 years. Over 50% of the remaining birds are located in a five-county area which includes two large federal land holdings, the Ocala National Forest and Merritt Island National Wildlife Refuge. The birds are listed as a threatened species by both the U.S. Fish and Wildlife Service and the Florida Fish and Wildlife Conservation Commission.

The Florida scrub jay is about the same size as a blue jay. The scrub jay is a dusky shade of blue which grades into a pale gray on the head and belly. They do not have the striking black and white markings of the blue jay. Plumage is similar in both sexes, although the juvenile plumage is different, being mostly smoky gray or with gray tips for the first year. Scrub jays have short wings and long tails, both being features adapted to their highly **terrestrial** existence. They are extremely friendly and can easily be tamed.

Scrub jays eat a wide variety of items, usually ones that can be picked up off the ground. The most important food item is acorns. Annually, a single jay will harvest and bury 6,000–8,000 acorns. These caches of acorns are utilized throughout the year. Other food items include insects, **arthropods**, small vertebrates (tree frogs, lizards, and small snakes), berries, and seeds. Birds forage independently in close proximity to each other. One bird often serves as a sentinel and warns feeding birds of approaching predators.

Scrub jays live in a large territory in a family group, with the most common family size being three to two adults and a juvenile helper. The jays actively defend their territory.

The nesting season extends from March through June. Nests are constructed of twigs in dense, low to mid-height shrubs. The usual clutch size is three or four eggs. The female incubates the eggs and broods the young while the male forages and defends the territory. The helper may assist the male with his tasks of food gathering, feeding young, and mobbing predators. Three is the average number of young fledged; however, mortality of newly fledged birds is high — 65%. They can re-nest if a predator destroys a nest, but are not documented raising more than one brood per year.

Juvenile birds may begin dispersing at a year or may stay and assist as a helper. Since the birds are highly territorial and the habitat is limited, nesting territories are often limited. As such, the helpers may actually be positioning themselves to take over a territory should something happen to the nesting pair. It has also been shown that pairs with helpers have a higher fledgling success rate than nests without a helper.

There are several known causes for population declines. These include habitat elimination, habitat fragmentation, habitat degradation, and direct human-related mortality. These factors are manageable through population growth planning and control burning.

GOPHER TORTOISE (*Gopherus polyphemus*)

The gopher tortoise is one of four tortoises in North America. It is the only species east of the Mississippi and is generally limited to the southeastern states from eastern Louisiana to southeastern South Carolina, south into Florida. They are restricted to areas of sandy soil with a herbaceous understory and open canopy.

The gopher tortoise is a medium-sized turtle with a broad head and relatively short tail. It does not have webbed feet and its shell is not hinged. Gophers have stiff, flattened forelimbs used during burrow excavation. Adults are usually 9–11 inches long and weigh 8–10 pounds. The shell is domed and varies in color from a light tan to gray. Hatchlings are yellow-orange, less than two inches long, and soft-shelled for several days. Gopher tortoises do not reach sexual maturity until they are 10–15 years old. Recent studies in Georgia indicated the animals may not reach sexual maturity until they are 21 years old. Gopher tortoises are known to live 40–60 years and may live up to 150 years! The period of highest mortality is when the animals are less than several years old. It is estimated that only 1–3% of the young which hatch live beyond two years of age.

Tortoises are considered herbivores, although their diet is varied. Broad-leafed plants and grasses are their primary food sources, but they also consume fruits and berries and small amounts of organic debris, insects, and carrion. Percentage of forages consumed varies with the season.

Gopher tortoises excavate burrows. These burrows are extremely important for their survival since the temperatures remain relatively stable. This allows the animals to escape the heat and moderates the cold. The burrows are also humid, which is believed to be important in preventing desiccation in the animals during the winter months. The burrows are oval-shaped and approximately the same width as the tortoise is long. Burrows average 10–15 feet in length and culminate in a small chamber area. One burrow is documented at over 40 feet long. Juvenile burrows are typically shallower, providing less protection from predators. One entrance is typical per burrow; however, a tortoise often has more than one burrow. Over 80 different species are known to use gopher tortoise burrows. These animals are called commensals and are dependent on the burrow for their survival.

Gopher tortoises have a defined social structure with dominant males. They have courtship displays (head bobbing and positioning) and actively defend their territories. Breeding activities throughout the state are varied, beginning in February and lasting into September; the peak period is May to June. Tortoises lay their eggs in a sunny,

sandy place, often the burrow apron. The average clutch size is six and ranges from 3 to 11. Incubation periods are between 80 and 110 days. Many nests are subject to predation. Gopher tortoises usually breed every other year.

Gopher tortoises from central and north Florida will hibernate for varying periods of time. At the southern end of their hibernation range, they may come out to forage when daytime temperatures exceed 70 degrees.

Gopher tortoises provide a variety of benefits for the community where they exist. Some of these include seed dispersal of herbaceous plants, nutrient recycling in the soil, and creation of underground habitats for many species. Gopher tortoise populations are suffering in Florida due to habitat loss, human harvest (which is illegal), road mortalities, habitat fragmentation, inadequate law enforcement, and disease.

Some conservation efforts were initiated to try to perpetuate the species. The most successful is the mitigation banking which charges developers a fee for destroying gopher tortoises. These moneys are combined to purchase large land holdings managed for gopher tortoises.

Gopher tortoise relocations have also been used as a conservation measure. This has been successful on sites where gophers were completely eliminated (like mining areas) and the land is being restored. Relocation of tortoises to sites where they previously were eliminated has been a successful element of restoration. However, scientific data presently indicate that relocation of tortoises into areas with existing populations may have negative impacts. Several specific diseases can be spread between different populations, potentially causing a die-off in both populations.

GREATER YELLOW-LEGS (*Totanus melanoleucus*)

The greater yellow-legs is a tall, long-beaked shorebird 13–15 inches long. Its body is gray with brown streaks, and it has long yellow legs which trail behind when it flies. Yellow-legs are often referred to as tattlers or telltales due to their talkative habits and vigilance to warn of approaching danger. Greater yellow-legs feed on mudflats, in grassy ponds, or in shallow water. Because their legs are longer than most other wading birds, they often feed in deeper water than the other shorebirds. They are particularly fond of minnows, but also eat insects and other small invertebrate animals.

They breed on the high tundra near ponds. Their nests are no more than depressions in the moss, with no other nesting materials added. The male stays close to the nest while the female incubates. He will distract and fend off intruders, making it extremely

difficult to find the female or the nest. Four buff colored eggs with brown blotches is the usual clutch size. Nesting usually occurs in late May.

The birds winter over a large area from the southern United States south into the West Indies and Central America to as far as the tip of South America. During the non-breeding season, they are often found in association with other shorebirds and teal. Rarely are greater yellow-legs found in large concentrations.

The greater yellow-legs can be distinguished from the lesser yellow-legs by its larger size, thicker bill, longer legs, and grouping behavior. (The lesser yellow-legs tends to be found in larger groups.) Both species are vocal.

GULF STURGEON (*Acioenser oxyrhynchus desotoi*)

The Gulf sturgeon is a subspecies of the Atlantic sturgeon. Both of these sturgeons and the short-nosed sturgeon can be found in Florida waters. All sturgeons are primitive fish with naked skin embedded with bony scutes (modified scales).

The Gulf sturgeon used to be common in the Gulf Coast estuaries as well as several major river systems along the Gulf Coast area of Florida, Alabama, and Louisiana. Near the turn of the century, heavy fishing pressure lowered most Gulf sturgeon populations beyond their sustainable yield levels. This pressure, in combination with the damming of rivers for hydroelectric power, isolated populations from their breeding grounds, causing the severe depletion in sturgeon numbers. Today, only the Suwannee River supports an intact breeding population of Gulf sturgeon.

Gulf sturgeons are large, long-lived fish. They can grow to 300 centimeters in length and weigh hundreds of pounds. They can live in excess of 60 years. Sturgeons have small, ventral mouths preceded by barbels. These features assist them in feeding on small, bottom-dwelling invertebrates. They can and do feed in other areas of the water column as well.

Sturgeons are **andromous** (a saltwater species requiring freshwater for breeding). The sturgeons move into freshwater to spawn. Migration from the estuaries into the rivers can begin in late winter. Peak migration usually occurs in May, with a secondary peak in October. These migration runs seem to be triggered by water temperature.

Spawning sites are relatively shallow water areas with a bottom substrate of mixed sands and gravel. After spawning, the adults will then return to the **estuary** systems along the coast.

Studies indicate spawning sites may be endangered by increased nitrates in the Suwannee and other rivers. The increased nitrates lead to increased algal growth, which can lower the dissolved oxygen levels in spawning grounds, reducing the viability of the site.

These very characteristics of using the entire river system and the fact that the adult populations seem to stay in a localized estuary area and do not intermix with breeding populations from other drainages make species recovery efforts difficult. These characteristics also make the species an excellent keystone species to monitor the health of an entire river system.

MOSQUITO (*family Culicidae*)

Mosquitoes are part of the insect family of flies. Like other flies, they only have two functional wings and two small stubs. Adult mosquitoes also have the characteristic six legs and three body parts. These are the head, the thorax (the middle section where the legs attach), and the abdomen (the last section, with most of the internal organs).

Mosquitoes undergo a complete metamorphosis to reach adulthood. The mosquito starts out as an egg, deposited in or near water — stage one. Depending on the type of mosquito, eggs are laid singly or in a group called a raft. To hatch, the eggs must be in water. Some eggs are able to survive for months or years before they are inundated with water and hatch. Once hatched, the mosquito larvae or wrigglers are dependent on water. They race time to mature before their water hole dries up; most mosquito eggs never survive to reach the adult stage.

While many aquatic areas — for example, ponds, pools, artificial containers, tree holes, salt marshes — have mosquito eggs, each species of mosquito usually only appears in one particular type of aquatic habitat. For example, one square foot of salt marsh may contain over 10,000 salt marsh mosquito eggs. There are 148 identified species in North America and over 3,000 species worldwide.

The larval stage is the second stage in the life cycle. Most larvae feed on organic debris and algae, although several species feed on other mosquito larvae. Mosquito larvae breathe at the water's surface through a breathing tube, or siphon, located at the posterior end of their body. Each larva has an exoskeleton which it molts as it grows. Mosquito larvae molt four times, or have four instar stages, before they pupate.

The pupa, or tumbler, is the third stage of the mosquito's life cycle. Unlike most pupas, the mosquito pupa is quite active. The pupa rests near the water surface and breathes

through two tubes located on the thorax. Occasionally, they will tumble to the bottom of the water if danger approaches. They do not feed in this stage.

The adult mosquito, stage four, molts out of the pupa. The exoskeleton of the pupa splits down the back and the adult climbs out. It will usually rest on the water for a short time before flying to nearby vegetation to rest and allow its wings to dry.

Adult mosquitoes feed mainly on plant juices and nectar. Only the female mosquito requires a blood meal prior to depositing eggs. The proteins in the blood are used to nourish the eggs. The female is able to extract the blood by injecting some saliva into her victim. The saliva contains an anti-coagulant. It is the saliva left in the body which may cause an irritation in the form of a bump and itching. Mosquitoes are most active at dawn and dusk, or in the dense shade.

Mosquitoes are known to carry diseases. Mosquitoes can act as **vectors** for malaria, yellow fever, dengue, and certain types of encephalitis. Most of these, however, have been eradicated or were never present in the southeastern United States, the exception being encephalitis.

Mosquitoes are an important lower link on many wildlife and fish food chains. Larval stages are eaten by fish and juvenile amphibians. Adults are an important food source for many birds, bats, and frogs.

The sex of adult mosquitoes can be determined by looking at their antennae. The male's antennae are plumose while the female's antennae only have a few sparse hairs on them. The feathers on the male's antennae actually help them locate females by picking up a high-pitched sound produced by the female's wings. There are differences also in life spans, with most males living only a few weeks and females up to several months.

Since Florida is blessed with abundant surface water reserves, it is also blessed with mosquitoes. The mosquito and people don't always mix well, consequently, mosquito control efforts are common. Control methods have improved through the years as people realize that ditching and draining create as many problems as they attempt to solve. Most control efforts today target the larval stage. These include natural "fixes" such as mosquito-eating fish and/or chemical larviciding. Adulthood is not as effective and is very expensive, so it is most commonly used only when mosquito problems become severe. People should take their own preventive measures to reduce contact with adults. Effective methods include protective clothing, screening, and use of repellents.

OSPREY (*Pandion haliaetus*)

The osprey is a large, fish-eating bird of prey that is frequently mistaken for a bald eagle because of its white head. However, the osprey has a dark band across its face and a smaller, less colorful beak than the eagle. Even more obvious is the white breast. Another good field identification mark is how the osprey holds its wings partly folded in an “M” shape in flight. Most other large raptors hold their wings straight.

Ospreys build large nests which they expand and improve year after year. Most nests are built in tall, dead trees, but the osprey is adaptable and will use man-made structures such as telephone or light poles and specially built nesting platforms. They have even been known to use abandoned great horned owl or eagle nests. They lay three eggs, creamy white blotched with red. The female, with some help from the male, incubates the eggs for 38 days. The young ospreys fly and leave the nest at about seven weeks old.

The osprey’s foot is very rough-textured for grasping the slippery fish which constitute their prey. This is extremely important, since osprey feed exclusively on fish. The osprey is the only hawk able to grasp with two toes in front and two in back rather than the usual three and one arrangement. In fact, its feet are so well adapted for gripping that some birds have been dragged underwater and drowned by large fish because the bird couldn’t let go!

When hunting for food, the osprey flies 65–100 feet above the water until it sees a fish. The pale plumage on the osprey’s underside makes it difficult for fish to see it against the sky. The osprey plunges down with wings swept back. Before reaching the water, it swings its feet forward, its legs breaking the surface to catch its prey.

The osprey is a species in recovery. For years it was persecuted by man because it hunted fish and was viewed as a competitor. Osprey also suffered from pesticide buildup and the resultant eggshell thinning. Since the ban on DDT, the osprey has made a remarkable recovery.

RIVER OTTER (*Lutra canadensis*)

The river otter is a large member of the Mustelid family (weasels, skunks) with a long, streamlined body; a long, thick, tapering tail; webbed feet on short legs; and a broad, flat head with a short neck. Their pelage is short and dense with a dark brown coloration on the upper parts and a paler, gray-tinted color on the lips, cheeks, and underparts. River otters are aquatic carnivores, eating mainly crustaceans, crayfish, and

fish. They fish opportunistically and may actually benefit sport fish by reducing trash fish competition. Otters don't store food or overkill.

Otters live in dens as a family unit. The den may be a hollow log, a stump or a burrow in the bank. They do not dig burrows; they take over an abandoned burrow of another animal. Otters mate for life, and both parents assist in the maintenance and rearing of the young. Breeding occurs in April or May shortly after the female has given birth. The fertilized ovum is retained in the uterus for up to eight months before implantation. It is unknown why otters have a delayed implantation.

A litter size of two or three is normal. Even though otters are aquatic, swimming is not instinctive for them. The parents have to teach the young to swim. The young are ready to follow their parents six to eight weeks after birth. They will stay with the parents for about a year, then disperse.

Otters have several interesting adaptations that allow them to better survive their aquatic environment. While swimming underwater, their heart rate slows to conserve oxygen and valve-like flaps of skin cover nostrils and ears, keeping water out. They can stay underwater three to four minutes on one breath. During this time, they can swim about a quarter of a mile at speeds up to six miles per hour, or dive up to 60 feet. An otter's hair is also so thick that its skin never gets wet.

River otters are highly intelligent, curious, and love to play. They have well-developed senses of smell, touch, and hearing. Otters can detect movement through sensitive whiskers (which sense vibrations) on the face which, when combined with their sense of smell, help them locate and catch fish in murky waters. Their sense of smell is also used to detect territorial scent boundaries. Their hearing is used in communications. Vocally, otters make a variety of sounds throughout the day. Otters also play games with each other and are known for their slides down banks or mossy rocks into the water.

Otters mark their territories with scent posts. One unusual type of scent post they use is dung piles — a location used as a toilet for depositing fecal material.

The historic range of river otters includes all of North America and Canada; however, today's populations are fragmented in the southeast, northwest, and along the Great Lakes and Canada. They have been completely eliminated from 11 states (and one Canadian province), and they are rare in 13 more states. Fortunately, they are common in all fresh Florida waters. A re-introduction program is under way in the Smokey Mountains.

River otters faced heavy trapping pressure from European settlers and periodically since. This is largely because of the fine quality of their fur, which is rated 100% on the fur quality scale. The greatest threat to otters today is development because of habitat destruction and water pollution. Many otters are also killed annually on roads.

WHITE-TAILED DEER (*Odocoileus virginianus*)

The white-tailed deer is a relatively small species of deer with short ears and a long, broad tail which is white on the underside. The upper parts of the body coat are reddish brown in the summer and a grayish brown in the winter. The deer have white markings on their face, neck, and belly. Only the males have antlers, and each branch of the antler originates on the main beam.

White-tailed deer range from the tree line in Canada to subequatorial South America, exhibiting 30 subspecies classifications. They are generally absent from California, Nevada, and Utah. Throughout this extensive range, the white-tail has been able to thrive and actually increase in numbers due to man's manipulation of the habitat. They do extremely well in edge habitat and agricultural settings.

Deer are browsers, and their preferred diet consists of new-growth twigs. They will also eat grasses, some fruits, and acorns. Deer are well adapted for this high fiber diet as they have four stomachs. They are termed a ruminant. The first stomach, or rumen, serves as a large holding vat. Food is regurgitated from this stomach and re-chewed. This process is known as rumination, and the act is chewing a cud. The fourth stomach, the abomasum, is the only true stomach and has a lining which allows for nutritional uptake.

Individuals exhibit **site fidelity**, meaning that the animals remain in the same area for extended periods of time. Their movements actually form trails. White-tails tend to be crepuscular and will feed into the night, especially during extreme heat.

White-tails are **polygamous**. The rut begins in early fall and continues through early winter. During this period, bucks are highly territorial (although these territories are relatively small). Pre-rut activities (late summer and early fall) produce easily tracked sign of the deer. Rubs can be seen on shrubs and trees from this activity. Antler re-growth begins in the spring; however, the antlers are not hard enough to rub off the velvet until late summer. During late summer, the males also begin marking and defending their territories. Marking is accomplished with scrapes and urination along the territory boundaries. Males will clash and fight throughout rut over territories and does.

Peak breeding time varies throughout Florida, ranging from July through February. Fawns are born after a seven-month gestation period. One or two fawns are common per doe. At birth, fawns are a reddish brown with white spots. For several weeks after birth, the fawns are hidden and left by the doe. The doe remains in the area feeding but only returns to nurse the fawn and sometimes to rest. After several weeks, the fawn is strong enough to follow the doe and will go with her.

Fawns retain their spots until early fall, when they go through their first molt. They are usually weaned about this time as well, but will often stay with their mother for the first year. Most deer reach sexual maturity between one and two years of age (depending on nutrition), but usually won't mate until they are two.

Post-rut begins in late winter, at which time the bucks cast their antlers. White-tails often travel in sex-differentiated groups from post-rut into the spring. The young of the year stay with the does. Does will become more solitary as the time for the fawns to drop approaches. Buck groups may remain together into the early summer.

The white-tailed deer can have a variety of positive and negative impacts for humans. They are the most popular big game species in North America. Hunting provides food and sport for many people. They are also a popular viewable wildlife species.

On the other side, high-density populations can negatively impact the vegetative communities in habitats occupied by the deer. Excessive browsing can effectively remove almost all vegetation within the deer's reach. High-density populations can also result in enormous economic losses for farmers and create nuisance situations in suburbs where expensive ornamental landscape is devoured. Millions of dollars are paid out annually by states trying to compensate landowners for the losses they incur. This problem is getting worse as deer are reproducing more quickly than they are being harvested throughout most of the United States. The insurance companies also pay substantial amounts in vehicular damage claims from road-hit deer.

High densities of deer also can promote the spread of diseases. White-tails can carry several diseases and disease vectors. Some diseases carried by deer are transmittable to livestock.

WILD HOG (*Sus scrofa*)

Wild hogs are the most successful naturalized large mammal in the United States. They occur in 11 southeastern states and range over 11 million hectares of land. The wild hogs are from two lineages which have hybridized — (1) hogs descended from

domestic stock that were released, abandoned, or escaped and (2) hogs descended from wild stock introduced for hunting purposes. They are often referred to with colloquial names such as razorback, referring to the prominent backbone on thin animals and the long, coarse hairs on their back which stand erect when the razorback is agitated, and piney woods roter, a reference to their habit of rooting in the soil. They are also known as wild boar, wild pig, feral pig, feral hog, and feral swine. Wild hogs are native to the Old World and were brought to the Americas by early European settlers — by Columbus in 1493 and by DeSoto (to Florida) in 1539.

Wild hogs are predominantly black in color, although brown, red, and spotted are common color variations. They are **omnivores**, eating almost anything including roots, tubers, grasses, mast, small animals, and carrion. They are sometimes even cannibalistic.

Rooting is the primary method of food procurement. This can lead to widespread habitat destruction and is a significant negative impact. Hogs also damage timber plantations and crops by rooting. They consume large quantities of food and are quite prolific. This creates direct competition with native wildlife including white-tailed deer, rabbit, turkey, and squirrels.

Hogs do not have sweat glands. This forces them to use external features to regulate their body temperatures, or they can literally overheat and die. Consequently, they feed mostly at night and spend much time near or in water or mud. This is why they are more common around wetlands, although they are adaptable to many habitats.

Most wild hogs roam in groups consisting of sows and their young. Boars are more solitary, but neither sex is territorial. They will breed year-round, and sows have one or two litters per year, with 5–12 piglets in a litter. Infant mortality is relatively low, although the baby pigs sometimes fall prey to hawks, owls, and eagles. Bobcats prey upon young wild hogs throughout the state, and in South Florida, panthers prey upon the adult wild hogs.

In addition to habitat destruction, wild hogs also pose health risks to domestic stock and humans. They carry pseudorabies, a disease that can be fatal to panthers, and swine brucellosis, another common disease. Swine brucellosis can be fatal to humans and is a serious threat to domestic stock. It is transmitted to humans by body fluids; mucous and blood should be avoided, and gloves should be worn when cleaning wild hogs. Hogs also carry many **parasites**, including trichinosis.

DISEASES

Disease is a natural part of ecosystems. Disease may be a limiting factor when carrying capacities are exceeded. In such instances, dramatic die-offs can occur. Disease may also work in concert with other limiting factors.

Some diseases are species-specific, while others can infect a variety of organisms. Some wildlife species may be intermediate carriers, allowing for the spread of the disease while never exhibiting disease symptoms themselves. Snails, insects, and arthropods often fall into the carrier category. Some diseases can be transmitted between domestic stock and wildlife, or domestic stock, wildlife, and humans. These diseases often create more concern because of their potential impacts on humans. Several wildlife diseases and the etiologies are listed below. The selected diseases are ones which are either transmittable to humans or which humans, through recreational activities, may unknowingly be spreading among wildlife populations.

CANINE DISTEMPER

Many species of wildlife and domestic animals can contract canine distemper. The most common wild hosts include raccoons, gray foxes, and coyotes. Skunks, red foxes, bears, and otters are also known to be susceptible. Domestic ferrets have been reported with distemper. It is unknown whether wild mustelids are susceptible. Dogs are usually vaccinated against canine distemper. Humans do not contract distemper.

Canine distemper is caused by a virus. The virus attacks epithelial cells primarily in the respiratory and digestive tracts, and eyes. Common symptoms include coughing, sneezing, watery eyes (with or without discharge), and diarrhea. The nervous system may also be damaged, causing the animals to lose the fear of humans and to have intermittent convulsions, tremors, or chewing fits.

As the disease progresses, the animal may get pneumonia, suffer from eye and nasal discharges, become emaciated, develop cut or bleeding feet, and develop gastroenteritis. The disease can be fatal.

Laboratory analysis is required to positively identify canine distemper. It does not require sacrificing the animal. Slides can be prepared from ocular exudate to test for antibodies, or the virus can be isolated from tissue.

Distemper is transmitted by contact with infected animals or their excretions. Canine distemper occurs throughout the southeast and Florida. It can be of epidemic proportions or in isolated cases. Raccoons appear to be the most susceptible. Because of the similarity of symptoms between distemper and rabies, it is important to determine which disease is present in an area.

LYME DISEASE

The disease is named for the town of Old Lyme, Connecticut, where it was first recognized. It appears to be most prevalent in the northeast, although cases have been reported throughout the Midwest and the southeastern United States.

Lyme disease is a bacteria-caused infection. Humans and a few other mammals can contract the disease, usually from ticks. Other blood-feeding arthropods may also be able to transmit the disease. Since a particular species of tick, *Ixodes dammini*, commonly called the deer tick, is associated with lyme disease, people tend to link deer to the disease as well. This is not a valid assumption though, as the tick will use a variety of hosts including reptiles, birds, and small mammals. Mice, especially deer mice and including the cotton mouse, are actually considered the most important host to the bacteria.

Lyme disease can be isolated from fresh blood specimens; the liver, spleen, and lymph nodes; serum; and live ticks.

Symptoms from lyme disease are varied; however, the typical bite will have a skin rash develop around it. The individual may also have flu-like symptoms. Arthritic symptoms can occur after the bite appears to be healed. The disease is treatable with antibiotics; consequently, if an illness occurs after a tick bite, consult a physician.

RABIES

Many species of wildlife can become infected with rabies but foxes, skunks, raccoons, and bats are considered the main reservoirs. Humans and domestic animals can also contract rabies. Some species, like rodents, opossums, and birds, seem to have a natural resistance to rabies.

Rabies is caused by a virus that attacks the nervous system. It has an incubation period (species-specific) when symptoms are masked; however, once the virus invades the brain, clinical symptoms are exhibited. When the virus reaches the brain, it also invades the salivary glands, making the victim contagious. Rabies is transmitted through saliva,

generally in association with bites. There have been several documented cases of rabies through aerosol transmission in bat caves, although the average rate of infection among bat populations is less than 5%. Death occurs after the virus invades the brain, usually by paralysis of the diaphragm.

There are two forms of rabies — dumb and furious. Dumb rabies is characterized by lethargy, aimless wandering, weakness of the legs, and lack of awareness. Furious rabies is characterized by violent attacks on moving objects and self mutilation.

The only way to positively identify rabies is through a diagnostic laboratory. The lab will require the undamaged brain of the animal in suspect. Local public health departments and the state wildlife agencies will provide assistance with the collection and submission of any suspected cases.

In the United States, 20,000 people are treated each year for exposure to rabies. The treatment now is not nearly so difficult or painful as it was years ago. Additionally, veterinarians and other people that may be exposed to rabid animals are periodically vaccinated against rabies as a precautionary measure.

HUMAN CAUSES AND EFFECTS

The act of driving down a road affects wildlife — habitat loss and fragmentation (land for the road), increased disturbance (road noise), habitat degradation (air pollution, litter, dropped oils and coolants), and increased risk of mortality (road kills). Negative effects, or impacts, were not always understood or were considered the price for development. Society is now choosing to mitigate for some of these effects. Examples of mitigation include catalytic converters, air emission standards, the Clean Air Act, the Clean Water Act, stormwater storage basins and, in some cases, fees levied for permits for new construction when it will destroy listed species or their habitats. Permit fees are pooled and used to purchase habitat similar to that destroyed. The lands acquired in this manner are being managed for the long-term preservation of indigenous species.

The concept of humans creating impacts to which wildlife must adjust is not new. However, the range of impacts increases as recreational use of natural areas increases on public lands. Unfortunately, determining the actual effects of a recreational activity on wildlife requires studying a single species or a community of organisms and evaluating specific impacts from recreational activities while keying into intensity by time of year.

Florida Envirothon Study Packet — Wildlife Section

Wildlife Species	Recreational Activity	Potential Impacts	Solutions
Wading birds	Boating, fishing, canoeing, wind-surfing, bird-watching, jet skiing (in rookery areas)	Birds highly susceptible due to nesting densities. Detrimental effects include egg and nestling mortality, premature fledglings, nestling slow growth or weight loss, nest or site abandonment	175-m buffer for terns and 125-m buffer for waders. Use professional discretion when birds are acclimated to humans
Green-backed heron	Canoeing, kayaking, fishing, boating	Heron activity declined in 76% of areas tested when river usage increased	May be able to use as an indicator species showing when recreational activity levels are too high to maintain natural wildlife population numbers
Waterfowl	Boating, fishing, water skiing	Bank erosion; loss of aquatic vegetation; excessive energy expenditures for wildlife; lower reproduction rates; abandonment; broods moved to margin habitats.	No-wake zones or non-motorized boat zones. Restrict fishing and hunting activities. Increase public awareness. Create inviolate refuges at least 1.5x2 kilometers in size. Move broods to margin habitats
Bald eagle	Boating, canoeing	Canoes flushed ground-feeding eagles at distances exceeding 460 m. Boats in winter caused flushing at distances of 265 m and in summer, 175 m	Restrict boating activities in known feeding areas during peak feeding times — early morning and late afternoon
Nesting raptors (southwestern United States)	Hiking, rock climbing, angling, hunting	Altered distribution; prevented incubation; caused abandonment of breeding territories; lowered reproduction; affected foraging	Deny access to important nesting areas or impose spatial/temporal restrictions
Alligator	Any activity decreasing water quality	Contaminant tests in the tail meat found eight metals (including mercury), DDE, DDT, DDD, PCBs, lindane, and others	Continue monitoring for contaminants. Potentially use contaminants as an environmental monitor. Retain functional Clean Water Act
Fish	Water activity using gas motors	Oily substances left in and on the water are toxic to fish. Decreased reproductive rates; disturbed nesting (can cause abandonment); tainted meat	Develop guidelines to restrict emissions from motors used on watercraft
Manatee	Motorboat racing, boating	Can hit, cut, and kill; killing is direct or through infection	Education and enforcement of recreational boaters and activities. Guidelines developed by USFWS and the Coast Guard are in use when manatees are in a race area
Wildlife communities	Fishing, hiking, rafting, photography, canoeing, kayaking, vehicles, off-road biking	Disrupts community dynamics. Can lead to displacement, reduced feeding times, sickness, and death. Reduces reproduction. Causes declines in population numbers and species diversity	Education

Note: m = meter
USFWS = U.S. Fish and Wildlife Service

REGULATORY PROTECTION OF THE ENVIRONMENT

Degradation and destruction of the environment can be grouped into three major categories — physical destruction, contamination of habitat, and human disturbance of important impacts. Some of the laws created to protect the environment are briefly discussed below. As with any type of law, the law is only good if it is enforceable, and this has become an issue with several of the laws. Also, several of the laws are presently being considered for revision by Congress. Well-developed revisions may increase or improve the cooperation of private landowners concerned about governmental regulation of their lands. Any such revisions of these acts should not adversely affect elements critical to the effective preservation of wildlife.

Endangered Species Act — The intent of this act is to protect fish, wildlife, and plant species facing extinction by encouraging the development and maintenance of conservation programs designed to increase population numbers to a point where the species can be removed from the protected status. The law specifically makes it illegal to “take” listed species. To take means to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or attempt to engage in any such conduct. However, there are provisions to take included under specific permits. Such provisions are important for some situations in which conflicts arise between wildlife and human populations.

Migratory Bird Treaty Act — This law makes it illegal to take non-game migratory birds or parts, including nests. There are provisions to take included under specific permits. This act covers almost all native bird species.

Bald Eagle Act — This law makes it illegal to take a bald or golden eagle.

Marine Mammal Protection Act — This law protects only the marine mammals. It contains minimal language for the protection of the mammal’s habitat. The Secretary of Commerce may grant a permit to take a marine mammal.

Clean Water Act — The intent of this law is to require a permit for the discharge of pollutants into waterways. It also addresses providing funds for the development of wastewater treatment facilities. It was based on engineering principles and not on types of, amounts of, or ecosystem tolerance for the pollutants.

Clean Air Act — This law sets standards for air health, provides money for research, and protects clean areas against significant deterioration. The act sets new emission

standards, but the regulation of existing pollutants is left up to the states. There are provisions for enforcement and compliance, although it is basically left up to the states.

U.S. Army Corps of Engineers Regulatory Program — This program is based on directives from the Clean Water Act and the River and Harbor Act that require permitting for anyone desiring to place dredge or fill material in waters of the United States or make any type of changes to navigable waters.

Pittman-Robertson Act — This law, established in 1937, placed an excise tax on firearms and associated equipment. This tax money is set aside specifically for the management, research, administration of, and acquisition of wildlife and their habitats. These funds were used to purchase many of the state and national wildlife refuges as well as to provide minimal staff to manage these areas.

Dingle-Johnson Act — This act, established in 1950, placed a similar excise tax on fishing equipment. These moneys are earmarked for fisheries management, purchase, administration, and research.

Wallop-Breaux Act — This 1984 act amends the Dingle-Johnson Act by broadening its scope to allow the taxing of other items used when fishing, such as boats, gas for marine use, depth finders, etc. Funds are still allotted as stated in the previous act.

There are notable differences in the response of wild animals to the sweeping changes in the environment caused by man. Some animals adjust very well to changes in vegetation and land use, and these animals, on the whole, persist or may even increase in abundance. Included in this group are many of the game species, raccoons, armadillos, and coyotes.

Some species are clearly associated with and dependent upon undisturbed climax situations, and these animals suffer the most from environmental change. They are designated as nonadaptive species. The list includes all the rare or endangered species and some that have become extinct.

There appears to be a direct correlation between the affinity subclimax with seral stages or biota and adaptability in the sense of the capacity to adjust to changing conditions. The ability to adapt seems to involve two distinct components: (1) genetic plasticity, or the capacity for segments of a population to evolve rapidly to fit local conditions, and (2) the capacity for individuals to learn new habits of survival under altered circumstances. These cannot readily be separated, since the capacity to learn is itself a genetic trait.

Many wildlife species that are declining in numbers prefer unique or narrowly distributed habitats. Many of those habitats are relatively stable and not subject to significant change. Disturbances can affect such habitats both directly and indirectly. Indirect effects may result from interactions among wildlife species. Indirect effects are the most difficult to understand and often the most difficult to correct. When humans alter the quality and abundance of available resources, the effects can be both numerous and widespread.

REFERENCES

- Avery, T.E. 1975. *Natural resource measurements*. McGraw-Hill Book Company.
- Bouffard, S.H. 1982. *Wildlife values versus human recreation: Ruby Lake National Wildlife Refuge*. Pages 553–558 in Transactions of the North American Wildlife and Natural Resources Conference 47.
- Boyle, S.A., and F.B. Samson. 1985. Effects of nonconsumptive recreation on wildlife: A review. *Wildlife Society Bulletin* 13:110–116.
- Boyle, S.A., and F.B. Samson. 1983. Nonconsumptive outdoor recreation: an annotated bibliography of human-wildlife interactions. U.S. Fish and Wildlife Service Special Scientific Report. *Wildlife* 252, 113 pages.
- Bratton, S.P. 1990. Boat disturbance of Ciconiiformes in Georgia estuaries. *Colonial Waterbirds* 13:124–128.
- Buckley, P.A., and F.G. Buckley. 1976. Guidelines for protection and management of colonial nesting waterbirds. North Atlantic Regional Office, National Park Service, Boston, Mass.
- Buehler, D.A., T.J. Mersmann, J.D. Fraser, and J.K.D. Seegar. 1991. Effects of human activity on bald eagle distribution on the northern Chesapeake Bay. *Journal of Wildlife Management* 55:282–290.
- Cochran, W.G. et al. 1954. Principles of sampling. *Journal of the American Statistical Association* 49:13–35.
- Committee on the Applications of Ecological Theory to Environmental Problems
Commission on Life Sciences. 1986. *Ecological knowledge and environmental problem solving: Concepts and case studies*. Washington, D.C.: National Academy Press.
- Davidson, W.R., and V.F. Nettles. 1988. *Field manual of wildlife diseases in the southeastern United States*. Athens: University of Georgia.
- Delany, M.F., J.U. Bell, and S.F. Sundlof. 1988. Concentrations of contaminants in muscle of the American alligator in Florida. *Journal of Wildlife Diseases* 24(1).

- Doster, G.L., ed. SCWDS Briefs, a quarterly newsletter from the Southeastern Cooperative Wildlife Disease Study, College of Veterinary Medicine, University of Georgia, Athens.
- Drent, R.H., and C.J. Guiguet. 1961. A catalogue of British Columbia sea-bird colonies. *Occasional Papers of the British Columbia Provincial Museum* 12:1–173.
- Duabemire, R. 1959. A canopy-coverage method of vegetational analysis. *Northwest Science* 33(1):43–64.
- [EPA] U.S. Environmental Protection Agency. 1995. Wetlands fact sheets.
- Foster, M.L., and S.R. Humphrey. 1995. Use of highway underpasses by Florida panthers and other wildlife. *Wildlife Society Bulletin*, Spring.
- Frederick, P. 1991. Environmental correlates of wading bird reproductive success. In *Proceedings of the Coastal Nongame Workshop, Southeast Region*. D.P. Jennings, compiler. Gainesville, Fla. U.S. Fish and Wildlife Service and Florida Game and Fresh Water Fish Commission.
- Gingerich, J.L. 1996. *Florida's fabulous mammals*. Tampa, Fla.: World Publications.
- Goldman, L. 1991. Regulatory protection of coastal nongame habitats. In *Proceedings of the Coastal Nongame Workshop, Southeast Region*. D.P. Jennings, compiler. Gainesville, Fla. U.S. Fish and Wildlife Service and Florida Game and Fresh Water Fish Commission.
- Halls, L.K., ed. 1984. *White-tailed deer: ecology and management*. Harrisburg, Pa.: Stackpole Books.
- Jackivicz, T.P., Jr., and L.N. Kuzminski. 1973. The effects of the interaction of outboard motors with the aquatic environment—a review. *Environmental Research* 6:436–454.
- Kadel, J.J., and J.F. Gorzelany. 1993. Manatee surveillance during high speed powerboat races. *Florida Scientist* 56:23.
- Kahl, R. 1991. Boating disturbance of canvasbacks during migration at Lake Poygan, Wisconsin. *Wildlife Society Bulletin* 19:243–248.

-
-
- Kaiser, M.S., and E.K. Fritzell. 1984. Effects of river recreationists on greenbacked heron behavior. *Journal of Wildlife Management* 48:561–667.
- Keeton, W.T. 1980. *Biological science*. New York: W.W. Norton & Company.
- King, T., R. Stout, and T. Gilbert. 1985. *Habitat reclamation guidelines*. Tallahassee: Florida Game and Fresh Water Fish Commission.
- Knight, R.L. 1984. Responses of wintering bald eagles to boating activity. *Journal of Wildlife Management* 48:999–1004.
- Knight, R.L., and S.K. Skagen. 1986. Effects of recreational disturbance on birds of prey: A review. In *Proceedings of the Southwest Raptor Management Symposium and Workshop*. National Wildlife Federation. Washington, D.C.
- Korchgen, C.E., and R.B. Dahlgren. 1992. *Waterfowl management handbook*. 13.2.15 — Human disturbances of waterfowl: Causes, effects, and management. Washington, D.C.: U.S. Fish and Wildlife Service.
- Leopold, A.S. 1974. Adaptability of animals to habitat change. *Readings in wildlife conservation*. James A. Bailey, William Elder, and Ted D. McKinney, eds. Washington, D.C.: The Wildlife Society.
- Mathews, G.V.T. 1982. The control of recreational disturbance. In *Managing wetlands and their birds: A manual of wetland and waterfowl management*. D.A. Scott, ed. Proceedings, 3rd Technical Meeting on Western Palearctic Migratory Bird Management, Biologische Station Rieselfelder Munster, Federal Republic of Germany.
- Martin, R. 1991. Overview of wading birds in Louisiana, Mississippi, and Alabama. In *Proceedings of the Coastal Nongame Workshop, Southeast Region*. D.P. Jennings, compiler. Gainesville, Fla. U.S. Fish and Wildlife Service and Florida Game and Fresh Water Fish Commission.
- Mueller, G. 1980. Effects of recreational river traffic on nest defense by longear sun-fish. *Transactions of the American Fisheries Society* 109:248–251.
- Pianka, E.R. 1978. *Evolutionary ecology*. New York: Harper & Row.
- Pomerantz, G.A., D.J. Decker, G.R. Goff, and K.G. Purdy. 1988. Assessing impact of recreation on wildlife: A classification scheme. *Wildlife Society Bulletin* 16:58–62.
-
-

- Rodgers, J.A., and H.T. Smith. 1991. Minimum buffer zone requirement to protect nesting bird colonies from human disturbance. In *Proceedings of the Coastal Nongame Workshop, Southeast Region*. D.P. Jennings, compiler. Gainesville, Fla. U.S. Fish and Wildlife Service and Florida Game and Fresh Water Fish Commission.
- Schemnitz, Sanford D. 1980. *Wildlife management techniques manual*. 4th ed., revised. Washington, D.C.: The Wildlife Society.
- Skagen, Susan K., Richard L. Knight, and Gordon H. Orians. 1991. Human disturbance of an avian scavenging guild. *Ecological Applications* 1(2).
- Vesilind, P.A., J.J. Pierce, and R.F. Weiner. 1994. *Environmental engineering*. 3rd ed. Boston: Butterworth-Heinemann.
- Wooding, J.B., and J.R. Brady. 1987. Black bear road kills in Florida. In *Proceedings of the Annual Conference of the Southeastern Association of Fish and Wildlife Agencies* 41:438-442.
- Zieman, J.C. 1976. The ecological effects of physical damage from motor boats on turtle grass beds in southern Florida. *Aquatic Botany* 2:127-139.

GLOSSARY

Adaptation. The process of change by an organism in response to a new condition in the environment.

Andromous. Fish species which spend long periods of time in salt water but require freshwater to breed.

Arthropod. An invertebrate of the phylum Arthropoda which includes the crustaceans, insects, centipedes, millipedes, and arachnids; the largest animal phylum; characterized by jointed appendages, segmented body, and an exoskeleton.

Carnivore. An animal that eats mostly meat.

Carrying capacity. The total number of any species that a given area of habitat will support at any given time; the number of organisms of a given species and quality that can survive in a given ecosystem without causing deterioration; the largest population the unit can support on a year-round basis, or during the most critical season. Carrying capacity varies throughout the year.

Circadian rhythms. Activity patterns associated with a 24-hour cycle.

Community. A group of populations of plants and animals that occupy the same habitat or area and interact with each other.

Crepuscular. The activity time of wildlife species with peak activity occurring around dawn and dusk.

Disturbance. An act that causes organisms to alter their position, arrangement, or behavior.

Ecosystem. An ecological system; a natural unit that includes the community of organisms and the physical environment in which they exist; a cyclic interchange of materials takes place between the living and nonliving units.

Endangered. An official (legal) designation for a species which is in danger of extinction throughout all or a significant portion of its range.

Environment. The total of all the surroundings including physical, biological, and all other factors which comprise the habitat in which an organism exists.

Estuary. Area where freshwater meets and mixes with salt water.

Ethogram. A species-specific outline showing how a species performs basic behaviors.

Ethology. The study of animal behavior.

Exotic. An organism which is not native to the area where it occurs, that is, introduced.

Extirpation.

Feral. Used in wildlife as referring to domesticated animals gone wild, for example, cats, dogs, hogs.

Forage. Refers to vegetation taken naturally by herbivorous animals (n); the act of eating vegetative materials (v).

Habitat. The arrangement of food, water, shelter, and space suitable to an animal's needs. It is the life range which must include food and water as well as escape cover, winter cover, cover to rear young, and even cover in which to play.

Herbivore. An animal that eats mostly plants.

Hibernation. The act of passing the winter, or a portion of it, in a torpid or resting state where body functions are greatly slowed.

Homeotherm. Organisms able to maintain a nearly constant body temperature; often used to describe mammals and birds.

Indigenous. A naturally occurring species.

Life cycle. The complete life history of an organism from any one stage to the recurrence of that stage.

Limiting factors. Influences in the life history of an animal, the abundance of which inhibits a population from reaching its biotic potential, for example, food, water, shelter, space, disease, predation, climatic conditions, pollution, accidents, hunting, etc.

Management. The manipulation of habitat and/or the organisms within the habitat to achieve some predetermined goal.

Mitigate. To make up for; to substitute some benefit for losses incurred.

Niche. A position or activity occupied by a species in reference to other species.

Nocturnal. Active by night; the opposite of diurnal.

Omnivore. An animal which eats a broad range of plant and animal materials.

Otolith. A tiny bone-like particle or plate-like structure found in the inner ear of fish (and other lower invertebrates). They can be beneficial to research studies since they grow with the fish and deposit annual growth rings.

Parasite. An organism that lives by deriving benefit from another organism, usually doing harm to the organism from which it derives benefit.

Pathogen. A disease-causing organism.

Polygamous. Having more than one mate at a time.

Population. A group of interacting individuals of the same species or smaller *taxa* in a common spatial arrangement.

Population dynamics. The totality of changes that take place during the life of a population.

Predator. An animal that kills and eats other animals.

Prey. Animals that are killed and eaten by other animals.

Scat. Excrement; feces; dung.

Scrub. A type of habitat dominated by woody vegetation composed principally of shrubs or shrub-like trees.

Seral. Refers to a particular stage along the successional continuum from the initial stage, through transitional stages to the climax community.

Site fidelity. The instinctual tendency of an animal to remain at or near a particular location.

Slough. An inlet from a river; backwater; tideflat; a creek in a marsh.

Species. A group of related individuals with a shared evolutionary history and able to interbreed and produce fertile offspring under natural conditions; a category of biological classification immediately below the genus or subgenus.

Succession. The orderly, gradual, and continuous replacement of one population or community by another.

Terrestrial. Ground-dwelling.

Territory. The concept of dominance over a unit of habitat; an area defended by an animal against others of the same species; used for breeding, feeding, or both. Many species of wildlife are territorial.

Threatened. An official (legal) designation for a species present in its range but in danger of extinction in the future if current trends (declines in numbers) continue. Additional population declines could lead the species to be listed as endangered.

Vector. An organism, usually an arthropod, which transports a pathogen.

Wetland. Land permanently or periodically flooded by water or where water is the dominant factor affecting the characteristics of soil, and supporting distinct plant and animal communities.

Wildlife. Animals that are not tamed or domesticated; may be small organisms only visible to humans if seen through a microscope, or as large as a whale. Wildlife includes, but is not limited to, insects, spiders, birds, reptiles, fish, and mammals, if non-domesticated.