4

Planning for Success

Kenneth A. Bridle

Channelized flow of water in a site where cattle have been excluded.

Planning for Success

Restoring damaged wetlands should be a high priority now that the public generally understands their functions and values. However, restoration of any ecological function is a long-term commitment and should be considered carefully prior to habitat or hydrologic manipulations. Planning may be the most important step in the process. Evaluating existing site conditions is an important part of decision making; likewise, documenting pre-existing conditions is an important part of evaluating the outcome.

Ann Berry Somers

*Spotted salamander eggs (*Ambystoma maculatum*).*

Documenting Site Conditions

One of the most important constraints on achieving success in restoration is the degree of disturbance to the sites. Almost all small wetlands in the Mountains and Piedmont of the Southeast have been cleared for pasture, filled, or drained by ditches or subsurface tiles (see Table 1.1). Some alterations have been more successful than others, and the degree of damage to the wetland varies. Very small wetlands in urban settings that have been severely ditched and are isolated from other similar wetlands have less potential for reaching restoration goals than wetlands in sites where the surrounding landscape is relatively intact and within reach of other similar areas (Figure 4.1).

Site character and restoration potential can be determined by examining the site size, history, hydrology, soils, natural plant and animal communities, landscape ecology, conservation potential, and management objectives. This is a complex matrix of features, which interact with each other to result in the character and potential of the wetland. Some wetlands are special because of their size, biodiversity, flood control, water purification, groundwater recharge, wildlife habitat, erosion control, or simply location. Most wetlands include a combination of many of these traits and are valued accordingly. A detailed assessment of wetland features may require the technical assistance of natural resource conservation professionals. However, many characteristics of the site can be recorded by anyone using the data sheet in Appendix E or something comparable. These data can then be used to assist field personnel

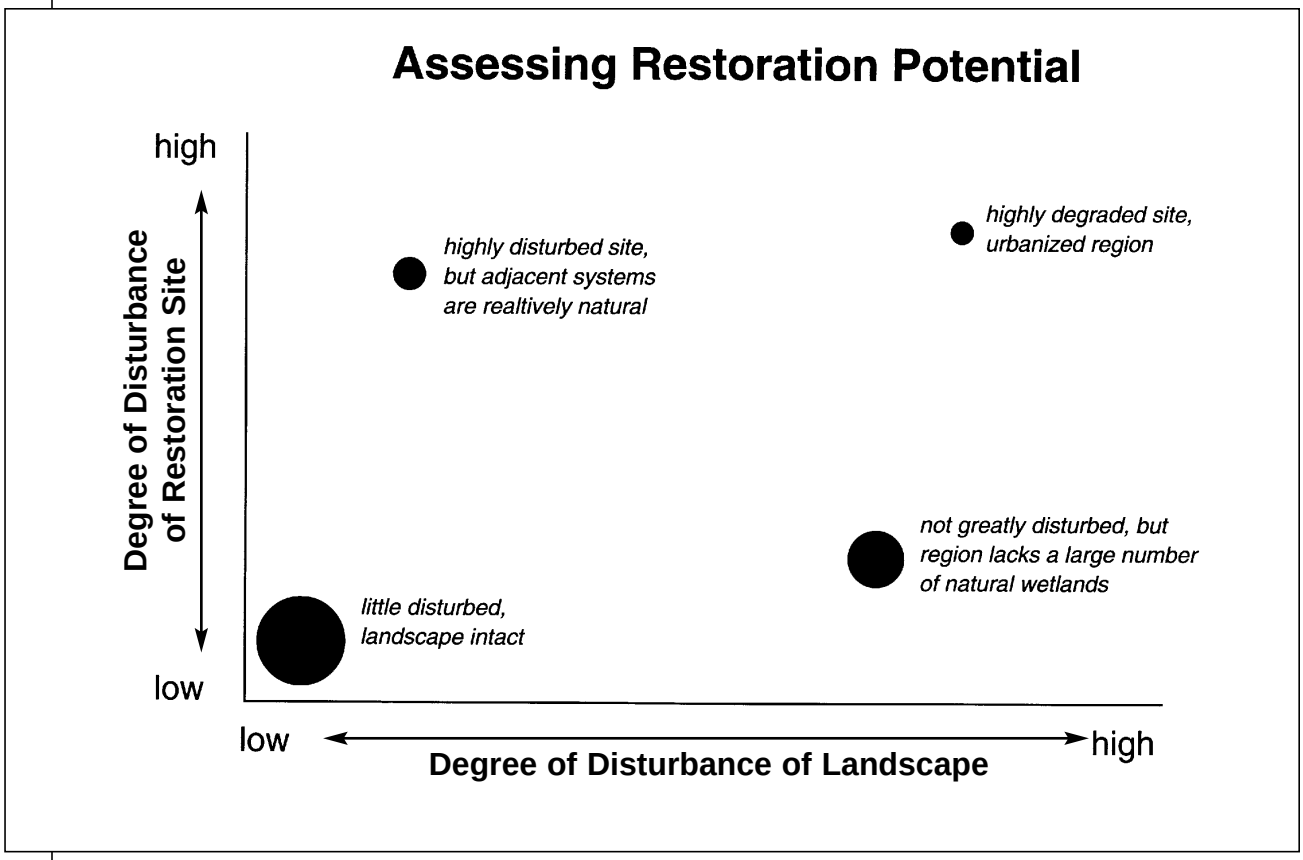

Figure 4.1 *Assessing restoration potential by using an hypothesized model for wetlands differing in degree of disturbance and landscape condition. Large dot indicates high potential for successful restoration; smaller dots indicate comparatively lower potential.* Used with permission from National Research Council, 1992.

and land managers when they evaluate the potential for restoration and expected outcome.

Site Hydrology

A key component for identification of a wetland type and its restoration potential is the water system on the site. The source of the water (groundwater, rainwater, surface runoff, snowmelt, etc.) is an important factor in the development of any wetland. The amount of water in an area and the duration of flooded conditions determine the kind of wetland that develops in any wet location. Under conditions of long duration of flooding, the soil chemistry is altered and produces soils known as hydric soils. Hydric soils form under saturated, anaerobic conditions and are recognizable by their gray-black colors and high organic contents. The 1987 Army Corp of Engineers Wetlands Delineation Manual, the standard for wetland delineation, focuses on three factors which must be met for a regulatory "wetland" to be defined: wetland plants, hydric soils, and hydrology. A site exhibits wetland hydrology if ponding over the soil surface is less than 2m deep and the soil is saturated to the surface during the growing season. Therefore a wetland is defined as "those areas that are inundated or saturated by surface or groundwater for a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions."

Management of a fresh water wetland generally requires that the hydrology of the site be maintained or enhanced by protecting the source quantity and quality. In most cases, past alterations that drain off water or drop the water level should be reversed, if possible, so that more water is resident in the site. However, it must be understood that efforts which increase the level and/or duration of

saturation for the benefit of one species, may have detrimental effects on other species. An accurate assessment of the hydrology of the site is essential if a restoration or enlargement of the wetland is desired. Measurement of groundwater levels in a series of test wells over the course of a year or two will provide valuable data.

Considering the importance of hydrology in your restoration plan, it is recommended that you:

- Delineate current and proposed hydric soil areas.
- Include plans for maintaining and protecting water quantity and quality.
- Analyze the water budget.

Wetland Size

The local topography, hydrology, and climate determine the potential of an area to host large wetlands. Places like the eastern Coastal Plain or along broad river systems, large wetlands are common. In other locations large wetlands are not a significant part of the landscape; smaller wetlands (a few acres or less) are more common in these areas. In the Piedmont and Mountains of the Southeast, the topography and local relief restrict water-collecting slopes to a small percentage of the total watershed. With the exception of large river valleys, largely converted to agriculture, most wetlands in these areas are, or were, small.

It is very important to consider and accurately define the size of the wetland under management consideration. Include a primary boundary around the core of the wetland and secondary boundaries around areas that buffer the core, which allows room for potential expansion of the wetland. Include this information in the form of a map of the local area and the watershed where the wetland occurs. Other information on the site map should include any ditches and drains, buried tiles or pipes, stream channels, trees and shrubs, rare plant and animal occurrences, and any other relevant information about the site. This forms the first step in baseline documentation of the site.

Dennis W. Herman

*Swamp Pink (*Helonias bullata*) is one of the rare species found in Mountain wetlands.*

Natural Communities

A natural community is "a distinct and recurring assemblage of populations of plants, animals, bacteria, and fungi naturally associated with each other and their physical environment." In most cases natural communities are at the heart of sites considered to be biologically significant. Although occasionally sites are recognized as significant simply because they contain populations of rare species, most contain examples of one to several community types ranging in quality from fair to excellent. The significance of such sites is often augmented by, but not dependent on, the presence of rare species. The condition and extent of natural community types within a site usually has a strong influence on its overall significance. Resource conservation professionals can help identify and rank the significance of natural communities and plan for their management.

Ann Berry Somers

*Spermatophores, found on leaf litter in winter or early spring, are evidence of breeding activity by spotted salamanders (*Ambystoma maculatum*).*

To successfully address the management of natural communities, these steps are recommended:

- Identify, map, and photograph current natural communities in and around the subject site.
- Map the ideal future natural communities after the restoration.

Wetland Animals

Most wetland types serve as habitat for animals of all shapes and sizes. Wildlife professionals, recreational wildlife enthusiasts, and many landowners appreciate the wildlife quality and quantity found in wetlands. The management objectives of many wetlands focus heavily on the needs of wildlife, often the target of restoration activity. Understanding the multiple demands, uses, and functions of all the wetland species, including humans, is important to integrating a successful management plan. Comprehension of wetland diversity and the plant and animal components is important to understanding wetland function. Identification guides are essential and many guides and keys are available; some excellent works are listed in the bibliography of this chapter.

Of specific interest in this manual is the bog turtle (*Clemmys muhlenbergii*), a small, elusive and rare turtle that lives in habitats of wet meadows, bogs, and other freshwater wetlands in the southern Appalachians and adjacent Piedmont. The biology, ecology, and distribution of the bog turtle are discussed in Chapters 2 and 3.

Other animal species that inhabit wetlands associated with the bog turtle include frogs, salamanders, snakes, turtles, various mammals from small insectivores to beaver, white-tailed deer, and a host of birds resident throughout the year or as seasonal migrants. Many of these animals are considered obligate wetland species (dependent on wetlands) and others can survive in many different habitats.

Wetlands can provide a variety of breeding sites for amphibians, reptiles, small mammals, insects, and spiders. Potential amphibian breeding sites include partially submerged or saturated logs, small pools along the edges of streams and rivulets, moss clumps, and rocks in and around moving water. Wet logs, damp soil, and mossy hummocks also make good spots for reptile eggs. Small mammals, such as meadow voles, build nests from grasses along the margins of the wet areas and birds nest in the woody vegetation or shrubs. Insects and spiders use a variety of habitats within the wetlands for breeding. More studies are needed to learn about their important roles in small wetland ecosystem ecology.

Considering the importance of wildlife in your restoration plan, these procedures are recommended:

- Survey wetland animals.
- Note wildlife habitat factors.
- Identify potential breeding sites.
- Describe desired habitat improvements.
- Monitor wildlife after restoration.

Following is a list of examples of a few species found in small wetlands of the Mountains and Piedmont of the Southeast. It is by no means intended to be comprehensive.

Amphibians are abundant around any healthy wetland. Some species of interest are:

- **Mud salamander** (*Pseudotriton montanus*), whose entire life cycle takes place in the muddy wetland.
- **Spotted salamander** (*Ambystoma maculatum*), whose winter or early

spring breeding migrations take them from adjacent woodlands to the deeper pools for courtship and egg-laying.

- **Pickerel frog** (*Rana palustris*), whose escape route takes them into the meadow instead of the water.
- **Four-toed salamander** (*Hemidactylium scutatum*), where females lay eggs under moss and attend them until hatching; larvae spend about 6 weeks in the water before transforming for terrestrial life nearby.

Common reptile species often found in these wetlands include the following:

- **Queen snake** (*Regina septemvittata*) - this slender snake eats mostly crayfish and is found near streams, rivers, and wetlands. Yellow on the lips and along each lower side distinguishes this animal from the northern water snake.
- **Eastern kingsnake** (*Lampropeltis getulua*) - a beautiful snake that eats turtle eggs, small mammals, birds, and other snakes. Usually quite gentle when handled.
- **Northern water snake** (*Nerodia sipedon*) - this extremely variable species is often mistaken for the venomous cottonmouth because of its affinity for water. The undersurface has half-moon-shaped spots, often outlined with dark brown or black. They prefer to escape, but will readily bite if prodded by humans.
- **Eastern box turtle** (*Terrepene carolina*) - often found in the shallow areas of wetlands but also can be found far upland. The carapace is dome-shaped like a German army helmet and the hinged plastron allows the turtle to completely withdraw its soft parts into the shell, protecting them from wildlife predators. However successful in the past, this adaptation does not protect them from road mortality and people who desire them as pets. Although it is hard to believe, this familiar turtle is in serious decline in many places throughout its range.
- **Common snapping turtle** (*Chelydra serpentina*) - become large as adults and can found in most of the wetlands of the Southeast. An impressive creature, this turtle may be found moving from one body of water to another in springtime.
- **Eastern mud turtle** (*Kinosternon subrubrum*) - a small turtle more abundant in the Coastal Plain than Piedmont wetlands and almost absent from the Mountains. They may compete with bog turtles when found in the same sites.

Ann Berry Somers

Children learn by doing. What better way to get them interested in conservation than by letting them help with restoration projects?

A few mammals of interest are these:

- **Meadow vole** (*Microtus pennsylvanicus*), a common yet important species that creates tunnels through the wetlands that bog turtles and other animals use, and whose presence can be identified by grass clippings in their runways and their dark gray to black droppings.
- **Southern bog lemming** (*Synaptomys cooperi*), a small rodent similar in appearance to the meadow vole, but it has an extremely short tail and its droppings are bright green.
- **Beaver** (*Castor canadensis*), a very important (at least in the past) species that helps create and maintain wetlands

and whose presence is identified by terraced pools backed up by dams and the ever present gnawed stumps around the wetland.

- **Star-nosed mole** (*Condylura cristata*), rarely observed but easily distinguished from other moles by the 22 fleshy appendages surrounding the nostrils. Important ecologically because they aerate the soil, consume insects, and serve as prey for a wide variety of other species.

Bird species are so numerous in these wetlands that it is difficult to list them. Just a few of interest are these:

- **Song Sparrow** (*Melospiza melodia*) - an abundant species with a lively song consisting of many short notes and a trill near the end.
- **Alder flycatcher** (*Empidonax alnorum*) - known to have nested in at least one Mountain Bog in North Carolina, this bird normally nests in alder wetlands of more northerly regions.
- **Chestnut-sided warbler** (*Dendroica pensylvanica*) - a small, colorful warbler of the higher mountain wetlands.
- **Common yellowthroat** (*Geothylpis trichas*) - a species heard more often than seen in the wetlands.
- **Ruby-throated hummingbird** (*Archilochus colubris*) - our smallest bird species and the chief pollinator of Gray's lily (*Lilium grayi*), a rare flower found in several mountain wetlands in the southern Appalachians.
- **Red-winged Blackbird** (*Agelaius phoeniceus*) - a common resident of open habitats. Nests are built of wetland grasses and attached to cattails or stems of bushes growing near water.

Wetland Plants

Wetland plant communities are often small, remote, and usually unnoticed by most people. There are important differences in fresh water wetlands that can be identified by the species composition of the plant community. Any remnant natural communities on a restoration site provide useful information to guide restoration.

One of the most interesting aspects of working in small wetlands of the Mountains and Piedmont of the Southeast is the opportunity to see unusual plants not found in the drier terrestrial communities nearby (Appendix B). Resources for the identification of wetland plants can be found in common keys and field guides of plants such as those listed in the bibliography section of this chapter. There are also specialty publications dealing with wetland plants. It is important to be sure that the guide or key being used to identify an unknown plant is intended for that use and covers the geographic area where the plant occurs. Some important indicator plants are listed in Chapter 3.

Landscape Ecology

The lay of the land and its natural and manipulated parts make up the local landscape ecology. As in other ecological systems, such as food webs, these parts interact with each other and merge into the characteristics of the familiar landscape. Common parts of our landscape include various forests, meadows, farms, roads, streams, hills, houses, shopping centers, and thousands of other land uses. All this taken together, gives a place its special unique features and values.

The Natural Resources Conservation Service has adopted a hydro-geomorphic (HGM) approach for developing objective models of wetland functions. This modeling process involves the classification of wetlands based on landscape position and hydrologic processes, use of reference wetlands to develop a reference domain, and collection of scientific data to verify the models. The NRCS state biologist can assist restoration planners in determining whether appropriate functional assessment tools are available.

Of interest for wetland restoration and management are features of the ecological landscape in the watershed, including the wetland. Hydrologic details of the watershed are part of the analysis needed to classify a wetland. Landscape ecology issues might also include the ability of the wetland to filter out

Table 4.1 Guidelines for Development of a Management Plan

1. **Document the Site** (see Appendix E)**.**
   This record forms the basis of your own "case study" which should capture enough information about the site to allow a person who has never been at the site to understand the basics of the situation. Document every phase of the project in writing and with photographs. Provide as much detail as possible. Photograph the site from several different positions and permanently stake the points where photos are taken. Date and keep on file.
2. **Assemble Pertinent Ecological Information.**
   Include publications, advice from experts, and new data that might be collected from the site. This targeted new information will help you understand the site. All this information should help you to develop an ecological vision of the natural systems at your site.
3. **Gather Human and Socioeconomic Information about the Site.**
   Answer questions regarding land use, economics, law and politics, constituencies, cultural attitudes, and general demographics. Identify stakeholders who would be affected by potential site changes. Identify partners that might help achieve targets and goals.
4. **Engage Partners.**
   People of many skills and interests will help. Specialists may be necessary to help analyze and interpret data and refine the goals and targets of the management plan.
5. **Identify Direction.**
   Some are short-term targets, others long-term goals. Define the targets and explain their importance. Proper targets insure good planning, avoid wasted time and resources, and are key to all other planning.
6. **Analyze Information.**
   List and rank the targets and their threats. Determine the level of support and resources needed to achieve goals.
7. **Develop Strategies and Zones.**
   Describe the different parts of the site and any buffer areas. What goals apply to which areas? Define the targets in each area. Where do the threats come from?
8. **Identify Actions.**
   What has to be done to implement the conservation strategy? Who will do them? When do they occur? What do they cost? Who will pay for it? Make a timeline of actions and budgets.
9. **Assess Feasibility.**
   It is a waste of time to work on projects that are unwise, unrealistic, and likely to drain resources from other projects. Is it reasonable to expect success? Are the necessary ecological processes in place? Do the resources exist to complete the project?
10. **Measure Progress in Mid-course.**
    Evaluate project success based on the results of monitoring. Are the actions having the desired effect? Is progress being made toward goals? Are changes needed in the management plan or monitoring program?
11. **Follow-up.**
    Write up your results. What lessons have you learned? Will maintenance be required or is the project self-sustaining? If the project was part of a mitigation agreement, provide reports with data. Good, bad, or ugly, your results are an important source of information for others and should be shared—so the same mistakes are not repeated or successful strategies overlooked. Publish if possible.

Modified with permission from National Research Council, 1992 and Poiani et al., 1998.

Ann Berry Somers

Well-placed tin can provide important cover for wildlife. A search of several toxicology databases revealed that elemental tin, like that used in sheet metal, is not toxic to humans or other animals. Plywood coverboards are also used by wildlife, but the glues are not environmentally friendly.

sediment or chemical contaminants; to function as a flood and flow control measure for the watershed; to provide wildlife habitat; and to recharge groundwater. All these functions have many benefits for the natural and human populations of the ecological systems in the watershed. Identification and description of all wetland features and neighboring areas is basic information needed for a successful management plan.

Management Planning

Preparation is important in successful restoration and management; developing a workable and adaptive plan is the key to restoration success. This plan should include a testable hypothesis, monitoring, and evaluation of results of the treatments (manipulation). The treatments should lead to some desired future condition, known and described in advance. Often small manipulations, correctly applied, can make dramatic changes in the wetland landscape. Frequently the ultimate impact of a manipulation may not be obvious until its effects can be separated from the natural dynamics of the system. To achieve the desired result, a plan must be in place. Guidelines for developing a management plan are given in Table 4.1.

Future site conditions will vary, depending upon management objectives formulated with the help of professionals. For example, if the objectives are to maximize favorable conditions for bog turtles, a large core wet area with deep, soft mud is desirable. Increasing the size and duration of shallow wet areas is likely to appear in every management plan. Water depths should not exceed a few centimeters (except during extremely wet

Table 4.2 Ways to Reduce Risk of Failure in Wetland Restoration Projects

a) Make detailed assessments of wetlands prior to manipulation.
b) Document existing site conditions in writing and with photographs.
c) Photograph the existing plant community from different positions for comparison with later conditions.
d) Allow time for careful planning, and clearly state goals.
e) Consult professionals and agency personnel.
f) Create large buffers.
g) Use methods that require little maintenance.
h) Use detailed and long-term surveillance and monitoring.
i) Minimize impact during monitoring and construction.
j) Require a biologist to be present at critical times during construction; some construction crew errors are uncorrectable.
k) Allow for midcourse correction based on monitoring results.

Modified with permission from National Research Council, 1992.

times) and some surface water should persist throughout the driest part of the year. A mosaic of vegetation types should be present and include some woody plants such as alders. Large areas of native herbaceous vegetation including sphagnum mosses, sedges, grasses, and ferns are desirable. Alien species such as multiflora rose and privet are not desired. A diverse assemblage of animals will improve general biodiversity, and some large grazing animals are considered a favorable addition under certain conditions. (See Chapter 2, Bog Turtle Habitat Dynamics for more details.)

Once documentation of hydrology, biology, and landscape ecology is completed, the project plan can be constructed and given a final evaluation to determine the feasibility of meeting the objectives of restoration and management. Data generated by the evaluation should support the intended restoration design and long-term management of the site. Complications or problems with the plan should be obvious at this point.

Once the project is underway, allowing for mid-course evaluation can reduce risk of unwanted results. Corrections can be made based on monitoring results. Other suggestions for avoiding failure are outlined in Table 4.2. Some wetlands will need periodic management in perpetuity, but all sites should be evaluated several years after project completion and compared with management objectives in order to evaluate results. Short-term evaluations resulting in claims of success may be premature. Plan on follow-up data collection to evaluate long-term outcome.

Bibliography

Blackburn, B. 1974. Trees and Shrubs in Eastern North America. Oxford University Press, New York. *A key to the trees of eastern United States. Easy-to-use keys to species, no maps or figures.*

Brown, L. 1979. Grasses: An Identification Guide. Peterson Nature Library, Boston. *A layman's guide and keys to grasses, sedges, rushes, and many other thin leaved plants commonly though of as grass-like. Nice drawings and plant descriptions with natural history information.*

Cobb, B. 1984. A Field Guide to the Ferns. Houghton Mifflin Co., Boston. *One of only a few field guides to ferns. Good descriptions and drawings of key fern features.*

Corps of Engineers. 1987. Wetlands Delineation Manual. United States Department of the Army, Vicksburg, MS. *The basis for wetland regulation as practiced in the United States.*

Crum, H.A. and L.E. Anderson. 1981. Mosses of Eastern North America. Volume 1. Columbia University Press, New York. *A useful guide with keys to the species of non-vascular plants.*

Falk, D., C.I. Miller and M. Olwell. 1996. Restoring Diversity, Strategies for Reintroduction of Endangered Plants. Island Press, Washington, D.C. *An edited collection of papers about rare plants that discuss biology, public policy, reintroduction methodologies, and case studies.*

Godfrey, R.K. and J.W. Wooten. 1979. Aquatic and Wetland Plants of Southeastern United States, Monocotyledons. University of Georgia Press, Athens. *Keys and descriptions of wetland plants, including excellent drawings and a description for each. This volume includes monocots like grasses, sedges, rushes, lilies, and others.*

Godfrey, R.K. and J.W. Wooten. 1981. Aquatic and Wetland Plants of Southeastern United States, Dicotyledons. University of Georgia Press, Athens. *Keys and descriptions of wetland plants, including excellent drawings and descriptions for each. This volume covers broad-leafed plants.*

Gleason, H.A. and A. Cronquist. 1963. Manual of the Vascular Plants of Northeastern United States and Adjacent Canada. D. Van Nostrand Co., New York. *A classic identification key for the higher plants of the eastern United States. No maps, drawings or photographs.*

Hammerson, G.A. 1994. Beaver (*Castor canadensis*): Ecosystem Alterations, Management, and Monitoring. Natural Areas Journal 14:44-57. *A review of the biology of beaver and their impact on the environment and interactions with human land use. Important considerations as these animals become more common in a more human-developed landscape.*

Harlow, W.M. 1946. Fruit Key to Northeastern Trees and Twig Key to the Deciduous Woody Plants of Eastern North America. Dover Publications, New York. *A good key to the twigs and fruits found during the dormant season. Includes photographs and drawings, small format.*

Harris, L.D. 1984. The Fragmented Forest, Island Biogeography Theory and the Preservation of Biotic Diversity. The University of Chicago Press. *A review of relevant ecological theory dealing with species conservation and habitat fragmentation. A must read for anyone who wants to understand the impact of current land use on nature.*

Hefner, J.M., B.O. Wilson, T.E. Dahl, and W.E. Frayer. 1994. Southeast Wetlands, Status and Trends, Mid-1970's to Mid-1980's. United States Department of the Interior, US Fish and Wildlife Service, US Environmental Protection Agency. *Inter-agency publication discussing the definition, types, and current status of the major wetland types in the Southeast. Documents the decline of wetland acres resulting from alterations and indicates serious and significant declines.*

Levine, C. and D. Rauh. 1995. A Guide to Wildflowers in Winter. Yale University Press, New Haven. *A useful key to plants that focuses on the stems, fruits, and seeds found during winter months.*

Lyon, J.G. 1993. Practical Handbook for Wetland Identification and Delineation. Lewis Publishers, Boca Raton, FL. *A discussion of wetland identification and mapping in practical terms with real world examples.*

Martof B.S., W.M. Palmer, J.R. Bailey, and J.R. Harrison III. 1980. Amphibians and Reptiles of the Carolinas and Virginia. The University of North Carolina Press, Chapel Hill. *Includes adult and juvenile photographs, range maps, and other information.*

Miller, D.S. 1989. Winter Weed Finder. Nature Study Guild, Berkeley, CA. *A small, pocket-sized guide to plants in the winter condition. Includes a key and clever drawings for habitat and key traits.*

National Research Council. 1992. Restoration of Aquatic Ecosystems. National Academy Press, Washington, D.C. *A report describing the status and functions of surface water ecosystems; the effectiveness of aquatic restoration efforts; the technology associated with those efforts; and the research, policy, and institutional reorganization required to begin a national strategy for aquatic ecosystem restoration.*

Neiring, W.A. 1987. Wetlands. Alfred A. Knopf, New York. *A comprehensive guide to wetlands with photos and descriptions of plants and animals found in wetlands throughout the eastern United States.*

Neiring, W.A. and N.C. Olmstead. 1979. The Audubon Society Field Guide to North American Wildflowers: Eastern Region. Alfred A. Knopf, New York. *A guide to wildflower identification based on inflorescence structure and flower color. Good photographs and plant descriptions.*

Newcomb, L. 1977. Newcomb's Wildflower Guide: An Ingenious New Key System for the Quick, Positive Field Identification of the Wildflowers, Flowering Shrubs and Vines of Northeastern and North-central North America. Little, Brown and Company, Boston. *A system for identifying wildflowers based on simple questions about the shape of the plant, its leaves, and its flowers. Good for comparing plants that look alike but are not related.*

Peterson, R.T. 1980. A Field Guide to the Birds. Peterson Field Guide Series, Houghton Mifflin Co., Boston. *Pocket-sized guide with lots of information on color maps, and drawings of the birds.*

Poiani K. A., J.V. Baumgartner, S. C. Butterick, S. L. Green, E. Hopkins, G. D. Ivey, K. P. Seaton, and R. D. Sutter. 1998. A scale-independent, site conservation planning framework in The Nature Conservancy. Landscape and Urban Planning 43: 143-156. *A simple system used to develop management plans that combines biological and phsysical information regarding the conservation target with social and cultural input from surrounding neighborhoods and other stakeholders.*

Radford, A.E., E.A. Harry, and C.R. Bell. 1964. Manual of the Vascular Flora of the Carolinas. The University of North Carolina Press, Chapel Hill. *Currently the best general guide to flora of the Carolinas that includes keys, range maps, and descriptions of about 5,000 plants found in the region.*

Schnell, D.E. 1976. Carnivorous Plants of the United States and Canada. John F. Blair Pub. Winston-Salem, NC. *A specialty guide to this popular group of wetland plants that includes the Venus' fly trap, pitcher plants, sundews, and others.*

Shafale, M.P. and A.S. Weakley. 1990. Classification of the Natural Communities of North Carolina: Third Approximation. North Carolina Natural Heritage Program, Division of Parks and Recreation, Department of Environment, Health, and Natural Resources. *The most current manual that classifies known natural plant communities in North Carolina and gives ecological discussion of each, with comparisons and examples.*

Department of Agriculture. 1998. Southern Wetland Flora: SCS Field Office Guide to Plant Species. USDA, SCS, South National Technical Center, Fort Worth, TX. *A helpful manual of common wetland plants in the Southeast. Line drawings, color photographs, range maps, identification, and diagnostic information included for each species.*

Thompson, G.F. and F.R. Steiner (Ed.). 1997. Ecological Design and Planning. John Wiley and Sons, New York. *Part of the Wiley Series in Sustainable Design, this book focuses on landscape ecology of created and managed environments.*

Tilman, D. 1988. Plant Strategies and the Dynamics and Structure of Plant Communities. Princeton University Press, Princeton. *Discussion and examples of the dynamics of plant communities through space and time. Shows changes in slow succession and evolution and the quick responses to dramatic change, integrated over time.*

Welsch, D.J., D.L. Smart, J.N. Boyer, P. Minkin, H.C. Smith, and T.L. McCandless. 1995. Forested Wetlands, Functions, Benefits and the Use of Best Management Practices. USDA, Forest Service, NRCS, USCOE, USEPA, USFWS. *An inter-agency booklet focusing on forested wetlands and the common best management practices that apply to them.*