PARTNERS IN AMPHIBIAN AND REPTILE CONSERVATION

HABITAT MANAGEMENT GUIDELINES FOR AMPHIBIANS AND REPTILES OF THE SOUTHEASTERN UNITED STATES

Technical Publication HMG-2

PARTNERS IN AMPHIBIAN AND REPTILE CONSERVATION

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PURPOSE AND INTENDED USE OF THIS DOCUMENT

The *Habitat Management Guidelines for Amphibians and Reptiles* series (hereafter Guidelines) is intended to provide private landowners, state and federal land agencies, and other interested stakeholders with regional information on the habitat associations and requirements of amphibians and reptiles, possible threats to these habitats, and recommendations for managing lands in ways compatible with or beneficial to amphibians and reptiles. The general information and specific management guidelines presented are based on best available science, peer-reviewed expert opinion, and published literature. The "Maximizing Compatibility" and "Ideal" management guidelines are recommendations made and reviewed by groups of professionally trained herpetologists and wildlife biologists from private, state, and federal organizations. Because of the taxonomic and ecological diversity of amphibians and reptiles, some recommendations may not apply to every species in every situation. The authors and editors of the Guidelines suggest consulting a local University, state wildlife agency, or federal herpetologist before significant land-use changes are implemented. These Guidelines are not legally binding, regulatory, or in any way an attempt to limit landowner rights. They can be regarded simply as recommendations from the PARC community for landowners and managers to consider the needs of amphibians and reptiles in the course of their land management activities. References to specific sources of information used in the each of the regional Guidelines can be found at www.parcplace.org.

Amphibian and reptile populations are declining in the United States and will continue to do so as long as human populations and associated developments expand. When applied on the ground as general management principles, these Guidelines will promote conservation of amphibians and reptiles by:

- keeping common species common,
- stemming the decline of imperiled species,
- guiding the restoration of amphibian and reptile habitats while benefiting many other wildlife species, and
- reducing the likelihood that additional species will be added to endangered species lists.

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Additional copies may be obtained for a $10 donation per copy; visit www.parcplace.org for more information about placing orders. Donations to PARC help defray the costs of development, printing, postage and handling, and can be made by check, credit card, or money order.

Cover: Composite image of Barking Treefrog and pine forest habitat by Mark Bailey.

Back cover: Image of Gopher Tortoise by Kurt Buhlmann and Tracey Tuberville.

James Kiser

Seasonal isolated wetlands (see page 23) support late winter breeders such as Eastern Newts, Four-toed Salamanders, Spotted Salamanders, and Mountain Chorus Frogs.

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James Kiser

The secretive Ringed Salamander of the Ozark Mountains is a striking yet seldom-seen example of the Southeast's "hidden biodiversity."

PREFACE

Habitat Management Guidelines for Amphibians and Reptiles of the Southeastern United States is a production of Partners in Amphibian and Reptile Conservation (PARC). PARC's mission is "to conserve amphibians, reptiles, and their habitats as integral parts of our ecosystem and culture through proactive and coordinated public/private partnerships." The emphasis is on partnerships, as PARC seeks to work with everyone to find solutions to common issues. PARC is not a funding or government agency. It does not create or dictate policy. Rather, it provides recommendations and guidelines based on sound science, consensus among scientists, and common sense. It is intended to increase communication and cooperation with many diverse groups who have a common interest in amphibians, reptiles, and their habitats. Through publications such as this, PARC will help individuals to be informed about how they or their agencies, companies, or organizations can contribute to the conservation and management of habitats. The diversity of partners makes PARC the most comprehensive conservation effort ever undertaken for these two groups of wildlife. At the core of PARC is the philosophy that we all must work together. There is no "us versus them." It is all "us." This publication is the product of extensive efforts of many people and contains the contributions of many individuals from academic, private, government, and industrial backgrounds.

Development of the PARC Habitat Management Guidelines series began shortly following the organization of PARC in 1999. The initial PARC Habitat Management Steering Committee consisted of Monica Schwalbach, Earl Possardt, Kurt Buhlmann, Joe Mitchell, Bruce Kingsbury, Randy Gray, John Jensen, Erin Clark, Robert Fisher, Whit Gibbons, and Klaus Richter. This group conceptualized the need for habitat management guidelines as a PARC product and agreed that at least five regional documents would be needed for the United States, including the Midwest, Southeast, Northeast, Southwest, and Northwest. Kurt Buhlmann, Joe Mitchell, and Whit Gibbons drafted a model document using the Savannah River Site in South Carolina as *the region*. The 2001 Steering Committee, chaired by Monica Schwalbach, organized a workshop in Chicago. At that meeting, 85 individuals representing the five regions worked for three days on drafts of the documents for each region.

Eric Soehren

The authors, from left to right: Mark Bailey, Jeff Holmes, Kurt Buhlmann, Joe Mitchell.

Subsequently, the Midwest document, spearheaded by Bruce Kingsbury, was the first to be completed. *Habitat Management Guidelines for Amphibians and Reptiles of the Southeast* is the second in this PARC technical publication series.

Lead writers for this book were Mark A. Bailey, Jeffrey N. Holmes, Kurt A. Buhlmann, and Joseph C. Mitchell. Bailey is Senior Biologist and founder of Conservation Southeast, Inc., current president of the Alabama Chapter of The Wildlife Society, and a director of the Alabama Wildlife Federation. Holmes is Senior Biologist and Conservation Planner with Conservation Southeast, Inc., and Co-chair of the Southeastern Working Group of PARC. Buhlmann was Coordinator for Turtle Conservation Programs with Conservation International's Center for Applied Biodiversity Science, is a Visiting Scientist at the University of Georgia's Savannah River Ecology Laboratory, and is the founder of Buhlmann Ecological Research and Consulting, LLC. Mitchell is founder of Mitchell Ecological Research, LLC and Chair of the PARC Habitat Management Working Group.

The Acknowledgments section at the back of this publication lists those who have helped with text, photos, and production of these guidelines. Contributors retain copyright ownership of their photographs. Copying and distribution of this document is encouraged, but please provide credit to the original sources of information.

To learn more about PARC, please visit the PARC web site at www.parcplace.org. The website of the Southeast Working Group of PARC is at www.separc.org.

David Cooper

INTRODUCTION

Five-lined Skinks are found in both pine and hardwood forests where large hollow trees and downed rotting logs provide structure in which to hide and lay eggs.

To address observed declines in our native amphibian and reptile fauna (herpetofauna), the Management Working Group of Partners for Amphibian and Reptile Conservation (PARC) has developed collaboratively-derived, scientifically based Habitat Management Guidelines for the 246 amphibians and reptiles (see list in Appendix A) in ten southeastern states: Alabama, Arkansas, Florida, Georgia, Kentucky, Louisiana, Mississippi, North Carolina, South Carolina, and Tennessee. Land managers in Virginia, eastern Texas, and southeastern Missouri will also find the recommendations applicable. The goal of this project is to use the best science available to produce habitat management and conservation guidelines that are easily understood and practical for land managers and private landowners to include with other management objectives on the landscape.

The habitat management recommendations included in this document have been derived from the body of published information on amphibians and reptiles of the southeastern United States, as well as on the extensive experiences of concerned biologists and scientists. We have not described the needs of every species of amphibian and reptile. Instead, we provide guidelines for managing habitats in each region in ways that have general positive benefits for the associated amphibians and reptiles.

Dirk Stevenson

Imperiled by habitat loss, automobile mortality, and collection for the pet trade, the harmless federally-threatened Eastern Indigo Snake, North America's largest snake, is the "gentle giant" of the Deep South's sandhill habitats.

Mark Bailey

Flattened Musk Turtles are found nowhere else on Earth except for the Cumberland Plateau portion of Alabama's Black Warrior River system.

Amphibian and reptile populations are declining in the United States and will continue to do so as human populations and associated development continue to expand. These guidelines are not regulations, nor are they an attempt to limit landowner rights in any way. They can be regarded simply as recommendations from the PARC community for landowners and managers to consider the needs of amphibians and reptiles in the course of their land management activities.

When applied on the ground as general management principles, these guidelines will promote the following proactive conservation objectives:

- Keep common species common,
- Stem the decline of imperiled species,
- Guide the restoration of amphibian and reptile habitats while benefiting many other wildlife species, and
- Reduce the likelihood that additional species will be added to state and federal endangered species lists.

Conservation needs for North American amphibians and reptiles were the focus of the first PARC meeting held in Atlanta, Georgia, in June 1999. The PARC partners recognized that Habitat Management Guidelines for amphibians and reptiles could be compiled from the available scientific literature and scientists' experiences/expertise, and summarized for landowners and land managers. The goal is to create several colorful, photo-filled publications, each specific to one of five geographic regions of the United States. Each of these identifies the important habitats used by amphibians and reptiles. Each also provides landowners and land managers with options for incorporating specific conservation efforts towards managing, improving, and/or protecting known amphibian and reptile habitat within their management program. Therefore, this book is primarily intended for southeastern landowners and public/private managers interested in including amphibian and reptile habitat conservation in their land management strategies.

Implementing these guidelines will provide ecological benefits beyond amphibian and reptile conservation. Habitat conservation is preventative maintenance. Thus, if many landowners and land managers each implement some of these guidelines, the cumulative effect will be positive.

AMPHIBIANS AND REPTILES OF THE SOUTHEAST

More than half of the United States' reptile and amphibian species can be found in Alabama, Arkansas, Florida, Georgia, Kentucky, Louisiana, Mississippi, North Carolina, South Carolina, and Tennessee. A complete species table with a matrix of state(s) and habitat(s) of occurrence is provided in Appendix A. Note that amphibians and reptiles in this region do not adhere to state boundaries, thus the Habitat Management Guidelines in this document are

Mark Bailey

Kids are fascinated by amphibians and reptiles. Educational programs and materials should target all ages.

Jeff Humphries

Spadefoot Toads need fish-free wetlands with short hydroperiods (i.e., hold water for a few months or less each year) for breeding. Spadefoot Toads forage at night during rains, and spend much of their time buried in forest floor substrate near their breeding ponds.

applicable to similar ecoregions in bordering states as well.

With the exception of lizards, which are more abundant in the West, each of the other groups of North American reptiles (snakes, turtles, crocodilians) and amphibians (salamanders, frogs) reach their highest species richness in the southeastern United States. Despite their abundance and diversity, amphibians and reptiles have only recently received consideration in many wildlife management programs. Their ecological importance has become more recognized as management objectives have begun to focus on non-game species, biodiversity conservation, landscape-level ecology, and the role of all plants and animals in ecosystems.

NATURAL HISTORY OF AMPHIBIANS AND REPTILES

The 44 frog species, 84 salamanders, 43 turtles, two crocodilians, 16 lizards, one worm lizard, and 56 snakes that occur in the Southeast illustrate a range of life histories and adaptations to various habitats in the region. Understanding their basic natural history is essential to effective management of their habitats and populations. Sources of information on these animals are included in the list of resources at the end of this guide.

Over 50 species of amphibians and reptiles are found in the southeastern United States and nowhere else on Earth.

Amphibians and reptiles (often shortened to “herps” or "herpetofauna," from the branch of science called herpetology) are vertebrates like birds and mammals, but they are fundamentally different in one very important way. Herps are “cold blooded,” whereas birds and mammals are “warm blooded.” This means that the source of body heat is external for herps and internal for the other two groups. Why is this important? Being warm blooded (= endothermy) requires birds and mammals to eat at regular or frequent intervals to fuel the biochemical mechanisms producing body heat. Most are therefore active year-round or nearly so.

Not so with herps. Because body heat derives from external sources (= ectothermy), these animals do not need to feed regularly and can be inactive for periods. Some large snakes, for example, need only one large meal per year. Terrestrial salamanders feed primarily on several warm, wet nights during their active season. Given a few exceptions, herps are inactive during cold periods and when environmental conditions are dry. Thus, the combined conditions of temperature and moisture dictate when and where amphibians and reptiles are active. This, in turn, greatly affects when and where we see them moving about or basking. Spadefoot Toads, for example, may stay buried in the ground for several years before they appear during or following heavy rainfall.

Bruce Means

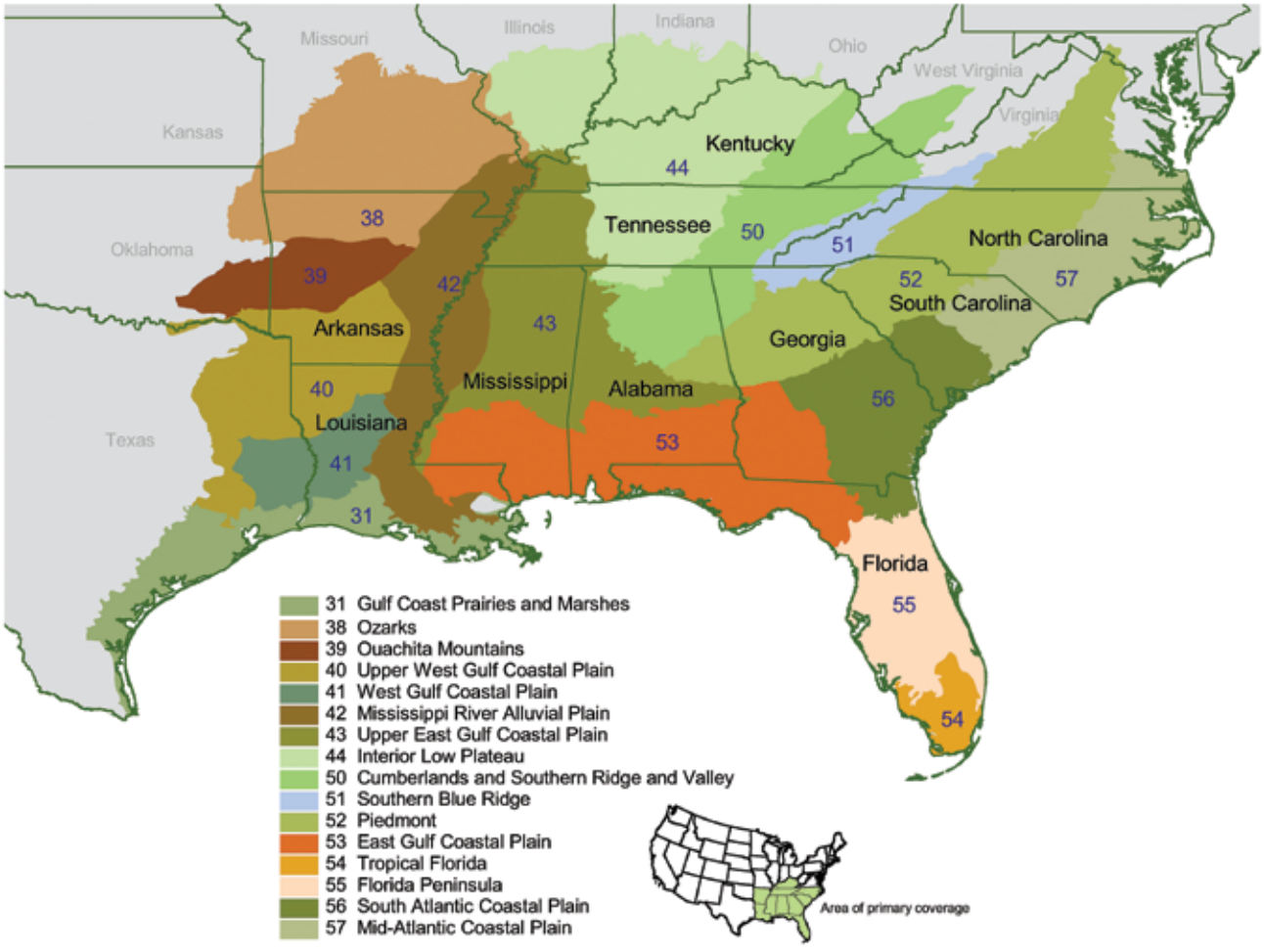
Common Kingsnakes are habitat generalists existing in habitats as diverse as floodplain forests and xeric pine uplands. Eastern Diamond-backed Rattlesnakes are restricted to xeric pine forests and maritime forests where old tree stumps provide underground refugia.

Amphibians and reptiles frequently require both an aquatic and a terrestrial habitat during their annual cycle. Many southeastern frogs (e.g., Gopher Frogs, Barking Treefrogs) and salamanders (e.g., Tiger Salamanders, Four-toed Salamanders) breed in ponds or vernal pools but otherwise spend the rest of their lives in adjacent terrestrial forested habitats. Freshwater turtles live in ponds and wetlands but lay eggs on land and often spend long periods buried in forest substrates. Movement between ponds and forests regularly occurs over distances of several hundred meters. During movements across the landscape, herps may encounter roads or other human-made structures. Many are barriers or death traps, and millions of herps are killed on roads annually. Such adverse features of the landscape should be kept in mind when managing habitats for these animals.

Amphibians are considered sensitive environmental indicators. They are susceptible to a variety of environmental contaminants because they have permeable skin and most have aquatic eggs and larvae. Reptiles lay shelled eggs or produce offspring via live birth, and scales serve as a more protective barrier to pollutants and moisture loss.

Understanding key biological characteristics of amphibians and reptiles is important if management is to have the desired beneficial effect. Longevity has important management implications. Most turtles and many salamanders take years to reach breeding age and live much longer than most game species. Thus, long-lived, late-maturing species require different management strategies, and sustainable harvest may not be a realistic option.

Amphibians and reptiles play important roles in their habitats, both as predators and prey. They are major links in the flow of energy from aquatic to terrestrial systems.



Ecoregions of the Southeast. Modified from NatureServe

ECOREGIONS

The ten southeastern states span 16 ecoregions, as defined by NatureServe. Ecoregions are presented to help identify where various habitats are located on the landscape. Some habitat types occur in multiple ecoregions. For example, pine forests of one kind or another occur in virtually every ecoregion, but caves are most prevalent in the Cumberland Plateau, Interior Low Plateau, and Ozarks. Isolated seasonal wetlands such as Carolina bays and sinkhole ponds are abundant in Coastal Plain ecoregions and the Florida Peninsula, but a few occur in the Piedmont. The most extensive floodplain forests are found in the Mississippi River Alluvial Plain. Spruce-fir forests are found only in the highest mountains of the southern Blue Ridge.

NASA

Night view from space. Populations of amphibians and reptiles will continue to decline as development of the landscape continues. It is important that we wisely target and manage key habitats for the benefit of these creatures, all wildlife, and ourselves.

HABITATS IMPORTANT TO AMPHIBIANS AND REPTILES

We have identified seven aquatic and 12 terrestrial habitat types in the Southeast that are recognizable and distinct, and can be associated with certain suites or assemblages of amphibians and reptiles. Some of these habitats are relatively small (e.g., seeps, seasonal wetlands) and are often embedded within larger habitats (e.g., mesic hardwood forests, pine forests). Each of these habitats is described in detail in the *Management Guidelines by Habitat Type* section.

Aquatic habitat types include:

A. Floodplain Wetlands
B. Seasonal Isolated Wetlands and Small Ponds
C. Permanent Wetlands
D. Small Streams, Springs and Seeps
E. Rivers and Large Streams (includes large reservoirs)
F. Brackish Wetlands
G. Wet Meadows and Bogs

Terrestrial habitat types include:

H. Mesic Hardwood Forests (includes white pine and hemlock)
I. Pine Forests
J. Xeric Hardwood and Pine-Hardwood Forests
K. Sandhill and Scrub
L. High Elevation Spruce and Fir Forests and Balds
M. Prairies, Glades, Barrens, and Old Fields
N. Rock Outcrops and Talus
O. Caves and Karst Systems
P. Beaches and Dunes
Q. Maritime Forests
R. Agricultural Lands
S. Urban and Residential Areas

HOW TO USE THESE GUIDELINES

We recognize that landowners and land managers have multiple goals and objectives for managing their land. PARC also recognizes that, depending on your land management objective(s), not all of our recommendations will be feasible. Nevertheless, we hope to foster an appreciation and understanding of amphibians and reptiles and their needs. If each landowner and land manager can implement some of these recommendations, then the net benefit to amphibians and reptiles across the southeastern landscape will be significant and positive.

Thus, each of the habitat sections contains two sets of guidelines, 1) Maximizing Compatibility and 2) Ideal.

What we have provided in this book are recommendations. Not every land manager or landowner can be expected to implement all of the guidelines.

"Maximizing Compatibility" guidelines are for landowners and land managers who wish to contribute to the conservation of these animals while primarily managing their land for other uses, such as timber production, hunting, other recreation uses, grazing, development, agriculture, and others.

"Ideal" guidelines are for situations where benefiting amphibians and reptiles is a PRIMARY objective, as with nature preserves, wildlife refuges, and private lands whose owners wish to optimize herpetofaunal diversity and abundance.

Using the information in this book, you will be able to:

1. Identify the habitat on which you need to focus (see preceding page for a list of habitat types).

2. Gain an understanding of which species are likely to occur and live in that habitat.

3. Establish your management goal for that habitat:
   * Review the recommended guidelines for that habitat and select those that will work on your land.
   * Work with regional experts to implement the guidelines you have selected.

Once you have implemented the guidelines that are feasible for your land, you may wish to conduct follow-up evaluations to determine if the guidelines are working. Depending on your resources, these could range from the most general field observations (e.g., "I'm seeing more box turtles than I used to") to implementing vigorous monitoring projects.

DEVELOPING A MANAGEMENT PLAN

An important first step in managing habitats for amphibians and reptiles, no matter what the designated land use, is development of the management plan.

1. Know what you have. Identify current conditions before initiating changes. This includes an inventory of habitat types, maps of their relative locations and sizes, composition and identification of land uses that may influence each habitat in some way. It is also important to inventory current amphibian and reptile populations, both to establish baseline data and to identify gaps between current and optimal species richness and abundance. Once such information is organized, it will be easier to identify features of habitats that need alteration, restoration, or other management to benefit amphibians and reptiles. If other land uses are the primary focus, you can identify ways to maximize compatibility between land use goals and habitat suitability.

2. Use maps and aerial photos. One of the most important first steps for landowners is to obtain available maps and imagery of their lands. Maps and imagery may be available at the Natural Resources Conservation Service (NRCS), the U.S. Geological Survey, the Forest Service, and on the Internet. Topographic maps are very informative, as roads, streams, outcrops, and other unique features of the land are apparent. Comparison of current aerial photos with older images provides a valuable historical perspective (i.e., what the habitats looked like). Aerial photographs are available for some parts of the Southeast dating back to 1937. A good map allows the landowner to visualize the arrangement of certain habitats, such as waterholes, wetlands, and forests, and can help the landowner locate the important amphibian and reptile habitats. Management needs may include undisturbed buffers along waterways, construction of artificial wetlands, natural corridors between disconnected habitats, and reintroduction of natural fire regimes.

Jeff Humphries

Work with herpetologists to survey lands and to determine the species present. See PARC's Inventory and Monitoring Guidelines publication for further guidance.

3. Find compatibility with other wildlife and land management goals. Incorporation of habitat management guidelines for amphibians and reptiles into current management plans can provide significant benefits to other native species of animals and plants. Both private and agency landowners can incorporate many of these habitat management guidelines easily and with little cost.

4. Collaborate with experts. Landowners and managers may benefit from the insights of an experienced local or regional biologist who understands the ecology, natural history, and behavior of amphibians and reptiles. Ecologists and land managers who know the local ecosystems and habitats may also be valuable sources of information and insights. Such experts can be found at local universities and county, state, or federal wildlife agencies.

5. Measure your success. Management plans should be be dynamic instruments. They allow you to visualize what the impacts of a project might be and how one can make beneficial changes. Periodic monitoring of amphibian and reptile populations will gauge whether or not your management actions have achieved the desired effect. If so, continue doing what you were doing. If not, adjust your management plan accordingly and try again. Remember that measurable changes in populations may take several years. Consult with local experts before making changes to your plans.

John Jensen

John Jensen

James Kiser

James Kiser

Common amphibians and reptiles tht occur in all of the ten southeastern states covered by this book. Clockwise from top left: Brown Snake, Northern Cricket Frog, Broad-headed Skink, Spring Peeper.

Matt Aresco

CONSERVATION CHALLENGES

The southeastern United States is a resource-rich region and a variety of land uses sustain economic and social prosperity. Some of these land uses are more challenging to herpetofaunal conservation than others. Although roads, development, agriculture, and certain timber practices alter landscapes in the Southeast, we hope to give land managers realistic options that can minimize adverse effects and maximize conservation potential for amphibians and reptiles.

In developing guidelines for the 19 habitat types covered in this book, a set of common challenges became apparent. These are discussed in some detail here, and will be presented briefly in subsequent sections where appropriate.

* Habitat Alteration, Fragmentation, and Loss
* Impacts of Roads and Trails
* Exploitation
* Fire Suppression
* Use of Herbicides, Insecticides, and Fertilizers
* Exotic and Invasive Species
* Subsidized Predators

A large Florida wetland is split in half by a high-volume highway and associated development, leading to thousands of turtle, snake, and frog deaths each year. Progressive highway designs are needed that provide either under-the-highway passage or effective barriers to keep animals off of these roads.

HABITAT ALTERATION, FRAGMENTATION, AND LOSS

Naturalists, scientists, and land managers agree that local habitat alteration is a major cause of reptile and amphibian declines in the Southeast. Any land use management can alter habitats for herpetofauna. Thus, there are many opportunities to modify land management practices in order to improve their compatibility with these animals.

The size of habitat patches, distances to other such patches containing populations, and barriers to dispersal in zones between patches all affect whether an amphibian or reptile population remains viable. Inbreeding and other genetic problems may occur in small isolated populations. Amphibians and reptiles are more vulnerable to single catastrophic events such as extreme weather or disease outbreaks. Simply finding mates for reproduction is a challenge

Habitat alteration changes the suitability of an area for herpetofauna. Amphibian and reptile species often respond differently to habitat alteration (i.e., abundance of some species may increase while others may decline). Species associated with habitats that take long periods of time to develop (e.g., longleaf pine) may be particularly sensitive to habitat alteration.

Habitat fragmentation results in the isolation of places where amphibians and reptiles live. Consequently, species may be forced to move across areas of unsuitable habitat to reach other suitable habitat. mmigration, necessary for genetic diversity, is impeded.

When habitat is severely altered and fragmented, as with development, herpetofauna populations may slowly decline to the point of extirpation.

when areas of inhospitable habitats do not contain dispersal migration corridors.

LANDSCAPE SCALE AND MATRIX

Think landscape scale and landscape matrix.

Integrating a landscape-level perspective into your **Management Plan** will greatly enhance the persistence of amphibians and reptiles. These animals use uplands and wetlands and move extensively between them. They have highly seasonal activity patterns that are tied to their use of different habitat types. Understanding the natural history of these animals, their seasonal movements between habitats, and the natural dynamics of the habitats themselves is crucial for management at the landscape level. For example, the traditional practice of "buffering" streams with narrow forested strips may contribute to maintaining water quality but may not meet the needs of associated reptiles and amphibians.

So think about the "matrix" of different habitats on a "landscape scale," and consider all possible habitats needed by these animals when creating management plans. For example, how much upland habitat is needed for non-breeding activities by species that breed in wetlands, ponds, or streams?

Kurt Buhlmann

A complex of sinkhole ponds on the edge of development. Because of yearly differences in hydroperiod and thus differences in breeding success among the amphibian species present, all ponds in the system are necessary for the long term persistence of the populations. Some ponds to the north have already been surrounded by human home construction. The "metapopulation" of ponds to the south needs to remain connected through corridors of natural habitat. The sinkhole pond complex and surrounding forest is home to a Tiger Salamander population.

Kurt Buhlmann

The largest terrestrial salamander in the Southeast, the Tiger Salamander, is declining due to loss and fragmentation of sinkhole ponds and habitat.

A Coastal Plain landscape consisting of agricultural fields, small woodlots, floodplain forest (bottom), and Carolina bay wetlands (center). From this landscape perspective, it is evident that forested dispersal corridors between the wetlands and floodplain have been broken and forested upland habitats immediately adjacent to the wetlands are absent.

Landscape scale is the geographic extent of the management area in question and includes all of the habitats within the area. A landscape can be defined as an entire watershed, the land within a political boundary, or even a single property under management. Landscape matrix refers to the patchwork of different habitat types, including the altered or unsuitable land between intact habitat fragments. Viewed from the animal's perspective, the matrix includes all the barriers and dangers in the gauntlet through which they must navigate in order to move between essential habitats.

Think connectivity. What habitats would amphibians and reptiles have to move through when migrating from one area to another? Patches of suitable habitat will enhance survival during migration and are essential for the conservation of many species, and corridors of habitat linking these patches are probably important.

Think impacts. How do various human activities impact each habitat type on your land? Learn how to minimize negative impacts of human activities. Maximize positive impacts. A well-designed Management Plan with these aspects in mind will greatly enhance success.

COMPLEMENTARY HABITATS

Most amphibians and reptiles require several "complementary" habitats annually for reproduction, foraging, and hibernating. Amphibians and reptiles frequently require both an aquatic and a terrestrial habitat during their annual cycle. Many southeastern frogs (i.e., Gopher Frogs, Barking Treefrogs) and salamanders (i.e., Tiger Salamanders, Four-toed Salamanders) breed in ponds or vernal pools but otherwise inhabit adjacent terrestrial forested habitats. Complementary habitats are not always obvious, because in many cases they harbor species when they are inactive or hidden. For example, Chicken Turtles and Eastern Mud Turtles are normally associated with seasonal wetlands, not pine forests, but these animals actually spend much of the year hidden beneath the forest duff layer when their wetlands are dry. Conversely, "terrestrial" Box Turtles may retreat to streams, seeps, or other wetlands to escape summer heat. Some snakes, e.g., Brown Water Snakes, may forage all summer in riverine habitats, but retreat to underground dens in floodplain forests during the winter. Aquatic turtles live in rivers and ponds. For a few hours each year, however, the females migrate to sandy uplands to lay their eggs. As such, these brief journeys are absolutely essential to the ability of these species to reproduce.

Mark Bailey

An ever-increasing network of roads leads to more fragmentation of habitats into smaller blocks. The additional highway mortality leads to the extirpation of snake populations, most notably large, slower-moving species such as pine snakes and rattlesnakes that have large home ranges. Some motorists go out of their way to run over snakes such as this Pine Snake.

IMPACTS OF ROADS AND TRAILS

Some ideas to consider...

- Consider the impacts of roads on a landscape or watershed level. "Managing the National Forest Transportation System," Miscellaneous Report FS- 643, explains the process. This is a U.S. Forest Service roads analysis handbook available in PDF from www.fs.fed.us. Using the concepts illustrated in the handbook can enable the development of a transportation management plan which incorporates reptile and amphibian conservation measures.

- New permanent road construction should be minimized where possible.

- Road placement should take into account the locations of sensitive habitats and migration routes.

- Soil erosion can be minimized by planting native grasses, mulching, liming and fertilizing on closed trails and dirt roads. Restricting access by gating or permanently closing nonessential roads can be very effective and is easily accomplished on some public and private lands.

Joe Mitchell

Kurt Buhlmann

Turtles are frequently killed by motor vehicles. Warning motorists to slow down and be alert for turtles can prevent mortalities, especially of nesting female turtles.

CASE STUDY: THE PAYNE'S PRAIRIE ECOPASSAGE

Kurt Buhlmann

U.S. Highway 441 transects two miles of this large Florida marsh, most of which lies within Payne's Prairie State Preserve. Turtles, snakes, alligators, and other animals attempt to migrate across the road, but because more than 10,000 vehicles use the highway daily, few survive the journey.

In 1998, the Florida Department of Transportation (FDOT) convened a multidisciplinary working group to discuss methods of reducing wildlife mortality on U.S. Highway 441 across Payne's Prairie. Biologists with the U.S. Geological Survey's Florida Integrated Science Center conducted a study to document preconstruction mortality levels in Payne's Prairie and the adjacent landscape. Between August 1998 and August 1999, at least 3,365 animals died trying to cross the highway.

With input from the working group, FDOT engineers designed a system of barrier walls and underpasses (called an Ecopassage) to be placed along the two-mile section of U.S. 441 across the Prairie. The Ecopassage was designed specifically to reduce road mortality of reptiles, amphibians, and small mammals. The $3.8 million Payne's Prairie Ecopassage was completed in early 2001, and monitoring has shown a 93.5% drop in herp mortality (treefrogs are an exception: they can climb over barrier walls).

The Payne's Prairie Ecopassage is the prototype of a system designed to reduce wildlife mortality and to allow safe passage under the roadway. Proven effective, this project may guide future highway design in critical wildlife areas nationwide.

William J. Barichivich

- Seasonal road closures using gates can help protect species and habitat. Upland snakes may be protected from vehicle mortality during the warm-season period of greatest surface activity. Gates may be opened selectively to maintain traditional fall and winter hunting uses.

- Reducing speed limits, installing speed bumps, and adding cautionary signage may help motorists to avoid hitting migrating amphibians and reptiles, especially where migration routes have been identified.

- A combination of fencing, overpasses, and underpasses can be used to funnel wildlife safely from one side of a roadway to the other.
  - Passageways could be located where a road separates breeding from non-breeding habitats.
  - When planning, designing and building wildlife crossings, ensure the future viability of habitat on either side of the passageway through land acquisition or easements.

EXPLOITATION

The Challenges

- Harvesting or collecting herps, including rare species, is legal under certain circumstances in some states (check with your state wildlife agency for a list of applicable laws).

AMPHIBIAN AND REPTILE COLLECTORS AND TRAPPERS

Local collectors may request permission to collect or trap reptiles and amphibians on lands under your management. This is especially true if your lands are large and support appropriate habitat for these animals. Collectors range from casual hobbyists to scientific researchers to commercial market professionals. PARC is not opposed to casual collectors removing a few animals for use as pets wherever collecting is legal. PARC also supports all forms of valid herpetological research, which may include some collection. In general, these forms of collection are not harmful to native populations of amphibians and reptiles.

Market collection (the collection of large numbers of individuals for commercial purposes) has a history of being detrimental to local amphibian and reptile populations if left unregulated. Market collectors typically employ some form of trap mechanism that may be active (e.g., hoop nets for turtles) or passive (e.g., boards or tin to provide shelter for snakes). If you find boards or sheets of tin in your woods, then it is likely that a collector is at work on the property you manage.

Some commercial collectors may offer to "help control overpopulation." There is no scientific evidence to suggest that amphibian and reptile populations need harvest to control them.

PARC recognizes that managers of lands with venomous snakes may feel the need to control those populations. The ecological role of snakes is extremely important. Most snakes large and small, venomous and non-venomous, not only serve as prey for bobcat, mink, owls, hawks and others, but are excellent rodent predators, feeding on the rats and mice that compete with quail for food.

Giff Beaton

Small, attractive, and mild-mannered, Spotted Turtles are popular targets for commercial and casual collectors.

Data suggest that turtles in a pond actually benefit fishing. Most of the common turtles, such as the Slider, are herbivores and scavengers that eat dead or dying fish and help keep game fish populations healthy. Because they are herbivores, Sliders can occur in great numbers in a pond and not be "overpopulated."

We recommend that land managers consider the potential detriment posed by commercial collectors. Consider the benefits of healthy amphibian and reptile populations before granting permission to individuals for collecting animals from your property.

—Steve Bennett, SCDNR

Mark Bailey and Kurt Buhlmann

Basking turtles and snakes are tempting targets for some. Appropriate regulations, enforcement, and public education and awareness can help curtail impacts.

- People still kill snakes and other amphibians and reptiles due to fear, hatred, and ignorance. (Ophidiophobia: an excessive and irrational fear of snakes)

- Many species cannot withstand prolonged, unregulated harvest.
  – Turtles are increasingly being caught and shipped to overseas meat markets in Asia and the pet trade in Europe.
  – Many other amphibians and reptiles are also collected illegally from the wild as pets.
  – Rattlesnakes are still collected for "roundup" events in several states.

Laws

- Laws protecting amphibians and reptiles vary from state to state. Check with your local state and federal wildlife conservation agencies.

- Where adequate laws exist, enforcement may be inadequate due to lack of identification expertise on the part of some enforcement officers and a lack of "prosecutorial appeal" (i.e., courts often do not place high priority on herp-related legal cases).

Awareness

- Hunters, fishermen, hikers, loggers, farmers, and others who interact regularly with the outdoors are seldom provided with amphibian and reptile-related educational materials.

What Can Land Managers Do?

- Incorporate protective measures, such as limiting access, to prevent recreational visitors and commercial collectors from harming amphibians and reptiles and their habitats.

- Provide recreational visitors with reptile and amphibian-specific educational opportunities and materials.

- Encourage enforcement agencies to become informed and knowledgeable about amphibians and reptiles, and when appropriate, ask for help patrolling your land for possible violators.

FIRE SUPPRESSION

Fire is likely the most important ecological process in the southeastern United States. It was a natural part of terrestrial ecosystems long before modern fire suppression was common. Depending on regional drought cycles, lightning-sparked fires would burn for weeks or months. American Indians would also set fires to clear undergrowth and stimulate herbaceous growth. Rivers, large streams, and some wetlands served as natural firebreaks, except during times of extreme drought. As a result, many reptiles and amphibians are tolerant of, or even dependent on, fire and its effects on habitats. Amphibians and reptiles throughout much of the Southeast are adapted to open woodlands and savannas interspersed with grasslands, glades, and scrublands.

Mark Bailey

Pine forests of the Southeast require periodic fire to reduce thick, flammable undergrowth and promote a diverse and healthy ecosystem. Fire suppression over the last century has lead to habitat degradation and sharp declines in fire-dependent species and has created dangerous conditions for nearby home developments.

Prescribed fire is a tool used by land managers to alter forest or grassland habitats in such a way as to restore or maintain desired forest stand structure, remove undesirable or introduced vegetation, stimulate natural growth of the native understory plants, and maintain a natural ecosystem.

Over the past century or so, humans in the southeastern United States have become skilled at fighting wild fires. While our civilization has prospered as a result, our environment has suffered. Flora, fauna, habitats, and predator-prey relationships have been disrupted and many once-common species have become critically imperiled.

Not only does prescribed, controlled fire benefit these declining species, it also reduces fuel supplies for unplanned wild fires which can cause extensive property damage and loss of life. Prescribed fiire also increases land value for hunting by enhancing game habitat.

Almost all of our southeastern ecosystems are adapted to occasional low- to moderate-intensity fire. Even wetlands naturally burn during times of extreme drought. The ideal frequency, intensity, and seasonality of prescribed fire is highly variable depending on:

- Climate
- Slope
- Aspect (direction the land faces, thus the amount of sunlight received)
- Elevation
- Soils
- Moisture retention capacity of native vegetation

CAUTION! Excessive or poorly planned fire can do more harm than good. Even where burning is used, there is often an overuse of dormant-season fire over growing-season fire. Before you strike a match, consult a qualified prescribed fire specialist. Your local state forestry agency, NRCS, USFS, or Nature Conservancy office can provide information on when, where, and how to burn, as well as when, where, and how NOT to burn. Some state forestry agencies will build fire lines on your property for an extremely reasonable fee, and will actually conduct the burn for you. Burning may be conducted as part of NRCS, USFWS, or other cost-share programs (see Appendix B).

Mark Bailey

Invasive exotic plants, like cogongrass, are greatly impacting southeastern habitats. The spread of cogongrass throughout the Gulf coastal region has been accelerated by road grading and logging equipment and transport of hay from infested fields.

"Restore natural fire regimes" frequently appears in the following management sections. Determining natural historic fire frequencies can be a challenge, and requires getting input from fire ecologists in your area. Long recognized as a part of pine forest ecology, fire also plays a role in the maintenance of certain hardwood-dominated habitats. Wildlife of much of the Ozarks, Ouachita Mountains, Interior Low Plateau, Cumberlands, Ridge and Valley, Piedmont, and Coastal Plain ecoregions were adapted to more open woodland and savanna conditions than exist today. Recent fire suppression has contributed to the declines, rarity, and extirpation of many species, such as Pine Snakes and glass lizards, even on publicly managed forestlands.

USE OF HERBICIDES, INSECTICIDES, AND FERTILIZERS

Herbicides are useful for achieving many habitat management objectives such as controlling invasive species, creating snags, and diminishing oak encroachment in pine habitats. Herbicides can be especially effective for meeting some objectives (e.g., diminishing oak encroachment) when combined with prescribed fire.

When chemicals are used:

- FOLLOW INSTRUCTIONS ON THE CONTAINER LABELS.

- Consult a trained forester or extension agent for determining the correct herbicide and application rate for your situation.

- When used improperly, chemicals may be directly toxic to amphibians and reptiles (aquatic species in particular), and may alter habitats and food supplies in unintended ways.

- Insecticides may reduce the abundance of valuable invertebrate prey species eaten by amphibians and reptiles, as well as birds, bats, and other wildlife.

- Herbicides should be used selectively in order to retain as much wildlife food as possible while still eliminating unwanted plants.

- Fertilizers may cause excessive algal blooms and alter dissolved oxygen and carbon dioxide levels if improperly applied near aquatic systems. Carefully adhere to Best Management Practices (BMPs) to minimize this possibility.

- In summary, be careful with chemicals.

INVASIVE EXOTIC SPECIES

Exotic species are defined as plants or animals that are introduced outside their native range. The most successful (and threatening) exotics are highly adaptable, rapidly-reproducing habitat generalists that can quickly out-compete, overwhelm, displace, and even extirpate native species and communities, and therefore are known as “invasive” species.

Some exotic species, such as cattle egrets, arrived in North America naturally. However, many others did not. For example, privet, Chinese tallow tree (“popcorn tree”), and water hyacinth were first introduced as ornamental garden plants. Others plants, such as kudzu, were introduced to control erosion. Still others, such as autumn olive and some lespedeza species were planted as game browse by wildlife managers.

Some exotic animals, such as fire ants, arrived in the Southeast on shipments of foreign plants, fruits, and other goods. Fire ants arrived from Brazil and have been documented to destroy reptile nests and kill hatchlings. In Florida, Cane Toads, Brown Anoles, Cuban Treefrogs, Green Iguanas, Nile Monitors, and Burmese Pythons have become established after escaping or being released from captivity, and are displacing native species. Even free-ranging pets become a problem when they kill amphibians and reptiles.

What Can Land Managers Do?

- Use native plants for:
  – Wildlife food plots
  – Commercial and residential landscaping
  – Erosion control

- Where invasive exotic plant species are already established, consult a qualified invasive species

John Jensen

The spread of non-native invasive fire ants, an increasing network of roads, agricultural chemical use, and loss of xeric pine forests and sandhill habitat are all believed to contribute to the alarming decline of Southern Hog-nosed Snakes.

Kurt Buhlmann

Amphibians breeding in temporary and semipermanent ponds are vulnerable to extirpation when fish are introduced. Public education can mean the difference between survival and extirpation of populations.

Tom Maier / U.S. Forest Service

Raccoons, opossums, and even family pets kill countless reptiles and amphibians. Raccoons are increasing because of the adaptability to human development and subsidized food sources (i.e., garbage). An over-abundance of raccoons leads to excessive mortality of reptile eggs, particularly turtles.

specialist (i.e., your state forestry agency or local NRCS or USFS office) for the safest, most effective means of eradication or control.

- Consult your state wildlife agency about problems with invasive wildlife and feral animals.
- Avoid introduction of non-native wildlife species.

SUBSIDIZED PREDATORS

Subsidized predators include raccoons, opossums, foxes, skunks, and crows. These animals are well-known predators of hatchling turtles and eggs in their nests. Raccoons are also adept at killing nesting adult turtles. These predators also eat frogs, small snakes, and lizards. Studies have documented 100% egg mortality in all nests in some Painted Turtle populations. Crows will perch on trees and power lines, observe nesting turtles, and subsequently raid the nest. Populations of subsidized predators are often uncontrolled in urban areas and flourish in state and national parks. In many parts of the Southeast, fur-bearing predators such as opossum, raccoon, and fox are at higher numbers due to the decline of trapping in recent decades.

Subsidized predators are native species whose populations have increased in parts of their range due to enhancement of food and habitat provided directly or indirectly by humans.

What Can Land Managers Do?

- Reduce the availability of human food sources (i.e., garbage).
- Consider removal of subsidized predators by humane means.
- Recognize that subsidized predators occur at unnaturally high population levels in some areas. Thus, evaluations of their behavior, effects, population sizes, and sources of subsidy could help identify ways to curb their impact on native amphibians and reptiles.

DON'T TURN IT LOOSE!

For PARC 's policy on release of captive herps (often from unknown places of origin), including those used as teaching aids, refer to the "Don't Turn it Loose" brochure available online through the PARC website (www.parcplace.org). This publication contains information on how to properly dispose of unwanted classroom or laboratory specimens. This is a useful resource for land owners and managers who may be unaware of the problems associated with "releasing animals into the ecosystem."

John Jensen

Keeping housecats indoors saves untold lizards and small snakes, as well as songbirds.

Boyd Blihovde

THE BASICS: MANAGEMENT GUIDELINES FOR ALL HABITAT TYPES

The guidelines in this section are pertinent to amphibian and reptile conservation in all or most habitat types.

Burning and thinning pine forests can significantly improve habitat suitability for many amphibians and reptiles by controlling hardwood succession and promoting vegetative and invertebrate diversity.

MAXIMIZING COMPATIBILITY

Timberlands, Hunt Clubs, Farmlands, Ranches, Recreation Lands, and other Integrated Land Uses: *When benefiting amphibians and reptiles is secondary to other management objectives:*

- **Fence livestock out of rivers, streams, wetlands, and other water bodies. Consider alternative watering sources or concentrate livestock watering and shading needs in a small area, leaving the majority of habitat intact.** *Livestock can graze and trample native plants, depriving amphibians and reptiles of vital habitat. Trampling can disturb and compact soil, increasing erosion and sedimentation. Excessive manure in aquatic systems may cause algal blooms, altering dissolved oxygen and carbon dioxide levels, possibly harming aquatic amphibians, reptiles, fish, and invertebrates.*

- **Restore natural fire frequency, intensity, and seasonality to the extent possible.** *The vegetation in which many reptiles and amphibians forage, nest, and shelter is often fire-dependent or fire-adapted. Without fire, canopies tend to close and shade out herbaceous groundcover, which is often the critical first link in many food webs.*

- **Where herbicides, pesticides, or fertilizers are used:**
  - *Follow label instructions carefully and precisely.*
  - *Use only those chemicals approved for the habitats to be treated.*
  - *Make sure that sensitive habitats, especially aquatic systems, are adequately buffered to minimize impacts of chemicals beyond the targeted area.*
  - *Give preference to individual stem treatment or spot application. Banded herbicide application, rather than broadcasting, can be used when appropriate, to reduce the amount of herbicide used and the area treated.*

John Jensen

Improper erosion control can result in severe damage to habitats of amphibians and reptiles that depend on healthy streams and wetlands.

- **Identify and protect embedded, adjacent, and sensitive habitat features such as seasonal wetlands, seeps, caves, and rock outcroppings.** *For example, leave forested buffers around amphibian breeding sites. Many forest-associated species require embedded, sensitive habitats for part of their life history and/or seasonal migration patterns. Both the embedded habitat and the surrounding matrix must be present for them to survive. Consult a qualified wildlife biologist to help identify special habitat features and determine which management practices will best benefit your local amphibians and reptiles.*

- **Minimize soil disturbance (e.g., soil compaction, tire ruts) when using heavy equipment.** *Use low pressure tires and/or limit use to drier seasons. In addition to directly contributing to vehicle mortality, heavy equipment can disturb/compact soil, increase erosion/sediment, disrupt vegetative succession, and provide distribution corridors for invasive exotic plants. Although some amphibian species may be able to breed successfully in tire ruts on low-traffic roads, the detrimental effects of excessive soil compaction and disturbances may outweigh the benefits.*

- **Minimize or exclude agricultural, residential, and industrial waste from aquatic habitats.** *Pollution can introduce toxins that adversely affect aquatic plants and animals.*

- **Meet or exceed state recommended Best Management Practices (BMPs) including recommendations for and Streamside Management Zones (SMZs).** *If possible, establish wide SMZs. For links to each state's BMPs, visit www.forestrybmp.net. In some cases, SMZs are adequate to protect streamside amphibians and reptiles; in other cases, these practices may need to be modified, especially for species that migrate or disperse in and/or out of adjacent upland habitats.*

- **Allow dead trees and woody debris to decompose naturally.** *After timber harvests, leave stumps, tip-ups, logs, dead standing snags, and other coarse woody debris. Many amphibians and reptiles nest, forage, or shelter inside or underneath rotten logs. Tip-ups and stump holes are critical hibernation habitats for most pine forest-related amphibians and reptiles. Dead standing snags provide important habitat for some snake and lizard species.*

- **Consider using fire and other site preparation techniques that minimize soil disturbances. When possible, harvest during drier seasons and/or use low-pressure tires on equipment.** *Disturbed soil may not adequately support fire-dependent vegetation, which is an important element of some ecosystems.*

- **When bedding must be used, consider wider bed spacing (12 to 15 feet) to retain undisturbed areas between beds.**

- **During timber stand establishment, plan for a future prescribed fire program.** *Planted or disked firebreaks (but not through wetlands!) are less disruptive than repeatedly plowed or bladed lines.*

- **Formulate forest regeneration plans before harvesting activities start.** *Consult your state forestry agency, certified forester, or a forest ecologist to determine the most appropriate composition of next-generation stands and how to best manage for regeneration.*

- **Maintain a diversity of forest age classes, densities, and structures either within the same stand or among adjacent stands.** *Large expanses of even-aged, closed canopy stands, where herbaceous and shrub layer abundance and diversity are suppressed, may not sustain many pine-associated species.*

- **Consider thinning, burning, and extending rotations in plantations to optimize the time herbaceous and shrub layer vegetation is available.**

Steve Bennett

Retain old stumps; as they rot, root networks create ideal underground retreats and hibernacula for a wide variety of wildlife, especially snakes and lizards.

- **Consider a mosaic of smaller, adjacent patches of varying management regimes.**

- **Maintain connectivity of suitable habitats to facilitate dispersal and migration of reptiles and amphibians between larger forest stands.** *In some cases, retaining corridors may be an appropriate way to link suitable habitat. Stands that are separated from other forested stands by unfavorable habitat may limit the movement of amphibians and reptiles. Site roads, fields, and other openings carefully to avoid fragmenting forests. When establishing wildlife food plots, stay within the footprint of previous disturbances to avoid additional impacts.*

- **Follow natural contours when designing and conducting timber sales.** *Soil erosion can be minimized when disturbances such as skidder trails run parallel to slopes.*

- **Leave large cull trees or patches of trees on harvested sites whenever practical.** *These patches may sustain pockets of shade-dependent species until the surrounding harvest area matures.*

- **When timber is harvested, consider harvesting techniques such as group selection, individual selection, or small clearcuts.** *Where shade-dependent species are present, consider leaving unharvested patches or some residual overstory. Rather than expecting re-colonization, it is preferable to ensure that population remnants can survive on the site.*

- **Try to minimize construction of new roads and ATV trails where possible; gate existing roads when not in use.** *Keep sensitive habitats, especially wetlands and stream channels, free of vehicle traffic. Where hunting and fishing access is provided, limit vehicles to designated roads and trails. Discourage motocross racing, "mud-bogging" and similar off-road uses. Motorized vehicle traffic can compact/disturb soil, increase erosion/sedimentation, increase herp mortality, and disrupt animal activities. ATVs can severely degrade seasonal wetlands.*

- **Use seasonal road closures as a tool to provide balance between species and habitat protection and maintain traditional uses such as hunting and fishing.**

- **Site regularly used roads, trails, landings, and recreational facilities away from sensitive habitats and migration corridors.** *Limit recreational access to as few points as is feasible. Vehicle-related mortality, direct persecution, and noise-related disruptions of natural behaviors are unfortunate side effects of recreational access.*

- **Provide conservation-related educational materials to boaters, fishermen, hunters, loggers, hikers, campers, farmers, and other people who regularly interact with the outdoors.** *Discourage field personnel and recreational visitors from shooting turtles and killing snakes. An informed public benefits everyone. People are often unaware of conservation issues related to amphibians and reptiles.*

IDEAL: Refuges, Sanctuaries, and Preserves: *When benefiting amphibians and reptiles is a PRIMARY objective, as with nature preserves, wildlife refuges, and private lands whose owners wish to optimize herpetofaunal diversity and abundance:*

- **Maintain and, where appropriate, restore native vegetative structure and composition.** *Remove or contain the spread of invasive plant species. Many reptiles and amphibians are specifically adapted to forage, bask, hibernate, and nest exclusively in native vegetative communities.*

- **Avoid residential, commercial or agricultural development.**

- **Avoid management practices that result in extensive areas of closed-canopy forest where open-canopy woodland or savanna conditions are native; maintain abundant, diverse groundcover vegetation.**

- **Restore and maintain natural fire frequency, intensity, and seasonality.** *Many reptiles and amphibians require early successional (such as maintained by fire) plant communities. Without fire, canopies tend to close and shade out herbaceous groundcover. Even wetlands burn during times of extreme drought. It is not critical that every acre receives fire every time a burn is conducted. Natural fires will skip or "spot" through areas where conditions are moist or fuel levels are low. Too much fire can be as harmful as too little fire. Consult your state forestry agency before implementing any burn.*

- **Direct recreational use (e.g., foot traffic, trails, and boat landings) away from sensitive habitat features such as snake hibernacula, wetlands, turtle nesting sites, seeps, ravines, and caves.** *Soil disturbances, direct persecution of herps, and noise-related disruptions of natural behaviors are among the unfortunate side effects of recreational access.*

- **Limit off-road vehicle access to official conservation-related traffic areas.** *Excessive motorized vehicle traffic can potentially compact/disturb soil, increase erosion/sediment, provide corridors for invasive plant species along trails, elevate vehicle-related mortality rates, and disrupt faunal activities. ATVs can severely degrade seasonal wetlands.*

- **Install culverts or tunnels in conjunction with barriers to direct animals under or away from roads.** *Barriers have been successful in certain instances to mitigate highway mortality near breeding sites or along seasonal migration corridors (see Roads section).*

- **Restore natural hydrology of wetlands. If necessary, fill old drainage ditches.** *The natural character of degraded Carolina bays, mountain bogs, and sinkhole ponds can often be restored.*

- **Avoid introduction of game and nongame fish to naturally fish-free isolated wetlands and ponds.** *Remove introduced fish where necessary. Restricting vehicular access may discourage fish stocking by locals. Predatory fish feed on breeding amphibians, their eggs, and tadpoles.*

- **Protect transition zones between adjacent complementary habitat types.** *Ensure that land use practices do not hamper seasonal migration and natural dispersal patterns.*

- **Ensure the availability of essential complementary habitat types.** *Most amphibian and reptile species require two or more habitats for their life history and annual activity patterns. Reducing the suitability of any one of these complementary habitats for sensitive amphibians or reptiles, even if the others are in ideal condition, may lead to declines and even local extirpation.*

- **Use the minimum amounts of herbicides, insecticides, and fertilizers necessary to achieve management objectives.** *When chemical application is needed, use selectively and follow instructions carefully.*

ECOSYSTEM-BASED FORESTRY: MEADWESTVACO

MeadWestvaco uses a land classification system called Ecosystem-based Forestry to manage its landbase for multiple-use forest management and to stratify its land into six zones. Timber Management Zones contain stands of varying age classes and are managed to increase timber production. Three zones (Water Quality Zones, Visual Quality Zones, and Habitat Diversity Zones) exist as linear forested corridors and provide habitat connectivity. Other zones within this stratified landscape are managed for primary purposes other than timber production, and most zones provide multiple functions. For example, MeadWestvaco's Special Areas include habitats managed for threatened or endangered species and Water Quality Zones ensure water quality is protected. These two zones also promote habitat diversity on the landscape by providing older age class habitats.

— Mac Baughman, MeadWestvaco

Mark Bailey

FLOODPLAIN WETLANDS

Floodplain or "bottomland" forests are found where streams and rivers occasionally flood beyond their channels. This habitat type can range in area from broad river floodplains to narrow strips along small stream channels. Associated habitats include swamps, sloughs, and oxbow lakes. Topographic relief is low, but natural levees of flood-deposited sediment may form high points along streams. Frequent flooding is a natural disturbance that greatly influences species abundance and distribution, and slight changes in elevation result in differences in vegetation so that a variety of species compositions may occur. Dominant canopy trees include cypress and several hardwood species, particularly oaks and water tupelo. River birch, eastern cottonwood, American sycamore, and other trees may be present, often with an understory of ferns, orchids, and vines such as grapes and trumpet creeper.

CHARACTERISTIC SPECIES

Gray Treefrog, Bird-voiced Treefrog, Fowler's Toad, Bronze Frog, Mud Salamander, Spotted Salamander, Southern Dusky Salamander, Three-lined Salamander, Green Anole, Five-lined Skink, Rat Snake, Plain-bellied Water Snake, Mud Snake, Box Turtle, Striped Mud Turtle

The presence of surface water, high soil moisture, and shaded conditions favor many amphibian and reptile species. Important microhabitats within floodplain forests include standing dead trees, logs, and drift piles left by receding floodwaters. Bottomland forests provide movement corridors for amphibians and reptiles as well as other wildlife ranging from bears to migratory songbirds.

MAXIMIZING COMPATIBILITY: Timberlands, Hunt Clubs, Farmlands, Ranches, Recreation Lands, and other Integrated Land Uses
When benefiting amphibians and reptiles is secondary to other management objectives:

- **Allow drift piles and standing dead trees to decompose naturally on the ground.** *Many amphibians and reptiles nest, forage, or shelter in or underneath rotten logs.*

- **Retain large trees and canopy cover where feasible.** *Shade and associated moisture retention is critical to the survival of many amphibians and reptiles.*

Mark Bailey

River Frogs are found in forested bottomlands along major river corridors in the Southeast.

- **Use chemical herbicides selectively and follow label instructions carefully where application is desirable or necessary (e.g., to remove invasive plants).**

- **Use Best Management Practices to minimize erosion and excessive runoff containing sediments, silt, and/or nutrients that may alter water quality, hydrologic processes, and flooding regimes.** *Excessive sediment can alter habitats essential to aquatic amphibians. Excessive erosion or sedimentation also can alter forest habitats in ways that may render habitat unsuitable for many species.*

- Locate mineral, mining, and other industrial facilities outside of forested floodplains where possible. Coal mining, oil production, and other forms of mineral extraction can potentially degrade surface water quality in floodplain wetlands and adversely affect aquatic life.

IDEAL: Refuges, Sanctuaries, and Preserves
When benefiting amphibians and reptiles is a PRIMARY objective, as with nature preserves, wildlife refuges, and private lands whose owners wish to optimize herpetofaunal diversity and abundance:

- Restore natural flooding regimes. Coordinate with U.S. Army Corps of Engineers and/or regional hydroelectric companies that may be capable of providing discharge from dams at ecologically appropriate times and amounts.

- Reclaim abandoned agricultural lands; replant to native floodplain trees.

IMPORTANCE OF HABITAT GRADIENTS

Floodplain forests provide habitat for only a portion of many species' life history. Contiguous gradients between floodplain forests and adjacent upland habitat types are essential in providing foraging habitat, hibernation sites, and refugia during high water events.

- Maintain or restore connectivity between floodplain forest stands. Floodplain forests are important distribution and dispersal corridors for many species. Allow for migration of amphibians and reptiles between larger forest stands.

- Minimize unnatural disturbance or alterations of embedded open-canopy wetlands. Natural patterns of shade and light gaps are important to some species.

- Maintain contiguous gradients between floodplain forests and adjacent uplands. Ensure that land uses between complementary habitats do interfere with seasonal migration and natural dispersal patterns.

See RIVERS section for more information on the importance of adjacent forested lands to water quality and migration patterns of riverine species.

Kurt Buhlmann

An old cypress stump. Many floodplain swamp forests of the Southeast were originally dominated by mature baldcypress. After logging, the regenerated forests are often dominated by black gum and red maple. Baldcypress regenerates under specific flood and drought conditions that occur rarely and are difficult to mimic with habitat management.

This is the Floodplain Wetlands module of the PARC publication, HMG-2. ISBN 0-9667402-2-X. Please visit www.parcplace.org for further information, copies of the complete document, or a web-based version of these guidelines.

Mark Bailey

SEASONAL ISOLATED WETLANDS AND SMALL PONDS

Seasonal wetlands are among the most important and imperiled habitats for southeastern amphibians and reptiles. Alarming declines in a number of species (e.g., Flatwoods Salamanders, Gopher Frogs, and Striped Newts) have been directly attributed to the loss or degradation of seasonal wetlands and adjacent complementary habitat types. Most amphibians that rely on seasonal wetlands for reproductive purposes also require upland habitats. However, these habitats must be within the home range or dispersal distances of the animals using the aquatic sites. Upland hardwood forests, pine forests, and sandhills are just a few examples of essential habitat types that may be required as complementary upland habitats in order to perpetuate reptile and amphibian viability.

CHARACTERISTIC SPECIES

Spotted Turtle, Eastern Mud Turtle, Chicken Turtle, Black Swamp Snake, Banded Water Snake, Ribbon Snake, Gopher Frog, Wood Frog, Ornate Chorus Frog, Southern Cricket Frog, Oak Toad, Eastern Narrow-mouthed Toad, Flatwoods Salamander, Tiger Salamander, Mole Salamander, Marbled Salamander, Spotted Salamander, Four-Toed Salamander

These systems are often small, isolated, and disjunct, and are usually "embedded" in a larger habitat matrix. These embedded communities rely heavily on surrounding habitats for landscape-scale functions and processes.

The concept of "core upland habitat" is a relatively new conservation approach for this habitat type. Consider treating the surrounding uplands as "core habitat" around the wetland or pond and the lands outside this adjacent upland zone as buffer. The width of the core upland is determined by the average dispersal distance of amphibians and reptiles away from the wetland to terrestrial summer or winter sites. This approach will ensure that amphibian and reptile populations have a much higher probability of long-term persistence.

Seasonal wetlands are typically isolated depressions (e.g., sinkhole ponds, Carolina bays, and vernal pools) that hold water in winter and spring, but are often dry by summer or fall throughout most of our region. The source of water is usually rainfall or an elevated water table rather than flooding events (see Floodplain

James Kiser

Spotted Salamanders live in mesic hardwood forests and breed most successfully in fish-free seasonal wetlands within that hardwood forest matrix.

Wetland section for information pertaining to stream-associated wetlands). The vegetational characteristics of a particular seasonal wetland will be dependent on soil type, hydrology, hydroperiod, latitude and elevation, and past land use. Open (non-forested to sparsely-forested) wetlands support a diversity of herbaceous plants including grasses, sedges, and rushes, while more densely forested wetlands may have little emergent non-woody vegetation. The species assemblages of amphibians and reptiles occurring from one pond to the next may vary according to differences in vegetative characteristics. Because fish are usually absent, seasonal wetlands are essential reproductive habitats for many amphibian species that are vulnerable to fish predation.

Many amphibian species (e.g., Tiger Salamanders, Mole Salamanders, Gopher Frogs) spend their entire adult life within a few hundred meters of the wetland or small pond in which they breed. Once a population is extirpated, it may take decades for recolonization to occur. Forested corridors between wetlands are necessary for dispersing juveniles to colonize other seasonal wetlands and to prevent populations from becoming isolated and vulnerable to local extirpation due to droughts and loss of genetic diversity.

MAXIMIZING COMPATIBILITY: Timberlands, Hunt Clubs, Farmlands, Ranches, Recreation Lands, and other Integrated Land Uses
When benefiting amphibians and reptiles is secondary to other management objectives:

- **Identify seasonal wetlands and maintain forested core uplands surrounding them**. *Forest cover around seasonal wetlands represents habitat for adult amphibians that breed in isolated ponds.*

- **Avoid diverting surface water from existing roads or facilities into wetlands.** *Surface run-off from roads may contain oil and other pollutants, as well as sediments which can fill seasonal wetlands, detrimentally affecting the quality of these important amphibian and reptile habitats.*

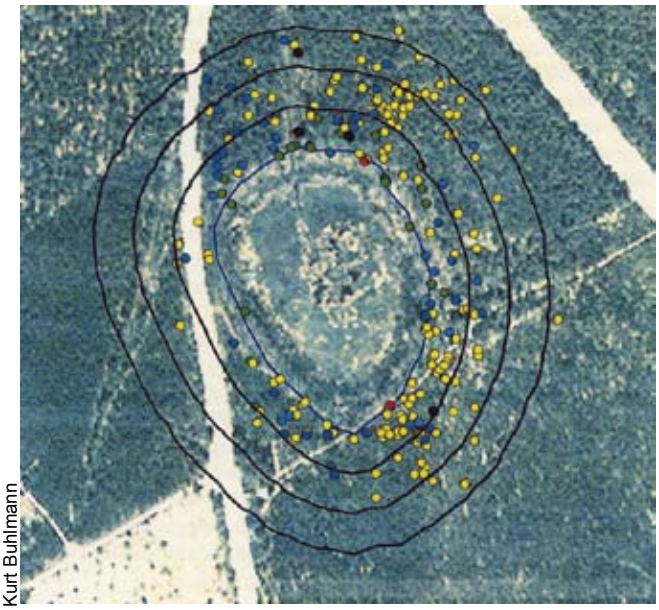
- **Avoid creating permanent farm ponds by altering seasonal wetlands; rather, create the farm pond elsewhere while retaining the seasonal wetland.** *Diversity of habitats and microhabitats increases the diversity of amphibian and reptile species.*

Betty Crump

Four-wheel drive roads and ATV trails can significantly damage bottomland habitats.

Margaret Gunzburger

Diverting traffic around wetlands is an effective, easy, and inexpensive way to protect sensitive habitats.



Kurt Buhlmann

The importance of upland habitats surrounding wetlands: colored dots represent the locations of aquatic turtles (Chicken Turtles and Eastern Mud Turtles) that buried themselves in the surrounding forest soil and leaf layer when the Carolina bay wetland (within the blue line) was dry. The black lines indicate 50, 100, and 150 meter distances from the wetland boundary. Thus, the adjacent forested upland habitat is as important to the persistence of the aquatic turtle population as the wetland itself.

- **Avoid stocking isolated seasonal wetlands with predatory fish.** *Larger ponds may hold water for several years between drying cycles and are prone to stocking of game fish (e.g., bass, bluegill). The presence of fish reduces and in many cases eliminates amphibian reproductive success.*
- **Permit prescribed fires to burn into wetlands and pond basins when water levels are naturally low.** *Southeastern wetlands rarely need "protection" from fire, which naturally occurs in and around these habitats. Historically, wetlands burned during periods of extreme drought, which removed organic matter and controlled woody succession.*
- **Avoid ditching and draining seasonal wetlands.**

IDEAL: Refuges, Sanctuaries, and Preserves
When benefiting amphibians and reptiles is a PRIMARY objective, as with nature preserves, wildlife refuges, and private lands whose owners wish to optimize herpetofaunal diversity and abundance:

- **Restore natural hydroperiod of seasonal wetlands.** *Fill old ditches if necessary. Many seasonal wetlands were ditched historically for agriculture and mosquito control.*

John Jensen

Chicken Turtles forage on dragonfly larvae and other invertebrates in shallow ponds that frequently dry completely. When that happens, they move into adjacent forest and bury themselves beneath forest litter and soil.

- **Construct artificial wetlands or ponds where natural wetlands have been degraded or lost.** *A chain of wetlands at 100-200 meter intervals can facilitate dispersal and accelerate the recolonization of amphibians where they have been extirpated. A Guide to Creating Vernal Ponds is an excellent resource, available online at www.southernregion.fs.fed.us/boone/vernal.pdf.*
- **Maintain contiguous gradients between wetlands and adjacent complementary habitat types.** *Ensure that land use practices do not fragment seasonal migration and natural dispersal patterns.*
- **Restore the natural composition and structure of adjacent complementary habitat types where these habitats have been degraded.** *Most pond-breeding amphibians disperse to adjacent uplands to forage and seek shelter as adults.*
- **Permit prescribed fires to burn into wetlands and pond basins when water levels are naturally low.** *Southeastern wetlands rarely need "protection" from fire, which naturally occurs in and around these habitats. Historically, wetlands burned during periods of extreme drought, which removed organic matter and controlled woody succession.*

IMPORTANCE OF ADJACENT UPLANDS

Protect small isolated wetlands and adjacent core upland habitats and promote a forested landscape connection to other wetlands. A seasonal wetland without appropriate surrounding upland habitat will lose its amphibian and reptile fauna.

- **Install culverts or tunnels in conjunction with barriers to direct animals under or away roads.** *Barriers have been successful in certain instances to mitigate highway mortality near breeding sites or along seasonal migration corridors.*

- **Inform local fire agencies of the presence of ecologically sensitive areas and clearly delineate boundaries with flagging tape, tree paint, or signs. Prevent firebreaks from being plowed into seasonal wetlands.** *Soil, hydrology, and vegetation disturbances, as well as direct mortality of sensitive fauna, can result from poorly placed firebreaks.*

Kurt Buhlmann

Kurt Buhlmann

Seasonal changes of an isolated sinkhole wetland: full and frozen in January; green and nearly dry in June. Because it does not support predatory fish, it is important to a diversity of winter-breeding and spring-breeding amphibians.

This is the Seasonal Isolated Wetlands module of the PARC publication, HMG-2. ISBN 0-9667402-2-X. Please visit www.parcplace.org for further information, copies of the complete document, or a web-based version of these guidelines.

WEST NILE VIRUS

Health concerns regarding West Nile Virus (WNV) has led to the erroneous assumption that all types of standing water, including natural and created wetlands, may produce dangerous numbers of virus-carrying mosquitoes and should be drained, filled, or sprayed to eliminate the possibility of WNV transmission to humans.

However, not all mosquitoes transmit WNV, not all mosquitoes feed on humans, and habitats vary for mosquito species. *Culex pipiens*, the northern house mosquito, is a common household mosquito and the primary vector of WNV. *Culex* larvae thrive in pooled water in areas not normally wet, which do not support their predators. Species of *Culex* will deposit eggs in a variety of water-holding containers such as old tires, birdbaths, buckets, and wading pools. Mosquitoes of the genus *Aedes* may also be vectors, and are typically produced in floodwaters in the spring and early summer.

Mosquitoes are a vital part of wetland food chains, and healthy wetlands have balanced predator-prey relationships that provide natural mosquito control. Altered or degraded wetlands often have stagnant water, increased nutrient levels and fewer natural mosquito predators. Maintaining the natural functions of wetlands and restoring impaired wetlands should be the goal of land managers as well as mosquito control agencies.

For more information:

- Centers for Disease Control www.cdc.gov/ncidod/dvbid/westnile/index.htm

- American Mosquito Control Association: www.mosquito.org

- The USDA Regional Pest Management Centers National Pest Alert brochure on WNV www.ncpmc.org/NewsAlerts/westnilevirus.html.

James Kiser

PERMANENT WETLANDS

Permanent wetlands are defined as areas always under water with little or no flow or current. This section will address issues related to beaver ponds, oxbow lakes, and human-made non-riverine impoundments such farm ponds and small fishing ponds. Naturally-occurring isolated permanent wetlands such as some large Carolina bays and large depressional wetlands can be managed using the guidelines presented in the *Seasonal Wetlands* section.

Beaver ponds provide important habitat for a number of amphibian and reptile species. Oxbow lakes also support amphibian and reptile species and their health is related to the management of associated large streams and surrounding forest. See the *Rivers, Large Streams, and Reservoirs* and *Floodplain Wetlands* sections for additional guidelines.

CHARACTERISTIC SPECIES

Alligator, Common Snapping Turtle, Softshell Turtles, Pond Slider, Stinkpot, Cottonmouth, Northern Water Snake, Plain-bellied Water Snake, Bullfrog, Green Frog, Green Treefrog, Bird-voiced Treefrog, Eastern Newt

Farm ponds are human-made habitats that provide some benefits to amphibians and reptiles. Although no reptile or amphibian species require these habitats, Alligators and "habitat generalists" (e.g., Slider Turtles, Bullfrogs, Banded Water Snakes) use them. The extent to which these bodies of water benefit amphibian and reptile populations is related to the type and intensity of shoreline management and adjacent land use. Fisheries management decisions may also affect the diversity and abundance of amphibians and reptiles that use farm ponds.

MAXIMIZING COMPATIBILITY: Timberlands, Hunt Clubs, Farmlands, Ranches, Recreation Lands, and other Integrated Land Uses
When benefiting amphibians and reptiles is secondary to other management objectives:

- **Retain patches of submerged, emergent, and shoreline vegetation wherever possible.** *These habitat elements are important shelter and forage sites for amphibians and reptiles.*

- **Avoid creating permanent farm ponds by altering seasonal wetlands; rather, create the farm**

Gene Ott

Woody structure, such as logs and snags, provide critical basking habitat for alligators and turtles.

pond elsewhere while retaining the seasonal wetland. *Permanent wetlands are more likely to support predatory fish and unfavorable vegetation.*

- **Avoid introductions of non-native aquatic plants (e.g. water hyacinth, alligator weed, hydrilla).**

- **Minimize pollutants and sediment in runoff.** *Many permanent ponds are created as "catchment basins." These are used by amphibians and reptiles but also concentrate pollutants.*

IDEAL: Refuges, Sanctuaries, and Preserves
When benefiting amphibians and reptiles is a PRIMARY objective, as with nature preserves, wildlife refuges, and private lands whose owners wish to optimize herpetofaunal diversity and abundance:

- **Maintain submerged, emergent, and shoreline vegetation (i.e., avoid "clean" margins).** *Many amphibians and reptiles require native vegetation for sheltering, foraging, breeding, and nesting. Mowing to the water's edge eliminates important habitat.*

- **Maintain native vegetative composition and structure of adjacent terrestrial habitats.** *Most amphibians and reptiles found in permanent wetlands benefit from suitable upland habitat corridors that facilitate movement between wetlands.*

- **Retain snags, logs, rocks, and other structure.** *Enhance permanent wetlands by adding structure as needed. These habitat elements are important for basking turtles, alligators, and snakes.*

INFORMATION FOR FISHERMEN
Contrary to popular belief, large basking turtles such as Sliders and Cooters do not eat fish. Snapping Turtles, Alligators, and aquatic snakes do prey on fish, including many game and bait species. More often than not, however, large healthy fish are too fast and strong to be caught by reptiles. Fish-eating reptiles can benefit game fish populations by reducing overpopulation and weeding out sick fish, thus preventing the spread of disease. Even the much-maligned Cottonmouth ("water moccasin") plays an important role in improving the native stocks of sport fish as it often scavenges on dead and dying fish, including carp, bowfin, and other "non-desirable" fish.

- **Direct recreational use away from permanent wetlands.** *Vehicle-related mortality, direct persecution (i.e., shooting basking turtles and snakes), and noise-related disruptions of natural behaviors are unfortunate side effects of recreational access.*

- **Provide open-canopy, well-drained upland terrestrial areas for turtle nesting.** *Turtles need sunny places for nesting. Patches of isolated, sandy nesting habitat are preferable to linear strips (e.g., roadsides and power line rights-of-way which tend to attract nesting turtles,) as predators can more efficiently search linear habitats for multiple nests.*

Mark Bailey

Beaver ponds often provide wetland habitats in areas where other wetlands are limited or absent, enabling species such as Bird-voiced Treefrogs and Plain-bellied Water Snakes to exist where otherwise they may not occur.

This is the Permanent Wetlands module of the PARC publication, HMG-2. ISBN 0-9667402-2-X. Please visit www.parcplace.org for further information, copies of the complete document, or a web-based version of these guidelines.

James Kiser

SMALL STREAMS, SPRINGS AND SEEPS

Groundwater-fed seeps, springs, and small streams often have good water quality and cool water temperatures. These waters provide ideal habitat for many of our streamside salamanders. Vegetative and geological features vary widely based on slope, aspect, latitude and elevation. Flow rates may vary according to season, but stream volume is usually too low to support large predatory fish. Large limestone springs are characteristic features of the Florida Peninsula ecoregion, and are scattered in the East Gulf Coastal Plain. In the more interior ecoregions, springs and small steams frequently have abrupt gradients and multiple microhabitat conditions, which are believed to have contributed to the Southeast's status as a global center of salamander endemism. Although many streamside and seep-dwelling salamanders are limited to the immediate vicinity of these aquatic habitats, other species require adjacent complementary terrestrial habitats (i.e., riparian zones) for dispersal, foraging, hibernation, and breeding.

CHARACTERISTIC SPECIES
Spotted and Northern Dusky Salamanders, Seal Salamander, Seepage Salamander, Two-lined Salamander, Many-lined Salamander, Green Frog, Pickerel Frog, Leopard Frog, Northern Cricket Frog, Queen Snake, Northern Water Snake, Banded Water Snake, Loggerhead Musk Turtle, Dwarf Waterdog, Coal Skink

MAXIMIZING COMPATIBILITY: Timberlands, Hunt Clubs, Farmlands, Ranches, Recreation Lands, and other Integrated Land Uses
When benefiting amphibians and reptiles is secondary to other management objectives:

- **Meet or exceed forestry and agricultural Best Management Practices (BMPs) including recommendations for Streamside Management Zones (SMZs).** *In some cases, SMZs and other BMPs are sufficient to protect streamside amphibians and reptiles. In other cases, these practices may need modification. If your situation is not covered by these guidelines, consider contacting PARC, NRCS, your state forestry commission, or your state Natural Heritage agency to determine what riparian zone management practice will best benefit your local amphibians and reptiles.*

James Kiser

Clear, cold water is essential to sustain amphibians, notably salamanders, in small, high-gradient streams. Even the slightest alterations in water chemistry or temperature caused by logging and road-building can be significantly detrimental.

- **Be aware that reducing the forest canopy along streams will allow more sunlight and increase stream temperatures, thus changing habitat suitability for streamside amphibians.** *Many aquatic amphibians are specifically adapted to survive in certain thermal conditions.*

- **Keep headwaters and seepage areas free from sediments, silt, excessive nutrients, and toxins.** *Toxins and excessive amounts of sediment can detrimentally affect aquatic plants and animals. Amphibians are especially sensitive to changes in water quality.*

- **Restrict and/or closely regulate collection of salamanders as bait.** *(See "Spring Lizards" information box)*

IDEAL: Refuges, Sanctuaries, and Preserves
When benefiting amphibians and reptiles is a PRIMARY objective, as with nature preserves, wildlife refuges, and private lands whose owners wish to optimize herpetofaunal diversity and abundance:

- **Restore stream microhabitat diversity such as channel meanders, riffles, runs, and pools, and allow natural flood regimes.** *Stream microhabitats are important to the survival of amphibians and reptiles. Periodic flooding revitalizes riparian areas, deposits new sediments, and prevents stream channels from down-cutting.*

- **Remove invasive exotic plant species unless their removal will destabilize stream banks.** *Stream bank failure may be more detrimental to sensitive riparian habitats than exotic vegetation. If you are uncertain, consult a qualified stream ecologist.*

- **Identify watershed boundaries and protect both groundwater and surface water from contamination via toxins, excessive nutrients, sediments, or silt.** *Pollution can adversely affect aquatic fauna.*

James Kiser

The southeastern United States has more salamander species than any other place on Earth. This Four-toed Salamander guards her nest at the edge of a sphagnum seep.

STREAMSIDE MANAGEMENT ZONES: TEMPLE-INLAND

Streamside management zones (SMZs) are areas of native vegetation retained along streams when adjacent upland forests are harvested. Temple-Inland recognizes that by expanding the definition, function, and value of a SMZ beyond that of maintaining water quality, they have the opportunity to provide a mature-forest habitat type in association with early succession forests. Thus, Temple-Inland manages SMZs on a site-specific basis as uneven-aged, mixed-species stands that are dominated by hardwoods and have a component of snags and mature trees. However, Temple-Inland's guidelines note that a pine component also enhances the diversity of SMZs. Thus, the SMZ guidelines encourage managers to consider retaining a pine component, particularly if the pine trees are close to the stream or if their removal would result in unacceptable site damage.

—Bill Goodrum, Temple-Inland

John Jensen

The colorful Red Salamander is at home in and around seeps, springs and other damp habitats.

Mark Bailey

Restricting in-stream vehicle and livestock access can help prevent losses of fragile aquatic species.

Spring and seepage amphibians are sensitive to changes in water chemistry.

- **Maintain upstream watershed quality by providing complementary native terrestrial habitats.** *Most streamside amphibians and reptiles require both aquatic conditions and adjacent riparian habitats.*

- **Restore or protect native stream bank vegetation and structure.** *Natural succession of native vegetation should be permitted, especially in higher-gradient upland systems where vegetation is dependent on flash flooding, a frequent ecological process.*

- **Remove trash and debris from seepages and streams.** *In mountainous areas of the Southeast, ravines are often used as trash dumps.*

Kurt Buhlmann

Limestone springs contain unique communities of amphibians and reptiles, including Rainbow Snakes and Florida Red-bellied Turtles. Recreational use and conservation of these irreplaceable habitats may be compatible, but effective management should protect against erosion and other degradation.

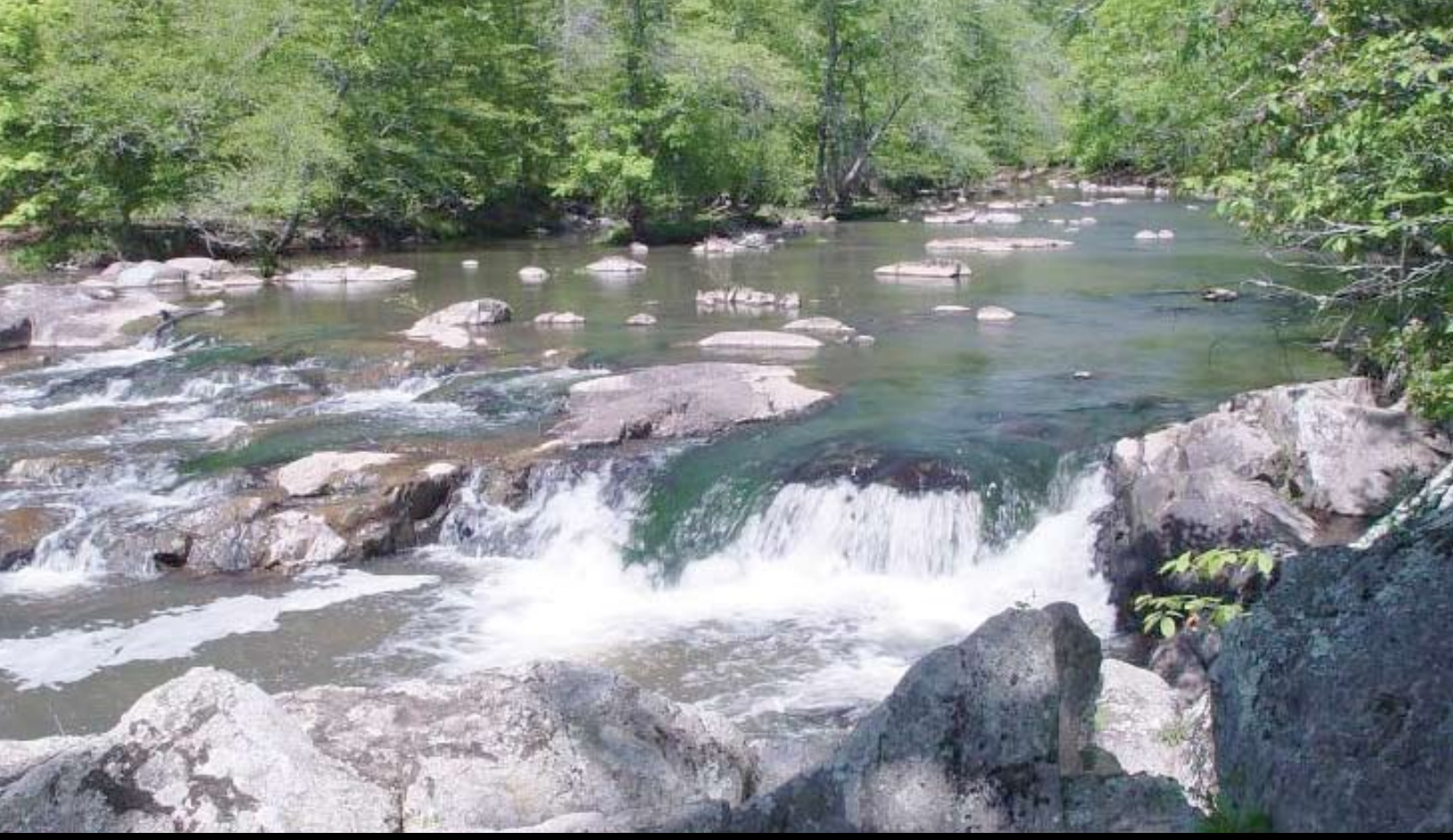
SPRING LIZARDS

Harvest of streamside salamanders (known locally as spring "lizards") for bait may lead to declines in sensitive populations. Some states permit fishermen to collect the relatively common Northern Dusky Salamander. Other less common species, however, are virtually indistinguishable from common "duskies" and are therefore incidentally taken as bait, even by the well-intentioned.

Kurt Buhlmann

Soil erosion due to recreational use is impacting this spring and favorite local swimming hole. Installing a bulkhead, silt fence, or other barrier to minimize erosion would benefit the aquatic fauna that exist here and enhance the aesthetic appeal for humans.

This is the Small Streams, Springs and Seeps module of the PARC publication, HMG-2. ISBN 0-9667402-2-X. Please visit www.parcplace.org for further information, copies of the complete document, or a web-based version of these guidelines.



Carl Brune

RIVERS, LARGE STREAMS, AND RESERVOIRS

The river systems of the southeastern United States are among the world's most diverse and are especially recognized for their diversity of fish, freshwater mussels and snails, and turtles. Rivers, large streams, and their impounded reservoirs are permanent waterways with a wide range of ecological characteristics. Temperature, gradient, speed, volume, associated floodplain width, and other ecological variables are dictated by geology, latitude, and elevation. In outer Coastal Plain regions, flow regimes, depth, and salinity may be tidally influenced.

Many amphibian and reptile species use riverine habitats for one or more portions of their life cycle. Specialists such as Hellbenders, Alligator Snapping Turtles, and several of the Map Turtles require larger streams and rivers. Important habitats include sand bars, banks, log jams, shoals, pools, riffles, and runs. Associated riparian corridors, floodplains, and adjacent uplands also provide critical complementary habitats.

CHARACTERISTIC SPECIES

Northern Cricket Frog, Bullfrog, River Frog, Hellbender, Mudpuppy, Alligator, Softshell Turtles, Map Turtles (all species), River Cooter, Pond Slider, Razor-backed Musk Turtle, Loggerhead Musk Turtle, Alligator Snapping Turtle, Brown Water Snake, Diamond-backed Water Snake, Rainbow Snake

Rivers are some of our most imperiled, degraded, yet aggressively protected ecosystems. Threats to river-associated amphibians and reptiles include changes in water quality, flow regimes, and associated vegetative communities due to land-use practices. Conservation efforts aimed at rivers focus primarily on drinking water, recreation, and flood control. Reductions in high-intensity land use within floodplains, such as agriculture and development, would limit the economic impact of naturally occurring floods, improve recreation opportunities, and improve drinking water quality while simultaneously enhancing habitat suitability for amphibians and reptiles and other riverine wildlife.

Most southeastern rivers have been impounded for hydroelectric power generation and flood control. The resulting reservoirs are not ideal for native river-dwelling species (e.g., Map Turtles, Alligator Snapping Turtles, Hellbenders, Waterdogs). Bottom-release dams send colder than normal and poorly oxygen-

Dirk Stevenson

One of our largest salamanders, the Hellbender requires free-flowing, well-oxygenated streams. It has been extirpated from many areas by impoundments and siltation.

Kelly Irwin

This impounded stream in northern Arkansas was once prime habitat for a rare and declining Ozark subspecies of the Hellbender. Since the dam was built, however, it is slower, warmer and less suitable.

ated water downstream. Dams change river ecology by reducing normal winter high flows and increasing summer low flows.

MAXIMIZING COMPATIBILITY: Timberlands, Hunt Clubs, Farmlands, Ranches, Recreation Lands, and other Integrated Land Uses
When benefiting amphibians and reptiles is secondary to other management objectives:

- **Meet or exceed forestry and agricultural Best Management Practices (BMPs), including Streamside Management Zones (SMZs).** *In some cases, SMZs and other BMPs are sufficient to protect riverine amphibians and reptiles. In other cases, these practices may require modification. If your situation is not covered by these guidelines, consider contacting PARC, NRCS, your state forestry commission, or your state Natural Heritage agency to determine what riparian zone management practice will best benefit your local amphibians and reptiles.*

For detailed, site-specific guidelines regarding restoration of stream banks and associated aquatic habitats, check with your local NRCS office (county directory available at www.nrcs.usda.gov).

- **Minimize activities that alter flow or temperature regimes.** *Discharges from dams should be scheduled to coincide with natural flooding cycles. Natural seasonal flow and temperature regimes should be maintained.*

- **Stabilize eroded and steep banks to allow turtles access to nesting sites.** *Heavily eroded, unnaturally steep stream banks can prevent turtles from migrating to adjacent upland nesting habitats.*

- **Minimize use of riprap for shoreline stabilization.** *Shores lined with large rocks can impede turtle movements between aquatic habitats and upland nesting sites.*

- **Control public access to important turtle nesting sites.** *Identify and manage human use (e.g., camping) of river sandbars that are also used by river turtles, especially Map Turtles, for nesting. Nesting sites can be adversely impacted by excessive recreational activities.*

- **Restrict recreational access such as boat landings to as few points as feasible.** *Vehicle-related mortality, direct mortality (i.e., shooting basking turtles and snakes), and noise-related disruptions of natural behaviors are unfortunate side effects of recreational access.*

Mark Bailey

Many riverine turtle species, notably Map Turtles, Softshells, and Cooters, nest exclusively in the loose, sandy soils of sandbars along larger streams and rivers.

- **Keep snag removal activities to the minimum necessary for boat traffic.** *As natural components of a river's flow regime, woody and rocky structure provide important shelter, basking, and other micro-habitat.*

John Jensen

James Godwin

Kurt Buhlmann

Large adult Alligator Snapping Turtles (top) and Barbour's Map Turtles (middle) can still be found in the impounded Chattahoochee River between Georgia and Alabama, but recruitment is reduced because snapping turtle hatchlings cannot survive in the deep water with no shallow edge habitat and neither species has good access to nesting habitat due to steeply eroded banks (bottom).

- **Avoid the introduction of non-native game fish and other invasive exotic species.** Propagation and stocking projects should focus on the restoration of native fishes, mollusks, and invertebrates.

- **Enforce existing regulations. Strongly discourage indiscriminant killing of amphibians and reptiles species.** *Shooting basking turtles and snakes for sport remains a persistent problem throughout much of the Southeast. Hellbenders and softshell turtles caught on hook and line are also frequently killed rather than released. These practices are widespread and may be contributing to the decline of these species.*

IDEAL: Refuges, Sanctuaries, and Preserves
When benefiting amphibians and reptiles is a PRIMARY objective, as with nature preserves, wildlife refuges, and private lands whose owners wish to optimize herpetofaunal diversity and abundance:

- **Use dredge spoil to benefit nesting turtles.** *Although dredging degrades habitat quality for some species, spoil piles that are high in sand content can serve as important turtle nesting habitat if deposited above the high-water mark along the shore or used to create islands.*

- **Allow natural movement of sand and gravel by avoiding in-stream mineral extraction, vehicular traffic, and other disruptions to streambeds.** *Sand and gravel bars are not permanent; the processes that produce them are. Dams restrict movement of sediments downstream. Even seemingly minor disruptions to streambed integrity may cause major changes in river health downstream. Head-cutting, down-cutting, and valley plugs (see case study below) alter water quality, hydrologic regimes, and may even damage adjacent floodplain forest.*

- **Avoid de-snagging. Allow the natural development and movement of woody and rocky structure.** *As natural components of a river's flow regime, woody and rock boulder/crevice structure provide important shelter, basking, and other micro-habitat.*

- **Restore native stream bank vegetation composition and structure.** *As the stream bank's physical structure changes in response to stream fluctuation,*

natural succession of native vegetation also should be allowed.

- **Restore processes that allow the development of channel meanders, oxbows, and sandbars.** *Periodic flooding revitalizes floodplains, deposits fertile soils, and prevents the river channel from down-cutting.*

- **Avoid thermal alteration and bank erosion by minimizing activities that alter temperature regimes or flow.** *Discharges from dams should be scheduled to coincide with natural flooding cycles. Natural seasonal flow and temperature regimes should be maintained, and native vegetation should be retained in riparian zones.*

- **Exclude point source pollution. Restrict the permitting of additional sewage outfalls.** *Pollution can adversely affect aquatic fauna. Aquatic amphibians are especially susceptible to changes in water chemistry.*

Mark Bailey

Dams can slow down and warm up swift, cool streams and disrupt the natural migration and dispersal patterns of aquatic herps, including Map Turtles, Alligator Snapping Turtles and Hellbenders.

This is the Rivers, Large Streams, and Reservoirs module of the PARC publication, HMG-2. ISBN 0-9667402-2-X. Please visit www.parcplace.org for further information, copies of the complete document, or a web-based version of these guidelines.

CASE STUDY: THE HATCHIE RIVER WATERSHED

The Hatchie River watershed (Mississippi and Tennessee) is renowned as one of the most ecologically significant river systems in the Upper East Gulf Coastal Plain. The main stem of the Hatchie River in Tennessee is one of the longest free-flowing rivers in the lower Mississippi River valley. However, nearly a century of tributary channelization and dredging on the Hatchie threatens to permanently impair many pristine habitats despite the fact that most of these operations ceased decades ago and, taken individually, seemed minor at the time.

The most severe threats to the Hatchie are caused by the channel modification in nearly every tributary stream. Streams that occur in coastal plain sand formations, where deep layers of unconsolidated sediment lie a few feet beneath the soil surface, are especially threatened. Compared to naturally meandering streams, these channelized streams exhibit accelerated erosional and depositional rates and altered stream flow patterns. The impacts of these disturbances continue to reverberate throughout the watershed today.

Stream habitats can be adversely impacted by excessive channel degradation, where channels are deeply incised, and/or aggradation where the streambed fills with sediment and rises. Resulting impacts to stream and floodplain forest ecosystems range from subtle changes to stream habitats to more extreme conversions and loss of aquatic and wetland habitats. Many of these streams move such a high volume of sediment that the sediment fills the channel to the top of the stream bank forming a valley plug. Forests in the vicinity of valley plugs are buried under deep sediment deposits and rising water levels swamp out other forests, leading to the widespread loss of less flood-tolerant species. In 1991, a single rain event caused approximately 500 tons of sediment to be deposited by Bear Creek on high quality bottomland hardwood on the Hatchie National Wildlife Refuge. Streams that lack valley plugs discharge sediments into the main channel of the Hatchie River causing extensive shoaling and increasing sedimentation of the Hatchie's rich bottomland hardwood forests.

Amphibian and reptile habitats are not the only victims of these processes. Tens of thousands of acres of valuable timber, agricultural, and recreational lands are also threatened.

—Alex Wyss, The Nature Conservancy of Tennessee

Mark Bailey

BRACKISH WETLANDS

Limited to the extreme outer Coastal Plain ecoregions, salt marshes, mangrove swamps, and tidal estuaries are characterized by cyclical tidal inundation and variable salinity. Wind, storms, and tide cycles are the primary processes that maintain these habitats. Associated vegetation is limited to salt-tolerant grasses, shrubs, and trees.

Brackish wetlands (and associated sandy reptile nesting sites) provide critical niche habitat for a small number of reptiles with significantly restricted distributions, (e.g., Salt Marsh Water Snake, Mangrove Water Snake, and Diamondback Terrapin). A limited number of other adaptable species, including Cottonmouth, Alligator, and American Crocodile, may also use brackish wetlands.

CHARACTERISTIC SPECIES

Alligator, American Crocodile, Cottonmouth, Salt Marsh Water Snake, Mangrove Water Snake, Diamond-backed Terrapin, Eastern Mud Turtle, Green Treefrog

MAXIMIZING COMPATIBILITY: Timberlands, Hunt Clubs, Farmlands, Ranches, Recreation Lands, and other Integrated Land Uses
When benefiting amphibians and reptiles is secondary to other management objectives:

- **Give preference to non-toxic techniques for mosquito control.** *Excessive use of insecticides can disrupt food chains by reducing the abundance of important invertebrates. Many biologically based controls for mosquitoes are environmentally sensitive and species-specific. Consult a licensed pesticide specialist before using any insecticide.*

- **Limit shoreline development and minimize use of riprap and bulkheads.** *Development destroys or fragments marsh habitat. Riprap and bulkheads form barriers between estuaries and marshes, impeding movement of Diamond-backed Terrapins and other salt marsh species.*

- **Increase awareness of Diamond-backed Terrapin and Alabama Red-bellied Turtle crossing areas.**

James Kiser

Diamond-backed Terrapins require healthy salt marsh habitats. Terrapins are unique because they are the only turtle to have colonized the extensive coastal salt marsh habitats, where they exist exclusively. Many are killed on causeways that traverse the salt marshes between the mainland and barrier islands as they search for nesting sites during May through June each year.

Kurt Buhlmann

Herpetology students search a salt marsh in South Carolina for Diamond-backed Terrapins.

Install signs along roadways to warn and inform motorists. Female Terrapins and Red-bellied Turtles are especially vulnerable to vehicle mortality as they cross causeways to nest.

- **Encourage the use of turtle-friendly fisheries equipment and monitor recreational and commercial crab trapping activities.** *he unintentional take of marine turtles in shrimp nets and Diamond-backed Terrapins in crab traps is a significant source of additive mortality. Diamond-backed Terrapins are killed frequently in submerged crab pots that are not checked several times a day.*

IDEAL: Refuges, Sanctuaries, and Preserves
When benefiting amphibians and reptiles is a PRIMARY objective, as with nature preserves, wildlife refuges, and private lands whose owners wish to optimize herpetofaunal diversity and abundance:

- **Restore natural shoreline integrity and submerged native vegetation.** *Prevent riprap and bulkheading of shorelines. These barriers separate estuaries from the grass-dominated salt flats, where terrapins forage for snails.*

- **Maintain or as necessary restore natural hydrological flow patterns in estuaries and bays.** *Pilings, inadequate culverts, causeways, and other manmade disruptions to tidal process may alter salinity and flow regimes, degrading habitat suitability.*

- **Avoid shoreline development. Development destroys and fragments habitat.**

- **Specific actions for Diamond-backed Terrapins:**
  - *Identify intensively-used nesting areas and design strategies that reduce female nesting mortality and nest predation.*
  - *Post signs for motorists that identify areas where terrapins cross roads while searching for nesting sites. Reduce roadway speed limits during the nesting season, May-June.*
  - *Provide educational materials that illustrate the drowning potential to terrapins in abandoned or infrequently checked crab pots.*
  - *Determine levels of predatory raccoon and fox populations and implement controls if necessary.*

This is the Brackish Wetlands module of the PARC publication, HMG-2. ISBN 0-9667402-2-X. Please visit www.parcplace.org for further information, copies of the complete document, or a web-based version of these guidelines.

George Folkerts

WET MEADOWS AND BOGS

These habitats include wet areas ranging from high elevation bogs in the Southern Blue Ridge to pitcher plant bogs in Coastal Plain ecoregions. They are usually associated with floodplains, seepage slopes, or springheads, and range in size from small and isolated in mountainous areas to relatively extensive in the Coastal Plain. Wet meadows and bogs are characterized by:

- Open to intermittent canopy
- Deep layers of peat muck or sand and high or perched water tables
- Abundant, specialized vegetation including sphagnum, cranberry, and carnivorous plants

CHARACTERISTIC SPECIES

Pine Barrens Treefrog, Southern Chorus Frog, Pickerel Frog, Carpenter Frog, Four-toed Salamander, Mud Salamander, Bog Turtle, Spotted Turtle, Box Turtle, Coal Skink, Garter Snake, Ribbon Snake

EMBEDDED

These systems are often small, isolated, and disjunct, and are usually "embedded" in a larger habitat matrix. These embedded communities rely heavily on surrounding habitats for landscape-scale functions and processes.

Fragile and easily disrupted, wet meadows and bogs depend on landscape-scale processes and hydrologic regimes such as floods and fire to maintain their ecological function. These habitats provide critical habitat for a wide range of imperiled flora and fauna including amphibians and reptiles. In the Southern Blue Ridge, grazing by bison, colonization by beaver, and subsequent cattle grazing have all helped to maintain or restore these sedge tussock and sphagnum-dominated wet meadows. The seepage and savanna bogs of the Coastal Plain ecoregions are maintained principally by fire.

John Jensen

Pine Barrens Treefrogs are distributed in a series of isolated, disjunct populations in the Coastal Plain ecoregions. They are usually found in hillside seeps and bogs.

James Kiser

Bog Turtles are limited to a series of isolated high-elevation wetlands in the Southern Appalachians. Habitat loss and collection for overseas markets appear to be the biggest threats to this species.

MAXIMIZING COMPATIBILITY: Timberlands, Hunt Clubs, Farmlands, Ranches, Recreation Lands, and other Integrated Land Uses
When benefiting amphibians and reptiles is secondary to other management objectives:

- **Avoid habitat alteration through filling, draining, damming/ inundating, and excessive groundwater withdrawal.** *Natural cycles of flood and drought are important to bog-associated amphibians and reptiles, and the maintenance of their habitat.*

- **Where haying is an objective, mow at high blade settings no more than once a year.** *Mow during drier periods to minimize soil disturbance and machinery-related mortality. Mower-related mortality can impact amphibians and reptiles. Begin in the center and use a back-and-forth approach to avoid concentrating animals where they may be killed. Raising the mowing deck height to 8 or even 12 inches will reduce mortality and will leave important cover.*

LIVESTOCK AND BOGS

Recent studies have shown that light to moderate grazing by cattle and other livestock may be vital to maintaining habitat suitability for Bog Turtles and other rare bog species in the Southern Blue Ridge ecoregion. Warning: Excessive cattle grazing can be harmful as it may trample the vegetation managers wish to promote. Goats will help control woody vegetation and are less damaging to bog plants and substrates. Consult a Bog Turtle specialist (Project Bog Turtle, N.C. Herpetological Society, P.O. Box 29555, Raleigh, NC 27626-0555) before implementing a grazing program.

- **When planning roads, include culverts or bridges.** *(See the "Roads" section under "Threats.") Well-planned culverts allow hydrologic connectivity between fragmented wetlands and dispersal corridors for small animals.*

- **Control woody encroachment and succession.** *Open conditions are a requirement of many bog-associated species. In Blue Ridge bogs, moderate livestock grazing can assist in maintaining desired vegetative composition and structure. Coastal Plain bogs are damaged by even moderate grazing and trampling; fire is needed to maintain these habitats.*

- **Avoid plowing firebreaks in bogs and wet meadows.** *Soil and vegetation disturbances as well as direct mortality of fauna can result from poorly planned firebreaks.*

Kurt Buhlmann

A wet, grassy Appalachian meadow in North Carolina that is suitable habitat for Bog Turtles. Bog Turtle habitats will become forested and unsuitable without active management. Historically, bison and beaver controlled woody vegetation and created new wetlands; respectively. In the last two hundred years, cattle helped mimic the effects of bison. But now the decline in farming and the loss of existing wetlands to development have lead to the endangerment of the Bog Turtle.

Kurt Buhlmann

Besides being unsightly, ditched or drained bogs can cause the loss of entire Bog Turtle populations. Because of these activities, as well as human development and natural succession, there are fewer populations of Bog Turtles in the Southeast each year.

IDEAL: Refuges, Sanctuaries, and Preserves
When benefiting amphibians and reptiles is a PRIMARY objective, as with nature preserves, wildlife refuges, and private lands whose owners wish to optimize herpetofaunal diversity and abundance:

- **Control woody encroachment and succession.** *Open conditions are a requirement of many bog-associated species.*

- **Restore natural surface water and groundwater hydrology using ditch plugs or temporary dams if necessary.**

- **Restore herbaceous vegetation using tools such as prescribed burning, low-impact mechanical removal of woody vegetation, low-impact controlled grazing (usually only applicable in high-elevation bogs).** *Under ideal conditions, these habitats and their inhabitants respond favorably to occasional natural disturbances.*

- **Avoid plowing firebreaks in bogs and wet meadows.** *Inform local fire agencies of the presence of ecologically sensitive areas and clearly delineate boundaries with flagging tape, tree paint, or signs. Prevent firebreaks from being plowed into seasonal wetlands. Bogs are very fragile systems. Soil and vegetation disturbances as well as direct mortality of fauna can result from poorly planned firebreaks.*

- **Restore native vegetation in between wet habitats and drier uplands.** *These adjacent habitats filter nutrients, absorb chemical runoff, and provide dispersal and migration habitats for amphibians and reptiles.*

John Jensen

Coastal Plain bogs, such as this one in Florida, are rich with plant diversity, including pitcher plants. Woody encroachment resulting from fire exclusion threatens these unique habitats.

- **Install culverts where roads are present or planned.** *(See the "Roads" section under "Threats.") Well-planned culverts allow hydrologic connectivity between fragmented wetlands and dispersal corridors for small animals.*

- **Prohibit and strictly enforce the collection of native species and the introduction of non-native species.** *Over-collection is a key threat to several rare bog-associated species.*

- **Manage beaver activities to attain desired bog conditions.** *In Appalachian bogs. Beavers often flood existing bogs, but their actions may help restore older bogs that have been ditched or filled with encroaching woody vegetation.*

This is the Wet Meadows and Bogs module of the PARC publication, HMG-2. ISBN 0-9667402-2-X. Please visit www.parcplace.org for further information, copies of the complete document, or a web-based version of these guidelines.

Mark Bailey

MESIC HARDWOOD FORESTS

(Guidelines also apply to White Pine and Hemlock Forests)

Variously classified as northern hardwoods, mixed mesophytic (cove) hardwoods, and southern mixed mesophytic hardwoods, these forests blanket large portions of the Southeast. Although most original hardwood forests were cut by the early 1900s, they have increased in recent decades as a result of farmland abandonment and fire suppression. The majority of these stands are today in mid-successional stages and therefore not in optimal condition for many species of vulnerable wildlife, including amphibians and reptiles. Oak-hickory forests predominate in the mountainous regions, and include white pine at the higher elevations. American chestnut, now virtually extirpated, was once the dominant component of mountain forests. Also in the mountains, hemlock-dominated cool moist cove forests can be found. Below the Fall Line, beech-magnolia forests occur in ravines, bluffs, and other areas not subject to frequent fire. Other characteristic trees of southeastern mesic hardwood forests include tulip poplar, sweetgum, black gum, dogwood, sourwood, American holly, basswood, and various maples and birches.

The low fire frequency and cool, moist conditions of mesic hardwood forests make these habitats important to many woodland species, particularly terrestrial salamanders. Salamander diversity is usually higher in well-developed forests than in recently disturbed sites.

Mid to late-successional forests may exceed 80% canopy closure, but truly mature mesic hardwood forest is characterized by blowdowns, tip-up mounds, dead standing snags, and canopy gaps resulting in patchy understory. Rotting stumps and root holes, logs, and other coarse woody debris enhance and provide important microhabitat structure for amphibians and reptiles.

Important habitats often embedded within hardwood forests include seasonal wetlands, seeps, springs, caves, and talus slopes.

CHARACTERISTIC SPECIES

American Toad, Gray Treefrog, Wood Frog, Spotted Salamander, Slimy Salamander, Zigzag Salamander, Eastern Box Turtle, Five-lined Skink, Broad-headed Skink, Ground Skink, Worm Snake, Ring-necked Snake, Brown Snake, Red-bellied Snake, Kingsnake, Milk Snake, Rat Snake, Timber Rattlesnake, Copperhead

John Jensen

Kurt Buhlmann

The forests and caves of Georgia's Pigeon Mountain represent the only place in the world where the Pigeon Mountain Salamander is found.

MAXIMIZING COMPATIBILITY: Timberlands, Hunt Clubs, Farmlands, Ranches, Recreation Lands, and other Integrated Land Uses
When benefiting amphibians and reptiles is secondary to other management objectives:

- **Minimize ground disturbance when possible.** *The duff layer is the key microhabitat for most hardwood forest-associated amphibians and reptiles.*
- **Use natural regeneration when possible.** *If site preparation is necessary, consider using techniques that minimize ground disturbance.*
- **Maintain a mixture of forest types and ages, including openings.** *Some woodland species, such as Box Turtles, benefit by having sunny openings for nesting.*
- **Carefully monitor the use of insecticides for control of gypsy moth and other invasive insects.** *Often, non-targeted insects, specifically moths, are affected, impacting the prey base of amphibians and reptiles.*
- **Occasional low-intensity "cool" fires may benefit some hardwood forest communities.** *Consider use of prescribed burning for some, but not all, hardwood habitats. Consult a certified forester.*
- **Avoid or minimize logging sensitive habitats such as vernal pools, seeps, and ravines.** *Soil disturbance and compaction from heavy machinery can degrade these habitats.*

THE VALUE OF FOREST OPENINGS

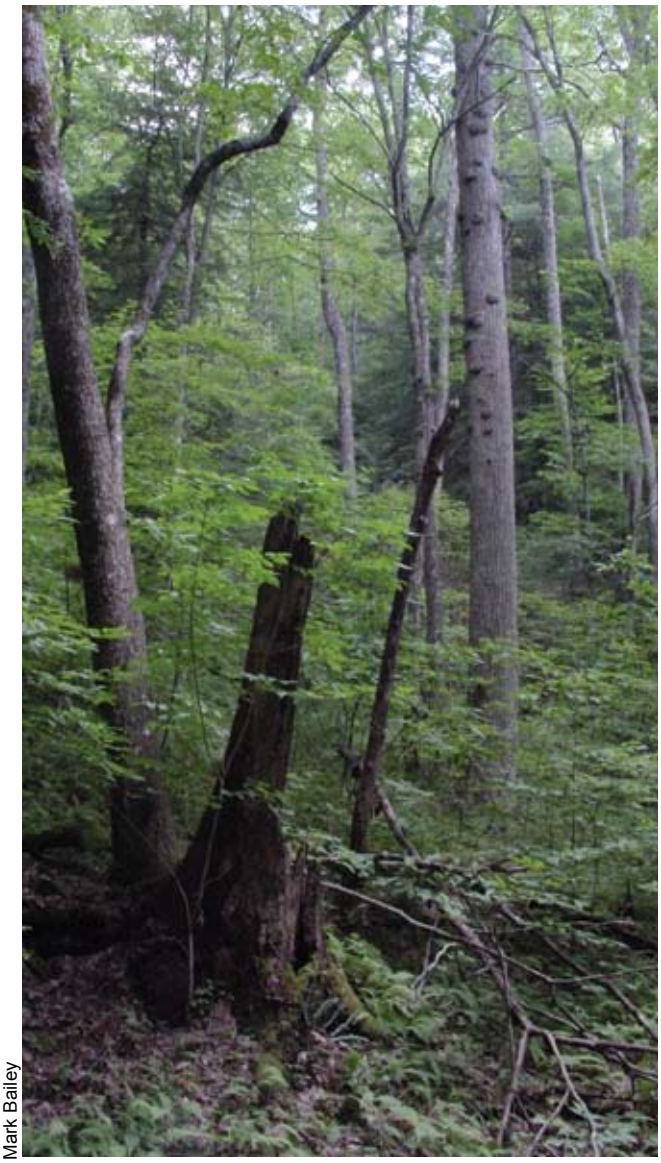
Box turtles and many other reptiles need nesting areas where soils are well drained and sunlight reaches the ground. In old-growth hardwood forests, these openings were created when single large trees died and fell. Before "reclaiming" old borrow pits, quarries, and other man-made openings that may actually be of considerable importance to nesting reptiles, determine first if natural openings are available. When the only available sun-exposed ground is along roadsides, increased road mortality may occur when reptiles seek nesting sites.

IDEAL: Refuges, Sanctuaries, and Preserves
When benefiting amphibians and reptiles is a PRIMARY objective, as with nature preserves, wildlife refuges, and private lands whose owners wish to optimize herpetofaunal diversity and abundance:

- **Protect and manage mature hardwood stands.**
- **Favor mature stands, but maintain a mixture of forest types and ages (including some openings).** *While many amphibians and reptiles of mesic hardwood forests need mature forest stands, others require a variety of structure and composition regimes.*
- **Direct foot traffic and trails away from sensitive embedded habitat features such as vernal pools, seeps, ravines, and caves.** *Soil disturbances, direct persecution, and disruptions of natural behaviors are unfortunate side effects of recreational access.*

James Kiser

The Caddo Mountain Salamander is found only in a small area of mesic, north-facing, forested slopes in the Ouachita Mountains of Arkansas.



Mark Bailey

Mesic hardwood and hemlock cove forests are scattered throughout the Southern Appalachians. This region is home to more salamander species than any other place on Earth. Many have extremely restricted distributions represented by few populations.

- **Maintain and, where necessary, restore the natural fire regime (some hardwood communities do benefit from infrequent burns).** *The optimal fire return interval for these systems may be very infrequent. Too much fire can be as harmful as too little fire.*

- **Support research efforts aimed at restoring American chestnut and hemlock--two important mesic forest species that have been impacted by introduced non-native fungi and insects.**

Mark Bailey

The superbly camouflaged Copperhead is our most widely distributed venomous snake, and may be quite common in deciduous forest.

Mark Bailey

Female Box Turtles often move into roadsides and other open, sunny areas to nest.

James Kiser

Small and secretive, the Ring-necked Snake preys on woodland salamanders and Ground Skinks in a wide range of habitats.

This is the Mesic Hardwood Forests module of the PARC publication, HMG-2. ISBN 0-9667402-2-X. Please visit www.parcplace.org for further information, copies of the complete document, or a web-based version of these guidelines.

Mark Bailey

PINE FORESTS

John Jensen

Drastic reductions of the longleaf pine/wiregrass community, alteration of forest structure, and loss of pine flatwoods cypress ponds have made the Flatwoods Salamander one of the most imperiled species in the Southeast.

CHARACTERISTIC SPECIES

Tiger Salamander, Dwarf Salamander, Oak Toad, Pine Woods Treefrog, Squirrel Treefrog, Ornate Chorus Frog, Gopher Tortoise, Slender Glass Lizard, Southeastern Five-lined Skink, Ground Skink, Green Anole, Eastern Racer, Corn Snake, Scarlet Kingsnake, Eastern Hog-nosed Snake, Pine Snake, Pygmy Rattlesnake, Eastern Diamond-backed Rattlesnake

The pine forest category encompasses a variety of natural habitats, ranging from coastal flatwoods to mountain ridges. It also includes modified habitats such as intensively managed pine plantations as well as former agricultural lands that are now forested. Historically, most naturally occurring pine forest habitats could be characterized by:

- High fire frequency
- Wide range of moisture regimes (wet flatwoods to dry ridge tops)
- Wide range of age classes, from early successional to mature
- Wide range of canopy conditions, from closed-canopy forest to open savannas
- Variable understory structure
- Abundant and diverse groundcover vegetation

Mark Bailey

IDEAL. This mature mixed pine stand has been thinned several times and burned regularly for many years. The abundant, diverse groundcover provides food and shelter for a plethora of amphibians, reptiles, and other wildlife. This habitat is also ideal for game animals, especially quail.

Jeff Humphries

COMPATIBLE. This maturing loblolly stand in South Carolina was thinned 5 years prior to this photo and placed on a 2-year fire rotation. The abundant shrubs, grasses, and sedges provide ample food and shelter for many herps, their prey, and other wildlife.

Kurt Buhlmann

POOR. Densely planted pines allow little sunlight to penetrate to the forest floor. Hence, few plants can grow, fewer insects find food and thus fewer vertebrates (from salamanders to box turtles to deer) can thrive. Thinning and burning would significantly improve this stand's capacity to support wildlife.

MAXIMIZING COMPATIBILITY: Timberlands, Hunt Clubs, Farmlands, Ranches, Recreation Lands, and other Integrated Land Uses
When benefiting amphibians and reptiles is secondary to other management objectives:

- **Whenever feasible, thin plantations, extend rotation age, and use prescribed burning to maintain some herbaceous ground cover.** *Canopy openings and periodic fire are both important to maintain herbaceous groundcover (i.e., grasses, sedges, and forbs) which are important wildlife foods. Light gaps and herbaceous groundcover are important in managed pine forests, whether the stand is longleaf pine, loblolly pine, slash pine, sand pine, or other species.*

- **On sites where options exist, favor site preparation techniques that minimize soil disturbance, such as fire and chemical site prep.** *If bedding is to be used, consider wider bed spacing (12 to 15 feet) to retain undisturbed areas between beds. Mechanical site prep techniques such as shearing, root raking, disking, and bedding can damage the soil structure in which fossorial (i.e., burrowing) herpetofauna (e.g., Flatwoods Salamander, Ornate Chorus Frog, Mole Skink, Pine Snake, Southern Hognose Snake) occur.*

- **When possible, harvest during drier periods and/or use low-pressure tires.** *Harvesting during dry periods minimizes rutting and disturbance to soil structure.*

- **Leave stumps, some logs, dead standing snags, and other coarse woody debris following timber harvests.** *Many amphibians and reptiles require woody debris and stump holes for shelter, nesting, and foraging.*

IDEAL: Refuges, Sanctuaries, and Preserves
When benefiting amphibians and reptiles is a PRIMARY objective, as with nature preserves, wildlife refuges, and private lands whose owners wish to optimize herpetofaunal diversity and abundance:

- **Restore native longleaf pine and wiregrass habitats in Coastal Plain ecoregions, as only two percent of this original formerly widespread ecosystem remains.**

Kurt Buhlmann

Large tracts of cleared forest land become inhospitable for some salamanders as ground temperatures increase and moisture decreases. Populations may take decades to recolonize reforested habitat.

- **Thin existing even-aged plantations, extend rotation age, manage toward uneven-aged stands, and restore historic fire frequency and seasonality to allow stands to remain relatively open.** *Canopy openings and frequent fire are both vital to the health and survival of herbaceous groundcover. Grasses, sedges, and forbs are important wildlife food sources in most pine forests. Light gaps and herbaceous groundcover are especially important in longleaf and shortleaf-dominated systems; they are also important to herpetofauna in other pine types.*

- **Restore natural fire frequency, seasonality, and (where feasible) intensity.** *Growing season burns mimic lightning-caused spring and summer fires that historically occurred under natural conditions. Frequent fire helps maintain open canopy conditions and promote growth and survival of herbaceous ground cover. Wiregrass, an important groundcover component, requires growing season fires for successful reproduction. Embedded seasonal wetlands are unlikely to burn during the dormant season (i.e., winter) because they are more likely to contain water at that time. Scrub oaks and other invasive hardwoods are more effectively controlled by growing season burns. All amphibian and reptile species that occur in pine-dominated habitats are adapted to periodic growing season fires.*

- **Identify, protect, and manage embedded habitats such as seasonal wetlands, rock outcroppings, and sandhills.** *Many pine forest-associated species require embedded, sensitive habitats for part of their life history and/or seasonal migration patterns. Both the embedded habitat and the surrounding pine matrix must be present for them to persist.*

This is the Pine Forests module of the PARC publication, HMG-2. ISBN 0-9667402-2-X. Please visit www.parcplace.org for further information, copies of the complete document, or a web-based version of these guidelines.

LOUISIANA PINE SNAKE HABITAT MANAGEMENT: INTERNATIONAL PAPER COMPANY

Historically, the Louisiana Pine Snake (*Pituophis ruthveni*) inhabited seven parishes in western Louisiana and twelve counties in eastern Texas. Populations have declined or become extirpated due to degradation of longleaf pine forests. The snakes have been documented from only four Louisiana parishes since 1993. The largest known extant population occurs on International Paper (IP) land in Bienville parish. Through a management plan, IP has identified a Habitat Management Area for the snake consisting of two Core Management Areas, the Kepler Lake Site (864 acres) and the Pink House Site (862 acres), and a Compatible Management Area (28,718 acres), which is situated between the two core areas. Through an innovative partnership with the USFWS and the Louisiana Natural Heritage Program, some of the loblolly stands, as they are harvested, are being converted to longleaf pine. Increased fire and banded herbicide applications are being used to enhance habitat for both the snakes and their prey. This management strategy allows a 60 percent increase in herbaceous growth over what would be expected from typical broadcast spraying.

—Mark Hughes, International Paper Company

Dan Saenz / U.S. Fish and Wildlife Service

Mark Bailey

XERIC HARDWOOD AND PINE-HARDWOOD FORESTS

Xeric (i.e., dry) oak and pine-oak forests are characterized by porous, well-drained soils and are generally found on higher elevations, ridge tops and south-facing slopes. A wide range of structure, density, and associated vegetation, including grasses and shrubs, occur within these habitat types. Many are extremely fire-dependent, with cones, acorns, and/or pods that only open and disperse seeds when exposed to fire. These forests are sometimes interwoven with other dry habitats such as sandhills, glades, and rock outcroppings.

Because these habitats are elevated, underground burrows are seldom flooded, making them ideal hibernation sites for many reptile species. Light gaps and south-facing aspects further enhance hibernacula by allowing reptiles to bask outside their dens in spring and fall before and after dispersing to summer foraging habitats.

Steve Osborne

Landscape-scale fire is used to restore or maintain vast expanses of xeric hardwood and hardwood-pine habitats in northwestern Arkansas.

CHARACTERISTIC SPECIES

Eastern Tiger Salamander, Fowler's Toad, Cope's Gray Treefrog, Squirrel Treefrog, Eastern Fence Lizard, Broad-headed Skink, Ground Skink, Green Anole, Eastern Rat Snake, Eastern Coachwhip, Eastern Hog-nosed Snake, Pine Snake, Pygmy Rattlesnake, Timber Rattlesnake, Eastern Box Turtle

Steve Osborne

After nearly a century of fire suppression, an aggressive fire restoration program revitalized this xeric oak woodland on the Bayou Ranger District of the Ozark National Forest.

MAXIMIZING COMPATIBILITY: Timberlands, Hunt Clubs, Farmlands, Ranches, Recreation Lands, and other Integrated Land Uses
When benefiting amphibians and reptiles is secondary to other management objectives:

- **Use prescribed burning as a management tool whenever feasible.** *When fire is suppressed or excluded, many amphibians and reptiles of these dry habitats are negatively impacted.*

- **Identify and retain embedded habitats such as seasonal wetlands, rock outcroppings, and sandhills.** *Many xeric forest-associated species require such embedded, sensitive habitats for part of their life history and/or seasonal migration patterns. Both the embedded habitat and the surrounding forest matrix must be present for them to survive.*

See "The Basics" (page 17). Consider recommendations regarding fire. These xeric systems are often fire-dependent. In addition to benefiting amphibians and reptiles, fire may enhance the habitat for game species.

IDEAL: Refuges, Sanctuaries, and Preserves
When benefiting amphibians and reptiles is a PRIMARY objective, as with nature preserves, wildlife refuges, and private lands whose owners wish to optimize herpetofaunal diversity and abundance:

- **Protect and manage remaining mature xeric hardwood stands.** *Very old xeric hardwood forest communities may not be immediately obvious due to limiting site conditions (i.e., soil, moisture, elevation) resulting in small size at maturity.*

- **Identify, maintain and, where disrupted, restore natural fire frequency, intensity, and seasonality.** *Vegetation in xeric forests is extremely fire dependent. This vegetation provides critical foraging, nesting, and shelter habitats for amphibians and reptiles. Without fire, less desirable canopy tress may crowd out higher-quality oaks. Canopies may close and shade out herbaceous groundcover, which is often the critical first link in the food chain.*

- **Identify and retain embedded habitats such as seasonal wetlands, rock outcroppings, and sandhills.** Many xeric forest-associated species require these embedded, sensitive habitats for part of their life history and/or seasonal migration patterns. Both the embedded habitat and the surrounding forest matrix must be present for them to survive.

- **Favor mature stands, but maintain a mixture of forest types and ages (including some open-**

Mark Bailey

This upland snake trap in Tennessee is placed for monitoring purposes in an area being restored to its natural condition; an open oak woodland. Pine Snakes occur in this habitat.

Mark Bailey

Pine Snakes are as apt to be found in xeric, open-canopied deciduous forest as they are in pine-dominated habitats. Providing a well-developed herbaceous groundcover is important when managing for many rodent-eating snakes such as Pine Snakes, Kingsnakes, and Corn Snakes.

ings). *While many amphibians and reptiles of xeric hardwood forests need mature forest stands, others require a variety of structure and composition regimes.*

- **Direct foot traffic and trails away from sensitive embedded habitat features such as vernal pools, seeps, ravines, and caves.** *Soil disturbances, direct persecution, and disruptions of natural behaviors are unfortunate side effects of recreational access.*

OAK DECLINE: AN ECONOMIC AND ECOLOGICAL THREAT.

Oaks are valuable to both humans as a timber source and wildlife as a food source. In some parts of the Southeast, xeric oak and pine-oak ecosystems are declining significantly due to a variety of factors such as pathogens, parasites, harvesting, and fire suppression. In addition to having economic consequences, the loss of oaks in particular has serious implications for many wildlife species including amphibians and reptiles. Acorns are a fundamental element in the forest floor food chain, providing forage for many wildlife species, including deer, squirrels, rats and mice (snake prey). In many cases, the restoration of natural fire frequency, intensity, and seasonality may be all that is needed to reduce less-desirable timber species (e.g., sweetgum, red maple) and increase higher-quality oaks.

Carl Brune

Five-lined Skinks are common in xeric forests.

David Cooper

Although Eastern Hog-nosed Snakes are upland species, they are dependent on the annual production of toads and other amphibians from isolated wetlands.

David Cooper

Our smallest venomous snake, the Pygmy Rattlesnake can frequently be found in xeric hardwood and pine habitats.

This is the Xeric Hardwood and Pine-hardwood Forests module of the PARC publication, HMG-2. ISBN 0-9667402-2-X. Please visit www.parcplace.org for further information, copies of the complete document, or a web-based version of these guidelines.

Mark Bailey

SANDHILL AND SCRUB

Sandhill and scrub are among the most important and imperiled habitats for southeastern amphibians and reptiles. Sandhill and scrub are ecologically similar habitats characterized by deep, well-drained sands supporting plants adapted to xeric (i.e.,dry) conditions such as wiregrass, prickly pear cactus, and saw palmetto. Dominant trees include longleaf pine (in sandhill and scrub), sand pine (scrub only), and bluejack, turkey, and other oaks. Gopher Tortoise burrows are often a distinctive feature of sandhill and scrub habitats, and provide shelter to many vertebrate and invertebrate species. Sandhill habitats are found in many areas throughout the Coastal Plain, but the more xeric and open scrub habitats are primarily limited to Florida Peninsula Ecoregion and a narrow strip along the Gulf Coast. Groundcover tends to be better developed in sandhill than in scrub, but bare sandy areas also may be found in the drier sandhills. Both habitat types require periodic fire, but scrub naturally burns less frequently due to its sparser vegetation and reduced fuel levels.

Loss of these uplands to development, conversion to other forest types, and fire suppression has led to alarming declines in a number of species (for example,

CHARACTERISTIC SPECIES

Oak Toad, Ornate Chorus Frog, Gopher Frog, Striped Newt, Gopher Tortoise, Eastern Diamond-backed Rattlesnake, Eastern Coachwhip, Eastern Racer, Indigo Snake, Mole Skink, Florida Scrub Lizard, Six-lined Racerunner

Mark Bailey

The rare, declining Gopher Tortoise is the keystone species of sandhill habitats. Their burrows provide shelter for numerous other sandhill-associated amphibians and reptiles, notably Gopher Frogs and Indigo Snakes, that might disappear with the Gopher Tortoise.

Mark Bailey

This Gopher Tortoise burrow shows signs of recent activity, including the freshly disturbed soil deposited at the entrance.

Indigo Snakes, Gopher Tortoises, Striped Newts, and Gopher Frogs). Amphibians of these habitats also require seasonal wetlands within their home range or dispersal distances. Florida scrub habitats support endemic species found nowhere else, such as the Florida Scrub Lizard and Florida Sand Skink.

MAXIMIZING COMPATIBILITY: Timberlands, Hunt Clubs, Farmlands, Ranches, Recreation Lands, and other Integrated Land Uses
When benefiting amphibians and reptiles is secondary to other management objectives:

- **When planting, use timber species (such as longleaf pine) adapted to sandhill communities and fire regimes.** *For most wildlife dependent on this habitat, basal areas exceeding 60 sq. ft/acre are detrimental. See also "The Basics" (page 17). Consider recommendations regarding fire. Sandhills and scrublands are often fire-dependent. In addition to benefiting amphibians and reptiles, fire may enhance the quality and value of game species.*

- **Consider site preparation techniques that minimize soil disturbance.** *When possible, harvest during drier seasons and/or use low-pressure tires on equipment.*

- **Where herbicides, pesticides, or fertilizers are needed, follow label instructions carefully and precisely and give preference to individual stem**

SAND PINE OR LONGLEAF PINE?

Pure stands of sand pine are a natural and important component of scrub habitats where fire is relatively infrequent due to the sparse groundcover and low fuel levels. However, in the Florida panhandle and elsewhere, the conversion of large areas of formerly fire-maintained and longleaf-dominated forest to "off-site" sand pine (and to some extent, slash and loblolly pine) has resulted in severe habitat degradation and local extirpations of many amphibian and reptile species. If the site formerly supported longleaf pine, its restoration should be a management consideration. Fortunately, the technology for successfully establishing longleaf seedlings now exists. Consult your state forestry agency or the Longleaf Alliance (www.longleafalliance.org) for more information.

Robert Zappalorti

Eastern Indigo Snakes are the largest and perhaps rarest snake in the Southeast. They require lots of space, which is being lost as development fragments the landscape. They move back and forth between sandy uplands, where they shelter in Gopher Tortoise burrows, and adjacent wetlands, where they forage for rodents and amphibians. During these movements, they are particularly vulnerable to road mortality.

Steve Bennett

Venomous but shy, the majestic Eastern Diamond-backed Rattlesnake is quickly vanishing from sandhills due to habitat loss and persecution by humans.

Mark Bailey

Pine Snakes, such as this one from southern Alabama, spend much of their lives underground. Radiotelemetry has shown that Gopher Tortoise burrows are only infrequently used by Pine Snakes, but the burrows of a mammal, the southeastern pocket gopher (*Geomys pinetis*) may be important when present.

John Jensen

Seldom encountered and sometimes confused with the Coral Snake or the Scarlet Kingsnake, the colorful Scarlet Snake burrows in loose sandy soils in search of its favored food, the eggs of other reptiles.

treatment or spot application. *Banded herbicide application, rather than broadcasting, can be used when appropriate, to reduce the amount of herbicide used and the area treated.*

IDEAL: Refuges, Sanctuaries, and Preserves
When benefiting amphibians and reptiles is a PRIMARY objective, as with nature preserves, wildlife refuges, and private lands whose owners wish to optimize herpetofaunal diversity and abundance:

- **Restore pine species to sites where they would naturally occur.** *See "Sand Pine or Longleaf Pine?" insert.*
- **Identify, maintain and, where disrupted, restore natural fire frequency, intensity, and seasonality.** *Virtually all sandhill-associated reptiles, amphibians, and the vegetation in which they forage, nest, and shelter are extremely fire-dependent.*
- **Exclude access by livestock.** *Excessive livestock traffic can disturb soil, degrade/destroy vegetation, and disrupt natural wildlife activities.*
- **Protect uplands from development.**

Mark Bailey

Gopher Frogs spend most of their time in underground retreats, including Gopher Tortoise burrows, stump holes, and mammal burrows. In areas lacking suitable isolated wetlands embedded in sandhill and scrub habitat, breeding and larval development cannot occur, and amphibians such as Gopher Frogs, Ornate Chorus Frogs, and Striped Newts will be absent.

This is the Sandhill/Scrub module of the PARC publication, HMG-2. ISBN 0-9667402-2-X. Please visit www.parcplace.org for further information, copies of the complete document, or a web-based version of these guidelines.

Jerrell Goodpaster

HIGH ELEVATION SPRUCE/FIR FORESTS AND BALDS

These isolated habitats are maintained by cool, moist, and windy conditions and are limited to the highest peaks of the southern Appalachians. Canopy trees are often pruned and misshapen by persistent high winds. In some cases, canopy trees may be sparse or entirely absent, replaced by heath or grassy balds. Exposed rock and thin soils are sometimes present. Farther down the slopes, high elevation habitats transition into other systems, most notably northern hardwoods.

Few reptiles can tolerate these harsh climates. The herpetological value of these high elevation forests lies in their locally high populations of plethodontid salamanders, some of which are endemic habitat specialists with very restricted ranges.

CHARACTERISTIC SPECIES

Pigmy Salamander, Jordan's Salamander complex, Weller's Salamander, Smooth Green Snake, Milk Snake, Ring-necked Snake, Eastern Garter Snake, Red-bellied Snake

James Petranka

The Yonahlossee Salamander requires moist, cool, high-elevation forest habitats in a small area of North Carolina and Virginia.

Mark Bailey

Among the few snakes to be found in the highest elevations, the adaptable Eastern Garter Snake exploits a variety of habitats, from high mountain to coastal areas to backyards.

MAXIMIZING COMPATIBILITY: Timberlands, Hunt Clubs, Farmlands, Ranches, Recreation Lands, and other Integrated Land Uses
When benefiting amphibians and reptiles is secondary to other management objectives:

- **Allow dead trees and woody debris to decompose naturally on the ground.** *Spruce-fir obligate salamanders rely on rotten logs for shelter and forage microhabitats.*

- **Control pedestrian and motorized vehicle access, including ATVs.** *Stabilize roads and trails if erosion is a problem. High elevation habitats and their obligate species are extremely rare and declining at alarming rates. Additional disturbances may irreparably damage these fragile systems.*

- **Where timber harvest is planned:**
  – Ensure that harvested sites are regenerated to spruce-fir
  – Harvest trees that are encroaching on grass or heath balds
  – Minimize soil disturbances associated with heavy equipment

IDEAL: Refuges, Sanctuaries, and Preserves
When benefiting amphibians and reptiles is a PRIMARY objective, as with nature preserves, wildlife refuges, and private lands whose owners wish to optimize herpetofaunal diversity and abundance:

- **Maintain and, where necessary, restore native forest cover.** *While favoring mature forests, maintain a diversity of age classes. Stands of mature spruce and fir are critically imperiled in the Southern Blue Ridge ecoregion. About 70,000 acres of spruce and spruce-northern hardwood mix forests were harvested during the late 1800's and early 1900's and are now mid-successional northern hardwood stands and should be considered for restoration. Further loss may extirpate these systems and their amphibians and reptiles inhabitants.*

- **Reduce or remove encroaching forest cover from balds.** *In bald or intermediate communities, maintain moss and herbaceous vegetation. Bald habitats are extremely fragile and highly susceptible to degradation from woody encroachment. Processes that maintain the open character of balds are poorly understood.*


Kurt Buhlmann

Acid rain and the balsam wooly adelgid have severely degraded many high elevation habitats such as Clingman's Dome in Great Smoky Mountains National Park. Note the numerous dead balsam firs.

- **Exclude pedestrian and motorized vehicle access, including ATVs.** *High elevation habitats and their obligate species are extremely rare and declining at alarming rates. Even the slightest disturbances may irreparably damage these fragile systems.*

- **Prohibit the collection of mosses for personal use and commercial sale.** *The recent level of moss harvest has the potential of severely damaging salamander populations and their habitats.*

- **Allow scientific research on your land.** *Encourage research to develop ways to control threats to existing spruce-fir systems including acid rain and invasive insects (i.e., balsam wooly adelgid, gypsy moth). Support regional/national efforts to understand and abate these threats. Acid rain, pathogens, and invasive exotics are among the key threats to these fragile, isolated habitats. Stay informed of the latest scientific developments to save high elevation habitats and species in the Southern Blue Ridge.*

This is the High Elevation Spruce/Fir Forests and Balds module of the PARC publication, HMG-2. ISBN 0-9667402-2-X. Please visit www.parcplace.org for further information, copies of the complete document, or a web-based version of these guidelines.

James Kiser

PRAIRIES/GLADES/BARRENS/OLD FIELDS

These systems include cedar glades, hill prairies, dry meadows, and abandoned agricultural lands. Often embedded in a larger forest matrix, these habitats are characterized by minimal woody vegetation, abundant grasses and sedges, and/or bare mineral surfaces. In some cases, fire or grazing is the main process that prevents woody encroachment. In other cases, soils may be too dry, thin, rocky, or low in nutrients to support large trees. With minimal shade, local microclimates are often hotter than nearby forests, especially where rock surfaces are exposed.

Many sun and heat dependent reptiles require these open conditions for basking and foraging. Amphibian use is frequently limited to wooded or rocky margins and seasonally wet areas.

CHARACTERISTIC SPECIES

Eastern Spadefoot Toad, Six-lined Racerunner, Slender Glass Lizard, Eastern Racer, Eastern Coachwhip, Eastern Hog-nosed Snake, Prairie Kingsnake

EMBEDDED

These systems are often small, isolated, and disjunct, and are usually "embedded" in a larger habitat matrix. These embedded communities rely heavily on surrounding habitats for landscape-scale functions and processes.

John Jensen

Eastern Coachwhips require open grasslands, barrens, and glades where they hunt Eastern Six-lined Racerunners and oldfield mice that also require the same habitats.

Kevin Fitch

Aggressive barrens restoration efforts at Arnold Air Force Base in Tennessee have significantly improved habitats for herps and other wildlife.

MAXIMIZING COMPATIBILITY: Timberlands, Hunt Clubs, Farmlands, Ranches, Recreation Lands, and other Integrated Land Uses
When benefiting amphibians and reptiles is secondary to other management objectives:

- **Where possible, use fire to manage vegetation rather than mowing.** *Where mowing is needed or where haying is a goal:*
  - *mow when amphibians and reptiles are least active (preferably prior to emergence from hibernation; see inset below)*
  - *mow at high blade settings (8 inches or greater)*
  - *mow no more than once per year (mower blades can kill amphibians and reptiles.)*
  - Where grazing is a goal, rotate livestock frequently to prevent over-grazing.
  - Prevent establishment of invasive exotic vegetation.

Mark Bailey

Due to the density of adjacent forest canopy, this open, abandoned game food plot in southern Alabama supports several Gopher Tortoises that otherwise would have abandoned the area.

IDEAL: Refuges, Sanctuaries, and Preserves
When benefiting amphibians and reptiles is a PRIMARY objective, as with nature preserves, wildlife refuges, and private lands whose owners wish to optimize herpetofaunal diversity and abundance:

- **Exclude and remove invasive exotic plant species, woody encroachment, and woody succession.** *Maintain and, where necessary, restore diversity and abundance of native grasses and forbs. Open habitat-associated amphibians and reptiles are dependent on native grasses, sedges, forbs and shrubs. Invasive exotic and/or woody species can crowd out native vegetation. Red cedar encroachment is of particular concern in rocky glade habitats.*

- **Maintain and restore natural fire frequency, intensity, and seasonality, including landscape-scale fire in surrounding, complementary habitats where appropriate.** *Natural disturbances, particularly fire, retard vegetative succession and maintain diverse and abundant native vegetation.*

- **Where fire is not possible, consider limited, controlled grazing, especially by softer-hoofed herbivores such as goats.**

- **Maintain and restore natural hydrology in wet grasslands.** *Fill ditches, break drainage tiles, remove berms, etc. in order to sustain wetland vegetation and associated wildlife.*

This is the Prairies/Glades/Barrens/Old Fields module of the PARC publication, HMG-2. ISBN 0-9667402-2-X. Please visit www.parcplace.org for further information, copies of the complete document, or a web-based version of these guidelines.

TIMING OF BURNING AND MOWING

Scheduling burning or mowing when amphibians and reptiles are least active (such as prior to emergence from hibernation) can reduce direct mortality, but spring and summer burns may be needed to maintain floristic diversity and community stability.

To avoid the loss of local populations of sensitive invertebrates, vary the timing of burning and do not burn entire grasslands during the same season. When grassland habitat is limited, a 100% burn can wipe out entire populations of invertebrates. Whenever possible, leave up to 50% of grasslands unburned in a given year.

James Kiser

ROCK OUTCROPS/TALUS

These habitats range from dry, sparsely-vegetated south-facing exposures to moist, wooded north-facing slopes and are usually associated with slopes and cliffs. Rock outcrops or talus may be sandstone, limestone, or granite. Crevices and rock piles provide abundant microhabitat conditions with abrupt gradients between different light, vegetation, and moisture regimes. In limestone areas, caves may also be present (See Caves section).

Dry, south-facing aspects provide ideal denning and basking sites for a wide variety of reptile species, especially when gradients into adjacent foraging/dispersal habitats remain intact. On cooler, wetter, north-facing slopes, the diversity of microhabitats is especially favorable for a wide range of amphibian species, including many salamanders.

CHARACTERISTIC SPECIES

Green Salamander, Cave Salamander, Zigzag Salamander, Coal Skink, Eastern Fence Lizard, Eastern Garter Snake, Timber Rattlesnake, Milk Snake, Copperhead, Eastern Coachwhip

EMBEDDED

These systems are often small, isolated, and disjunct, and are usually "embedded" in a larger habitat matrix. These embedded communities rely heavily on surrounding habitats for landscape-scale functions and processes.

James Kiser

Rare and protected in some states, Green Salamanders live in the vicinity of damp, cool cliffs, outcrops, and large trees in the Applachian ecoregion.

Phil Colclough

Loss of dens is believed to contribute to recent declines in Timber Rattlesnake populations. In the northern, more mountainous parts of our region, these animals are imprinted to hibernate together in the same underground dens their ancestors have used for centuries. If these dens are damaged or isolated by development, highways or other hostile habitats, they are apparently incapable of improvising to find suitable replacements. In these cases, Timber Rattlesnakes have been reported to remain above ground until they literally freeze to death.

MAXIMIZING COMPATIBILITY: Timberlands, Hunt Clubs, Farmlands, Ranches, Recreation Lands, and other Integrated Land Uses
When benefiting amphibians and reptiles is secondary to other management objectives:

- **Manage rock climbing and other recreational activities to areas away from biologically significant areas.** *Consider seasonal limitations if it meets reptile and amphibian conservation concerns. Humans may disturb or disrupt faunal behavior patterns, and may kill snakes. There is also a risk of venomous snakebite near hibernation dens.*

- **Implement Best Management Practices (BMPs) in order to minimize erosion and soil disturbances uphill from biologically significant outcrop or talus areas.** *Excessive sediment from uphill can wash down, filling cracks and crevices that amphibians and reptiles need for microhabitat.*

- **Restore outcrops that have been invaded by native or non-native plants that shade the area.** *Some outcrops are susceptible to forest shading from the edges and below as trees grow. If used by reptiles (e.g., timber rattlesnakes), outcrops and talus should be maintained in the open. If used by salamanders (e.g., green salamanders) outcrops and talus should be shaded by forest canopy.*

IDEAL: Refuges, Sanctuaries, and Preserves
When benefiting amphibians and reptiles is a PRIMARY objective, as with nature preserves, wildlife refuges, and private lands whose owners wish to optimize herpetofaunal diversity and abundance:

- **Limit heavy human use such as ATV access in the vicinity of rock outcrops and talus as well as gradients between rocky areas and surrounding, complementary habitats.** *Excessive ATV and other motorized vehicular traffic can compact/disturb soil, increase erosion/sediment, provide corridors for invasive plant species along trails, elevate vehicle-related mortality rates, and cause noise-related disruptions of faunal activities.*

- **Ensure that land uses uphill from biologically significant sites do not generate excessive sediment.** *Sediment from uphill can wash down, filling cracks and crevices that amphibians and reptiles need for microhabitat.*

- **Maintain biologically significant areas, including reptile den sites and significant salamander occurrences.** *Because of limited mobility, most rock-dwelling salamanders are unable to move elsewhere if their habitat is lost.*

Mark Bailey

Rock outcrops, cliffs, and talus provide innumerable microhabitats for herps and other wildlife. On cooler, north-facing slopes salamanders can be abundant. On warmer, south-facing slopes, snakes and lizards bask and hibernate.

A LONG WINTER'S NAP

Like all amphibians and reptiles, snakes are cold-blooded and their body temperature is dictated by their surroundings. As temperatures become increasingly cold, snakes become increasingly sluggish. During winter, snakes cannot hunt and feed and may freeze to death if they stay on the surface. Therefore, they hibernate to conserve energy and avoid freezing.

In order to successfully hibernate, snakes must use an underground location that is deep enough to escape freezing temperatures and has a south-facing aspect to allow them to warm quickly when basking.

Lance Benedict

Basking Timber Rattlesnake.

To survive long winters, snakes "fatten up" prior to hibernation in the fall and feed as soon as possible after emergence in the spring. Since temperatures are often marginal during these times, snakes must bask in direct sunlight (preferably on heat-absorbing surfaces such as rocks or fire-blackened ground) in order to build up enough energy to forage. Woody encroachment and excessive shading around hibernation sites (often due to fire suppression) may render basking difficult or impossible. As the habitat surrounding a hibernation den degrades, fewer and fewer snakes are able to survive the winter.

Why not simply move to another den? Snakes are often imprinted on a single hibernation site and are incapable of finding a suitable replacement. In colder climates, generations upon generations of snakes from the same colony may gather at the same hibernacula. These annual migrations repeat for decades or even centuries, as long as the site remains favorable. If the den is destroyed by development or degraded by fire suppression, the entire colony may be lost.

- **Minimize publicity of biologically significant areas to prevent poaching or indiscriminate killing.** *Hibernating snakes and dense colonies of salamanders are extremely vulnerable to collecting or killing because they are concentrated in a small area.*

- **Protect surrounding complementary habitats and gradients between habitats to allow for unimpeded season dispersal of amphibians and reptiles.** *Hibernating reptiles and rock-dwelling salamanders usually spend only a part of their annual cycles in talus and outcroppings. Reptiles often disperse to adjacent habitats to forage during warmer months. Some salamanders may breed in nearby springs, seeps, and headwaters. Both the rocky uplands and the adjacent, complementary habitats must be present for these species to survive. Ensure that land uses do not render seasonal migration and natural dispersal patterns difficult.*

- **Where appropriate, maintain and restore natural fire frequency, intensity, and seasonality, especially at landscape scales in surrounding, complementary habitats.** *Fire is especially important for reptiles that hibernate in sunny, south-facing rock exposures. Woody encroachment and excessive shade may render basking impossible. (See insert: "A Long Winter's Nap")*

This is the Rock Outcrops/Talus module of the PARC publication, HMG-2. ISBN 0-9667402-2-X. Please visit www.parcplace.org for further information, copies of the complete document, or a web-based version of these guidelines.

John Jensen

CAVES/KARST SYSTEMS

These systems are most commonly found in areas underlain by limestone of the Cumberlands/Southern Ridge and Valley, Ozark and Ouachita Mountains, and some locations in the Coastal Plain ecoregions.

Within caves, underground crevices, rock piles, pools, and streams provide critical habitat to endemic salamanders, some with extremely limited dispersal capabilities, including the troglobitic (i.e., cave-obligate) Tennessee Cave Salamander. The “twilight zones” near cave entrances are also used by a number of amphibians that are also found in the surrounding forest (e.g., Cave Salamander, Dark-sided Salamander, Longtail Salamander, Spring Salamander, and Pickerel Frog). These cave-associated amphibians require foraging habitat outside of the cave.

EMBEDDED

These systems are often small, isolated, and disjunct, and are usually "embedded" in a larger habitat matrix. These embedded communities rely heavily on surrounding habitats for landscape-scale functions and processes.

CHARACTERISTIC SPECIES

Cave Salamander, Tennessee Cave Salamander, Long-tailed Salamander, Spring Salamander, Pickerel Frog

The health of underground cave systems is heavily influenced by surface activities. Airflow, microclimate, water quality, organic influx, and hydrology can all be impacted by land management within the porous karst landscape. The “recharge area” identifies the region of the landscape upon which precipitation runoff ends up in the cave system. Underground flow patterns may not correspond to surface topography, and harmful pollutants may originate long distances from recognized cave locations. Disturbances by human visitors can also influence the quality of subterranean systems.

The management of caves and karst landscapes is complex and requires much planning at the landscape level, primarily because of the subterranean waterway component. Sinkholes, solution channels, and similar surface features are all points where silt and pollutants can potentially enter cave systems and do considerable damage to cave-dependent aquatic spe-

Brian Miller

Cave Salamanders are typically found near the mouths of caves and crevices in karst-dominated geologic regions.

John Jensen

Pickerel Frogs can sometimes be found near the mouths of caves, especially where underground springs are present.

cies such as Tennessee Cave Salamanders, Georgia Blind Salamanders, cave fishes and cave-endemic invertebrates. Maintaining entrance microclimate is probably best done by maintaining forested buffers of varying sizes.

MAXIMIZING COMPATIBILITY: Timberlands, Hunt Clubs, Farmlands, Ranches, Recreation Lands, and other Integrated Land Uses
When benefiting amphibians and reptiles is secondary to other management objectives:

- **Limit human cave access to times of low seasonal fauna activity/presence.** *Favor guided tours over open access. Work with a management partner (caving grotto organization) or develop a permitting system to foster user accountability.*

- **Establish natural buffer zones around sinkholes in order to maintain the quantity and quality of water entering the aquifer.**

- **Protect subterranean systems from excessive sediment when timber harvest and other activities in surrounding forests are planned; sinkholes (even dry ones) should be afforded the same buffers as streams.** *"SMZ" can also be thought of as "sinkhole management zone."*

- **Meet or exceed BMPs.** *Pollution can detrimentally affect underground habitat and fauna, and alter faunal community composition. Cave-associated amphibians are often specifically adapted to a particular hydrologic regime. A single pollution event can cause the extirpation of a species.*

IDEAL: Refuges, Sanctuaries, and Preserves
When benefiting amphibians and reptiles is a PRIMARY objective, as with nature preserves, wildlife refuges, and private lands whose owners wish to optimize herpetofaunal diversity and abundance:

- **Limit cave access to times of low seasonal fauna activity or presence.** *If privately owned, consider partnering with a caving grotto to oversee visitation management. If government owned, consider a permitting system.*

- **Protect airflow regimes in caves and prevent excessive sediment from reaching the cave.** *Underground ecosystems are extremely fragile. Cave-associated amphibians are often specifically adapted to a particular temperature/air flow/microclimate regime. Digging activities by unauthorized individuals may sometimes enlarge entrances or create access to new passages.*

FOR ADDITIONAL INFORMATION ON CAVE CONSERVATION VISIT THESE WEBSITES:

– Virginia Cave Board:
www.dcr.virginia.gov/dnh/vcbsinkholes.htm

– National Speleological Society:
www.caves.org

– American Cave Conservation Association:
www.cavern.org/acca/accahome.html

– Southeastern Cave Conservancy:
www.scci.org

Steve Osborne

The same underground hydrology that created these beautiful limestone formations in Arkansas also supports a number of highly sensitive and specialized subterranean creatures.

Jim Godwin

The Tennessee Cave Salamander is known from only a handful of caves in Tennessee and Alabama. It is extremely rare and, due to its often inaccessible habitat, difficult to study. These animals are highly sensitive to alterations of underground water quality.

- **Maintain and restore forested buffers around cave and sinkhole openings.** *In addition providing foraging, critical dispersal and migration habitat for some species, native forests also positively influence water and air quality, temperature, and flow regimes. Additionally, organic debris generated by forest cover is critical as a food source for amphibians and cave invertebrates.*

- **Exclude point-source and non-point source water pollution throughout the surface recharge area.** *Prohibit dumping, including trash and organic debris. Pollution can detrimentally affect underground habitat, and alter faunal community composition. Input of fertilizers and sewage on the land and in caves can destroy the faunal community, especially invertebrates, and extirpating native troglobitic caves species.*

- **Maintain and, where necessary, restore surface hydrology throughout the recharge area.**

This is the Caves/Karst Systems module of the PARC publication, HMG-2. ISBN 0-9667402-2-X. Please visit www.parcplace.org for further information, copies of the complete document, or a web-based version of these guidelines.

David Cooper

Cave Salamander

Malcolm Pierson

BEACHES AND DUNES

Restricted to the immediate vicinity of oceans or bays, beaches and dunes are characterized by sandy soils and sparse, saltwater-adapted grasses and shrubs, and are restricted to the immediate vicinity of oceans or bays. Interdunal pools and swales may be present. Wind, tides, and storm-related overwash cause these habitats to undergo constant change as sands advance and retreat, with vegetation and fauna changing in response.

Beaches and dunes provide critically important nesting habitat for endangered marine turtles as well as Diamond-backed Terrapins. Female Sea Turtles often return to the same nesting site in successive years. Light pollution from nearby development can be particularly disruptive to both nesting females and emerging hatchlings.

CHARACTERISTIC SPECIES

Green and Loggerhead Sea Turtles, Diamond-backed Terrapin, Eastern Six-lined Racerunner, Island Glass Lizard, Eastern Kingsnake, Eastern Coachwhip, Southern Toad

EMBEDDED

These systems are often small, isolated, and disjunct, and are usually "embedded" in a larger habitat matrix. These embedded communities rely heavily on surrounding habitats for landscape-scale functions and processes.

Dune habitats support the rare Island Glass Lizard and the Coastal Dunes Florida Crowned Snake. Other, more common sun-dependent species may also use dune habitats.

Jim Rorabaugh

Freshwater swales on edges of coastal dunes and beaches represent suitable habitat for Island Glass Lizards.

Dennis Desmond

A female Loggerhead Sea Turtle heads back out to sea at dawn after a long, energy-draining night of laying eggs on the beach. Lights from beachfront development can disorient turtles, causing post-nesting female turtles and emerging hatchlings to walk inland instead of returning to the ocean.

MAXIMIZING COMPATIBILITY: Timberlands, Hunt Clubs, Farmlands, Ranches, Recreation Lands, and other Integrated Land Uses
When benefiting amphibians and reptiles is secondary to other management objectives:

- **Limit foot traffic (keep foot traffic on boardwalks) and motorized vehicles, including ATVs, especially during sea turtle nesting season.** *Nesting sea turtles and nests are easily disturbed by human activity.*

- **Minimize lighting or use low-intensity and/or directional lighting near sea turtle nesting areas.** *Unnatural lighting inhibits nesting behavior and causes hatchlings to crawl toward lights, often inland instead of out to sea.*

- **Where fencing is used to restore damaged dunes, consider the needs of nesting sea turtles.** *Beach obstructions may result in unsuccessful nesting attempts.*

- **Coordinate "beach re-nourishment" activities outside of the sea turtle nesting season.**

- **Control free-roaming pets, especially dogs, in the vicinity of turtle nesting areas.** *Free-ranging dogs dig up nests and kill hatchlings.*

IDEAL: Refuges, Sanctuaries, and Preserves
When benefiting amphibians and reptiles is a PRIMARY objective, as with nature preserves, wildlife refuges, and private lands whose owners wish to optimize herpetofaunal diversity and abundance:

- **Maintain and restore natural vegetation, especially where beach and dune stabilization is needed.** *Exclude and remove invasive exotic plant species..*

- **Keep foot traffic on boardwalks and exclude motorized vehicle traffic, including dune buggies and ATVs.** *Nesting sea turtles and nests are easily disturbed by human activity.*

- **Consider sea turtle nesting needs before constructing or removing pilings, sea walls, and jetties.** *Improperly placed structures may result in erosion of sea turtle nesting beaches. Conversely, properly placed structures may enhance nesting habitat in some cases.*

- **Avoid the use of beach lighting where sea turtle nesting is expected.** *Unnatural lighting inhibits nesting behavior and causes hatchlings to crawl toward lights, often inland instead of out to sea.*

- **Protect sea turtle nests from predators and poachers. Implement predator controls when necessary.** *Even when sea turtles are able to nest successfully, loss of eggs or newly emerged hatchlings continues to be a threat. Exclude dogs, coyotes, raccoons, foxes, and other predators. Strictly enforce poaching laws.*

- **Determine nesting and hatching periods so that monitoring efforts will aid protection of endangered and threatened sea turtles.** *Knowing the extreme dates of nesting period and hatching period will allow you to allocate time to accurately monitor females, nests, and hatchlings. This process will also work with diamond-backed terrapins.*

- **Determine population levels of predatory raccoons and foxes, and implement control measures if necessary.**

This is the Beaches and Dunes module of the PARC publication, HMG-2. ISBN 0-9667402-2-X. Please visit www.parcplace.org for further information, copies of the complete document, or a web-based version of these guidelines.

Sarah Holmes

MARITIME FORESTS

Maritime forests are restricted to a narrow band of "low country" and barrier islands along the extreme outer Coastal Plain ecoregions. Sandy soils and wind-pruned canopy trees, such as live oak, characterize these systems. The main processes that maintain these forests are wind and occasional overwash, as occurs during hurricanes.

Although few reptiles or amphibians are found only in maritime forests, these habitats support a variety of Coastal Plain "generalists." Because of the isolated nature of barrier islands in particular, some populations and assemblages are otherwise noteworthy because of unusual densities (e.g., certain eastern diamondback rattlesnake populations in maritime forests are large).

CHARACTERISTIC SPECIES
Eastern Narrow-mouthed Toad, Squirrel Treefrog, Eastern Spadefoot, Southern Toad, Eastern Box Turtle, Island Glass Lizard, Green Anole, Broad-headed Skink, Ground Skink, Eastern Racer, Pygmy Rattlesnake

Much maritime forest has been lost or fragmented by coastal development. Populations of one or more invasive exotic invasive reptile or amphibian species (e.g., Cuban treefrogs, greenhouse frogs, brown anoles) have been established in some areas.

MAXIMIZING COMPATIBILITY: Timberlands, Hunt Clubs, Farmlands, Ranches, Recreation Lands, and other Integrated Land Uses
When benefiting amphibians and reptiles is secondary to other management objectives:

- **When planning developments in maritime forests, provide for retention of forest canopy and structure.** *Dense canopies are a key habitat element in maritime forests.*
- **Keep pets indoors, leashed, or penned.** *Control, spay, and neuter free-ranging dogs and cats to keep feral populations at a minimum. Cats and dogs frequently kill amphibians and reptiles.*
- **Control subsidized natural predators such as raccoons.** *Keep garbage out of reach of raccoons,*

Steve Bennett

The beautiful but venomous Coral Snake can be found in maritime hardwood hammocks as well as sandhills.

James Kiser

When suitable breeding sites exist, Eastern Narrowmouth Toads, along with Spadefoot Toads, Green Treefrogs, Mole Salamanders, and several other amphibians, may be abundant in maritime forest.

crows, and other wildlife. Artificially subsidized mammalian and avian predators attain abnormally high population densities and pose a threat to native amphibians and reptiles.

- **Control or remove non-native species.** *Feral hogs, horses, nutria, rats, and several species of plants (e.g., phragmites) can dramatically change coastal habitats.*

IDEAL: Refuges, Sanctuaries, and Preserves
When benefiting amphibians and reptiles is a PRIMARY objective, as with nature preserves, wildlife refuges, and private lands whose owners wish to optimize herpetofaunal diversity and abundance:

- **Allow for natural regeneration of maritime forests.**
- **Avoid conversion to non-forest uses.** *Development-related loss and disturbance of habitat is the single greatest threat to coastal habitats.*
- **Remove feral non-native species, including dogs and cats.**
- **Reduce subsidized native predator populations that directly impact amphibians and reptiles.**
- **Reduce subsidized native predator populations that directly impact amphibians and reptiles.**
- **Control or remove non-native species that impact maritime forest habitat.** *Feral hogs, horses, nutria, rats, and several species of plants (e.g., phragmites) can dramatically change coastal habitats.*

This is the Maritime Forests module of the PARC publication, HMG-2. ISBN 0-9667402-2-X. Please visit www.parcplace.org for further information, copies of the complete document, or a web-based version of these guidelines.

John Jensen

Live oak and saw palmetto.

Mark Bailey

Developed Florida coastline.

Mark Bailey

AGRICULTURAL LANDS

With some thought to the naturally occurring habitat that existed before conversion, agricultural lands can provide significant and critical habitat for amphibians and reptiles. Croplands, rice fields, pastures, and orchards can support some of the amphibians and reptiles that occurred there under natural conditions. Embedded wetlands, vegetated stream banks, wooded slopes adjacent to fields, remnant prairie patches, glades and barrens, and other non-cultivated areas (even fencerows and irrigation ditches) may serve as important patches of "natural" habitats in which amphibians and reptiles can survive in agricultural landscapes. Amphibians and reptiles will use agricultural lands to forage or to migrate to other natural habitats. For this reason, it is important to maintain and create corridors of suitable habitat connecting natural areas within agricultural lands.

CHARACTERISTIC SPECIES

Fowler's Toad, Upland Chorus Frog, Northern and Southern Cricket Frog, Tiger Salamander, Six-lined Racerunner, Slender Glass Lizard, Eastern Racer

Stan Trauth

The increasing use of precision land-leveling for agriculture has removed or drastically reduced the breeding habitat of Strecker's Chorus Frog and other amphibians that otherwise can tolerage agricultural land use. Without the retention and reintroduction of depressions, the Illinois Chorus Frog (a subspecies of Strecker's Chorus Frog) may become extirpated in Arkansas.

MAXIMIZING COMPATIBILITY: Timberlands, Hunt Clubs, Farmlands, Ranches, Recreation Lands, and other Integrated Land Uses
When benefiting amphibians and reptiles is secondary to other management objectives:

- **Protect and buffer any remaining natural areas.** *These are the areas where most amphibians and reptiles will persist.*

John MacGregor

Crawfish Frogs spend much of their lives underground, and frequently breed in ephemeral pasture pools and roadside ditches.

- **Develop naturally vegetated corridors between habitat fragments.** *Remnant natural areas provide core habitats, refugia, and migration/dispersal corridors and are essential to many amphibians and reptiles.*

- **Consider restoring natural hydrology to drained wetlands.** *Natural flood cycles and seasonal water retention may enhance breeding amphibian populations.*

- **Avoid mowing wetlands, shorelines, and ditches mid-spring through mid-fall.** *When mowing fields, raise deck height to at least 8 inches. See insert section: "Pasture and Hayfield Tips."*

PASTURE AND HAYFIELD TIPS:
When sown to native grasses, pastures and hayfields can closely mimic natural prairie habitats and may provide relatively stable habitat for grassland-adapted amphibians and reptiles and other wildlife. If mowed, start in the center and use a back-and-forth approach to avoid concentrating fleeing animals where they may be killed or stranded. Raising the mowing deck height to 8 or even 12 inches will reduce mortality and will leave important cover.

FOR FURTHER READING:
Managing Pastures and Haylands for Wildlife, University of Arkansas Cooperative Extension http://www.wildlifemanagement.info/publications/forestry_mgt_2.pdf

IDEAL: Refuges, Sanctuaries, and Preserves
When benefiting amphibians and reptiles is a PRIMARY objective, as with nature preserves, wildlife refuges, and private lands whose owners wish to optimize herpetofaunal diversity and abundance:

- **Avoid overgrazing and keep livestock out of wetlands.** *Rotate cattle frequently in order to retain groundcover vegetation as habitat for amphibians, reptiles, and other wildlife. Where feasible, pump water to troughs away from wetlands: livestock can graze and trample native plants, adversely altering habitats. Trampling can disturb and compact soil, increasing erosion and sedimentation. Excessive amounts of manure in aquatic systems may cause algal blooms, reduce dissolved oxygen levels, and detrimentally affect aquatic amphibians, especially tadpoles.*

- **Follow pesticide/fertilizer directions very carefully; use precisely where needed and minimum amounts necessary to achieve objectives.**

- **Consider the effect of agricultural land alterations on the larger landscape.** *Work with other adjacent land managers to provide natural habitat components and connective corridors within the agricultural-dominated system.*

- **Avoid chemical applications. Use organic treatments and biocontrol.**

- **Restore wetlands.**

This is the Agricultural Lands module of the PARC publication, HMG-2. ISBN 0-9667402-2-X. Please visit www.parcplace.org for further information, copies of the complete document, or a web-based version of these guidelines.

Steve Bennett

In addition to being beautifully colored, Corn Snakes are a farmer's best friend. Like other barnyard snake species, corn snakes eat large quantities of rodents, thus preventing costly crop damage. Snakes have an advantage over hawks, cats and other rodent predators: they can squeeze into tight spaces where rodents nest and hide.

Joe Mitchell

URBAN/RESIDENTIAL AREAS

In urban and residential areas, habitats are highly variable, small, and isolated. Hedgerows, flowerbeds, stone retaining walls, woodpiles, and old growth shade trees are used by a handful of highly adaptable habitat generalists. Vacant lots, railroad rights-of-way, and abandoned construction debris may also provide habitat for urban-tolerant species. Maintaining population persistence is challenging because of the combined effects of pollution, pesticides, children, pets, invasive species, and vehicle mortality on roads.

James Kiser

Thriving in shrubbery and often using buildings for hibernacula, Green Anoles, or "chameleons," are common garden lizards of southeastern Atlantic and Gulf coastal states.

MAXIMIZING COMPATIBILITY: Timberlands, Hunt Clubs, Farmlands, Ranches, Recreation Lands, and other Integrated Land Uses
When benefiting amphibians and reptiles is secondary to other management objectives:

- **Include existing natural areas in the design of new neighborhoods.**
- **Protect and maintain riparian and wetland areas, including the maintenance of pre-development hydrology (depth, duration, and frequency of flooding) of streams and wetlands.** *Many species that would otherwise be lost to development may be able to persist if natural hydrology and associated vegetation buffers are protected or restored.*

CHARACTERISTIC SPECIES
Fowler's Toad, Cope's Gray Treefrog, Green Frog, Slider, Box Turtle, Painted Turtle, Green Anole, Eastern Fence Lizard, Brown Snake, Eastern Garter Snake, Eastern Rat Snake

Mark Bailey

A rather sterile neighborhood pond. Taller, denser native grasses and shrubs around the margins of this pond would attract more wildlife.

Mark Bailey

This neighborhood backyard pond with "naturalized" borders attracts frogs, toads, and salamanders from adjacent woodlots.

- **Identify and protect existing special habitat features such as streams, wetlands, and rock outcroppings.** *Small colonies of amphibians and reptiles may remain viable if pockets of critical habitat are protected.*

- **Install a garden pool.** *If you build it, frogs will find it. Don't stock it with fish, though.*

- **Landscape with native species.** *Prevent the introduction and spread of invasive exotic plants and animals. Many reptiles, amphibians, and other wildlife (including songbirds) are specifically adapted to survive in native vegetative communities. Highly adaptable, rapidly reproducing invasive plants (e.g., English ivy, privet, wisteria) can sometimes outcompete, displace, and ultimately extirpate more specialized native species.*

THE MOST ENVIRONMENTALLY-FRIENDLY PESTICIDE?

Anyone who owns a flowerbed knows that slugs and other garden pests can seriously damage ornamental foliage. Although many chemicals on the market target garden pests, questions are often raised: How safe are they? Why do the pests keep coming back?

Garter snakes and brown snakes love to eat slugs and other pests and have adapted to urban life in many areas. Unlike most pesticides, these are guaranteed 100% environmentally safe and can find and eat source populations of pests in places where chemicals can't (i.e., foundations, burrows, and stone walls).

- **Spay and neuter cats and dogs, and keep them indoors.** *Uncontrolled pets and feral animals kill amphibians, reptiles, songbirds and other wildlife.*

- **Control subsidized predator populations by limiting access to garbage and other household food sources (e.g., pet food bowls).**

- **Limit the use of fertilizers, herbicides, and pesticides on lawns and golf courses.**

IDEAL: Refuges, Sanctuaries, and Preserves
When benefiting amphibians and reptiles is a PRIMARY objective, as with nature preserves, wildlife refuges, and private lands whose owners wish to optimize herpetofaunal diversity and abundance:

- **Convert your yard into a natural area, including a small garden pool.** *If your yard is adjacent to or near a stream corridor, park, or other natural habitat, the animals will come*

- **Eliminate exotic invasive plants.** *Replant with native species (e.g., replace privet with wax myrtle, Autumn olive with Carolina laurel cherry, English ivy with yellow jessamine).*

- **Avoid chemical pesticides when possible.** *Use natural means of controlling insect pests*

- **Reduce or eliminate your unnatural lawn.**

This is the Urban/Residential Areas module of the PARC publication, HMG-2. ISBN 0-9667402-2-X. Please visit www.parcplace.org for further information, copies of the complete document, or a web-based version of these guidelines.

APPENDIX A: AMPHIBIANS AND REPTILES OF THE SOUTHEAST

The Southeast supports at least 246 taxa of amphibians and reptiles: 44 frogs, 84 salamanders, 43 turtles, 2 crocodilians, 1 amphisbaenid, 16 lizards, and 56 snakes. The following table presents species occurrence information for each state and habitat covered in this book. We have used the most recent taxonomic information available, but some of the names used to describe species may change over time.

Species occurrences by Habitat are provided, and each habitat is qualitatively assessed as O (optimal), S (suitable), or M (marginal).

Global and State ranks: We have used NatureServe's global (G) and state (S) ranks to provide a standardized measure of abundance of each species throughout its global range and by each State within which it occurs. This numeric system is not regulatory, and does not indicate federal or state protected status. Ranks may change as more information becomes available.

Each species has a single G rank indicating the total number of occurrences throughout its range. An S rank is also assigned for each species' state occurrence (blank fields in the table below indicate the species does not occur in the state). The definitions provided below apply to both global and state ranks. Note that a species ranked G1 is at very high risk of extinction globally, whereas a species ranked S1 is at very high risk of extirpation within a particular state, and may be secure elsewhere in its range. Several species are ranked by NatureServe with a range (e.g., 2-3, 3-4), but for space considerations, the lower number (i.e., higher conservation priority) is used in the following table.

1 Critically Imperiled—At very high risk of extirpation due to extreme rarity (often 5 or fewer populations), very steep declines, or other factors.

2 Imperiled—At high risk of extirpation due to very restricted range, very few populations (often 6-20), steep declines, or other factors.

3 Vulnerable—At moderate risk of extirpation due to a restricted range, relatively few populations (often 21-80), recent and widespread declines, or other factors.

4 Apparently Secure—Uncommon but not rare; some cause for long-term concern due to declines or other factors.

5 Secure—Common; widespread and abundant.

NR Not Ranked--Some states have put their efforts into accurately categorizing the species with protected status. In many cases, but not always, a rank of NR coincides with greater abundance of known occurrences (3-5) and lower conservation concern.

NA Conservation Actions Not Applicable within a state (applies here only to "transient" Sea Turtles that typically occur only in offshore waters and do not nest in a state)

H Species was known Historically, but its presence may not have been verified in the past 20-40 years.

U Unranked. Frequently applies to recently described species for which information is still being gathered.

X Species regarded as Extirpated.

More information about the NatureServe ranking system may be found at: www.natureserve.org/explorer.

Federal Status: Endangered Species Act protection, according to U.S. Fish and Wildlife Service, as of January 2006. **E** = Endangered, **T**=Threatened. Information about Federally protected species can be found at: www.fws.gov/endangered.

State Protection Status: Each state has laws and/or regulations protecting certain amphibians and reptiles. These may appear on state lists as Special Concern (Florida, South Carolina, North Carolina), Rare (Georgia), Unusual (Georgia), Proposed Threatened (Kentucky), Candidate (Louisiana), Protected (Alabama), and Deemed in Need of Management (Tennessee). The NatureServe state rank for these state-protected species is in **boldface red**.

One of the goals of PARC is to help keep common species common, as well as to restore species that have declined as a result of human activities. Therefore, providing information about species occurrences and their rarity, as well as current protected status, may be useful to land owners and land managers for evaluating the positive effects of their habitat management actions. These ranks and protected status listings were accurate as of January 2006. Future actions by the PARC community may affect whether species become scarcer or more abundant. Thus, this table can also be used as benchmark to measure our future success.

PARC — PARTNERS IN AMPHIBIAN AND REPTILE CONSERVATION

Scientific Name	Common Name	NATURESERVE GLOBAL RANK	FEDERAL (USFWS) STATUS	NatureServe State-level Rank and State Protection: KENTUCKY	ARKANSAS	LOUISIANA	MISSISSIPPI	ALABAMA	FLORIDA	GEORGIA	TENNESSEE	SOUTH CAROLINA	NORTH CAROLINA	FLOODPLAIN WETLANDS	SEASONAL WETLANDS	PERMANENT WETLANDS	SMALL STREAMS, SPRINGS, SEEPS	RIVERS, RESERVOIRS	BRACKISH WETLANDS	WET MEADOWS & BOGS	MESIC HARDWOOD FOREST	PINE FOREST	XERIC HARDWOOD & MIXED PINE	SANDHILL/SCRUB	HIGH ELEVATION SPRUCE/FIR	PRAIRIES, GLADES, BARRENS	ROCK OUTCROPS / TALUS	CAVES / KARST	BEACHES AND DUNES	MARITIME FORESTS	AGRICULTURAL	URBAN / RESIDENTIAL
AMPHIBIANS: Frogs, Toads																															
Acris crepitans	Northern Cricket Frog	5		5	5	5	5	5	NR	5	5	4	5	O	S	O	M	M		M											
Acris gryllus	Southern Cricket Frog	5				5	5	5	NR	5	4	NR	5	O	S	O	M	M		M											
Bufo americanus	American Toad	5		5	5	3	4	5		5	5	NR	5	S	O	S				S	O	S	S			S	M			S	M
Bufo fowleri	Fowler's Toad	5		5	5	NR	5	5	4	5	5	NR	5	S	O	S	M			S	S	S	S			S	M			S	M
Bufo quercicus	Oak Toad	5				3	4	5	NR	5		NR	3		O					S		S	O	O		S			S	S	
Bufo terrestris	Southern Toad	5				5	5	5	NR	5		NR	5	S	O	S	M			S	S	S	S	S		S			S	S	S
Bufo valliceps	Gulf Coast Toad	5			1	5	3							S	S	S	S			S	S	S	S			M			S	M	
Bufo woodhousii	Woodhouse's Toad	5				5								S	O	S	M			S	S	S				S	M			S	
Gastrophryne carolinensis	Eastern Narrow-mouthed Toad	5		4	5	5	5	5	NR	5	5	NR	5	S	O	M				S	S	S	S	M		S			S	S	
Gastrophryne olivacea	Great Plains Narrow-mouthed Toad	5			2										O	M				O			O			O				S	
Hyla andersonii	Pine Barrens Treefrog	4						2	3			2	3		M	S	S			O											
Hyla avivoca	Bird-voiced Treefrog	5		3	3	5	5	5	NR	4	5	5		O	S	O	M				O	M									
Hyla chrysoscelis	Cope's Gray Treefrog	5		5	4	5	NR	5	NR	5	5	NR	5	O	O	S					O	O	S							S	M	S
Hyla cinerea	Green Treefrog	5		3	5	5	5	5	NR	5	5	NR	5	M	O	O			M		O	S	M							O		M
Hyla femoralis	Pine Woods Treefrog	5				4	5	5	NR	5		NR	5		O					S		O	O	M								
Hyla gratiosa	Barking Treefrog	5		3		3	4	5	NR	5	3	NR	3	S	O						O	O	S	M						S		
Hyla squirella	Squirrel Treefrog	5				5	5	5	NR	5		NR	5		O						O	O	S	M						O		M
Hyla versicolor	Gray Treefrog	5		2	4	4	NR			5	5	NR	1	O	O	S					O	O	S							S	M	S
Pseudacris brachyphona	Mountain Chorus Frog	5		5			3	5		3	4		1	M	O					S	O	M										
Pseudacris brimleyi	Brimley's Chorus Frog	5								1		NR	3	O	O	M					O	O	M									
Pseudacris crucifer	Spring Peeper	5		5	5	5	5	5	NR	5	5	NR	5	O	O	S				S	O	O	M									
Pseudacris feriarum	Upland Chorus Frog	5			5				NR	5		5	5	O	O		M			S	O	O	M							S	S
Pseudacris nigrita	Southern Chorus Frog	5					5	5	NR	5		NR	4	O	O					S	S	O	M							S	
Pseudacris ocularis	Little Grass Frog	5						1	NR	4		NR	5		O	S				O											
Pseudacris ornata	Ornate Chorus Frog	5				1	2	5	NR	5		NR	3	S	O						S	O	M	M						M		
Pseudacris streckeri	Strecker's Chorus Frog	5			NR	1								O	O		S			S	S					S				S		
Pseudacris triseriata	Western Chorus Frog	5			3									O	O	S				O	O	S	S			O				S	S
Rana areolata	Crawfish Frog	4		3	NR	3	3				4			S	O					S	S	S	S			S				S	
Rana blairi	Plains Leopard Frog	5			1										S					O						O				M	
Rana capito	Gopher Frog	3						2	3	2	1	1	2		O						S	O	S	S		S			S	M	
Rana catesbeiana	Bullfrog	5		5	5	5	5	5	NR	5	5	NR	5	S	M	O	M	O		S										S	S
Rana clamitans	Green Frog	5		5	4	5	5	5	NR	5	5	NR	5	O	S	O	S	S		S										S	S
Rana grylio	Pig Frog	5				5	5	4	NR	5		5		M	M	O															
Rana heckscheri	River Frog	5					1	1	NR	5		NR	H	O		S	S	S													
Rana okaloosae	Florida Bog Frog	2							2								O														

John Jensen

Pine Barrens Treefrog

Scientific Name	Common Name	NATURESERVE GLOBAL RANK	FEDERAL (USFWS) STATUS	NatureServe State-level Rank and State Protection										FLOODPLAIN WETLANDS	SEASONAL WETLANDS	PERMANENT WETLANDS	SMALL STREAMS, SPRINGS, SEEPS	RIVERS, RESERVOIRS	BRACKISH WETLANDS	WET MEADOWS & BOGS	MESIC HARDWOOD FOREST	PINE FOREST	XERIC HARDWOOD & MIXED PINE	SANDHILL/SCRUB	HIGH ELEVATION SPRUCE/FIR	PRAIRIES, GLADES, BARRENS	ROCK OUTCROPS / TALUS	CAVES / KARST	BEACHES AND DUNES	MARITIME FORESTS	AGRICULTURAL	URBAN / RESIDENTIAL
				KENTUCKY	ARKANSAS	LOUISIANA	MISSISSIPPI	ALABAMA	FLORIDA	GEORGIA	TENNESSEE	SOUTH CAROLINA	NORTH CAROLINA																			
Rana palustris	Pickerel Frog	5		5	4	4	4	5		4	5	NR	5	O	M	O	S		M	S	S							S			S	M
Rana pipiens	Northern Leopard Frog	5		3										O	O	S	S			S						S					S	
Rana sevosa	Mississippi Gopher Frog	1	E			H	1	H							O						S	S										
Rana sphenocephala	Southern Leopard Frog	5		5	5	5	5	5	NR	5	5	NR	5	O	O	S	S			S						S					S	
Rana sylvatica	Wood Frog	5		5	3			2		4	5	3	5	O	O		S			S	O											M
Rana virgatipes	Carpenter Frog	5							2	3		NR	4	O	M	O																
Scaphiopus holbrookii	Eastern Spadefoot	5		4	2	4	5	5	NR	5	5	NR	5	S	O						S	S	O	S		S				S	S	
Scaphiopus hurterii	Hurter's Spadefoot	5			2	NR									S						S	S	S									
Spea bombifrons	Plains Spadefoot	5			1										O											O					S	M
AMPHIBIANS: Salamanders																																
Ambystoma annulatum	Ringed Salamander	4			3									S	O	M					S	S	O								M	
Ambystoma barbouri	Streamside Salamander	4		4							2						O				O		S									
Ambystoma cingulatum	Flatwoods Salamander	2	T					1	2	2		1			O							O	S									
Ambystoma jeffersonianum	Jefferson Salamander	5		4										O	S	M					O		S									
Ambystoma mabeei	Mabee's Salamander	4										4	3	S	O						S	S	S									
Ambystoma maculatum	Spotted Salamander	5		5	5	5	5	5		5	5	NR	5	O	O	S					O		S									
Ambystoma opacum	Marbled Salamander	5		5	5	5	5	5	NR	5	5	NR	5	O	O						O	S	M									M
Ambystoma talpoideum	Mole Salamander	5		3	3	5	5	5	NR	5	4	NR	2	O	O						O	S	S									
Ambystoma texanum	Small-mouthed Salamander	5		5	5	5	5	3			5			O	S	S					O											
Ambystoma tigrinum	Tiger Salamander	5		4	3	1	1	3	3	3	5	2	2		O						S	O	O			S				M	
Amphiuma means	Two-toed Amphiuma	5				3	4	3	NR	5		NR	4	O	O	S	M															
Amphiuma pholeter	One-toed Amphiuma	3					1	1	3	1				O			O															
Amphiuma tridactylum	Three-toed Amphiuma	5		1	5	5	5	3			5			O	S	O	M															
Aneides aeneus	Green Salamander	3		3			1	3		2	3	1	2								O	M	M				O	S				
Cryptobranchus alleganiensis	Hellbender	3		3	2		1	2		3	3	NR	3				S	O														
Desmognathus aeneus	Seepage Salamander	3						2		3	1	NR	3				O				S				S			M				
Desmognathus apalachicolae	Apalachicola Dusky Salamander	3						3	3	2							O				S											
Desmognathus auriculatus	Southern Dusky Salamander	5				4	4	U	3	5		NR	5	S			O				S												
Desmognathus brimleyorum	Ouachita Dusky Salamander	4			4												O				S											
Desmognathus carolinensis	Carolina Dusky Salamander	4									2		3				O				S				S		S					
Desmognathus conanti	Spotted Dusky Salamander	5		3	2	U	U	U	NR	U	U	U	U	S			O				S											
Desmognathus folkertsi	Dwarf Black-bellied Salamander	1								1							O				S				S							
Desmognathus fuscus	Northern Dusky Salamander	5		5	2	5	5	5	NR	5	5	NR	5				O				S											M
Desmognathus imitator	Imitator Salamander	3									3		3				O				S				O		M					
Desmognathus marmoratus	Shovel-nosed Salamander	4								3	4	2	4				O				S				O							
Desmognathus monticola	Seal Salamander	5		5				5	1	5	5	NR	5				O				S											
Desmognathus ochrophaeus	Allegheny Mountain Dusky	5		4							5						O				O				O		M					
Desmognathus ocoee	Ocoee Salamander	3						2		5	2	NR	3				O				S				S		M					

John Jensen

Red Salamander

Scientific Name	Common Name	NATURESERVE GLOBAL RANK	FEDERAL (USFWS) STATUS	NatureServe State-level Rank and State Protection: KENTUCKY	ARKANSAS	LOUISIANA	MISSISSIPPI	ALABAMA	FLORIDA	GEORGIA	TENNESSEE	SOUTH CAROLINA	NORTH CAROLINA	FLOODPLAIN WETLANDS	SEASONAL WETLANDS	PERMANENT WETLANDS	SMALL STREAMS, SPRINGS, SEEPS	RIVERS, RESERVOIRS	BRACKISH WETLANDS	WET MEADOWS & BOGS	MESIC HARDWOOD FOREST	PINE FOREST	XERIC HARDWOOD & MIXED PINE	SANDHILL/SCRUB	HIGH ELEVATION SPRUCE/FIR	PRAIRIES, GLADES, BARRENS	ROCK OUTCROPS / TALUS	CAVES / KARST	BEACHES AND DUNES	MARITIME FORESTS	AGRICULTURAL	URBAN / RESIDENTIAL
Desmognathus orestes	Blue Ridge Dusky Salamander	4									3		3				O				S				S		M					
Desmognathus quadramaculatus	Black-bellied Salamander	5								5	4	NR	5				O				S				S							
Desmognathus santeetlah	Santeetlah Dusky Salamander	3									3		2				O				S				S							
Desmognathus welteri	Black Mountain Salamander	4		4							3						O				S											
Desmognathus wrighti	Pigmy Salamander	3									2		3				O				S				O							
Eurycea chamberlaini	Chamberlain's Dwarf Salamander	3						U		1		U	U	O	O		S				S	S										
Eurycea cirrigera	Southern Two-lined Salamander	5		5		4	4	5	NR	5	5	NR	5	S			O				S	M										
Eurycea guttolineata	Three-lined Salamander	5		2		4	5	5	NR	4	5	NR	5	O			O															
Eurycea junaluska	Junaluska Salamander	3									2		2				O				S											
Eurycea longicauda	Long-tailed Salamander	5		5	NR		4	5	NR	4	5		2				O				S						M	O				
Eurycea lucifuga	Cave Salamander	5		5	4		1	4		4	5						S				S						S	O				
Eurycea multiplicata	Many-ribbed Salamander	4			4												S				S							O				
Eurycea quadridigitata	Dwarf Salamander	5			3	5	5	5	NR	5		NR	5	O	O		S					M										
Eurycea tynerensis	Oklahoma Salamander	3			3												O															
Eurycea wilderae	Blue Ridge Two-lined Salamander	5								3	5		5				O				S				S							
Gyrinophilus palleucus	Tennessee Cave Salamander	2						2		1	2																	O				
Gyrinophilus porphyriticus	Spring Salamander	5		4			1	4		4	5	NR	5				O				S							S				
Haideotriton wallacei	Georgia Blind Salamander	2							2	1																		S				
Hemidactylium scutatum	Four-toed Salamander	5		4	3	1	1	3	2	3	3	NR	3	S	O		S			O	S											
Necturus alabamensis	Black Warrior Waterdog	2						2									O	S														
Necturus beyeri	Gulf Coast Waterdog	4				4	4	U	NR	3							S	O														
Necturus lewisi	Neuse River Waterdog	3											3				S	O														
Necturus maculosus	Mudpuppy	5		4	5	4	4	U		1	5		H				S	O														
Necturus punctatus	Dwarf Waterdog	4								2		NR	4				O	M														
Notophthalmus perstriatus	Striped Newt	2							2	2					O						S	S	S	M								
Notophthalmus viridescens	Eastern Newt	5		4	5	5	5	5	NR	5	5	NR	5	S	S	S	M			M	O	M										S
Phaeognathus hubrichti	Red Hills Salamander	2	T					2													O						M					
Plethodon ainsworthi	Catahoula Salamander	H [1]					H [1]														O	?	?									
Plethodon angusticlavius	Ozark Zigzag Salamander	4			3												S				O		M				S	S				
Plethodon aureolus	Tellico Salamander	2									2		2								S	M	S				S					
Plethodon caddoensis	Caddo Mountain Salamander	2			2																S	S	S				S					
Plethodon cinereus	Northern Red-backed Salamander	5		3							4		5								O	M	M				M					S
Plethodon dorsalis	Northern Zigzag Salamander	4		5							4										O	M	M				S	S				
Plethodon electromorphus	Northern Ravine Salamander	5		NR																	O		S				M					
Plethodon fourchensis	Fourche Mountain Salamander	2			2																S	M	S									
Plethodon glutinosus sp.	Slimy Salamander Complex	5		5	5	4	U	5	NR	5	5	NR	U								O	S	S				S	S				S
Plethodon jordani	Jordan's Salamander Complex	5								2	2	NR	5								O		M		S		S					
Plethodon kentucki	Cumberland Plateau Salamander	4		4							2										O		S				S	M				
Plethodon ouachitae	Rich Mountain Salamander	2			2																O	M	S									

John Jensen

Southern Red-backed Salamander

Scientific Name	Common Name	NATURESERVE GLOBAL RANK	FEDERAL (USFWS) STATUS	NatureServe State-level Rank and State Protection: KENTUCKY	ARKANSAS	LOUISIANA	MISSISSIPPI	ALABAMA	FLORIDA	GEORGIA	TENNESSEE	SOUTH CAROLINA	NORTH CAROLINA	FLOODPLAIN WETLANDS	SEASONAL WETLANDS	PERMANENT WETLANDS	SMALL STREAMS, SPRINGS, SEEPS	RIVERS, RESERVOIRS	BRACKISH WETLANDS	WET MEADOWS & BOGS	MESIC HARDWOOD FOREST	PINE FOREST	XERIC HARDWOOD & MIXED PINE	SANDHILL/SCRUB	HIGH ELEVATION SPRUCE/FIR	PRAIRIES, GLADES, BARRENS	ROCK OUTCROPS / TALUS	CAVES / KARST	BEACHES AND DUNES	MARITIME FORESTS	AGRICULTURAL	URBAN / RESIDENTIAL
Plethodon petraeus	Pigeon Mountain Salamander	1								1											O		M				O	O				
Plethodon richmondi	Southern Ravine Salamander	5		5							2		3								O		S				M					
Plethodon serratus	Southern Red-backed Salamander	5			3	1		2		5	4		4								O	M	S									
Plethodon teyahalee	Southern Appalachian Salamander	3								1	3	NR	3								O		M		O							
Plethodon ventralis	Southern Zigzag Salamander	4		4			2	4		4	4		1								O	M	M				S	S				
Plethodon websteri	Webster's Salamander	3				1	3	3		3		2									O	S	S									
Plethodon wehrlei	Wehrle's Salamander	4		1							1		1								O		M				O	S				
Plethodon welleri	Weller's Salamander	3									1		2								O				O		S					
Plethodon yonahlossee	Yonahlossee Salamander	4									3		4								O		M		S			O				
Pseudobranchus axanthus	Southern Dwarf Siren	4							4					S	S	S																
Pseudobranchus striatus	Northern Dwarf Siren	4							5	3		2		S	S	S																
Pseudotriton montanus	Mud Salamander	5		4		1	2	4	NR	4	5	3	5	O			O			O						S						
Pseudotriton ruber	Red Salamander	5		5		2	3	5	NR	5	5	NR	5	S			O			O												
Siren intermedia	Lesser Siren	5		3	5	5	4	5	NR	5	5	NR	3	S	S	S	O	M														
Siren lacertina	Greater Siren	5						3	5	5		NR	3	O	O	O	S	M														
Stereochilus marginatus	Many-lined Salamander	5							1	4		NR	3	O		S	O			S												
Typhlotriton spelaeus	Grotto Salamander	5			3												O											O				
REPTILES: Turtles																																
Apalone ferox	Florida Softshell	5						2	NR	5		NR			M	O	S	S								S				M	
Apalone mutica	Smooth Softshell	5		3	4	4	5	5	2		4						S	O														
Apalone spinifera	Spiny Softshell	5		5	NR	5	5	3	NR	5	5	NR	3				S	O														
Chelydra serpentina	Snapping Turtle	5		5	5	5	5	5	NR	5	5	NR	5	O	S	O	S	O	M	S										S	S
Chrysemys dorsalis	Southern Painted Turtle	5		2	3	5	5	NR			NR			S		O	S	S		M										S	S
Chrysemys picta	Painted Turtle	5		5				5		5	5	NR	5	S		O	S	S		M										S	S
Clemmys guttata	Spotted Turtle	5							3	3		5	3	O	O		M		M	O	S										
Deirochelys reticularia	Chicken Turtle	5			3	3	3	3	NR	5		NR	3	S	O						O	S	S								
Glyptemys muhlenbergii	Bog Turtle	3	T[2]							1	1	1	2				S			O											
Gopherus polyphemus	Gopher Tortoise	3	T[3]			1	2	3	3	3		1										O	S	O		M				M	
Graptemys barbouri	Barbour's Map Turtle	2						2	2	2								O													
Graptemys ernsti	Escambia Map Turtle	2						2	2									O													
Graptemys flavimaculata	Yellow-blotched Map Turtle	2	T				2											O													
Graptemys geographica	Common Map Turtle	5		4	4		NR	3		1	5					M		O													
Graptemys gibbonsi	Pascagoula Map Turtle	3				3	3											O													
Graptemys nigrinoda	Black-knobbed Map Turtle	3					2	2										O													
Graptemys oculifera	Ringed Map Turtle	2	T			2	2											O													
Graptemys ouachitensis	Ouachita Map Turtle	5		4	4	5	4	2			5					S		O													
Graptemys pseudogeographica	False Map Turtle	5		3	4	4	4				NR							O													

Mark Bailey

Gopher Tortoise

Scientific Name	Common Name	NATURESERVE GLOBAL RANK	FEDERAL (USFWS) STATUS	NatureServe State-level Rank and State Protection: KENTUCKY	ARKANSAS	LOUISIANA	MISSISSIPPI	ALABAMA	FLORIDA	GEORGIA	TENNESSEE	SOUTH CAROLINA	NORTH CAROLINA	FLOODPLAIN WETLANDS	SEASONAL WETLANDS	PERMANENT WETLANDS	SMALL STREAMS, SPRINGS, SEEPS	RIVERS, RESERVOIRS	BRACKISH WETLANDS	WET MEADOWS & BOGS	MESIC HARDWOOD FOREST	PINE FOREST	XERIC HARDWOOD & MIXED PINE	SANDHILL/SCRUB	HIGH ELEVATION SPRUCE/FIR	PRAIRIES, GLADES, BARRENS	ROCK OUTCROPS / TALUS	CAVES / KARST	BEACHES AND DUNES	MARITIME FORESTS	AGRICULTURAL	URBAN / RESIDENTIAL
Graptemys pulchra	Alabama Map Turtle	4					2	3		1								O													
Graptemys sabinensis	Sabine Map Turtle	4				3												O													
Kinosternon baurii	Striped Mud Turtle	5							NR	4		NR	3	O	S						O	S	S								
Kinosternon subrubrum	Eastern Mud Turtle	5		3	5	5	5	5	NR	5	5	NR	5	S	O	S	M		M	S	O	O	S						S	M	
Macrochelys temminckii	Alligator Snapping Turtle	3		2	4	3	3	3	3	3	2			O			S	O													
Malaclemys terrapin	Diamond-backed Terrapin	4				2	2	2	2	3		NR	3						O										O		
Pseudemys alabamensis	Alabama Red-bellied Cooter	1	E				1	1						O				O													
Pseudemys concinna	River Cooter	5		3	5	4	5	5	5	4	5	NR	4					O													
Pseudemys floridana	Florida Cooter	5				5	5	4	NR	5		NR	NR	O	S	O	S	M													
Pseudemys nelsoni	Florida Red-bellied Cooter	5							NR	2					S	O	S		M							O				M	
Pseudemys peninsularis	Peninsula Cooter	5							NR	NR				S		O		M													
Pseudemys rubriventris	Northern Red-bellied Cooter	5											3			O		M	M												
Pseudemys suwanniensis	Suwannee Cooter	3							3	1							O	S	M												
Sternotherus carinatus	Razor-backed Musk Turtle	5			3	5	5	1						S			S	O													
Sternotherus depressus	Flattened Musk Turtle	2	T					2									O	O													
Sternotherus minor	Loggerhead Musk Turtle	5				1	5	5	NR	5	5		1				O	O													
Sternotherus odoratus	Stinkpot	5		5	5	5	5	5	NR	5	5	NR	5	O	M	O	S	S													M
Terrapene carolina	Eastern Box Turtle	5		5	4	5	5	5	NR	5	4	NR	5	M	M		S			S	O	S	S	S		O			M	S	S	S
Trachemys scripta	Slider	5		5	5	5	5	5	NR	5	5	NR	5	S	O	O	S	S													S	S
Caretta caretta	Loggerhead Sea Turtle	3	T			1	1	1	3	3		3	3																O			
Chelonia mydas	Green Sea Turtle	3	E [4]			NA	NA	1	2	1		NA	1																O			
Dermochelys coriacea	Leatherback Sea Turtle	2	E			NA	NA	NA	2	1		NA	NA																O			
Eretmochelys imbricata	Hawksbill Sea Turtle	3	E			NA	NA	NA	1	NA		NA	NA																O			
Lepidochelys kempii	Kemp's Ridley Sea Turtle	1	E			NA	1	NA	1	NA		NA	NA																O			
REPTILES: Crocodilians																																
Alligator mississippiensis	American Alligator	5	T [5]		4	5	4	4	4	4		5	3	O	S	O	S	O	M							O				M	M
Crocodylus acutus	American Crocodile	2	E						1										O												
REPTILES: Lizards																																
Anolis carolinensis	Green Anole	5			5	5	5	5	NR	5	3	NR	5	O							O	S	S	M		S				S		S
Cnemidophorus sexlineatus	Six-lined Racerunner	5		3	5	5	5	5	NR	5	4	NR	5									S	M	O		S	S		O		S	M
Eumeces anthracinus	Coal Skink	5		2	5	4	3	3	3	2	1	1	3				S				O	S	M				S					
Eumeces egregius	Mole Skink [6]	4						4	5	3												S		O					O	S	M	
Eumeces fasciatus	Five-lined Skink	5		5	5	5	5	5	NR	5	5	NR	5	O							O	S	S								O		S
Eumeces inexpectatus	Southeastern Five-lined Skink	5		3		4	5	5	NR	5	5	NR	5	O							S	O	O	O							S		
Eumeces laticeps	Broad-headed Skink	5		4	5	5	5	5	NR	5	5	NR	5	O							O	S	S	M							S		S
Neoseps reynoldsi	Florida Sand Skink	2							2															O								
Ophisaurus attenuatus	Slender Glass Lizard	5		2	2	4	3	5	NR	3	3	4	3									S	S	S		S			S	S	S	M
Ophisaurus compressus	Island Glass Lizard	3							NR	2		1										S		O					O	S		

John Jensen

Southeastern Five-lined Skink

Scientific Name	Common Name	NATURESERVE GLOBAL RANK	FEDERAL (USFWS) STATUS	NatureServe State-level Rank and State Protection: KENTUCKY	ARKANSAS	LOUISIANA	MISSISSIPPI	ALABAMA	FLORIDA	GEORGIA	TENNESSEE	SOUTH CAROLINA	NORTH CAROLINA	FLOODPLAIN WETLANDS	SEASONAL WETLANDS	PERMANENT WETLANDS	SMALL STREAMS, SPRINGS, SEEPS	RIVERS, RESERVOIRS	BRACKISH WETLANDS	WET MEADOWS & BOGS	MESIC HARDWOOD FOREST	PINE FOREST	XERIC HARDWOOD & MIXED PINE	SANDHILL/SCRUB	HIGH ELEVATION SPRUCE/FIR	PRAIRIES, GLADES, BARRENS	ROCK OUTCROPS / TALUS	CAVES / KARST	BEACHES AND DUNES	MARITIME FORESTS	AGRICULTURAL	URBAN / RESIDENTIAL
Ophisaurus mimicus	**Mimic Glass Lizard**	3					2	2	NR	2		NR	2							O		O									
Ophisaurus ventralis	**Eastern Glass Lizard**	5				3	5	5	NR	5		NR	5							O		S	M				O			O	S	S	
Sceloporus undulatus	**Eastern Fence Lizard**	5		5	5	5	5	5	NR	5	5	NR	5								M	O	O	S		S	S			M		M
Sceloporus woodi	**Florida Scrub Lizard**	3							3															O					S		M	
Scincella lateralis	**Ground Skink**	5		5	5	5	5	5	NR	5	5	NR	5								O	O	O			S				S		S
Sphaerodactylus notatus	**Reef Gecko**	5							NR													S							S	S		S
REPTILES: Amphisbaenids																																	
Rhineura floridana	**Florida Worm Lizard**	4							NR	1												S		O		M					M	
REPTILES: Snakes																																	
Agkistrodon contortrix	**Copperhead**	5		5	NR	5	5	5	2	5	5	NR	5	S			S				O	S	S			S	O			S	S	M
Agkistrodon piscivorus	**Cottonmouth**	5		3	5	5	5	5	NR	5	5	NR	5	O	O	O	S	O		S						S						
Carphophis amoenus	**Eastern Worm Snake**	5		5	NR	5	5	5		5	5	NR	5	S							O	S	M									S
Carphophis vermis	**Western Worm Snake**	5			5	1								S							O											
Cemophora coccinea	**Scarlet Snake**	5		3	3	3	4	5	NR	4	5	NR	3								S	O	S	S								
Clonophis kirtlandii	**Kirtland's Snake**	2		2										S						O	S		S			O						M
Coluber constrictor	**Eastern Racer**	5		5	NR	5	5	5	NR	5	5	NR	5	S	S					S	M	O	O	O		O	S			S	S	S
Crotalus adamanteus	**Eastern Diamond-backed Rattlesnake**	4				1	3	3	3	4		3	1						M			O	O	S					S	S	S	
Crotalus atrox	**Western Diamond-backed Rattlesnake**	5			2																	O				S						
Crotalus horridus	**Timber Rattlesnake**	4		4	4	3	5	5	3	4	4	NR	3	O							S	S	S			S	O				M	
Diadophis punctatus	**Ring-necked Snake**	5		5	5	5	5	5	5	5	5	NR	5	S	S		S			S	O	M	M			S	S			S	S	S
Drymarchon couperi	**Eastern Indigo Snake**	3					1	1	3	3				O								S	S	O		S				S	M	M
Elaphe guttata	**Corn Snake**	5		3	3	5	5	4	5	5	5	NR	4	O							S	O	S	S						S	S	S
Elaphe obsoleta	**Eastern Rat Snake**	5		5	4	5	5	5	NR	5	5	NR	5	O							O	O	S			S	M	M		O	S	S
Farancia abacura	**Mud Snake**	5		3	5	5	5	5	NR	5	5	NR	4	O	O	O	S	M														
Farancia erytrogramma	**Rainbow Snake**	5				2	2	3	NR	3		NR	3	O	S	O	O	S														
Heterodon platirhinos	**Eastern Hog-nosed Snake**	5		5	5	5	5	5	NR	5	4	NR	4								M	O	S	S		S			S	S	S	M
Heterodon simus	**Southern Hog-nosed Snake**	2					X	H	2	2		NR	2									S	S	O		S						
Lampropeltis calligaster	**Prairie Kingsnake**	5		4	5	4	4	3	2	5	5	NR	4										S			O				S	M
Lampropeltis getula	**Common Kingsnake**	5		5	5	5	4	5	5	5	5	NR	5	O	S		S			S	M	S	S			S				S	M
Lampropeltis triangulum syspila	**Red Milk Snake**	5		3	4		3	2			NR												O			O	S			M	
Lampropeltis triangulum	**Scarlet Kingsnake**	5		3	NR	4	4	5	NR	5	NR	5	3									O	S	S								
Lampropeltis triangulum triangulum	**Eastern Milk Snake**	5		4				2		2	5	3	2								O		O		S	S	S			S		
Masticophis flagellum	**Coachwhip**	5		X	5	5	3	3	NR	5	2	NR	3				M					O	O	O		S			S	S	S	
Micrurus fulvius	**Eastern Coral Snake**	5			2	5	3	3	NR	3		2	1		S						S	O	O	S								
Nerodia clarkii	**Saltmarsh Snake**	4	T [7]			3	2	2	NR										O													
Nerodia cyclopion	**Western Green Water Snake**	5		1	3	5	5	2	1		2			O	S	O		S														
Nerodia erythrogaster	**Plain-bellied Water Snake**	5		5	5	5	5	5	NR	5	5	NR	5	O	S	S	S				S											
Nerodia fasciata	**Southern Water Snake**	5		1	5	5	4	4	5	5	4	NR	5	O	O	O	O	S		S												M

John Jensen

Scarlet Kingsnake

Scientific Name	Common Name	NATURESERVE GLOBAL RANK	FEDERAL (USFWS) STATUS	NatureServe State-level Rank and State Protection										FLOODPLAIN WETLANDS	SEASONAL WETLANDS	PERMANENT WETLANDS	SMALL STREAMS, SPRINGS, SEEPS	RIVERS, RESERVOIRS	BRACKISH WETLANDS	WET MEADOWS & BOGS	MESIC HARDWOOD FOREST	PINE FOREST	XERIC HARDWOOD & MIXED PINE	SANDHILL/SCRUB	HIGH ELEVATION SPRUCE/FIR	PRAIRIES, GLADES, BARRENS	ROCK OUTCROPS / TALUS	CAVES / KARST	BEACHES AND DUNES	MARITIME FORESTS	AGRICULTURAL	URBAN / RESIDENTIAL
				KENTUCKY	ARKANSAS	LOUISIANA	MISSISSIPPI	ALABAMA	FLORIDA	GEORGIA	TENNESSEE	SOUTH CAROLINA	NORTH CAROLINA																			
Nerodia floridana	**Eastern Green Water Snake**	5						2	NR	2		2		O	S	O			M							S						
Nerodia rhombifer	**Diamond-backed Water Snake**	5		5	5	5	5	3			5			O		S		O													
Nerodia sipedon	**Northern Water Snake**	5		5	5	4	5	5	NR	5	5	NR	5	S	S	O	S	S		S											S
Nerodia taxispilota	**Brown Water Snake**	5						3	NR	5		NR	4	O		S	S	O													
Opheodrys aestivus	**Rough Green Snake**	5		5	5	5	4	5	NR	5	5	NR	5	O	S	S				S	S	M	M						S		M
Pituophis melanoleucus	**Pine Snake**	4		2		1	3	4	NR	3	3	3	3									O		O		S				S	
Pituophis ruthveni	**Louisiana Pine Snake**	2				2																O		O							
Regina alleni	**Striped Crayfish Snake**	5							NR	2					S	O	M			S						O					
Regina grahamii	**Graham's Crayfish Snake**	5			2	4	5							S	S	O	O			S											
Regina rigida	**Glossy Crayfish Snake**	5			3	5	4	4	NR	4		NR	2	O	S	M															
Regina septemvittata	**Queen Snake**	5		4	2		3	5	NR	5	5	NR	4			M	O	S												M	M
Rhadinaea flavilata	**Pine Woods Snake**	4				1	3	2	NR	2		NR	3								S	O							S		
Seminatrix pygaea	**Black Swamp Snake**	5						2	NR	3		3	2	S	O	S															
Sistrurus miliarius	**Pygmy Rattlesnake**	5		2	4	4	5	5	NR	5	2	NR	3									O	O	S		S				M	
Sonora semiannulata	**Ground Snake**	5			H																					O					
Stilosoma extenuatum	**Short-tailed Snake**	3							3													S		O							
Storeria dekayi	**Brown Snake**	5		5	5	5	5	5	5	5	5	NR	5	S	S					S	O					S				M	S
Storeria occipitomaculata	**Red-bellied Snake**	5		4	4	5	5	5	NR	5	5	NR	5				S			S	S	S	S		S					M	S
Tantilla coronata	**Southeastern Crowned Snake**	5		3		3	4	5	NR	4	5	NR	3								S	O	S								
Tantilla gracilis	**Flat-headed Snake**	5			4	4															S	S	S			S					
Tantilla oolitica	**Rim Rock Crowned Snake**	1							1												S	S								S	
Tantilla relicta	**Florida Crowned Snake**	5							NR	1														S					S	S	
Thamnophis proximus	**Western Ribbon Snake**	5		1	5	5	5				4			S	S	S	S														
Thamnophis sauritus	**Eastern Ribbon Snake**	5		3		4	5	5	5	5	4	NR	4	S	S	S	S			O	S					S				M	
Thamnophis sirtalis	**Common Garter Snake**	5		5	5	5	5	5	NR	5	5	NR	5	S	S		S			O	S	S	M			S	S		S	S	S
Virginia striatula	**Rough Earth Snake**	5			4	5	5	5	NR	4	2	NR	5								S	S				S					S
Virginia valeriae	**Smooth Earth Snake**	5		4	4	4	5	5	NR	4	5	NR	3								O		S			S					M

[1] The Catahoula Salamander, known only from one Mississippi county, was last observed in 1964--may be extinct.
[2] The Green Sea Turtle is federally listed as endangered in Florida only in our region; threatened elsewhere in its U.S. range
[3] The Bog Turtle is federally listed as Threatened in the Southeast by similarity of appearance to threatened populations in the Northeastern U.S.
[4] The Green Sea Turtle is federally listed as Endangered in Florida only in our region; threatened elsewhere in its U.S. range
[5] The American Alligator is listed as federally Threatened by similarity of appearance to the American Crocodile.
[6] A Florida subspecies, the Bluetail Mole Skink (*Eumeces egregius lividus*), is federally listed as Threatened.
[7] A Florida subspecies of the Saltmarsh Snake (*Nerodia clarkia taeniata*) is federally listed as Threatened.

John Jensen

Mud Snake

APPENDIX B: CONSERVATION OPTIONS

Many opportunities are available to help you protect and improve natural resources on your property. Many include incentives such as annual rental payments, cost-share payments, tax relief, and technical assistance. Deciding which of them is right for you can be confusing. Some of the more popular options are presented here. For an excellent review of these programs from a landowner's perspective, refer to Landowner's Guide to Conservation Options by Shan Cammack and Eric Van De Genachte, downloadable from www.georgiawildlife.com. The following information is adapted from that publication and used with permission.

CONSERVATION RESERVE PROGRAM (CRP)

Website: www.nrcs.usda.gov/programs/crp

CRP protects erodible soils by removing them from agriculture. It also improves water quality adjacent to agricultural lands and can enhance wildlife habitats. CRP annual land rental payments are provided based on the dry land cash rental rate in your county. Cost-share payments are available for establishing conservation practices. Additional incentive payments (up to 20%) are available for high priority practices. Erodible soils are protected, meaning your soil stays on your property. Water quality is improved by reducing erosion. Wildlife habitats are enhanced. Landowners are compensated for the land taken out of production and are provided funds for conservation practices.

ENVIRONMENTAL QUALITY INCENTIVES PROGRAM (EQIP)

Website: www.nrcs.usda.gov/programs/eqip

EQIP identifies resource conservation priorities and addresses concerns such as soil erosion, water quality, wildlife habitat, and waste management. Cost-share payments of up to 75% are available for implementing certain conservation practices. For some practices, incentive payments are available on a per-acre basis over a term of 1 to 3 years. Funding and technical assistance are provided to establish various conservation practices.

PARTNERS FOR FISH AND WILDLIFE

Website: http://partners.fws.gov

Partners for Fish and Wildlife restores and enhances unique ecosystems such as wetlands and improves wildlife and fish habitats. Priorities include migratory birds, threatened and endangered species, floodplains, streams and riparian areas, and imperiled natural communities, like longleaf pine-wiregrass. Cost-share payments (up to 100%) are available for habitat restoration and direct benefits to federally protected species. Technical assistance is also offered. This is a good way to help fund conservation practices specific to your needs and those of the resource.

LANDOWNER INCENTIVE PROGRAM (LIP)

Website: each state's fish and wildlife agency website should have details.

The Landowner Incentive Program (LIP) is a Federal grant program, through the U.S. Fish and Wildlife Service, recently established within state fish and wildlife agencies. LIP is designed to protect and restore habitats on private lands to benefit federally listed, proposed or candidate species or other species determined to be at-risk, and provide technical and financial assistance to private landowners for habitat protection and restoration. Locations where opportunities exist to provide financial assistance to landowners will be identified based on the number of benefited target species, the quantity and quality of habitat managed and the longevity of the benefits. Partnerships will be established through other state and federal agencies and non-governmental organizations in order to promote and execute projects. The Service requires a minimum 25% non-federal match for LIP grants.

WETLAND RESERVE PROGRAM (WRP)

Website: www.nrcs.usda.gov/programs/wrp

WRP is a voluntary land-retirement program. The program is designed to improve water quality and enhance wildlife habitats by restoring wetlands that have been degraded due to agricultural practices. The program provides both technical and financial assistance. Payments are available based on the agricultural value of the land and the duration of the easement placed on the property.

WILDLIFE HABITAT INCENTIVES PROGRAM (WHIP)

Website: www.nrcs.usda.gov/programs/whip

WHIP is a land-management program. The primary focus is to create, enhance, and restore habitats for upland and wetland species, threatened and endangered species, fish, and other types of wildlife. Of particular concern are habitats for threatened species, bobwhite quail, neotropical songbirds, and amphibians, including plant communities such as early succession habitats, upland and bottomland hardwoods, longleaf pine communities, and habitats associated with isolated wetlands. Technical and cost-share assistance up to 75% for conservation practices is available.

CONSERVATION EASEMENT

A Conservation Easement is a legal agreement between a landowner and a qualified conservation organization (land trust, government agency, or other organization) which contains restrictions that you voluntarily place on your property. Easements are a flexible tool used to protect your property and to help you keep the land in your family. Since you help write the easement, you can choose which rights are restricted. Incentives include keeping the land in the family, maintaining traditional uses that are compatible with conservation, reduction in federal and state income and estate taxes, and potential property tax savings. Contact your state wildlife or forestry agency, or consult the Land Trust Alliance website (www.lta.org) for a list of land trusts in your area.

BEST MANAGEMENT PRACTICES (BMPS) FOR FORESTRY AND AGRICULTURE

Website: For links to each state's BMPs for forestry, visit www.usabmp.net. For forestry BMPs, contact your state forestry agency. For agricultural BMPs, contact the NRCS office in your county.

Best Management Practices promote voluntary compliance. If resource users implement BMPs successfully, there is less need for mandatory programs. BMPs provide guidance to protect basic soil and water resources while promoting healthy forests and/or sound agricultural practices.

FOREST STEWARDSHIP PROGRAM (FSP)

Website: www.fs.fed.us/spf/coop/programs/loa/fsp.shtml

FSP provides technical assistance, through state forestry agencies, to non-industrial private forest owners to encourage and enable active long-term forest management. Technical assistance is provided and landowners are furnished with a management plan. This program enables you to manage your land for multiple resource objectives, such as conservation, wildlife, timber, recreation, water quality enhancement, and aesthetics.

Mark Bailey

Southern Leopard Frog

APPENDIX C: REFERENCES

GENERAL HABITAT MANAGEMENT REFERENCES

References below provide a starting point for land managers who wish to learn more about the subject. This is a small sample of the abundant literature available.

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AMPHIBIAN AND REPTILE IDENTIFICATION RESOURCES

Titles below provide a sample of the available literature on identification and natural history of amphibians and reptiles.

REGIONAL

Conant, R. and J.T. Collins. 1998. A Field Guide to Amphibians and Reptiles: Eastern and Central North America. 3rd Ed. expanded. The Peterson Field Guide Series. Houghton Mifflin Co., Boston, MA. 634 pp.

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Arkansas

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Florida

Bartlett, R.D. and P.P. Bartlett. 1999. A Field Guide to Florida Reptiles and Amphibians. Gulf Publishing, Houston, TX. 278 pp.

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Kentucky

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STATE AGENCY WEBSITES

Consult these state wildlife and forestry agency websites for information on common and locally protected amphibians and reptiles, conservation plans, educational materials, regulations, forest management assistance, and more.

Alabama Dept. of Conservation and Natural Resources . . . . . www.dcnr.state.al.us
Alabama Forestry Commission . . . . . www.forestry.state.al.us
Arkansas Game and Fish Commission . . . . . www.agfc.state.ar.us
Arkansas Forestry Commission . . . . . www.forestry.state.ar.us
Florida Fish and Wildlife Conservation Commission . . . . . http://myfwc.com
Florida Division of Forestry . . . . . www.fl-dof.com
Georgia Department of Natural Resources . . . . . http://georgiawildlife.dnr.state.ga.us
Georgia Forestry Commission . . . . . www.gfc.state.ga.us
Kentucky Department of Fish and Wildlife . . . . . www.kdfwr.state.ky.us
Kentucky Division of Forestry . . . . . www.forestry.ky.gov
Louisiana Department of Wildlife and Fisheries . . . . . www.wlf.state.la.us
Louisiana Department of Agriculture and Forestry . . . . . www. ldaf.state.la.us
Mississippi Department of Wildlife, Fisheries, and Parks . . . . . www.mdwfp.com
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North Carolina Wildlife Resources Commission . . . . . www.ncwildlife.com
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