Wildlife Management Concepts and Terms

Wildlife management is both art and science that deals with complex interactions in the environment. Before you can evaluate wildlife habitat and make management recommendations, some basic concepts used in wildlife management should be understood. It is critical to understand basic concepts about wildlife ecology and wildlife habitat requirements before management practices can be recommended to enhance habitat and manage populations for a particular wildlife species. Some of the basic concepts are described in this section. WHEP is based on these concepts, so it is important to study and understand them.

Definitions of various words or terms may be found in the **Glossary**. Look up the definitions of words or terms you do not understand in a dictionary, wildlife management or ecology textbook, field guide or the glossary found in this handbook. Extension Wildlife Specialists, Extension educators, and local state agency wildlife biologists can provide clarification if needed. Wildlife management textbooks offer more in-depth reading and explanation.

Concepts and Terms

- Organization of Life: Species, Communities, Ecosystems, and Landscapes
- Biotic Communities, Climate, and Soils
- Plant Succession
- Habitat and Habitat Requirements
- Species Richness and Diversity
- Nonnative and Invasive Species
- Focal Species and Ecosystem Management
- Edge
- Arrangement and Interspersion
- Area Sensitive Species
- Buffers and Corridors
- Vertical Structure
- Carrying Capacity
- Compensatory and Additive Mortality
- Home Range, Movements, and Migration
- Food Webs
- Pond Dynamics and Balance
- Stream Habitat

Organization of Life: Species, Communities, Ecosystems, and Landscapes

A ***species*** is a group of individuals that can interbreed and produce viable offspring. A ***population*** is a group of individuals of the same species interacting and living in a given area. Populations of various species interact to form communities. Therefore, a biotic (living) ***community*** includes all the plant and animal populations living in a defined area. Communities interact with the abiotic (nonliving) resources (soil, air, water, and sunlight) to form what is known as an ***ecosystem***. The size of the area involved when defining communities or ecosystems can vary. For example, the interacting communities of organisms associated with a decaying log or within an ephemeral pond may form an ecosystem. Likewise, this can be expanded to include all the communities associated with a forest ecosystem. The ***landscape*** is a larger area that composes interacting ecosystems.

Biotic Communities, Climate, and Soils

A biotic (living) community includes all the plant and animal populations living in a defined area. The composition of a biotic community changes over time in response to plant succession and climate (rainfall and temperature). Communities interact with the nonliving, or abiotic, resources (soil, air, water and sunlight).

The relationship between climate (rainfall and temperature) and soils affects vegetation and types of wildlife species which live in a particular area. The Eastern Deciduous, Grassland – Tallgrass/Mixed Prairie, and Southeast Mixed and Outer Coastal Plain Forest ecoregions of the state reflect different climate and soil conditions, though they may be blurred along boundaries where these ecoregions meet. Within these ecoregions, Wetlands and Urban ecoregions can be found.

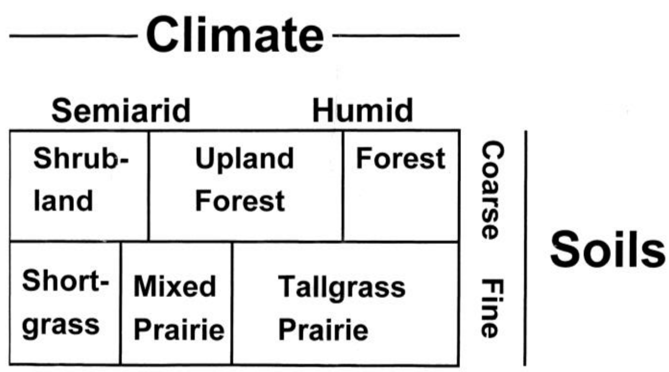


Figure 1. The type of climate and soil determines the type of plant community found in a particular region in the United States.

Much discussion has occurred nationally and globally about climate change. In Arkansas, data from a weather station at the U of A Southwest Research and Extension Center in Hope suggests periodic cycles of heat/drought and cooling/flooding are normal for that part of the state. The Center has temperature and rainfall data spanning almost 100 years and is reportedly the second oldest continuous weather dataset in Arkansas. Their data indicate unpredictable warming and cooling cycles have occurred with relative frequency over the past 100 years.

Plant Succession

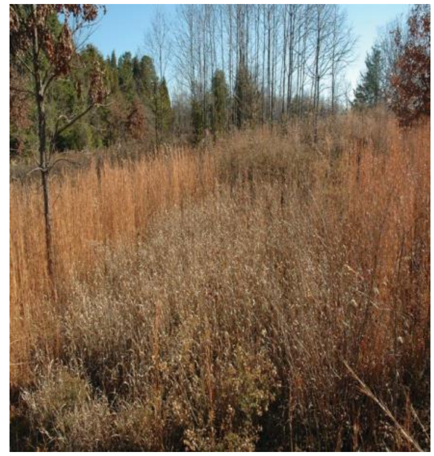


Figure 2. Plant succession involves a change in plant species composition over time. This field represents an early successional stage with blackberry, persimmon, and scattered oak trees pioneering into perennial grasses (switchgrass and broomsedge).

Plant succession represents the orderly and fairly predictable change in plant species that occur in a particular area over time. Various plant species that typically occur together represent plant communities, or vegetation types. The sequence of vegetation types which replace one another in an orderly progression during plant succession is called a ***sere***. Thus, each vegetation type represents a seral stage, which is also commonly called a successional stage.

Climate, soils, and disturbance events determine which plant species (and therefore vegetation types) are found on a particular site. Climate, soils, and disturbance events (such as fire, wind storms, ice storms, flooding) are highly variable; thus, there are many vegetation types that can occur within any of the ecoregions represented in this handbook. Examples of vegetation types include an oak-hickory forest; an emergent wetland with cattails, sedges, and smartweeds; a stand of loblolly pines; a grassland dominated by big bluestem and Indiangrass; a thicket of brambles and blackberries; or a fallow field of annual forbs, such as common ragweed, horseweed, and fleabane.

Depending on climate in a particular ecoregion, there may be several or only a few successional stages that compose a sere. For example, in the Eastern Deciduous Forest ecoregion where annual precipitation may average 40+ inches, annual grasses and forbs represent the initial successional stage following soil disturbance. Perennial grasses, forbs, and brambles dominate by year 2 or 3 after the disturbance. Woody species, such as winged sumac, winged elm, eastern redcedar, and persimmon might become prevalent within 7 or 8 years after disturbance. Various oaks, hickories, yellow-poplar, and other tree species may slowly pioneer into the site and dominate the area within 20 years. Without additional disturbance, such as fire, maples may eventually dominate the forest within 100 – 150 years. Approximately 5 seral stages (or successional stages) can be expected to compose a sere on many sites within the Eastern Deciduous Forest ecoregion. Development of the later successional stages in a sere is continual, but slow, as one successional stage gradually develops into the next. As a result, the process can be imperceptible to many people. Full development of some seres takes longer than the average lifespan of a human.

Descriptions of the successional process in different ecoregions in Arkansas can be found in the *Ecoregions* section of this handbook. Successional stages can be difficult to identify or distinguish. Plant identification skills and some knowledge of plant community ecology are helpful.

The final seral stage that a site will transition to in the absence of disturbance is called the ***climax seral stage.*** The climax seral stage is dominated by plant species that can reproduce and replace themselves without additional disturbance. In ecoregions with sufficient rainfall (such as Eastern Deciduous Forest and Southeast Mixed Outer Coastal Plain Forest), early successional plant communities ultimately succeed to forests. In drier ecoregions (such as Great Plains Grasslands, Prairie Brushland, and Hot Desert), fewer seral stages compose the sere. In Arkansas, glade habitat along rocky hillsides is a mico-habitat in which some plant species found in drier ecoregions can be found. (The Arkansas Natural Heritage Commission's website has information about glades, as well as other natural areas.) Vegetation communities of perennial grasses, forbs, shrubs, and cacti may represent the climax seral stage. Disturbance events, such as fire, grazing, ice and wind storms, lightning, and flooding, continually set-back succession and the process starts over.

Although succession is set-back through natural disturbances, many natural disturbances have been disrupted by humans. For example, levees have been built to prevent natural flooding, and great effort is expended to suppress and control fire. Also, extensive plantings of nonnative sod-forming grasses have unnaturally altered or interrupted succession in nearly every ecoregion of the country. Because of their dense nature at ground level, the seedbank is suppressed and response (thus succession) is suppressed. Suppressing succession is called ***arrested succession***.

Plant succession is an important concept for wildlife managers. As succession takes place and vegetation composition changes, the structure (density and height of vegetation, or cover) of the vegetation change. These changes affect the type of food available for wildlife. **As vegetation structure and food availability change, the wildlife species that use the area also change, because different wildlife species have different habitat requirements**.

All wildlife species are associated with various plant communities or successional stages. Some species, such as wild turkey, white-tailed deer, and coyote, may use several successional stages to meet various life requirements. Others, such as grasshopper sparrow and ovenbird, may only be found in one or two successional stages. The fact that different wildlife species require different vegetation types highlights the importance of having a diversity of successional stages, *if* a diversity of wildlife species is a goal or consideration.

Figure 3. Oak or pine savannas and woodlands represent early successional vegetation with scattered trees. However, without continued fire, savannas and woodlands will change into forests.

The compositional and structural changes of plant communities following disturbance events are fairly predictable within a given ecoregion. Wildlife managers intentionally manage disturbance to provide the appropriate successional stage(s) for various wildlife species or groups of species. Wildlife management practices, such as prescribed burning, timber harvest, selective herbicide applications, grazing, and disking, can be used in the absence or interruption of natural disturbance events. Alternatively, planting various plants (especially trees and shrubs) and lack of disturbance will advance succession.

Identifying successional stages can be difficult where grasslands, savannas, woodlands, and forests all occur. Grasslands are areas dominated by herbaceous plants (grasses, forbs, sedges, and brambles) and very few, if any, trees. Savannas and woodlands are areas with sparse to moderate tree cover and a well-developed understory of herbaceous plants. Forests are dominated by tree cover. In areas with abundant precipitation, grasslands, savannas, and woodlands will become forests if not continually disturbed (usually with fire). *When evaluating a savanna or woodland in these areas, it is not important to define the successional stage.* Instead, evaluation of the structure and composition of the plant community and whether it provides habitat for the wildlife species under consideration is most important.

Descriptions of a typical successional stage can be found in the regions section of this handbook.

Conceptual learning tools

To illustrate the concept of plant succession, the following diagram and photos are provided. In previous WHEP handbooks, successional stages were numbered to help define plant communities and the structure they represent. Most wildlife biologists describe plant succession in terms of the composition and structure of the plant communities, rather than stating “stage two,” for example. These successional stage numbers were used as a teaching tool for plant succession. Although the stage numbers are no longer applied in the contest, they are presented here as a way to help learn this concept.

Stage 1: Bare ground
Stage 2: Annual forbs and/or grasses
Stage 3: Perennial forbs and grasses
Stage 4: Shrubs
Stage 5: Young forest
Stage 6: Mature forest

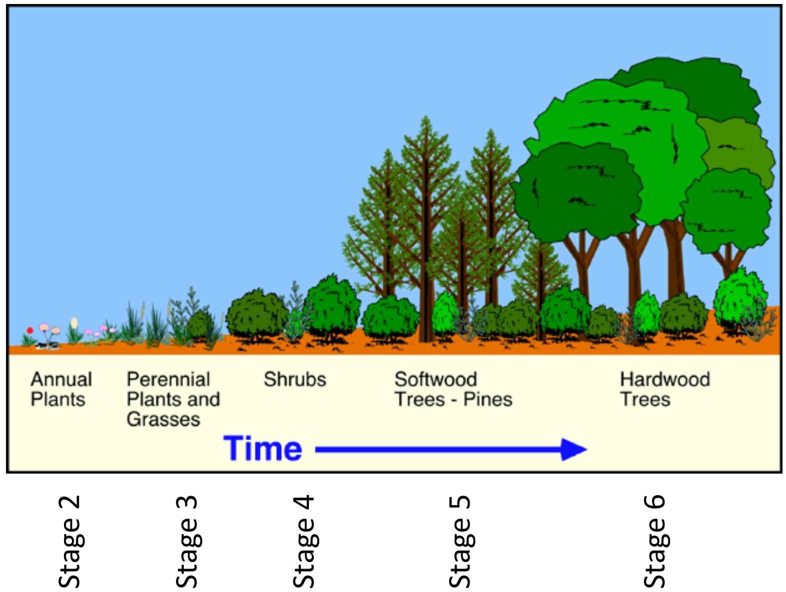


Figure 4. Plant Succession. Illustration from Pidwirny, M. (2006). "Plant Succession". *Fundamentals of Physical Geography, 2nd Edition*. January 27, 2009. http://www.physicalgeography.net/fundamentals/9i.html

Successional stages have been defined and numbered for simplicity, though in reality successional stages can be difficult to distinguish. That's because succession is continual, and one successional stage gradually develops into the next. When evaluating habitat, consider the dominant plants in the area. For example, both annual and perennial grasses and forbs are often present in early successional areas. Brushy areas often slowly develop into young forest, depending on the species present.

Stage 1 – Bare ground.

Stage 2 – Annual forbs and/or grasses.

Stage 3 – Perennial forbs and grasses.

Stage 4 – Shrubs.

Figure 5. Photos illustrating successional stages.

Habitat and habitat requirements

Habitat represents the physical and biological resources (food, cover, water, space) required by a particular wildlife species for survival and reproduction. Habitat requirements are species specific. That is, not all species require the same resources in the same amount or distribution. If those resource requirements are provided in a particular area for a particular wildlife species, then that area represents habitat for that species. There is no such thing as “suitable habitat”—the area either is, or isn’t, habitat for a particular species. Habitat *quality* may range from excellent to poor, depending on resource availability, but if the minimum habitat requirements for a given species are not provided, then the area is not considered habitat for that species.

Habitat should not be confused with vegetation or vegetation types, such as a mature hardwood forest or grassland. Some wildlife species may find all of their habitat requirements within one vegetation type. For example, an eastern gray squirrel may live its entire life within one mature oak- hickory stand. However, other species, such as white-tailed deer, thrive in areas with considerable interspersion of vegetation types. Thus, habitat for these species usually includes several vegetation types or successional stages.

Although the term “habitat type” is often used interchangeably with “vegetation type,” it is confusing, technically inaccurate, and should be avoided.

Differences in habitat requirements among some species are subtle, whereas differences in habitat requirements among other species are dramatic. For example, habitat requirements for northern bobwhite and American kestrel are somewhat similar. They both require cover dominated by shrubs, forbs, and grasses. Bobwhites primarily eat various plants, seed, mast, and insects. Kestrels prey on other animals, including small mammals, lizards, and insects. Even though bobwhites and kestrels may use the same vegetation type or successional stage, their habitat requirements are different. Habitat requirements for eastern gray squirrel and mourning dove are not similar at all. Although they may be found in the same ecoregion, they use different vegetation types and foods and have different space requirements.

Habitat requirements for various wildlife species often change through the year or life stage. Food and cover resources needed during one season or for one age of animal may be much different than what is required or available during another. For example, wild turkey hens and their broods spend the night on the ground where there is adequate groundcover until the poults are able to fly. During summer, wild turkey broods use early successional areas with abundant forbs where they feed upon insects and are hidden from overhead predators. As young wild turkeys reach 2 to 3 weeks of age they roost in trees and shrubs. As mast becomes available in the fall, wild turkeys are frequently found in mature hardwood forests when available.

Species richness and diversity

Species richness refers to the total number of different species present in an area. Species richness differs from diversity in that diversity not only accounts for the number of species present in an area, but also how those species are distributed and how abundant each species is on that area. One goal in wildlife management may be to provide habitat for as many different species as possible, as contrasted to managing for a maximum number of individuals within a species or limited number of species. Generally, habitat requirements are provided for more wildlife species when a variety of vegetation types and successional stages are present in an area.

Nonnative and invasive species

Many plants and animals have been introduced, either accidentally or intentionally, into the United States from around the world. These species are commonly referred to as nonnative. Some nonnative species are most useful and have filled a need in our society. For example, wheat (native to southwest Asia) and soybeans (native to northeast China) are two nonnative plants that have provided high-quality foods for both humans and wildlife in the U.S. The domestic cow (ancestors native to Europe and Asia) and chicken (ancestors native to Asia) are examples of nonnative animal species that provide benefit for our society.

Some nonnative species have become naturalized. That is, they are able to maintain populations in the wild. Many of these species have not only become naturalized, but they have become competitive with native plants and animals, sometimes displacing native species. Some naturalized nonnative species are actively managed, such as ring-necked pheasants (native to China), brown trout (native to Europe), wild goats (western Asia), and white clover (native to Europe).

Often, nonnative species are successful because the climate is similar to that from which they originated and they do not have many natural pests or competitors that may have limited them in their native range. Some nonnative species are so favored by the conditions where they were introduced that they spread at incredible rates and controlling them can be very difficult. These species are both nonnative and invasive. Kudzu (native to Asia), cogongrass (native to southeast Asia), and Japanese stiltgrass (native to eastern Asia) are examples of nonnative invasive plants. Norway rats (native to Asia) and silver carp (native to Asia) are examples of nonnative invasive wildlife and fish.

Nonnative invasive plants contribute to loss of habitat for native wildlife and fish species and can lead to population declines of both native plants and wildlife species. Nonnative invasive wildlife and fish often outcompete native wildlife and fish and cause population declines of native species.

Top Ten Abundant Invasive Plants for Arkansas (Center for Invasive Species and Ecosystem Health, 2012)

1. Japanese honeysuckle
2. Chinese privet
3. sericea lespedeza
4. shrubby lespedeza
5. fall fescue
6. mimosa
7. Japanese privet
8. kudzu
9. johnsongrass
10. chinaberry

Nonnative invasive species (both plants and animals) pose a considerable challenge for natural resource managers. Many nonnative invasive species are extremely difficult to control or eradicate. Herbicide applications, prescribed fire, mechanical removal, and biological control are commonly used to limit the impact of nonnative invasive plants on native plants and animals. Not only do nonnative invasive species impact native wildlife and plants, they also impact agriculture production, water resources, municipal capacity, and even human health and safety. Every effort should be made to prevent the introduction of nonnative species that may become invasive. Examples of invasive plant species are below.

Figure 6. Cogongrass.

Figure 7. Sericea lespedeza.

Figure 8. Japanese honeysuckle.

Focal species management and ecosystem management

Wildlife management generally is practiced with a focal species approach or an ecosystem management approach. The ***focal species*** approach involves managing specifically for one or a select few wildlife species. The ***ecosystem management*** approach involves managing for a healthy and functioning ecosystem without focusing specifically on one or more wildlife species. This approach is most often used in an effort to restore imperiled ecosystems on large tracts of land, such as the longleaf pine or shortgrass prairie ecosystems, and allowing the associated wildlife species to respond.

Most landowners have specific objectives or concerns about a particular species. Once the species is determined, resources that may be limiting (such as cover, food, or water) for that species on that property can be identified and the appropriate wildlife management practices can be prescribed. Occasionally, the focal species may be totally incompatible with the area under consideration and management goals and objectives must be changed.

It is best to select wildlife management practices which provide or improve the habitat requirements most lacking or limiting the population (limiting factors). For example, if a species requires trees for cover with water nearby, and the area being evaluated has plenty of trees but no water, a management practice that will supply water will improve the area more effectively than planting trees.

Figure 9. Ecosystem management does not focus specifically on one or more wildlife species, but the health and functioning of the area as a whole.

The size of the area being managed is not a factor when determining whether the approach is focal species or ecosystem management. Some species do not require much space to live. An eastern gray squirrel or eastern box turtle might spend their entire lives on only a few acres. Other species, however, require considerable area. Grasshopper sparrows, for example, are rarely found in grasslands smaller than 100 acres. Even though managing ecosystems would benefit grasshopper sparrows, if increasing the population of grasshopper sparrows over thousands of acres is the objective for the management plan, then it is considered focal species management.

Figure 10. Most landowners identify focal species when managing their property for wildlife, because not all species benefit from the same wildlife management practices.

Wildlife management practices which improve habitat for some wildlife species may be helpful or detrimental to other wildlife species. It is impossible to manage an area for any one species or group of species without influencing other species in some way. For example, if a mixed hardwood stand is clearcut to benefit wild turkey, then white-tailed deer and eastern cottontail may also benefit. However, species, such as ovenbird, wood thrush, and eastern gray squirrel, which prefer mature deciduous forest, will be forced to use another area.

Edge

An ***edge*** is formed where two or more vegetation types or successional stages meet. An obvious example is where a field meets a forest. A less obvious example is where a 40-year-old mixed hardwood stand meets an 80-year-old mixed hardwood stand.

The transition in vegetation types or successional stages can be abrupt or gradual. An example of an abrupt change would be where a hayfield meets mature woods. This type of edge has high contrast and is called a ***hard edge***. A more gradual change would be where a 40-year-old forest meets an 80-year-old forest. A much more gradual change is where an overgrown field with native grasses, forbs, and scattered shrubs blends into a brushy thicket or a 3-year-old regenerating hardwood stand. This type of edge has low contrast and is called a ***soft edge***.

Sometimes the edge or transition between two vegetation types is so gradual, characteristics of both are evident in a relatively wide zone, called an ***ecotone***. A common example of an ecotone is where an upland hardwood stand meets a bottomland hardwood stand. Species transition occurs gradually with the elevation as the upland blends into the bottomland.

Figure 11. A hard edge separates the field and trees.

The abrupt change in species composition and structure (Figure 11) is typical of a hard edge. Allowing native grasses, forbs, and brambles to grow into the field from a woods edge is typical of a soft edge (Figure 12) and increases the amount of "usable space" for many wildlife species by providing suitable cover and food resources.

Figure 12. A soft edge has a transitional area of taller grasses and forbs between the field and trees.

The concept of edge is important in wildlife management. If there is increased edge, then there is increased interspersion of vegetation types or successional stages. This may be beneficial for a particular wildlife species *if*:

- both vegetation types are usable by the species and provide some habitat requirement;
- the arrangement of the vegetation types is suitable for the focal species.

Increased interspersion can also lead to increased species diversity, as more vegetation types are available, and can potentially provide habitat requirements for a larger number of species.

On the other side of the coin, if vegetation types or successional stages present do not provide any habitat requirement for the species in question, the interspersion and resulting edge is not beneficial. **It is important to realize the presence of edge is not always beneficial for any wildlife species.** The habitat needs for the species needs to be carefully considered.

- Some species which prefer unfragmented interior habitat will not respond well to increased edge. For example, areas of 1 acre in size with an edge width of 150 feet basically have no interior. As the acreage increases, more interior habitat becomes available, and habitat quality improves for those species.

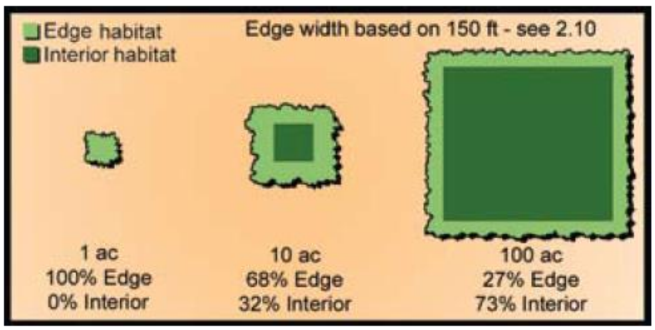


Figure 13. The relationship between edge and interior habitat.

- Some species are found along an edge because the interior of the adjacent vegetation type does not provide any habitat requirement. For these species, the edge is not what is necessarily important, but rather the *composition and structure of the vegetation.* For example, wild turkey and northern bobwhite broods might be found along the edge of a field dominated by tall fescue or bermudagrass. The structure of the vegetation in the field could be too thick at ground level, and the birds cannot walk through it. Practices which promote native warm season grasses and remove sod grasses from the field, or increasing the edge width, would improve mobility and escape cover for these ground-nesting birds. Vegetation management for these birds would increase the carrying capacity of the property.

Figure 14. For those wildlife species considered "edge" species, the physical edge presented where two vegetation types or successional stages meet is not as important as the actual structure presented within a vegetation type or successional stage.

Arrangement and interspersion

How different successional stages or vegetation types are situated in relation to each other is often referred to as *horizontal arrangement* or ***juxtaposition***. Juxtaposition refers to the placing something close together or side by side for comparison purposes. Juxtaposition is important for species which need more than one type of habitat requirement.

Figure 15. The forest and field which a wild turkey needs for nesting and brooding are separated on the left by a barrier (for example a mountain range, river, or highway). The forest and field on the right are next to each other and demonstrate juxtaposition.

Some wildlife species may obtain all of their habitat requirements from only one vegetation type or successional stage (such as eastern gray squirrel, ovenbird). Other species require (or greatly benefit from) more than one successional stage to provide all their habitat requirements (bobcat, northern bobwhite, white-tailed deer, wild turkey, American woodcock). For example, white-tailed deer may forage on acorns in mature mixed-hardwood stands during fall and winter, but use young forest stands with high tree stem densities for escape cover.

Required successional stages should be close to each other to allow for safe travel to and from those areas. Proximity is especially important for species with limited movements and relatively small home ranges.

Interspersion is the frequency of occurrence of different vegetation types. Increased interspersion generally leads to increased "mixing" of vegetation types and often supports a greater diversity of wildlife. However, the vegetation types present and the quality of cover and food resources present in those vegetation types are more important than whether or not there is much interspersion. As interspersion increases, so does the amount of edge. However, as discussed in the section about ***Edge***, increased interspersion is not necessarily beneficial to all species.

Interspersion is easily viewed on satellite images. However, habitat quality cannot necessarily be assessed by viewing satellite images. It is true that where there is increased forest cover, the amount of habitat for eastern gray squirrel is likely increased, and where there is increased grassland cover, the amount of habitat for grasshopper sparrow is likely increased. However, the composition and structure of the vegetation in fields, shrubland, and woods greatly influences habitat quality for many species, and that fine-level analysis is not possible by viewing photos. Walking over the property and taking a closer look is necessary when evaluating habitat for most species.

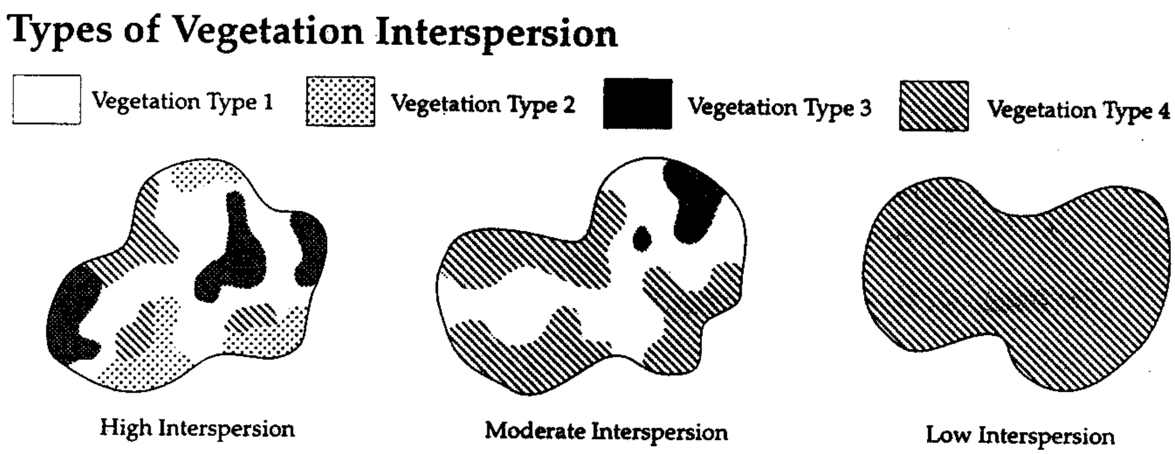


Figure 16. The degree of interspersion or "mixing" of habitat types can be important for some species.

Figure 17. The arrangement of vegetation types and successional stages directly influences animal movements and home range size. Here, nesting cover, brooding cover, and escape cover are all arranged in close proximity (juxtaposed) to favor habitat requirements for northern bobwhite.

Area-sensitive species

Some species need large, unfragmented areas in a certain successional stage to provide some or all of their habitat requirements. Such species are referred to as ***area-sensitive***. For these species, large areas in one successional stage are desirable. Unfragmented habitat of at least 100 acres is considered the minimum requirement for many area-sensitive species. Some species, such as the grasshopper sparrow, may require a minimum of 1,000 acres of relatively unfragmented habitat to sustain a viable population. Others, such as the greater prairie-chicken, may require 30,000 acres of relatively unfragmented habitat.

Figure 18. Fragmentation is harmful to area sensitive species. *Photo courtesy of Chesapeake Workshops Unlimited.*

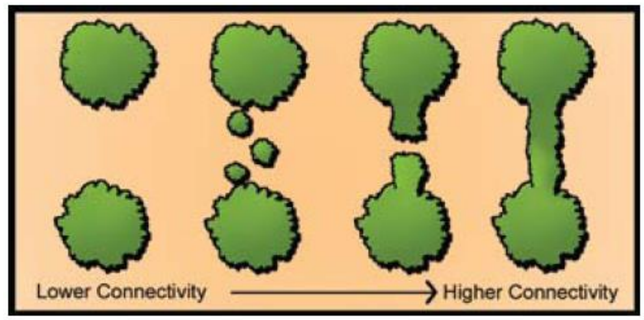
Fragmentation is the disruption of vegetation types either by man or by natural processes. All wildlife species do not respond to fragmentation the same way. For some, the edge between a young forest and an older forest may fragment their habitat, whereas others may not respond to fragmentation except under extreme circumstances such as an interstate highway bisecting a forest or prairie.

In many cases, area-sensitive species are also species of concern. Their populations are declining because of habitat loss.

Buffers and Corridors

Areas of suitable habitat or paths that do not restrict movement are required for animals to move from areas within their home range or during migration. These areas are known as corridors. ***Corridors*** are areas of continuous habitat that permit animals to travel securely from one habitat to another. The type of vegetation within and the size (both width and length) of the corridor varies depending on the animal.

Figure 19. A complete corridor (far right) provides protective cover for wildlife traveling from one area to another. Fragmented corridors offer less protection, but can be better than no corridor at all (far left).



A corridor allows various wildlife species to travel through areas of otherwise unsuitable habitat. In large expansive fields or open areas, riparian buffers, hedgerows or grown up fencerows can act as corridors for wildlife. When landscape becomes broken up (fragmented), only small islands of suitable vegetation might remain. Fragmentation may occur from road construction, urban development, timber harvesting, clearing for agriculture, hurricanes, wildfires, etc. Corridors provide protective travel, escape and nesting cover for certain wildlife species.

However, corridors can be harmful if they are too small. Predators may be attracted to the corridor edge and corridors then become unknowing traps for some animals. Having a narrow corridor increases the chance of a ground nest being discovered by raccoons, skunks, bobcats, and coyotes.

If properly developed, corridors allow animals to meet and mate with other animals of the same species but from different populations, thus maintaining genetic diversity. Corridors also allow animals to find and use islands of suitable habitat that are otherwise not available to them.

Figure 20. A riparian corridor along a stream. *Photo courtesy of the Natural Resources Conservation Service.*

A *riparian buffer* is a type of corridor that occurs along riparian areas, or waterways. A riparian buffer is an area of trees, shrubs, forbs and grasses located adjacent to streams, lakes, ponds and wetlands. Riparian buffers are important for providing habitat and protecting water quality in streams and wetlands. The recommended minimum width is 100 feet, however the width may vary based on various factors including the size and order of stream, as well as topography.

In an urban area, relatively unbroken corridors found along riparian areas and ravines allow wildlife to move into parks and other suitable habitats. Preservation, maintenance, and creation of uninterrupted corridors are very important in urban wildlife habitat management.

Riparian buffers provide shade for summer cooling and cover in the stream or wetland. They provide corridors for wildlife to move from one habitat to another as well as providing nesting cover. Buffers slow overland flow of water and help maintain water quality. They provide structural diversity both adjacent to and within the stream. As trees die then fall into the stream, the large woody debris helps create pools and riffles and provides cover for fish and other aquatic life. Leaves, stems, branches and large woody debris fall into streams, providing nutrition and habitat for aquatic insects, a major food source for fish and amphibians. Insects from the trees fall into the stream and provide a food source for fish, amphibians and other aquatic life. Tree roots improve soil and stream bank stability.

To develop a riparian buffer, implement practices such as planting grasses, forbs, shrubs and trees along streams and wetlands. Fencing off riparian areas from livestock grazing will allow succession to advance, creating a riparian buffer over time. When using forest management practices, especially those that create openings, consider leaving vegetation near bodies of water and promoting growth of existing vegetation near water.

Vertical structure

In most vegetation types, there are distinct layers of vegetation. In a grassland, there is often a litter layer (decaying vegetation on the ground) with one or two layers of grasses and forbs. In a forest or woodland, there may be three distinct layers of vegetation. The understory is composed of those plants growing near the ground, up to 4.5 feet tall. The understory may be very diverse and include grasses, forbs, ferns, sedges, brambles, vines, shrubs, and young trees. The midstory is represented primarily by shrubs and trees more than 4.5 feet tall yet below the overstory canopy. The overstory is made up of those trees in the canopy.

Figure 21. Vertical structure of a forest.

How the different layers of vegetation are arranged in relation to each other is important to many wildlife species. For example, some birds require more leaf litter in a grassland than others. Some like taller grasses whereas others prefer shorter grasses. Some birds may require a herbaceous understory for foraging in the forest, but nest in the overstory.

Figure 22. The vertical structure in this mature oak/hickory forest provides cover and food for a suite of forest songbird species that otherwise would not be found here.

Vertical structure may vary dramatically from site to site, even within a given field or forest type. For example, one mature oak-hickory forest might have a well-developed understory and midstory with visibility of no more than 30 feet, whereas another has very little understory vegetation and no midstory at all. Although they are the same forest type, these two forests would not necessarily provide habitat for the same wildlife species. The structure could be manipulated on these sites depending on the objectives. Thinning and prescribed fire are two management practices commonly used to influence understory and midstory structure in forests and woodlands.

Carrying capacity

There are only so many animals that can live in an area. The concept of carrying capacity is related to the number of animals that can exist in an area. ***Biological carrying capacity*** refers to the maximum number of animals, within a given species, an area can support before that species or another species is negatively affected. The quantity and quality of food, cover, water, and space determines the carrying capacity. The requirement that is in shortest supply, called the ***limiting factor***, determines carrying capacity. Increasing the requirement in shortest supply can increase the area's biological carrying capacity.

Biological carrying capacity varies from season to season and often from year to year. For most species, it is usually greatest from late spring through fall when food and cover are most abundant. This time of year is when most young are born, which helps ensure adequate nutrition and cover are available for growth and survival. With the coming of winter or summer drought, food and cover gradually diminish.

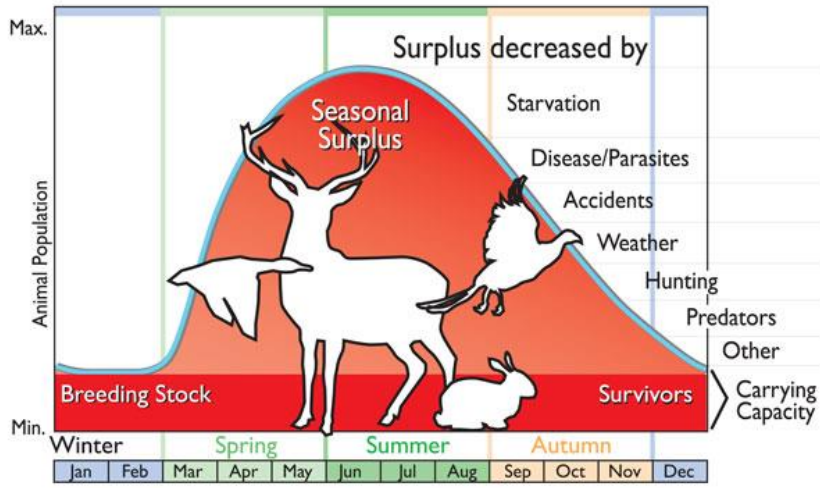


Figure 23. An illustration of factors affecting population fluctuations in relation to carrying capacity.

More animals are produced each year than will survive. Surplus animals are lost to predation, starvation, competition, or disease. Young wildlife and animals in poor health experience the highest mortality rates. Hunting and fishing remove some animals and may help prevent over-population for some species.

In suburban areas, humans often demand the density of certain wildlife species be lower than the biological carrying capacity because of wildlife damage issues. For example, white-tailed deer populations can thrive in suburban areas where the biological carrying capacity is relatively high because deer have adapted to feed opportunistically on ornamental plants. Homeowners generally have low tolerance for deer feeding on expensive landscape plants. The deer population must be reduced to limit damage. In this case, the ***cultural carrying capacity*** (determined by human tolerance) is lower than the biological carrying capacity.

Figure 24. Chronic overbrowsing, by an overabundant deer herd has eliminated the forest understory.

Any area is only able to support a certain number of animals before available food and cover resources are depleted. In Figure 24, overabundant white-tailed deer have exceeded the carrying capacity of the area. Chronic overbrowsing has eliminated the forest understory. A lack of vegetation negatively affects many other wildlife species that require understory vegetation for nesting, feeding, roosting, or escape cover.

Compensatory and additive mortality

Annual mortality is the rate at which animals die per year. The mortality rate for a species is often estimated by biologists to help determine management efforts for that species. Animals die from many causes, including predation, diseases, malnutrition, weather, hunting, accidents, fighting, and others.

All these factors may contribute to the annual mortality rate for a particular species. For example, each of those factors contributes to the annual mortality rate of white-tailed deer in Arkansas each year. However, the number of deer that die from each of these causes of mortality is not the same, and the number of deer that die from each of these causes fluctuates somewhat from year to year.
The number of animals that die from one cause of mortality often influences the number that may die from another cause. For example, increased harvest of deer by hunters in October and November leaves fewer animals in the population that winter. More food is available per animal and the likelihood of deer dying from starvation decreases. Mortality from hunting and mortality from malnutrition are ***compensatory***. As mortality from one cause is increased, the mortality rate of another is decreased. To relate this to the WHEP contest, ***Increase Harvest*** is a management practice that contestants may be recommended to lower white-tailed deer populations, so that food availability is increased per animal and fewer animals are susceptible to winter starvation.

Mortality can be ***additive***. Mortality from one year "adds up" to affect future populations and species survivability. For example, rainfall commonly influences northern bobwhite populations in portions of Texas and Oklahoma. In years with little rainfall, there is less groundcover to provide cover and food and, as a result, fewer bobwhites survive through summer and fall. Thus, the bobwhite population going into winter may be quite low because of malnutrition, predation, and heat stress through the summer. If the population is at a critically low level, additional mortality from hunting through winter may be *additive*, especially if hunting pressure is equal to that in normal years. As related to WHEP contests, if the population of a game species has declined for some reason and is considered too low to sustain the level of mortality experienced recently by regulated hunting or trapping, the wildlife management practice of ***Decrease Harvest*** may be warranted.

Hunting is not the only mortality factor that could be additive. Using the scenario above with relatively few bobwhites surviving through summer and fall, there still may be sufficient numbers of bobwhites to replenish the population when the breeding season begins. However, what if a late winter storm that dumps unusually deep snow and persists for a while? This can limit food availability even further, and more quail die. In this situation, mortality is *additive* from the snowfall. Regardless of whether the population was high or low, a significantly high percentage of the population would have been affected by weather.

It is important for biologists to monitor mortality rates for various species, especially those that are hunted, and be prepared to adjust regulations and management practices to better manage for a particular species. Adjusting regulations and management practices as conditions change and additional information becomes available is termed ***adaptive management***. Adaptive management is a structured management approach for addressing uncertainties by testing hypotheses, linking science to decision making, and adjusting implementation, as necessary, to improve the probability of restoration success. Adaptive harvest management has been used in North America to help determine the number of ducks hunters can harvest with the goal of sustainable waterfowl populations.

Home range, movements, migration, and corridors

A **home range** is the area in which an animal lives. Home range size is related to habitat quality. Daily movements include those for normal day-to-day activities. In higher-quality habitat, home ranges tend to be smaller than in poor habitat, because movements necessary to meet life requirements are reduced. A *seasonal home range* is the area an animal uses in a particular season of the year. A seasonal movement, or ***migration***, is made when an animal moves from one seasonal home range to another. Migration may represent movements to and from wintering and nesting areas, such as waterfowl and songbirds.

Migration distances may be short or very long, depending on the species. Long migrations for some species require habitat along the route to stop, rest and eat. Wildlife managers with shorebird and waterfowl habitat consider this in landscape planning, which means habitat conditions might have to be considered among states, countries, or even continents.

Corridors (also described in this section) are areas that do not restrict movement and allow various wildlife species to move from areas within their home range or during migration. The type of vegetation within the corridor and the size (both width and length) of the corridor varies depending on the species. An example of a corridor might include a stream or river with trees and shrubs along both sides (the riparian zone) cutting through a large grassland. The wooded, riparian corridor facilitates movement for squirrels, deer, wild turkey, and other species that require or otherwise seek the security of wooded cover to cross a broad open area. A smaller version of such a corridor would be a hedgerow traversing a large field. Other examples of corridors might include underpasses facilitating black bear movement under interstates and major highways.

Food webs

Food chains are the step-by-step passage of material and energy (food) through an ecosystem. A network of interconnected food chains is called a ***food web***. It takes an enormous number of individual plants (or amount of phytoplankton) to support the other parts of a food web.

- In terrestrial ecosystems, plants are primary producers in a food chain because they supply food at the lowest level of the food chain.
- In aquatic ecosystems, phytoplankton (microscopic algae) is the base of the pond food chain.
- At the next level of a food chain are primary consumers, plant-eating animals or herbivores. Primary consumers include rabbits, mice, deer, and certain other mammals; some insects and fish; and dabbling ducks, geese, and certain other birds. In aquatic ecosystems, zooplankton and aquatic insects feed on phytoplankton.
- Primary consumers are eaten by secondary consumers, or carnivores (meat-eaters). This group includes predators, such as birds of prey, snakes, foxes, cats, and people. In aquatic ecosystems, zooplankton and aquatic insects are eaten by small fish. Small fish are eaten by larger fish.

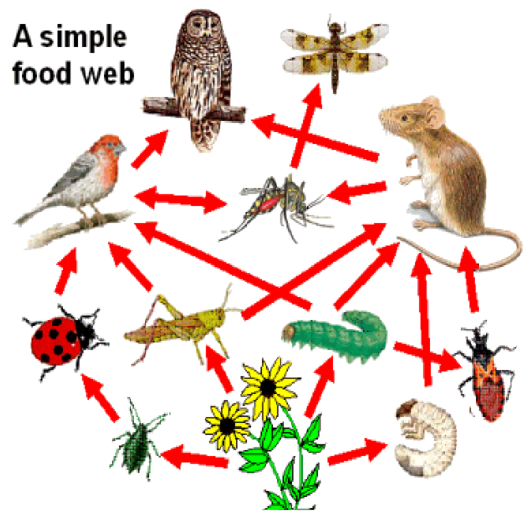


Figure 25. A simple food web. Source: John R. Meyer, North Carolina State University

- Secondary consumers are eaten by tertiary consumers, which may be predators or scavengers, such as turkey vultures, crabs, and sometimes people. Predators are necessary to buffer populations of various prey species. For most predators, when one prey species begins to decline, other prey species become more prevalent in the diet.
- Any of the food web components mentioned above can be broken down by decomposers— organisms such as bacteria and fungi that reduce dead plant or animal matter into smaller particles. A decaying plant, for example, will be broken down into nutrients that enrich the soil. This process supports the growth of more plants and thus, more animals.

Note these categories are very broad and general. Many animals fit into more than one group, and there are more complex levels of a food web. An example is an omnivore, which is an animal that eats both plant and animal matter.

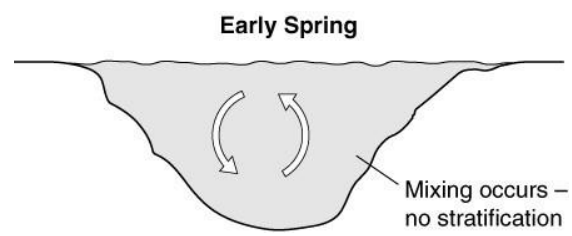
Pond dynamics and balance

Thousands of farm ponds dot the landscape across rural Arkansas. These non-free flowing bodies of water are considered to be ponds when they are less than 20 acres. What's more, they are scenic, functional, and deeply affected by the interplay of a host of environmental factors, such as temperature, oxygen content, nutrients, and biological activity.

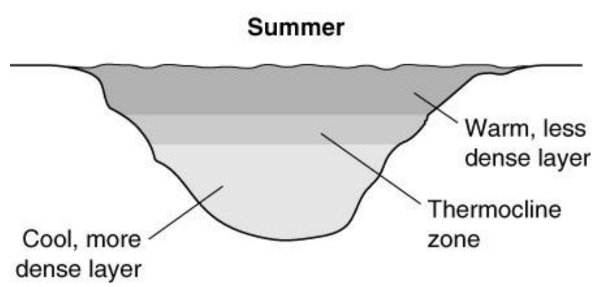
Ponds and temperature

Take the case of changing temperatures within a pond. Water reaches its maximum density, or weight, when its temperature is 39 F. As temperatures either drop below or rise above 39 F, water density lessens. This is important because water density has a major effect on the stratification, or layering, of water. And stratification can sometimes affect oxygen levels available for fish and other aquatic life. To understand how this can happen, take a look at the seasonal stratification process.

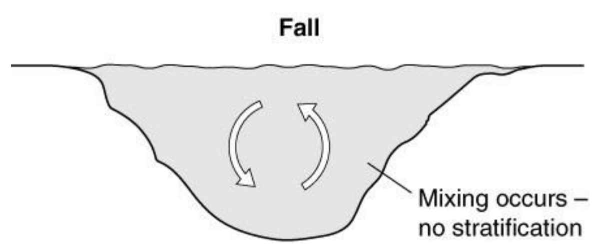
Spring. In early spring, the different layers of water mix. But as surface water warms, it decreases in density or weight. A layer of warmer, less dense water forms on top, while the cooler, denser water forms a layer near the bottom of the pond. Stratification has begun.



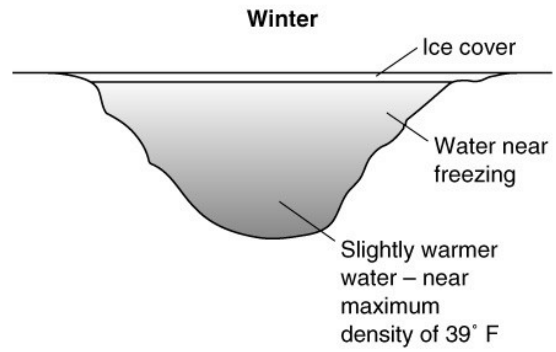
Summer. As summer progresses, so does stratification. The warmer water remains on top, while the cooler water stays below. In between the two layers, a transition zone forms during the summer. This "thermocline" zone is characterized by a rapid change in temperature.



Fall. During fall, stratification disappears, allowing surface and deeper waters to mix. This is sometimes known as the "fall turnover" and may be characterized by a temporary change in water color or turbidity (cloudiness). As water mixes, sediment from the bottom is stirred up, causing the water to become a muddy brown.



Winter. Stratification returns in winter. A layer of colder water (near freezing) forms on top, just beneath the ice cover, while slightly warmer water (near 39 F) stays close to the bottom.



This pattern is the typical way in which stratification plays out over the seasons. But problems can arise if the pond's "turnover" occurs prematurely during the summer. If there is a heavy, cold rain, the cold, dense water sinks, causing oxygen-depleted water at the bottom to mix with the surface waters. The result: There is less oxygen in the surface water. In some cases, "catastrophic oxygen depletion" can even lead to a large fish kill in the pond.

Ponds and dissolved oxygen

In addition to the problems posed by premature turnover, ponds can become oxygen depleted for other reasons—such as when there is an overabundance of microscopic plants (which give the pond a green color) coupled with several cloudy days.

Photosynthesis by aquatic plants produces oxygen during the day. But at night, these plants consume a lot of the oxygen. Therefore, if you have several cloudy days, the plants may not produce as much oxygen by day—and then they deplete the oxygen at night. This can lead to early morning fish kills. Other factors that affect oxygen levels include the following:

- ***Temperature.*** Warmer water holds less dissolved oxygen than cold water.
- ***Biological Oxygen Demand*** (BOD). This is the amount of oxygen required for microbes as they decompose organic materials. Large amounts of decomposing material create a high BOD, lowering dissolved oxygen levels for fish.
- ***Time of year***. If a pond is covered by ice and snow in winter, dissolved oxygen content can plummet, leading to winter fish kills. Seasonal turnover of water can also create low dissolved oxygen levels near the surface.

Ponds and nutrients

Nutrients such as nitrogen and phosphorus are essential for aquatic plants and microbial activity. However, excessive levels of these nutrients can create an overabundance of plant growth. Surface runoff from nearby lawns or fields that have been fertilized can lead to excessive weed growth, including filamentous algae—better known as "pond scum."

Ponds and biological activity

Depending on the depth of the pond, two or three biological zones may be present.

- ***The Littoral Zone*** is close to shore. It has an abundance of rooted and floating plants, and it contains a diverse biological community.
- ***The Limnetic Zone*** is found in deeper water away from the shore. It contains a large amount of microscopic organisms.
- ***The Profundal Zone*** is the lowest zone, found only in deep ponds. It receives little or no sunlight, and organisms rely on the settlement of organic matter to the bottom for survival.

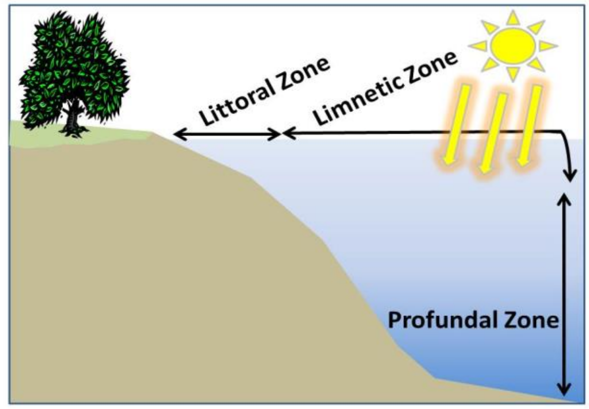


Figure 26. Illustration of pond depths.

All ponds require some aquatic plants to be present for fish habitat and oxygen replenishment. Living trees along the shoreline provide shade, as well as organic matter for fish to feed on. Dead trees in ponds provide habitat for aquatic insects and cover for young fish.

Phytoplankton (microscopic algae) are the base of the pond food chain. Zooplankton and aquatic insects feed on phytoplankton, which are eaten by small fish. Small fish are eaten by larger fish. Managing phytoplankton through fertilizing and liming (if necessary) is the key to producing abundant and healthy fish populations. Suspended mud in ponds blocks sunlight, and algae cannot bloom. Low water levels can cause significant problems also. Improperly constructed or damaged spillways can lead to excessive dam erosion. Low water levels, resulting from damaged spillways or improperly sloped banks, can lead to excessive aquatic vegetation along pond margins.

A properly managed pond can provide excellent fishing. The basics of a well-managed pond are properly stocking the right species, a balanced harvest, proper fertilization, a stable water level and aquatic weed control. Pond balance occurs when a balance between prey and predator fish is established and maintained. In most warm-water ponds, bluegill is the prey species and largemouth bass is the predator species. In cold-water ponds, a trout species is usually the predator, and insects and small fish are prey. Balance between predator and prey is achieved by establishing an adequate food chain for the prey species and controlling the prey and predator species numbers through fishing.

Each pond, no matter how small, is a dynamic aquatic ecosystem. As with any ecosystem, a change in one part of the system will affect the other parts. So be sure to consider all aspects when managing your pond.

Stream habitat

A stream can be defined as a body of water moving in a definite pattern and following the course of least resistance to a lower elevation. Because water volume and rate of land erosion fluctuate along the course of the stream, the bottom and shoreline are relatively unstable. As the water moves, it carries materials that have been picked up—such as gravel, sediment and debris—and redistributes them along the stream course. When water flow is restricted to a narrow area, the stream can create more erosion, resulting in deeper areas or pools. As the stream passes through wider passages, the water flow slows and material is deposited to form areas known as riffles.

Pools and riffles are important habitat features for various fish species that inhabit streams. Pools provide areas for fish to feed and find refuge from fast-moving water that requires more energy for swimming. Riffles are usually preferred areas for spawning. It is important that fish have the ability to move freely between various features in the stream. While some species can complete their life cycle within a small portion of the stream, other species, such as salmon, must migrate to the ocean and return to the stream to spawn.

Riparian buffers (such as grass or forest plant communities) are important to filter sediment entering aquatic systems. They can also regulate water areas and provide wildlife habitat. ***Riparian buffers*** are vegetated areas along streams and ponds. They may be forested or grassy depending on the water body. Vegetated buffers are important to maintain streambank stability as the roots of the vegetation along the stream help to hold the soil in place along the stream. Additionally, the above ground vegetation in buffers filters sediment from water moving into the stream or pond after rainfall events. Water quality is impacted by the amount of buffer along these wetlands. Finally, buffers of vegetation provide shade to keep the water temperatures during summer lower, which may allow for cold-water fish species to survive.

Figure 27. Clean water is essential for healthy aquatic life. Water quality is improved and fish populations benefit when sufficient vegetation is present along riparian areas to buffer sedimentation and nutrient run-off.

Acknowledgments:

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