NRCS Natural Resources Conservation Service

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Bog Turtle
(*Clemmys muhlenbergii*)

October 2006 *Fish and Wildlife Habitat Management Leaflet* *Number 44*

Introduction

The bog turtle, North America's smallest turtle, is primarily found in fens, bogs, wet meadows, and emergent freshwater wetlands associated with streams and bordered by wooded areas in the Northeast and mid-Atlantic regions of the United States. Bog turtles have never been widely distributed, but continued loss and degradation of habitats have further reduced their occurrence to isolated pockets within northern and southern parts to their historic range. Because of dramatic population declines in the 1980s and 1990s, northern populations of bog turtles were listed as a federally threatened species on November 4, 1997. It is prohibited to collect individual turtles from these populations, and interstate and international commercial trade is banned. Because of the similarity in appearance between the southern and northern populations, pet dealers have difficulty distinguishing between the two. Due to this, the southern population has since been listed as threatened, as well.

This leaflet provides an introduction to the habitat requirements of the bog turtle and is intended to assist landowners and managers plan, implement, manage, and monitor for bog turtles. The success of any species-specific management plan depends on targeting the needs of the desired species and analyzing existing habitat conditions to ensure that the required habitat elements are present. This leaflet provides a number of practical habitat management practices that can be used to improve bog turtle habitat. Landowners and managers are encouraged to enlist the expertise of wildlife and natural resource professionals to help identify additional habitat management needs and actions.

Description

Bog turtles are characterized by their small size (about 3 to 4 inches long), dark color, and large yellow to orange colorations on both sides of the head. Head coloration of juvenile and newly hatched bog turtles is lighter, whereas older adults have brighter and more intensely colored blotches. The upper shell is usually black to mahogany-brown and may be marked with lighter whitish to yellowish rays of color. The lower shell, or plastron, is usually black with varying amounts of white or pale yellow patches. The body is very dark brown or black, sometimes with streaks of red or orange. The top of the head is usually speckled with black and the lower jaw may be spotted with red or orange. The upper jaw is notched creating two sharp points on the beak.

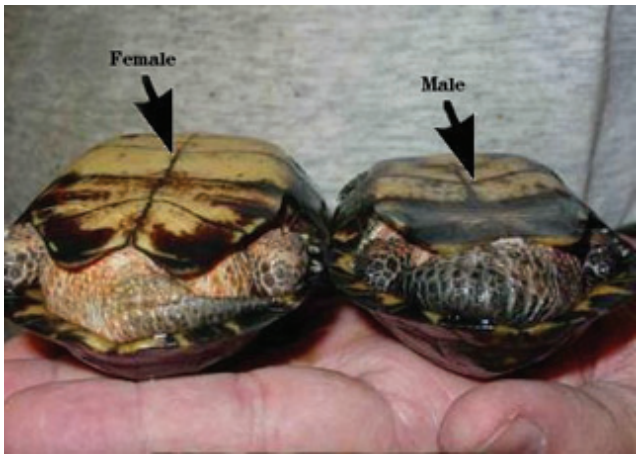
Bog turtle (*Clemmys muhlenbergii*)

There is a high degree of sexual dimorphism in bog turtles, making it fairly simple to distinguish between the male and female. Male shell lengths tend to average 3½ to 4 inches, while females are 3 to 3¾ inches in length. The plastron is dished or concave in males, while the female's plastron is flat. Male bog turtles have long, thick tails with the cloacal opening extending past the edge of the under shell, and females have shorter tails with the cloacal opening inside the under shell.

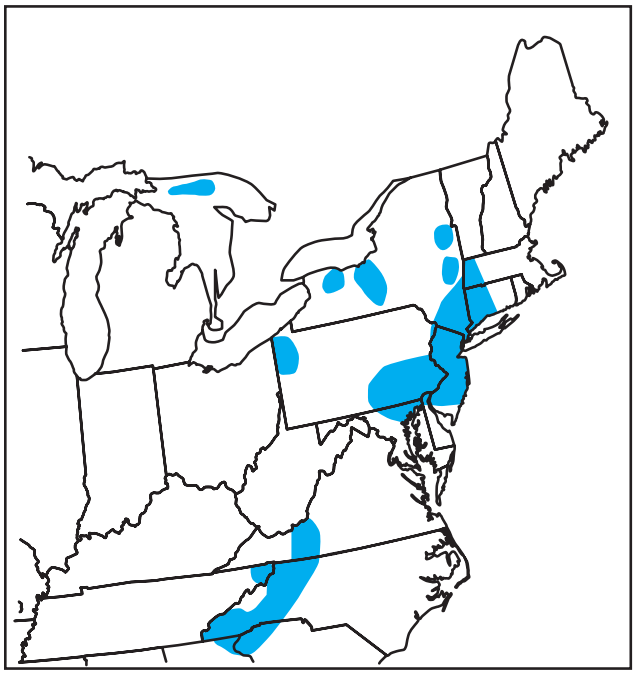
Distribution

The northern populations of bog turtles are found in western Massachusetts and Connecticut, south to New York, New Jersey, Pennsylvania, Delaware, and Maryland. The southern population, separated from the northern population by 250 miles, begins in southwestern Virginia and ranges through North Carolina, Tennessee, and South Carolina to northern Georgia.

Currently, the range is diminishing, and fewer then 200 sites in the northern range have been found to contain populations of bog turtles. Additionally, based on habitat quality, it has been found that only 35 of 176 assessed sites in North Carolina were capable of supporting healthy bog turtle populations. Please reference the U.S. Fish and Wildlife publication Bog Turtle (*Clemmys muhlenbergii*) Recovery Plan at *http://www.wcs.org/media/file/Cm_Recovery_Plan.pdf* for county specific locations of bog turtles within the above regions.



Male bog turtle (right) with the concave plastron and the female (left) with the flat plastron



The northern and southern populations are separated by 250 miles.

Behavior

Bog turtles are a very secretive species, often burrowing in muck or vegetation undetected. Bog turtles are primarily diurnal and emerge from cover in early morning and bask until they move off in search of food or mates. In the hottest part of the day, bog turtles seek shade until the evening when activity resumes. Bog turtles are active at air temperatures between 60 and 87 degrees Fahrenheit; however, as air temperature increases throughout the summer, bog turtles will congregate in wet areas and inhabit networks of tunnels partly or completely filled with water.

The species begins hibernation in late September and will use abandoned animal burrows, cavities in mud, sedge clumps, the base of tree stumps, or shrubby hummocks for hibernacula (a hibernation location), occasionally hibernating with other species of turtles. Hibernacula tend to be in secretive, protected areas to hide the turtle from predators and the moderate temperature extremes during the harsh winter months. Turtles emerge in late March to April when the air and water temperature exceeds 50 degrees Fahrenheit.

Reproduction

Mating occurs in spring (sometimes in the fall) near the hibernaculum. The females are known to be very secretive during mating season, and the males travel to locate them. Nesting usually occurs in the late afternoon or early evening from May to July. The female digs a cavity with alternating scoops of the hind feet

Nests are often located inside an open, grassy tussock.

and lays one to five eggs in the nest, generally located inside the upper part of an open, grass tussock, or sphagnum moss (*Sphagnum* spp.). Incubation lasts 42 to 56 days.

Eggs are white and elliptical in shape and hatch in August to September; however, some of the young remain in the nest, emerging the following spring. Sexual maturity is reached at 8 to 11 years. The eggs of the bog turtle are preyed upon by birds, snakes, rodents, and other mammals.

Habitat

The bog turtle home range is relatively small (ranging from 1 to 74 acres). Bog turtles are found in seepage or spring-fed emergent freshwater wetlands associated with streams and bordered by wooded areas. Clear, slow moving rivulets or brooks with soft, highly organic substrates are required. These wetlands have a variety of micro-habitats that include dry pockets, saturated areas, and areas that are periodically flooded. The turtles depend upon this diversity of micro-habitats for foraging, nesting, basking, hibernation, shelter, and other needs. Primary habitats in these areas include fens, bogs, wet meadows, and drainage ditches. They prefer shallow water (4 inches deep or less) and saturated soils that contain surface water year round.

Unless disrupted by fire, beaver activity, grazing, or periodic wet years, open-canopy wetlands are slowly invaded by woody vegetation and undergo a transition into closed-canopy, wooded swamplands that are unsuitable for habitation by bog turtles. Bog turtles are dependent on open-canopy sedge meadows and fens bordered by wooded areas for foraging, reproduction, nesting, hibernation, and maintaining body temperature. Open canopies allow for dense growth of low vegetation providing a habitat for the range of animals that contribute to the diet of bog turtles, as well as providing ample opportunities for basking which helps maintain body temperature.

Plant species commonly associated with bog turtle habitats include alders (*Alnus* spp.), willows (*Salix* spp.), sedges (*Carex* spp.), spike rushes (*Eleocharis* spp.), jewelweed (*Impatiens capensis*), rice cut-grass (*Leersia oryzoides*), tearthumb (*Polygonum sagittatum*), arrow arum (*Peltandra virginica*), red maple (*Acer rubrum*), skunk cabbage (*Symplocarpus foetidus*), cattails (*Typha* spp.), juneberry (*Amelanchier spicala*), sphagnum moss (*Sphagnum* spp.), and bulrushes (*Juncus* spp. and *Scirpus* spp.). Tussock sedge (*C. stricta*) and sphagnum moss is commonly used for nesting and basking.

Typical sedge meadow habitat for bog turtles in Maryland. Note spring-fed flow of shallow water meandering between clumps of sedges. Woody vegetation is encroaching from the upper right.

North Carolina bog turtle habitat (*Photo courtesy of Romy Myszka*)

Sphagnum moss is important in bog turtle habitats. Bog turtles frequently use sphagnum for nesting and basking areas.

As an omnivore and opportunistic feeder, the bog turtle readily consumes any available food source in land or water. However, bog turtles prefer invertebrates such as slugs, worms, spiders, and insects. Additional food sources include frogs, snails, root hairs, seeds, fruits, leaves, carrion, and moss. The turtles feed during the daylight hours; however, they are seldom active during the hottest part of the day and are inactive on chilly mornings.

Habitat communities and components that are absent or present in limited amounts are likely limiting bog turtle habitat quality. Management actions should be taken to address these limiting factors. Land uses on adjacent properties may need to be considered to accurately rate the quality of a habitat management area for bog turtle. Limitations can become quite common, especially if there is little habitat to work with.

Population densities and home range

Densities of bog turtles have been estimated at 5 to 125 individuals per 2 acres. Many populations, however, contain fewer than 50 animals. Home ranges and movement reports are variable with an average home range found in eastern Pennsylvania of 3 acres for 19 bog turtles. In Maryland, sites were surveyed finding an expansion in home range when compared to historic studies in the same area. It was suggested that the expansion in home range size may indicate a decrease in habitat quality from succession or invasive species.

Home range sizes and distances traveled are not significantly different between sexes, although, one study did find that males expand their home ranges during the mating season. Occasionally, individual turtles will cross roads a considerable distance from any apparent suitable habitat. These long distance movements may be the result of emigration, or the moving out of habitats that are declining in quality through succession or invasive encroachment.

Reasons for decline

Bog turtles are very sensitive to habitat changes and have suffered greatly from habitat loss and degradation such as wetland filling, fragmentation, and drainage. Other reasons for their decline include nonnative and native plant species invasions, increased nutrient load from runoff, and woody encroachment. Due to East Coast urban sprawl, these alterations have seriously changed many turtle habitats and have had a serious effect on the bog turtle because of their specific habitat needs. Illegal collection has also contributed to the bog turtle's decline as they are highly prized in the pet trade.

Certain amounts of light must reach the ground in bog turtle habitat through openings in the canopy for them to effectively regulate their body temperature. Unless disrupted by beaver activity, grazing, periodic wet years, or some human interference, open-canopy wetlands are slowly invaded by woody vegetation and undergo a transition into closed-canopy, wooded swamplands that are unsuitable for habitation by bog turtles. Historically, turtles moved from one open-canopy wetland patch to another as succession progressed and the canopies closed in one area and natural disturbances (fire, beaver, buffalo) opened canopies in another. Today, however, development (such as roads, ditches, culverts, and urbanization) inhibits the turtle's ability to move to new habitat, preventing new populations from being established as old sites deteriorate.

Habitat management recommendations

Restoration and enhancement projects are often complicated as the hydrology, climate, and current and historic plant and animal communities must be considered. Extensive planning must be done before a restoration or enhancement project can be implemented.

A bog turtle survey and determination of current conditions should be conducted before beginning a habitat management project.

The landowner must understand the problems (bog turtle habitat that has been compromised) and opportunities (how lost habitat can be restored) that exist. For wetland restoration or enhancement projects, the local landscape and historical factors that led to the creation and function of the wetland in the first place must be understood. These factors include land use, topography, climate, precipitation patterns, soil types, ground and surface water flows, and vegetation communities. The factors contributing to the wetland loss or degradation must also be researched, as well as the possible opportunities to restore or enhance the wetland. For bog turtle habitat, locations should be surveyed to determine whether or not the site can support (or does support) populations of bog turtles.

Once the problems and opportunities are understood, objectives for restoration must be outlined. Objectives might include implementing rotational grazing systems, increasing habitat for bog turtles, or reducing habitat fragmentation. The resources available to undertake the restoration or enhancement project must be inventoried and analyzed to formulate a plan of action and any alternative plans of action that might be considered. Available resources might include wetland restoration expertise or financial resources. Armed with all this information, landowners will be well equipped to make decisions and decide on the proper plan of action for their bog turtle habitat restoration or enhancement project.

Before implementing their plan, landowners and managers are strongly urged to discuss their restoration or enhancement plans with experts from Federal, State, or local government agencies or qualified personnel from conservation organizations. Evaluation of the plan, throughout the planning process, as well as during and after its implementation, is vital to the success of the project, as well as future wetland restoration and enhancement projects.

Habitat assessment

Before beginning a habitat management project, planners should determine the current conditions of the planned site including the soil conditions, current plant diversity, and future successional management. A bog turtle site-quality analysis protocol was developed to assess capacity of sites to maintain viable population of bog turtles. Sites are ranked on the basis of their size and degree of fragmentation, presence of invasive plants and later successional species, immediate threats (ditching, draining, filling, excavation), and type and extent of land use in the area. While this protocol was developed to be used by persons qualified to conduct bog turtle surveys and delineate wetlands, the same assessment can be used by a landowner to achieve a general understanding of the status of their habitat in relation to bog turtles. For a more detailed description including the assessment matrix, please reference the U.S. Fish and Wildlife publication Bog Turtle (*Clemmys muhlenbergii*) Recovery Plan at *http://www.wcs.org/media/file/Cm_Recovery_Plan.pdf*.

Before surveys are conducted, the areas should first be assessed to establish if the key elements are present to qualify for bog turtle habitat. Bog turtle habitat is recognized by the characteristics of its soils, hydrology, and vegetation. Suitable hydrology, soils, and vegetation are necessary to provide the critical wintering sites and nesting habitats for bog turtles; however, one or more of these criteria may be absent from portions of a wetland or wetland complex supporting bog turtles. Absence of one or more criteria does not preclude bog turtle use of these areas to meet important life functions including foraging, shelter, and dispersal. If these criteria (suitable soils, vegetation, and hydrology) are present in the wetland, then the wetland is considered to be potential bog turtle habitat, regardless of whether that portion of the wetland occurring within the project boundaries contains all three criteria.

Soils

Soils should be soft muck and rock. Some areas may have scattered pockets of peat (6 inches or deeper) instead of muck. Soils should have low permeability, a restrictive underlying layer, or high water tables. These soils will ensure that the site can support a wetland ecosystem.

Hydrology

The area should be spring-fed or with a high water table close to the surface providing shallow surface water or saturated soils year round. Dry and wet pockets are often intermittent throughout. There is often subsurface flow and shallow rivulets (less then 10 cm deep). In Delaware, pH ranged from 5.5 to 7.4, and the salinity was always zero.

Vegetation

The area should consist of low grasses, sedges, and shrubs characteristic of scrub-shrub wetlands. Some wetlands may already have desired openness with a high diversity of native herbaceous and woody plants. At such sites the need to manage vegetation may be minimal. However, at sites with closed canopies caused by dense, mature woody plants (red maple, *Acer rubrum*; willow, *Salix* spp.), invasive, nonnative plants, or some combination of the two factors, vege-

tation management will be required to open the canopy and favor native grasses and sedges.

Water management

In drained and degraded basins, structural modifications may need to be undertaken to restore wetland hydrology. Wetland restoration and management plans are site specific and legal restrictions often apply, so landowners are strongly encouraged to contact a wetlands specialist before beginning work.

Removing hydrologic alterations

Ditch filling can be used where wetlands have previously been drained. Drainage ditches can be filled and plugged which restores the wetland to pre-drainage levels and maintains the ideal level of surface water. A spillway or outlet control gate can be constructed, located at the downstream end of a drainage ditch as it exits the wetland, to allow for manipulation of the surface water level. The original soil that is commonly left beside the ditch upon its creation is a source of fill for the channel. Soil with the same approximate composition, grain size, and permeability of the soil that was originally removed from the ditch should be used to refill it if the original soil is not available. The ditch plug should be at least 150 feet long at minimum, and the plug should rise 33 percent above the grade to allow for settling. Additionally, appropriate native vegetation should be established to secure soils.

Drain tile, or "field tile" as it is often called, is a section of underground agricultural tile set to drain a wetland basin. Drain tile is usually made of clay or perforated plastic and buried at a depth of 2 to 6 feet. If the site contains drain tiles, tile removal is a simple form of restoration. A contractor with a backhoe generally removes or crushes a section of tile about 25 or 50 feet long downstream from the wetland. Following this, the downstream or outlet pipe is plugged with concrete or clean clay fill, and the trench is filled.

To slow water flow and increase the diversity of flow conditions, it may be necessary to reestablish bends and meanders in straightened waterways. This restoration option should be conducted in unison with a revegetation plan that places the appropriate native vegetation in wet and dry areas when modifications are complete.

Managing water level

Sometimes it is necessary to create a very low earthen berm to impond sufficient water to reach a desired water level. A berm is created using subsoil, often mixed with clay. Topsoil is spread on top of the berm to provide a medium for plant growth. To prevent over flooding, a riser may be installed to remover overflow through a tub once it reaches a certain level. This berm can prevent the drainage of water downstream; however, it requires a spill way or other water-control structure to regulate the water level and prevent the dike from being washed away during periods of heavy runoff. Since water management is critical, a professional biologist should be consulted for design specifications suitable for specific wetlands.

Many farmers use drainage ditches when converting wetlands into croplands.

This outlet pipe is a sign of drain tile located in this field. Removal of drain tile is fairly simple, and outlets such as these are subsequently plugged.

Vegetation management

Succession of wetlands is a natural process that may result in significant changes to a wetland over time (see Fish and Wildlife Habitat Management Leaflet, Number 41: Early Successional Habitat for more information on successional management). Primary changes include the invasion of wetlands by trees and shrubs and canopy closure over wetlands. Considering that bog turtles require open canopy habitats, plans to periodically (every 10 to 15 years) reverse the effects of succession on some or all of the project area are important to consider. Management can reverse succession by mimicking natural disturbance such as flooding, grazing, fire, or using timber harvesting, mowing, or herbicide treatment. Any management effort should consider possible negative direct and indirect effects and plan accordingly (see Fish and Wildlife Habitat Management Leaflet, Number 37: The Importance of Disturbance in Habitat Management for more information on disturbance).

If a wetland is already established, the vegetation in the area must be managed to keep the wetland in an early successional state. Chemical use, invasive species control, prescribed grazing, and mechanical management, as well the reduction or elimination of beaver control can be used to change vegetative structure to suit bog turtles.

Chemical use

Herbicides are commonly applied to wetlands as sprays, liquid paints, or injections. Care must be taken whenever chemical manipulations of wetland vegetation might have impacts broader than the target goals. There should always be concern for the sensitivity of nontarget species to herbicide chemicals or their by-products in the wetland. For additional information on application and use of herbicides, see Fish and Wildlife Habitat Management Leaflet Number 24: Wildlife and Integrated Pest Management (IPM). Always consult with State and local authorities and wildlife professionals for proper timing and application techniques, and to obtain applicable permits. For more information involving chemical treatments, please visit the USDA NRCS Web site at *http://www.wsi.nrcs.usda.gov/products/piedmont/c-5.pdf*.

Invasive species control

Invasive plants may produce undesirable functional and structural changes in bog turtle habitats. For example, some invertebrate foods preferred by bog turtles cannot survive in wetlands dominated by invasive plants. Consequently, when invasives spread so significantly that they out-compete native plants, the suitability of bog turtle habitat may be reduced. Eliminating these nonnative invasives from wetlands, even relatively small wetlands, takes substantial effort. For more information on invasive species and their control, visit The Nature Conservancy invasive species initiative Web site at *http://tncweeds.ucdavis.edu/*.

The most common invasive species in wetlands include purple loosestrife (*Lythrum salicaria*), reed canarygrass (*Phalaris arundinacea*), phragmites (*Phragmites* spp.), and multiflora rose (*Rosa multiflora*).

Purple loosestrife—This plant is easiest to detect when it flowers in late July to August. Biological control is available for significant infestations. The USDA Animal and Plant Health Inspection Service approved the use of a root-mining weevil (*Hylobius transversovittatus*), two leaf-eating beetles (*Galerucella calmariensis* and *Galerucella pusilla*), and a flower-feeding weevil (*Nanophyes marmoratus*). These insects can significantly reduce coverage of loosestrife, opening up the ground layer and allowing other plants to thrive. Chemical and manual control is inexpensive for small infestations (less than 100 plants). Manual control would involve pulling up the roots and then applying an herbicide. This treatment should not be used after flowering because rough handling can spread the seeds. Mowing, burning, and flooding are not effective techniques to control purple loosestrife.

Purple loosestrife is a common wetland invasive species that requires careful management.

Reed canarygrass—This plant is one of the most persistent invasive species and one of the most difficult to remove. In areas that have high densities of canarygrass, repeated burning in late autumn or late spring may useful; however, annual burning for 5 to 6 years may be necessary to be effective. Canarygrass can also be treated with herbicides; however, mowing, tilling, and biological control are not effective control methods.

Phragmites—Species of phragmites can be largely controlled with herbicides. Success depends primarily on the growth stage of the plant and population size. Herbicides are most effective when applied in the autumn on new shoots with at least four true leaves. In areas with high population numbers of phragmites, plastic sheeting can be used to kill the root system. Sheeting is less labor intensive then cutting, but stands must be mowed or burned prior to sheeting to reduce plant mass. Six-millimeter black plastic is used, secured with stakes or sandbags to create the barrier. The temperature will increase under the plastic and kill surface growth.

Multiflora rose—Control of this plant involves removing all roots, as new plants can grow from severed roots. Prescribed grazing can be effective, as well as prescribed burning. In areas with extensive infestation, repeated mowing (three to six times during the growing season) for 2 to 4 years is effective. An application of herbicide on freshly cut stems destroys the root system and prevents resprouting, removing the necessity for many years of mowing. Herbicide should be applied after the stem is cut, or to flowering or budding plants.

Many species of invasives thrive in areas with high nutrient and sediments enrichment from runoff and erosion. Simple steps can be taken to reduce the amount of excess nutrients and sediment in the area. For more information, please visit the Environmental Protection Agency's Web site on polluted runoff at *http://www.epa.gov/owow/nps/facts/*.

Prescribed grazing

Prescribed grazing is one of the most effective methods to remove many woody or invasive plants. Grazing is also cost effective as livestock owners are usually willing to maintain animals on the selected site. Grazing animals can provide favored microhabitats for turtles by creating deeper pockets of water in animal footprints and creating low mounds of earth for foraging and nesting. Grazing also promotes a warmer, more open environment for basking and nesting. When properly controlled, grazing has few potential side effects on wildlife.

Grazing has been shown to be effective in controlling invasive species such as purple loosestrife (*Lythrum salicaria*), reed canarygrass (*Phalaris arundinacea*), cattail (*Typha* spp.), phragmites (*Phragmites* spp.), and multiflora rose (*Rosa multiflora*). The type of plant that is to be managed and the size of the habitat are considerations when selecting what herbivore to use in grazing. Goats and sheep are used in smaller sites (less than an acre) where the primary vegetation consists of reedgrass, shrubs, and briars. These animals search for forage in the core of dense vegetation whereas cattle dislike thicket like habitats and prefer to forage more in the open. Goats are additionally very effective in removing woody species. Larger herbivores, such as cattle and horses, are used primarily in locations greater than 1 acre. Horses are least effective as they tend to stay away from wetter land, grazing primarily on dry sites.

Grazing will require the instillation of a fencing system around the area to be managed. It is recommended that a three to four strand electrified high tensile should be used when considering using cattle and sheep in bog turtle habitats . For goats, either woven wire or five to six strand electrified high tensile has been used on sites. Planners can refer to NRCS fencing standards and specifications for further information. Multiple paddocks should be considered to allow rotation of animals through the habitat. Rotational grazing prevents overgrazing and manipulates succession simultaneously. Excluder fencing should be used in areas known or suspected to have nesting turtles, and fencing constructed around the entire site will allow a buffer of native vegetation to filter polluted run-

Fencing opens up opportunities for rotation grazing. Note the different vegetative growth stages on either side of the fence.

off. If fencing is not practical, it is possible to tether some animals depending on the overall size of the location and number of animals needed to effectively graze.

Grazing should not take place during the nesting or incubating seasons (approximately May to August), and the density of animals should be about one to two large animals (cows or horses) per acre, or 5 to 10 small grazers (goats, sheep) per acre. Higher numbers of animals per acre can be used briefly to achieve a higher level of control for a short period of time; however, on small sites greater numbers of animals can cause damage through trampling.

Prescribed burns

Prescribed burns maintain bog turtle habitat by bringing vegetation back to an early successional, or disturbed, state. Historically, fire caused by lightning strikes, sparks from falling rocks, or even spontaneous combustion of organic plant material had successfully maintained portions of the landscape in a natural state of early succession. Unfortunately, human suppression of fire during the last century has reduced its effects on most ecosystems even though the results can significantly improve existing habitats.

Prescribed burn frequency varies among forestlands, wetlands, grasslands, and scrublands. In general, however, burns should be conducted on a 4- to 5-year (2- to 3-year in the Southeast) rotational basis in late winter or early spring (February–April, depending on the region). Dividing the burn area into strips or plots can leave undisturbed escape and nesting cover for wildlife adjacent to burned plots. Disked firebreaks should be created around burn areas to maintain control of prescribed burns. Refer to the Fish and Wildlife Habitat Management leaflet number 37: The Importance of Disturbance in Habitat Management for additional information.

Prescribed burns are a useful tool to bring bog turtle habitat bach to an early successional state.

Although beneficial, prescribed burning is a highly regulated activity and should only be conducted in cooperation with State fish and wildlife agencies and with assistance from licensed burners. These agencies and individuals can help in the development of a burn plan, provide necessary tools, equipment, and supervision, and assist in obtaining all required permits.

Mechanical management

Mechanical management includes physical techniques that can be used directly on plants such as cutting, clipping, bark girdling, mowing, and haying. Depending on the size of the land and the amount of vegetation to be manipulated, a variety of equipment can be used. Smaller wetlands, like most seeps and bogs, are easily managed by using hand tools, without the need for heavy machinery. However, large areas like flood plain forests may require larger equipment to achieve management goals. In general, care should be taken when using manual labor or machinery in these sensitive habitats.

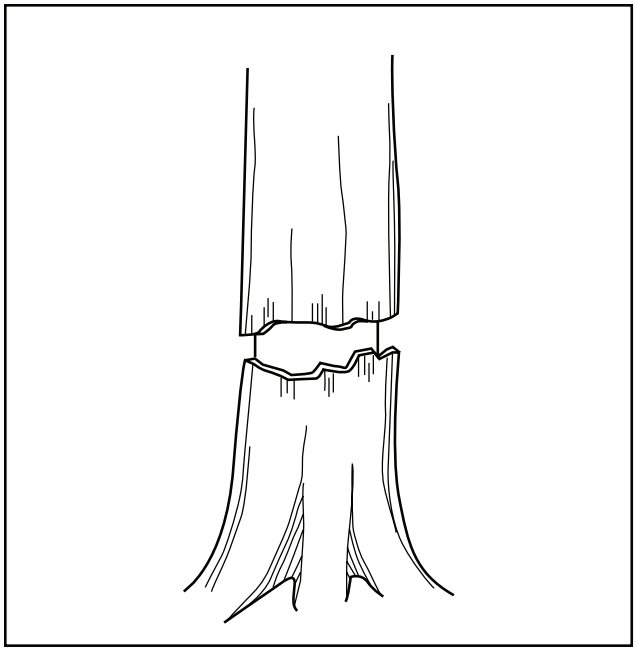
Cutting of woody wetland vegetation can have a positive impact by opening up the canopy allowing light to penetrate. Plants can be completely removed, limbed or topped to create these openings. Selective cutting with hand tools or hand-held power equipment is the most effective method of removing or modifying woody plants. Allowing light to reach the ground surface generally has a positive impact on reptiles, amphibians, and insects. Cutting suggestions include:

- Use the least impact method available.
- Plan to use or manage the cuttings.
- Avoid stepping on hummocks and other areas where hatchlings or eggs could be disturbed.

Bark girdling is another method to remove woody vegetation and has a positive impact in addition to increasing light. Bark girdling removes the bark, cutting off nutrient supplies to the roots resulting in the death of the plant. Once dead, the remains are referred to as a snag. Standing snags can provide additional habitat for a variety of species for many years. Girdling is an effective, inexpensive, and relatively easy selective technique to remove woody vegetation using simple tools.

Mowing and haying can be used to manage vegetation around and in a wetland site. Timing of such management should be such that no harm is done to native

species of plants and animals. Care should be taken to not cut vegetation so low that it damages nests or kills small animals. Delaying mowing just a few weeks to late June or early July, or leaving unmowed areas as a buffer and refuge may be critical to flowering or nesting species reproductive success for that year. Additionally, turtles often move out of wetlands in late spring to utilize nearby pastures and meadows for feeding. Early mowing could be potentially fatal to some individuals.



Bark girdling is an easy and effective way to remove selected woody vegetation while leaving additional habitat for wildlife.

Case studies

Conserving Maryland's threatened bog turtle
One innovative partnership in Maryland brought together private landowners and farmers with key partners such as the Natural Resources Conservation Service, U.S. Fish and Wildlife Service, Environmental Defense, and Maryland Department of Natural Resources to help recover the threatened bog turtle in Maryland. Farmers are working with agencies to find turtles and are carrying out monitoring of turtles by radio-tracking tagged animals. To date, three important wetlands have been restored, and another three restorations began in autumn 2005. For more information, please visit *http://www.cooperativeconservationamerica.org/viewproject.asp?pid=572*.

Restoring bog turtle habitat in New York
In New York, farmers have teamed up with New York Natural Resources Conservation Service, Environmental Defense, U.S. Fish and Wildlife Service, New York Department of Environmental Conservation, New York Natural Heritage Program, Friends of the Great Swamp, and The Nature Conservancy to use prescribed grazing, mechanical, and manual clearing of woody vegetation and limited use of herbicides and biocontrol agents to restore bog turtle habitat. Farmers are enthusiastic about the project because they are gaining new pasture, improved fencing and, in some cases, reimbursement for providing livestock grazing services to the project. Four projects got underway on private lands during the 2004 field season, and another six projects began development in 2005. For more information, please visit *http://www.cooperativeconservationamerica.org/viewproject.asp?pid=806*.

Assistance programs

Financial and technical assistance for wetland habitat projects are available from an array of government agencies and public and private organizations. Table 1 lists the contact information of organizations that can provide information about wetland management, as well as other natural resource projects, and describes their associated conservation incentive programs.

Table 1 Technical and financial assistance to restore or enhance wetlands

Program	Land eligibility	Type of assistance	Wetland restoration or enhancement opportunities	Contact
Conservation Reserve Program (CRP)	Highly erodible land, wetland and certain other lands with cropping history. Streamside areas in pasture land	50% cost-share for establishing permanent cover and conservation practices, and annual rental payments for land enrolled in 10- to 15-year contracts. Additional financial incentives available for some practices	Plant long-term, resource-conserving covers in wetland and upland areas to improve water quality, control erosion, and enhance wildlife habitat	NRCS or FSA State or local office
Partners for Fish and Wildlife Program (PFW)	Most degraded fish and/or wildlife habitat	Up to 100% financial and technical assistance to restore wildlife habitat under minimum 10-year cooperative agreements	Restore wetland hydrology; plant native trees, shrubs, grasses, and other vegetation; install fencing and off-stream livestock watering facilities to allow for restoration of stream and riparian areas; remove exotic plants and animals	U. S. Fish and Wildlife Service local office
Waterways for Wildlife	Private land	Technical and program development assistance to coalesce habitat efforts of corporations and private landowners to meet common watershed level goals	Enhance wetland and adjacent upland habitats by planting buffers, creating habitat structures, and other activities	Wildlife Habitat Council
Wetlands Reserve Program	Previously degraded wetland and adjacent upland buffer	75% cost-share for wetland restoration under 10-year contracts and 30-year easements, and 100% cost-share on restoration under permanent easements. Payments for purchase of 30-year or permanent conservation easements	Restore and protect wetlands and limited adjacent upland area; improve wetland wildlife habitat	NRCS State or local office
Wildlife at Work	Corporate lands	Technical assistance on developing habitat projects into programs that allow companies to involve employees and the community	Enhance wetland and adjacent upland habitats by planting buffers, creating habitat structures, and other activities	Wildlife Habitat Council
Wildlife Habitat Incentives Program (WHIP)	High-priority fish and wildlife habitats	Up to 75% cost-share for conservation practices under 5- to 10-year agreements	Establish and improve fish and wildlife habitat, including wetland and adjacent upland habitats, particularly those for wildlife species experiencing declining or significantly reduced populations	NRCS State or local office

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