PARTNERS IN AMPHIBIAN AND REPTILE CONSERVATION

HABITAT MANAGEMENT GUIDELINES FOR AMPHIBIANS AND REPTILES OF THE NORTHWESTERN UNITED STATES AND WESTERN CANADA

Technical Publication HMG-4

PARTNERS IN AMPHIBIAN AND REPTILE CONSERVATION

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Front cover photo by David Herasimtschuk

Back cover photos by Alan St. John

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PURPOSE AND INTENDED USE OF THIS DOCUMENT

The goal of this book is to provide amphibian and reptile habitat management guidelines that are easily understood and practical for resource managers and private landowners to integrate with other management objectives on the landscape.

Many amphibian and reptile populations are vulnerable to the effects of habitat loss and degradation in the United States and Canada. A significant challenge is to ensure the persistence of amphibians and reptiles through thoughtful management of private and public lands and the resources they contain. When applied on the ground as general management principles, the guidelines provided in this document will promote conservation of amphibians and reptiles by

- Keeping common species common
- Stemming the decline of imperiled species
- Maintaining existing habitats
- Guiding restoration of degraded habitats

Landowners and resource managers will benefit from these guidelines because their implementation will provide ecological benefits beyond amphibian and reptile conservation. Even if only some of these guidelines are implemented, the cumulative effect will be positive.

The general information and specific management guidelines presented here (hereafter Guidelines) are based on the 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/provincial, 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 herpetologist before making significant land-use changes when implementing the suggested guidelines. The Guidelines, which are developed by Partners in Amphibian and Reptile Conservation (PARC), are not legally binding or regulatory, and they do not in any way attempt to limit landowner rights. They can be regarded simply as recommendations from the PARC community to landowners and managers who are considering the needs of amphibians and reptiles in the course of their land and resource management activities. References to specific sources of information used in each of the regional Guidelines can be found at ***www.parcplace.org***.

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Additional copies may be obtained through PARC. 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.

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Elke Wind

Newly metamorphosed Rough-skinned Newt.

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David Pilliod

Lost Trail National Wildlife Refuge, MT is located in Pleasant Valley in the west-central portion of Flathead County. It is home to six amphibian and seven reptile species. Although refuges such as this play an important role in safe-guarding habitat for local populations of amphibians and reptiles, the contributions of management actions taken on all lands will contribute to landscape-level protection.

PREFACE

This book 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, and it is non-regulatory. Rather, PARC provides recommendations and guidelines based on sound science, consensus among scientists, and common sense. A PARC objec-

Each Habitat Management Guide covers several ecoregional provinces (see page 14). Striped areas represent overlap between adjacent Guidelines.

tive is to increase communication and cooperation among many diverse groups that have a common interest in amphibians, reptiles, and their habitats. PARC is the foundation for the most comprehensive conservation effort ever undertaken for these two groups of wildlife. Through documents such as this, PARC will provide individuals, agencies, companies, and organizations ideas for how to conserve and manage amphibian and reptile habitats. At the core of PARC is the philosophy that we must all work together; there is no "us versus them," it is all "us." If you want to find out more about PARC, please visit the PARC web site at ***www.parcplace.org***.

This book is part of a five-volume series covering the contiguous United States and parts of Canada. Each volume covers a regional, geographic area and is largely based on ecoregions. The Northwest volume was written with the intent of eventually making it available to the public as modules via the PARC website. As such, some redundancy among sections was required to ensure that key points were captured for those that may not read the document in its entirety.

Development of the PARC Habitat Management Guidelines series began shortly following the organization of PARC in Atlanta, Georgia, June 1999. The initial PARC Habitat Management Steering Committee consisted of Kurt Buhlmann, Erin Clark, Robert Fisher, Whit Gibbons, Randy Gray, John Jensen, Bruce Kingsbury, Joe Mitchell, Earl Possardt, Klaus Richter, and Monica Schwalbach. 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 Midwest, Southeast, Northeast, Southwest, and Northwest. Kurt Buhlmann, Whit Gibbons, and Joe Mitchell drafted a model document. The Steering Committee, chaired by Monica Schwalbach, organized a workshop in Chicago that was held in 2001. At this meeting, 85 individuals representing the five regions worked for 3 days on drafts of the documents for each region. Subsequently, the first edition of the Midwest Habitat Management Guidelines was published in 2002 by Bruce Kingsbury and Joanna Gibson. The Southeast and Northeast Guidelines were published in 2006.

This publication is the product of extensive efforts made by many people and contains the contributions of individuals from academic, private, government, and industry backgrounds. Lead technical coordinators and editors for this book were David Pilliod, a research ecologist at the U.S. Geological Survey Forest and Rangeland Ecosystem Science Center and Elke Wind, a contract biologist in Nanaimo, British Columbia (E. Wind Consulting). Some of the introductory sections of this document were extracted or developed from previous Guidelines with the express permission of the lead authors.

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

Kurt Buhlmann

The authors/editors, from left to right: Elke Wind and David Pilliod.

Todd Leifer

The breeding call of the Great Plains Toad is a loud, jackhammer-like trill. This call, used to attract females, can be used by landowners and resource managers to identify occupied areas in desert shrublands and grasslands areas.

Bill Leonard

Three species of Giant Salamander breed in streams and small rivers in the Northwest. The Coastal Giant Salamander, the largest of the three species, can reach up to 13 inches (330 mm) total length. Healthy ecosystems depend on species such as these that play an important role as both predators and prey in aquatic and terrestrial habitats.

Elke Wind

Bill Leonard

Many amphibians, like the Pacific Treefrog (upper image), have feet adapted for climbing in vegetation. Some, like the Wandering Salamander (lower image), have been found in tree canopies.

Charles Peterson

INTRODUCTION

The goal of this book is to use the best science available to produce amphibian and reptile habitat management and conservation guidelines that are easily understood and practical for resource managers and private landowners to integrate with other management objectives on the landscape. The guidelines included in this document have been derived from an extensive body of published information on amphibians and reptiles of the northwestern United States and western Canada (hereafter Northwest), as well as extensive experience of biologists and scientists. We have not described the needs of every species of amphibian and reptile in this document. Instead, we provide guidelines for land-use practices and activities in terrestrial and aquatic habitat types in ways that have general benefits for the associated amphibians and reptiles.

Recently, scientists and resource managers have placed a greater emphasis on the conservation and management of ecosystems and broad landscapes to benefit multiple species. Ecosystem management offers a more holistic perspective by focusing on integrated natural systems at some landscape scale (for example, the Greater Yellowstone Ecosystem). Effective management of amphibians and reptiles spans the spectrum from single-species to ecosystem-based management practices.

Charlotte Corkran

Virgil Hawkes

People, especially children, are fascinated by amphibians and reptiles. The development and promotion of educational programs that focus on these fascinating creatures will gain support for habitat management taken now and in the future.

HOW TO USE THESE GUIDELINES

Landowners and resource managers have multiple goals and objectives for managing their lands. Partners in Amphibian and Reptile Conservation (PARC) also recognizes that, depending on land management objectives, not all of the recommendations in these Guidelines will be feasible. Nevertheless, knowledge of these management considerations will foster an appreciation and understanding of amphibians and reptiles and their needs. If a majority of landowners and resource managers implement some of these recommendations, then the net benefit to amphibians and reptiles across the greater Northwest will be significant and positive. The majority of the guidelines, although common sense, have not been "tested" with long-term experimental studies and are best incorporated in an adaptive management process with well designed monitoring.

Charles Peterson

As wildlands are developed, the persistence of amphibians and reptiles in these areas may depend on naturalized landscaping of yards and protection of green spaces within rural and urban areas.

The Guidelines are organized into two sections. The first section describes the major conservation challenges facing amphibians and reptiles and provides brief suggestions for "what landowners and resource managers can do" on their lands to reduce or mitigate these threats. The second section covers general habitats where amphibians and reptiles can be found in the Northwest and provides guidelines for maintaining or improving habitats for these animals. Each of the habitat sections contains two sets of guidelines: (1) Maximizing Compatibility and (2) Ideal.

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

"Ideal" guidelines are for landowners and land or resource managers who want to make amphibian and reptile conservation a primary objective, such as on nature preserves, wildlife refuges, and private or agency lands where optimizing the diversity and abundance of herpetofauna is desired.

Using the information in this handbook, you will be able to do the following:

1. Identify the habitat on which to focus.

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

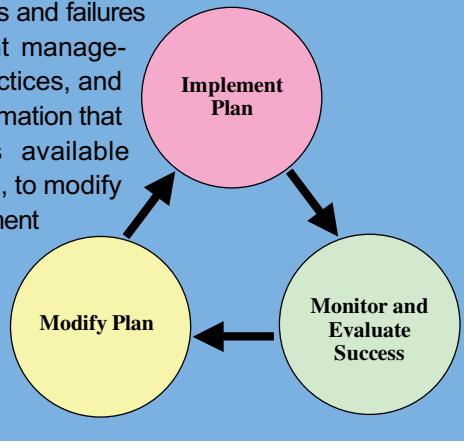
3. Establish management goals for that habitat:

    - Review the recommended guidelines for that habitat and select those that are possible to implement given land use and other issues.

    - If possible, work with local and regional experts to implement the guidelines.

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 (for example, "I'm seeing more Columbia Spotted Frogs than I used to") to implementing scientifically-based monitoring projects. An adaptive management approach may be necessary as you learn more about the amphibian and reptile species on your land, their habitat-use patterns, and their response to management goals.

Adaptive management is a flexible approach to management that uses feedback on successes and failures of current management practices, and new information that becomes available over time, to modify management plans.



DEVELOPING A MANAGEMENT PLAN

An important first step in managing habitats for amphibians and reptiles, no matter what the designated land use, is the development of a management plan. For a private landowner, a simple management plan may include a list of habitats, a list of species that may occur in those habitats, a list of land-use activities associated with each habitat, a brief description of which land-use activities are compatible or incompatible with amphibian and reptile habitat requirements, and perhaps most importantly, a description and schedule of specific actions that will be implemented to address those activities that may be less suitable for conserving amphibians and reptiles. Public land managers or large landowners may wish to develop a more comprehensive management plan (see Appendix A).

Elke Wind

Regardless of the level to which a management plan is developed, habitat management benefits from having a clear understanding of 'what you have' in terms of both species and habitats.

Aerial photographs and maps are important tools in the development of management plans to help land managers visualize areas that may provide good habitat and places in landscapes that may limit the survival of amphibian and reptile populations.

Jason Jones

Individuals that have experience working with amphibians and reptiles, such as naturalists or biologists, can help you identify what species occur in the area.

AMPHIBIANS AND REPTILES OF THE NORTHWEST

The various habitat types that exist across the Northwest are used by an equally diverse assemblage of amphibian and reptile species. Ninety-four amphibian and reptile species occur in the region encompassed by British Columbia, western Alberta, Yukon, Alaska, Washington, Oregon, Idaho, Montana, northern Utah, Wyoming, northern Nevada, and northern California.

A complete species list with status, states and provinces of occurrence, and habitat associations is provided in Appendix B. The common and scientific names used throughout the document follow that of Crothers et al. 2001. Note that the range of most amphibian and reptile species in this region spans several states with some ranges extending outside the Northwest region.

The diversity of climate, topography, and elevation in the Northwest has resulted in a variety of local conditions. In general, coastal areas are moister and have more stable temperatures throughout the year compared with inland regions. Inland from the ocean, the high mountain ranges of the Coast Mountains, Cascades and Rockies

cause water vapor to condense and precipitate as rain or snow on the west sides of these ranges, resulting in drier conditions to the east. Habitat changes also occur over short distances in the Northwest due to local topography. North-facing slopes, for example, are generally cooler and moister than south-facing slopes. This local variation is reflected in the plant species composition, which can change dramatically with slope and aspect, particularly in arid environments.

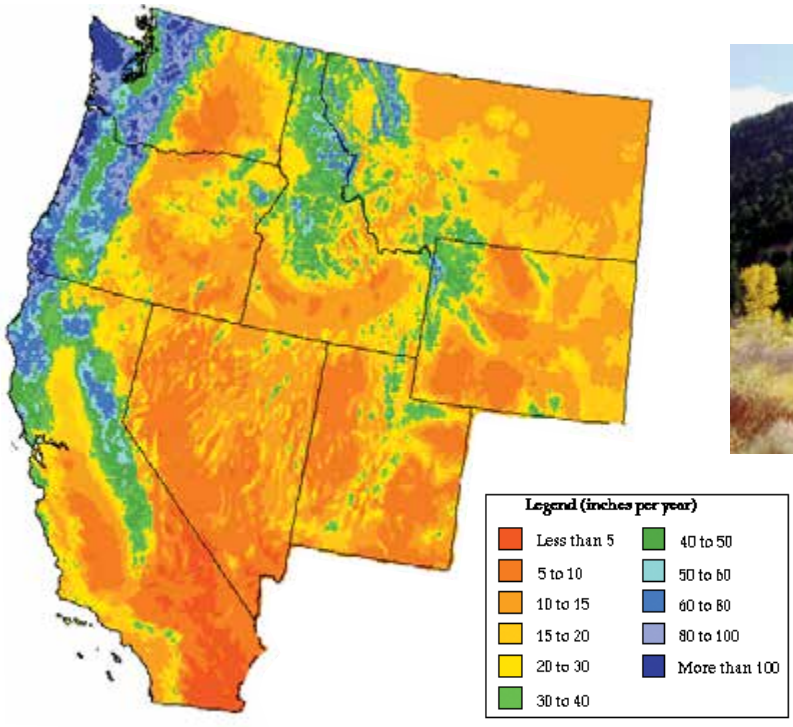
Amphibians and Reptiles Found in the Northwest	Number of Species	
	Native	Non-native
Frogs and Toads	18	2
Salamanders	27	0
Turtles	5	1
Lizards	18	1
Snakes	22	0
Total	**90**	**4**

As a result of habitat and environmental variability, the Northwest has many species that do not occur anywhere else in the world. These endemic species are adapted to local conditions and have limited ability to disperse through environments that do not have these conditions. Consequently, endemic species arise as populations of a species become isolated from other populations, and through time, adaptations to local environments accumulate.

Alan St. John

Javan Bauder

The Rubber Boa and Long-toed Salamander are representative species of this guide, in that the majority of their range occurs within the Northwest. Due to their secretive nature, many people are unaware that amphibians and reptiles occur in all habitats of the Northwest, except perhaps some of the harshest alpine environments such as glaciers.



David Pilliod

The Northwest has a wide variety of habitats that change over relatively small areas, resulting in dramatic shifts in climatic conditions such as temperature and moisture that affect the distribution of amphibians and reptiles. Map provided by Oregon Climate Service (OCS) and National Resource Conservation Service (MRCS) *www.wrcc.dir.edu/precip.html*

NATURAL HISTORY OF AMPHIBIANS AND REPTILES

An understanding of the natural history of amphibians and reptiles is essential to effective management of their habitats and populations. There are five main factors to keep in mind:

1. Amphibians and reptiles are ectothermic ("cold blooded") vertebrates that may lie dormant during periods of cold and drought.

2. Amphibians and reptiles are often hidden and mostly solitary, but may be conspicuous and occur in large numbers under certain conditions.

3. Amphibians and reptiles use a variety of aquatic and terrestrial habitats during their lifetime, and some may move over several miles to reach them.

4. Some species of amphibians may have widely fluctuating populations, usually in response to changes in climatic conditions.

5. Amphibians and reptiles play important roles as predators and prey in functioning ecosystems.

Sources of information on the natural history of individual species can be found at the end of this guide in Appendix C.

Elke Wind

Charlotte Corkran

Turtles are conspicuous when basking in the sun to increase their body temperature. Amphibians and reptiles maintain their preferred body temperature by behavioral thermoregulation. When not basking, turtles may rarely be seen.

Elke Wind

These Western Toad tadpoles increase their body temperature by forming dense schools. This behavior can also reduce predation risk by overwhelming and confusing predators of frogs and toads. After the tadpoles metamorphose into toads, they leave the pond, and move into adjacent terrestrial habitats where they are rarely encountered.

Herpetology is the branch of science that deals with amphibians and reptiles, which are often called “herpetofauna” or “herps”, collectively. The etymology of the term herpetology is "study of reptiles," from French herpétologie, coined from Greek herpeton "reptile," literally "creeping thing," from herpein "to creep" + logia "speaking in a certain manner, study of."

Ectotherms

Amphibians and reptiles are vertebrates like birds and mammals, but they are different in an important way. Amphibians and reptiles are ectothermic, or what is commonly referred to as “cold-blooded”, whereas birds and mammals are endothermic (“warm-blooded”). This means that birds and mammals need to eat regularly to fuel the biochemical mechanisms producing body heat, whereas amphibians and reptiles derive their body heat from external sources in their environment. Ectothermy allows herpetofauna to feed less often and to be inactive for extended periods. Rubber Boas and some other snakes are able to survive on perhaps only one meal per year if prey is unavailable or environmental conditions are unfavorable. Terrestrial lungless salamanders spend most of their time underground and may come to the surface to feed on only a few warm, wet nights during their active season.

The use of the term **“cold-blooded”** to describe amphibians, reptiles, fishes, and other ectothermic animals is misleading as some “cold-blooded” animals have body temperatures higher than “warm-blooded” or endothermic animals in the same environment. **Ectothermic animals** are generally incapable of warming themselves through internal mechanisms but can regulate their body temperature by moving to locations that are warmer or cooler than the ambient air temperature. Many of the hourly, daily, and seasonal movements and habitats occupied by amphibians and reptiles can be explained by their need to regulate their body temperature. This may explain, for example, why snakes show up in unexpected places like pumphouses and log piles. In general, amphibians prefer cooler temperatures than reptiles.

Amphibians and reptiles are usually inactive during cold periods. Amphibian activity is further limited by available moisture. Many amphibians remain underground, under cover objects, or in leaf litter until warm, rainy nights. This pattern often takes landowners by surprise when frogs and toads begin loud chorusing from seasonally inundated wetlands.

Alan St. John

Spadefoots may stay buried in the ground for several years until heavy rains bring hundreds to thousands of them to the surface to feed and reproduce among eerie, screaming choruses produced by the males. Their survival during periods of inactivity depends on the subsurface soil conditions providing a safe refuge.

Reproduction

Like many other animals, the most vulnerable life stages of amphibians and reptiles are the egg, larval (amphibian only), and juvenile stages. Amphibian eggs are surrounded by a viscous jelly layer, but by being deposited directly in water or on moist substrates (soil, rotting wood), they are sensitive to desiccation (i.e., if water levels drop or moist substrates dry out), freezing, predation, aquatic mold or fungal infections, and environmental contaminants (e.g., pollution, pesticides). Reptiles lay shelled, amniotic eggs in moist, warm substrates (sand, soil) and are sensitive to drying conditions, predators, and soil disturbance. Some Northwest reptiles, like Rattlesnakes, Gartersnakes, Rubber Boas, and Pygmy Short-horned Lizards, give birth to live young. Many amphibians and reptiles take years to reach sexual maturity and have relatively long life spans (up to 12 years for some frogs and toads, up to 30 years for snakes, and even more for turtles). When managing lands for long-lived, late-maturing species, it is important to maintain habitats for larval and juvenile life stages as well as adults.

Migration and Dispersal

Most amphibians and reptiles do not travel long distances, but all species move to some extent and some

David Pilliod

Amphibian eggs are vulnerable to physical disturbances in their aquatic breeding sites such as trampling by cattle, water fluctuations, changes in flow rates, and runoff containing sediment or chemical contaminants.

Charlotte Corkran

Reptile eggs are laid in terrestrial locations, but will only develop if temperature and moisture levels are suitable. Some reptiles, like Western and Prairie Rattlesnakes, give birth to live young. These turtle eggs were rescued from an underground nest during an excavation project.

will travel 5 miles (8 km) or more. Individuals will move among populations, among suitable habitats, or colonize new habitats. Some species require different habitats seasonally or annually, depending on their sex and life stage (juvenile versus adult). Although many amphibians have relatively thin skin, which makes them vulnerable to desiccation and environmental contaminants, many are still capable of traveling across relatively dry terrestrial environments. Migration and dispersal of salamanders, frogs, and toads are often initiated by warm, moist conditions, such as rainy nights or periods of high humidity. Because scales serve as a protective barrier to pollutants and moisture loss, reptiles are capable of traveling during dry conditions. For the latter group, temperature is a more limiting factor in daily and seasonal movements.

David Pilliod

Some human activities in rural and urban areas have allowed amphibians and reptiles to persist. Pacific Treefrogs are often found near homes in cities where garden and yard maintenance have provided water in naturally dry environments.

Population Fluctuations

Like many wildlife species, amphibian and reptile populations have been observed to vary widely in response to annual variation in weather. Therefore, observing a low number of animals 1 year may not necessarily be the result of habitat management practices. Populations of amphibians and reptiles are likely more stable and persistent than associated birds or mammals. A bird species may breed in a given area 1 year, but be gone in another. Conversely, Spadefoot Toads may be observed breeding in one year, but not another – but the species is still there! They are likely buried in refugia, awaiting the right conditions. This can make it difficult to determine whether management practices are effective. One way to resolve this uncertainty is to compare population trends with those of populations from neighboring properties, unmanaged areas, or undisturbed areas.

Predator and Prey

Amphibians and reptiles play important ecological roles as both predators and prey in terrestrial and aquatic food webs. For example, snakes are prey for many hawks and important predators of small mammal populations. Amphibians and some reptiles like Gartersnakes also serve as ecological links between aquatic and terrestrial ecosystems. Several frog and toad species deposit hundreds to tens of thousands of eggs

per female in water bodies. Developing tadpoles feed on algae, bacteria, and fungi in ponds and wetlands, and in turn are an abundant source of food for aquatic predators. After metamorphosis, juvenile amphibians transport aquatic resources (i.e., the food energy they consumed) into terrestrial habitats.

Habitat Use and Availability

Amphibians and some reptiles frequently require both aquatic and terrestrial habitats over the course of a year. All Northwest amphibians, except the lungless salamanders, breed in water bodies but spend most of the year in riparian or terrestrial environments. Some individuals of Ambystomatid salamander species (e.g., Giant, Long-toed, Northwestern, and Tiger Salamanders) retain larval characteristics (external gills, larval body form) yet reach sexual maturity in a process called paedomorphosis or neoteny. These individuals are strictly aquatic and may coexist with individuals that metamorphose. Most amphibians use upland forests, shrublands, and grasslands for foraging, overwintering, or dispersal. Many reptiles are adapted to be less dependent on water bodies, but Pacific Pond Turtles and Painted Turtles live in ponds and wetlands and lay their eggs on land, often spending winter months buried and inactive in soft mud (Painted Turtles and Spiny Softshell Turtles) or in surrounding terrestrial habitats (Pacific Pond Turtles).

Virgil Hawkes

Bill Leonard

Bill Leonard

Bill Leonard

Bill Leonard

WHAT ARE LUNGLESS SALAMANDERS?
As their name implies, lungless salamanders are a group of amphibians that do not have lungs. They breathe through their skin and are generally restricted to moist environments such as the litter and duff layer of moist forest floors, spray zones of waterfalls, and seeps. Others live underground during the dry season and only come to the surface during the rainy season (winter in coastal areas). Members of this group also undergo direct development and thus do not have an aquatic larval stage that the rest of North American amphibians require. This interesting family of salamanders includes Climbing Salamanders, Slender Salamanders, Ensatina, Web-toed Salamanders, and Woodland Salamanders.

Habitat quality for herpetofauna can be negatively affected by degraded air and water quality, soil erosion and disturbed soil structure, loss of suitable cover, altered hydroperiods or water levels, changed microclimate (i.e., altered soil temperature and moisture regimes), physical disturbance (i.e. from vehicles or trampling by livestock or recreationists), or the introduction of invasive and non-native species. More than one of these factors may degrade habitat quality for amphibians and reptiles, and it is often difficult to identify which factor is causing the greatest problem. Chronic habitat degradation usually results in unsuitable conditions or habitat loss.

When once continuous habitats become subdivided into small patches due to human activities or other factors, the habitat is considered fragmented. Thus, habitat fragmentation can result in small, vulnerable populations surviving in isolated patches of favorable habitat. Concerns regarding habitat fragmentation include patch size and degree of isolation. The smaller and more elongated a patch of remaining favorable habitat, the more edge versus interior habitat. This reduces the amount of high quality habitat for some species because edges have altered microclimates and higher predator abundance, especially introduced predators. Highly fragmented landscapes may contain a high proportion of roads and other high-risk areas that result in high mortality when amphibians and reptiles attempt to move between isolated habitat patches.

Species survival is dependent upon connectivity among populations and between habitats. Movement between populations ensures long-term survival of a species in an area. Most species use or require different habitats on a daily, seasonal, and annual basis to meet all their life-history needs. Free movement between these different habitat areas is critical for survival. These habitats are often called essential or complementary. For example, Gartersnakes may move between foraging areas along wetlands and through grasslands, shrublands, and forests to overwinter in rock outcrops or talus slopes. Tiger Salamanders often live in rodent burrows during much of the year and migrate to shallow ponds in the spring to breed.

Habitat Availability: Amphibians and reptiles need habitats that contain suitable breeding or nesting sites, offer food and water, and provide shelter from inhospitable environmental conditions and predators. To meet all of these life-history requirements, more than one habitat type may be needed, causing animals to migrate seasonally between different areas to feed, overwinter, and/or reproduce. However, amphibians and reptiles are not as mobile as most mammal or bird species. Therefore, additional lands that provide suitable travel corridors for amphibians and reptiles may also be required.

David Pilliod

The Ring-necked Snake occurs in a variety of habitats in the Northwest but is largely confined to riparian areas and higher elevation forests in arid areas east of the Cascades. This relatively small, colorful snake hides its head and coils its tail when threatened to intimidate potential predators. Land managers who gain a better understanding of local species will be taking an important first step in habitat management for amphibians and reptiles.

Habitat Quality: Not all habitats are of equal quality to an amphibian or reptile. High quality habitats will usually be identifiable by the number of young produced or by higher survival rates. Populations occurring in these habitats produce more individuals than are lost to mortality (oftentimes called source populations), and thus it is particularly important to identify and appropriately manage high quality habitats that support these healthy populations. Keep in mind, however, that high numbers of individuals of many species may only be observed during certain periods of the year, such as during breeding, and some species may occur in low numbers even in high quality habitat. A high diversity of native species and/or the occurrence of rare species, are also good indices of high quality habitat.

Landscape level is the geographic extent of the management area in question and includes all of the habitats within that area. A "landscape" is a geographic area that falls somewhere between the range of a species and an individual animal's home range. Hence, for amphibians and reptiles a landscape can be defined as an entire watershed, the land within a political boundary, or even a single property under management. Landscapes are generally mosaics of suitable habitat patches and less suitable areas and are collectively called the "habitat matrix."

Managing for Conservation Buffers

On managed lands where native vegetation has been removed or altered (e.g., urban development, agriculture), retained vegetation zones are often referred to as conservation buffers because they provide a protective zone or barrier between a disturbance or unsuitable environment and a habitat or habitat feature of concern. For example, vegetation around an amphibian breeding pond could be used to buffer it from contaminants, siltation, or microclimate changes. In addition to aquatic habitats, upland terrestrial environments and habitat features also require buffers. For example, the terrestrial forest around a wetland used by juvenile and adult Tiger Salamanders is as important to the population as the wetland itself. In this case, the terrestrial habitat may require buffering from adjacent land use impacts as well. Lastly, buffers around specific features used by amphibians and reptiles, such as rock outcrops and overwintering dens, can help reduce effects of surrounding land-use. These are important distinctions when considering the function of a conservation buffer.

Think connectivity. Many amphibian and reptile species may need to move among different habitats at different times of the year in order to survive and reproduce. Habitats that amphibians and reptiles move through when migrating from one area to another greatly affect survival. Corridors of suitable habitat that interconnect habitat patches will enhance survival during migration and increase exchange of individuals among populations. For example, amphibians often use riparian corridors as migration routes, taking advantage of the higher moisture levels and cover from predators. Providing cover objects, vegetation, and culverts in intervening areas may enhance movement between patches when true corridors are unavailable.

Species and populations are affected by habitat change at different spatial scales depending on their habitat requirements, home range size, the degree to which they use or return to the same place for breeding, and their ability to move to new areas. Isolation and fragmentation adversely impact a species that has a large home range and requires unique habitats that are dispersed across a landscape. Species that have very small home ranges and limited movement may not be as affected by habitat fragmentation.

Depending on the objectives and situation, buffers may include some within-buffer management or be considered no-management zones. Around water bodies, buffers are often used as a management tool to meet a number of possible objectives:

1. *Maintain water quality*—riparian vegetation appropriate for the site (i.e., native species) often helps reduce bank erosion and thus siltation of stream substrates; some types of vegetation also effectively remove harmful chemicals from the soil.

Elke Wind

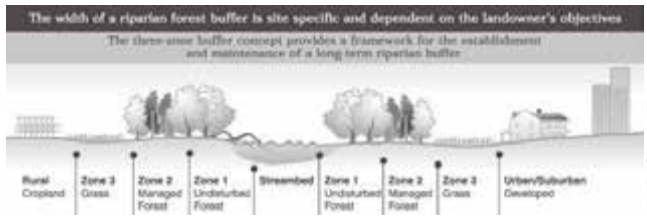
Some frog species are less willing to cross dirt roads or even some powerline right-of-ways, probably because they are drier and more exposed to predators. However, aquatic turtles will take the shortest, straightest, most direct route between two bodies of water, regardless of the intervening habitat. They may die from exposure while trying to cross a large, debris-strewn clearcut. The habitat management challenge is to provide them with a passable corridor and correctly predict where the corridor is needed.

2. *Maintain thermal regimes*—mature trees and shrubs in riparian areas shade water bodies and maintain stable water temperatures; they also help maintain cool and stable soil and air temperatures in the adjacent upland habitats used by many amphibian and reptile species.
3. *Maintain moisture regimes*—water bodies and their adjacent shoreline vegetation contribute to higher humidity levels in riparian areas compared to uplands; many amphibians are dependent on this soil moisture.
4. *Provide organic input*—shoreline habitats provide an important input of nutrients and other resources into water bodies (e.g., leaf fall, invertebrates, which are prey for fish and amphibians).
5. *Provide habitat*—because of their combination of aquatic and terrestrial habitat features, riparian areas have relatively high biodiversity compared to upland habitats.

Depending on the water body characteristics (e.g., type, size, presence of fish) and the surrounding land use (e.g., forestry, mining, highway or housing development), **there are different approaches for managing riparian areas and providing conservation buffers.** These may include:

- ***no-entry buffer***—no entry by machinery is permitted into the buffer zone
- ***management zone***—some development or resource management is permitted within the management zone (e.g., a recreational trail may be put in, but not a road)
- ***combination of a no-entry buffer and a management zone***—for example, no entry by machinery is permitted within 30 feet (9 m) of a wetland, but some development or resource management is permitted within the management zone (e.g., 10% basal area removal of trees)
- ***no buffer***—development or resource management is permitted to the boundary of the water body

Integrating a landscape-level perspective into management plans is helpful because most animals move among habitats. Many amphibians and reptiles 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.



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ECOREGIONAL CONTEXT OF THE NORTHWEST

The geographic area defined as the Northwest in this document includes British Columbia, western Alberta, Yukon, Alaska, Washington, Oregon, Idaho, Montana, northern Utah, Wyoming, northern Nevada, and northern California. Based on climate and vegetation, The Nature Conservancy (TNC) identifies all or portions of 29 "ecoregions" within this area. The purpose of this section is to link Northwest habitat types to these ecoregions so that landowners and managers can place the particular habitats they oversee in a geographical and ecological context (for more information on ecoregions see ***www.nationalgeographic.com/wildworld/profiles/terrestrial_na.html*** or vegetation characteristics of an ecoregion visit: ***www.nps.gov/plants/sos/species/index.htm)***.

HABITATS IMPORTANT TO AMPHIBIANS AND REPTILES IN THE NORTHWEST

The northwestern United States and western Canada are often thought to be dominated by large expanses of moist coniferous forests along the coast, dry coniferous forests throughout the Rocky Mountains, grasslands in the Northern Great Plains Steppe, and desert shrublands in the Columbia Plateau and Wyoming Basins. While this is partly true, there are at least 21 general habitat types or habitat features that we have identified within the 29 ecoregions of the Northwest Region that are important for amphibians and reptiles. The following is a list of the most common habitat types or features in the Northwest for which these Guidelines have been developed.


David Pilliod

Providing livestock-specific access points to streams, rivers, and ponds can increase bank stability, reduce erosion and sedimentation, and allow riparian vegetation to provide shade and habitat structure for wildlife. See *www.kansasforests.org/pubs/riparian/Fencing.pdf* for more information.

Terrestrial Habitat Types or Features Include

- Moist Coniferous Forest
- Dry Coniferous Forest
- Mixed Coniferous and Deciduous Forest
- Moist and Dry Deciduous Forest
- Alpine and Subalpine
- Northern Boreal Forest
- Juniper and Pinyon-Juniper Woodlands
- Sagebrush Steppe/Desert Shrublands
- Grasslands
- Arctic and Coastal Tundra
- Rock Outcrops, Talus, Cliffs, and Caves
- Beaches and Dunes
- Riparian Areas
- Conventional Production Agricultural Lands
- Urban and Suburban Areas

Aquatic Habitat Types or Features Include

- Reservoirs
- Rivers and Large Streams
- Small Streams
- Springs and Seeps
- Semi-permanent and Seasonal Wetlands
- Permanent Wetlands, Ponds, and Lakes

In a park in Whistler, British Columbia, a temporary ramp was constructed that allowed toadlets to disperse safely underneath a heavily used hiking trail.

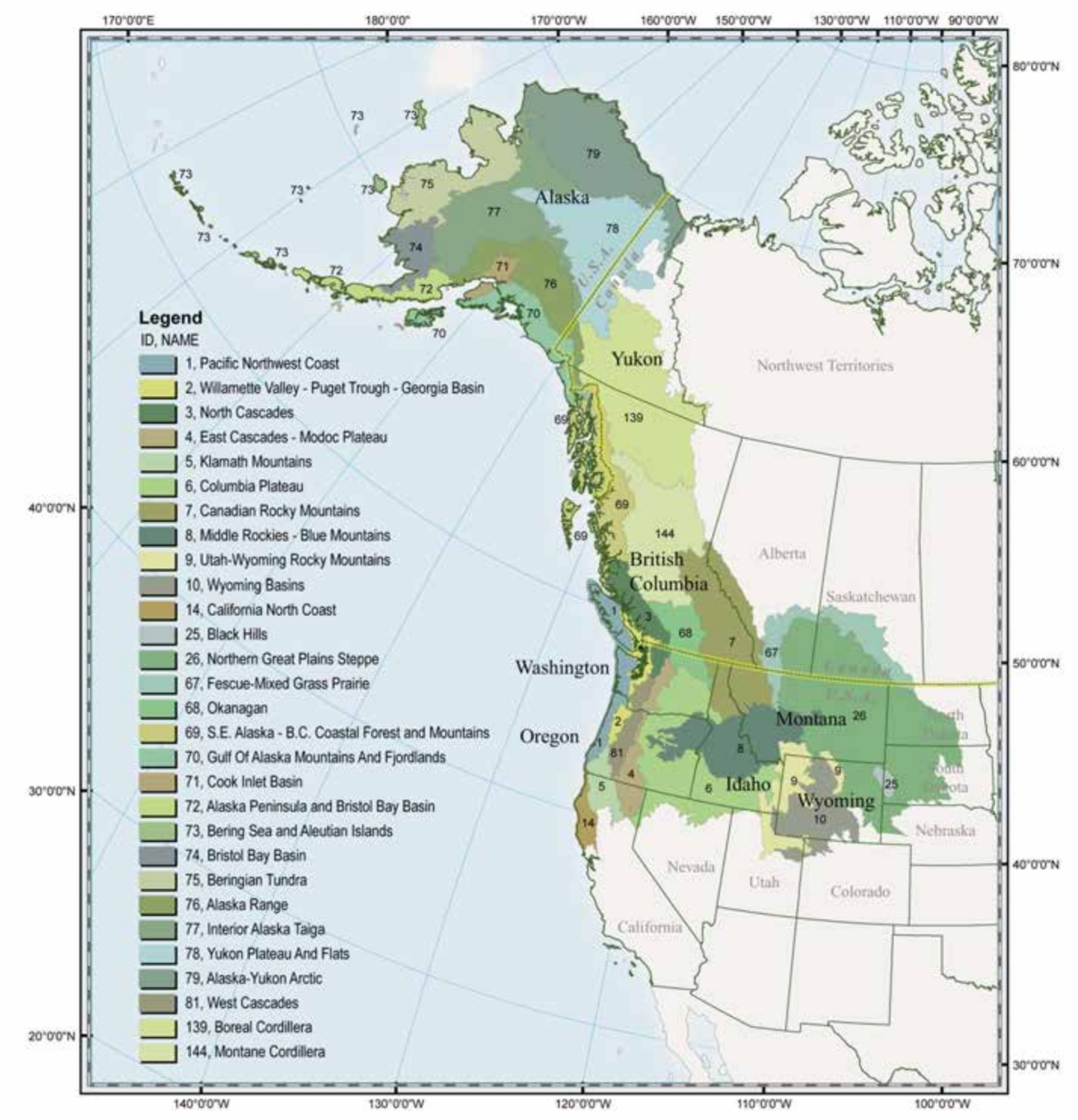
NASA

Night view from space showing areas of higher illumination, such as cities. Habitat conversion is the greatest threat to the persistence of local amphibian and reptile populations. Resource managers are faced with the challenge of striking a balance between habitat and species protection and the needs of an expanding human population. Identifying and using a variety of land and resource management 'tools' will help facilitate this balance.

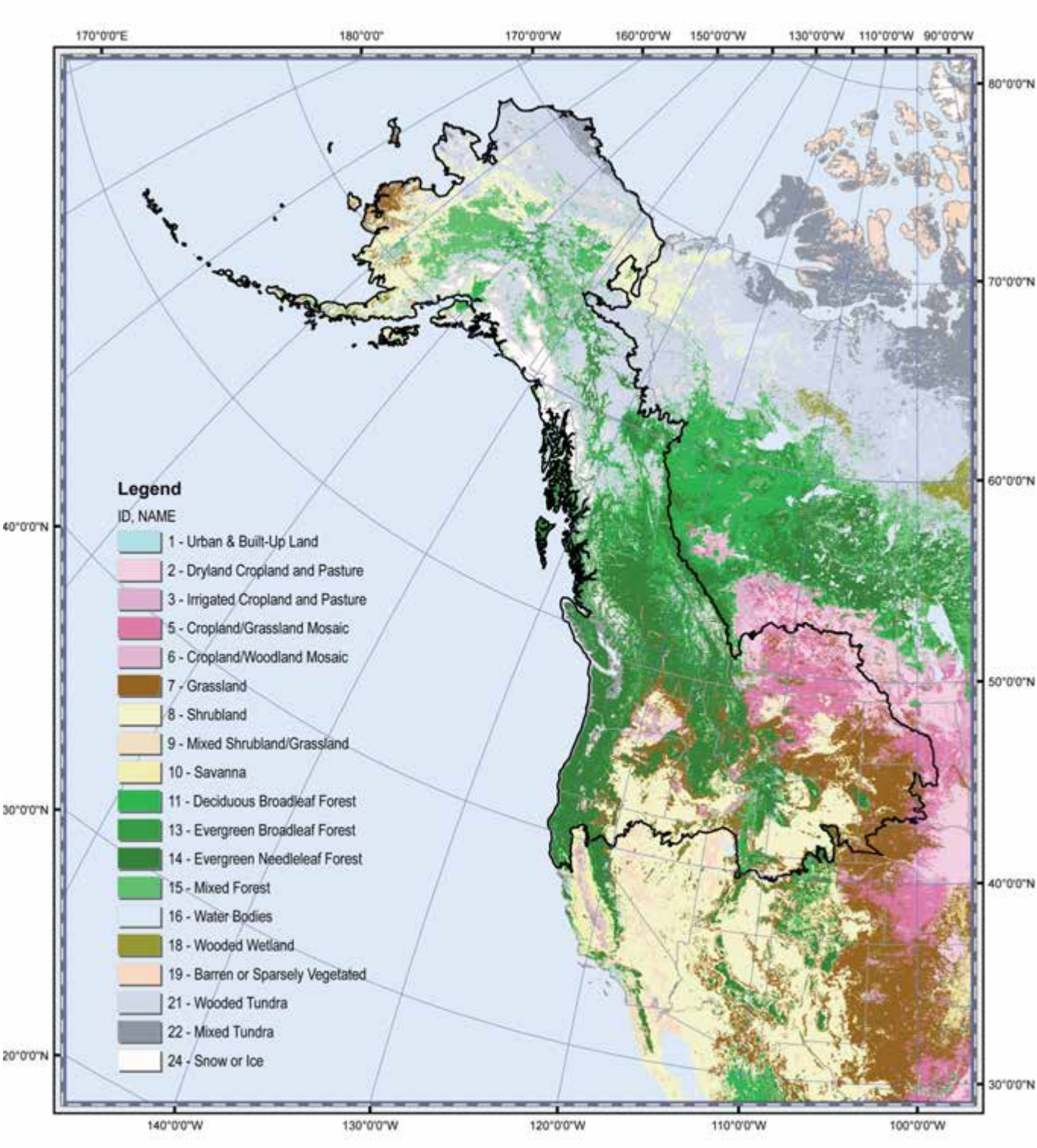
Jason Jones

Charles Peterson

Riparian areas are transition zones between aquatic sites and drier upland areas. They often contain distinct vegetation (e.g., plants that prefer moist soil conditions).



The 21 Ecoregions of the Northwest included in these Guidelines. State asnd provinces identified in black are only referred to in the Northwest guide. Those in gray occur along PARC regional boundaries and are included in other Guidelines. (Source: NatureServe)



Map of the 19 land use or land cover in the Northwest. See Anderson et al. (1976) for definitions of classes. For more information visit: *http://edcsns17.cr.usgs.gov/glcc/*

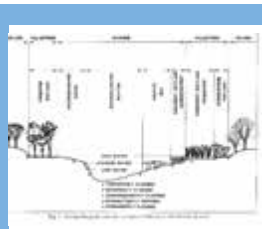
Ecoregion Number and Name		USGS Land-Use/Land-Cover Classification																	
		Urban and Built-Up Land	Dryland Cropland and Pasture	Irrigated Cropland and Pasture	Cropland/Grassland Mosaic	Cropland/Woodland Mosaic	Grassland	Shrubland	Savanna	Deciduous Broadleaf Forest	Evergreen Broadleaf Forest	Evergreen Needleleaf Forest	Mixed Forest	Water Bodies	Wooded Wetland	Barren or Sparsely Vegetated	Wooded Tundra	Mixed Tundra	Snow or Ice
1	Pacific Northwest Coast	0.2	0.3	<.1	0.1	0.2	0.1	0.7	0.1	0.8	<0.1	**71.4**	2.3	23.5	–	<.1	0.1	–	–
2	Willamette Valley – Puget Trough – Georgia Basin	4.4	10.6	0.2	0.1	0.2	0.2	0.5	0.2	0.1	–	**53.6**	1.4	28.6	–	–	–	–	–
3	North Cascades	<.1	0.4	<.1	0.3	0.7	0.3	3.7	0.1	6.1	–	**53.7**	9.4	5.5	–	3.8	14.1	<.1	1.8
4	East Cascades – Modoc Plateau	0.1	1.3	2.2	1.1	0.1	19.8	15.3	0.0	0.8	–	**57.2**	0.6	1.1	–	0.2	0.2	–	–
5	Klamath Mtns	0.2	4.3	2.1	0.2	–	1.5	1.2	0.2	0.7	–	**89.0**	0.4	0.3	–	<.1	<.1	–	–
6	Columbia Plateau	0.2	6.4	6.0	1.0	<.1	19.7	**61.0**	<.1	2.3	–	1.7	0.1	0.7	–	1.0	<.1	–	–
7	Canadian Rocky Mtns	<.1	<.1	0.4	0.6	0.6	3.5	3.3	0.1	9.9	–	**63.7**	7.0	1.3	–	1.2	8.0	<.1	0.3
8	Middle Rockies – Blue Mtns	0.1	0.4	4.6	2.8	<.1	24.1	11.1	0.1	2.7	–	**53.4**	0.5	0.1	–	<.1	0.2	–	–
9	Utah – Wyoming Rocky Mtns	0.1	<.1	3.9	0.4	0.1	14.5	8.7	0.6	17.3	–	**48.6**	3.6	0.7	–	0.1	1.6	–	–
10	Wyoming Basins	0.1	<.1	1.2	0.1	–	11.9	77.5	<.1	1.8	–	4.6	0.0	0.4	–	2.3	0.1	–	–
14	California North Coast	0.2	0.1	0.3	<.1	0.3	0.1	0.5	5.1	7.0	<.1	**69.1**	5.4	11.9	–	0.0	–	<.1	–
25	Black Hills	0.2	–	0.3	1.6	0.1	41.0	4.9	0.4	0.7	–	**50.7**	–	0.1	–	–	–	–	–
26	Northern Great Plains Steppe	<.1	8.1	1.4	31.7	0.2	**39.1**	17.5	<.1	0.4	–	0.7	<.1	0.6	–	<.1	0.2	<.1	–
67	Fescue-Mixed Grass Prairie	0.2	**50.8**	0.7	27.1	1.3	12.4	0.5	<.1	4.7	–	1.3	<.1	0.9	–	–	0.2	<.1	–
68	Okanagan	0.3	0.4	0.4	1.6	0.3	10.1	2.2	0.1	3.2	–	**76.2**	2.3	1.1	–	0.2	1.5	–	0.1
69	SE Alaska – BC Coastal Forest and Mtns	<.1	<.1	0.1	<.1	<.1	0.6	1.7	<.1	6.6	–	**39.9**	7.0	7.8	–	4.0	24.1	0.1	8.1
70	Gulf of Alaska Mtns and Fjordlands	<.1	<.1	<.1	–	–	0.4	12.5	0.2	0.6	–	0.5	5.8	4.3	–	8.5	26.0	<.1	41.1
71	Cook Inlet Basin	0.1	–	–	–	–	0.4	35.6	–	**43.7**	–	0.3	1.3	2.9	–	0.1	15.6	–	–
72	Alaskan Peninsula & Bristol Bay Basin	–	<.1	–	<.1	–	5.8	**44.0**	0.1	1.0	–	1.1	11.4	13.1	–	6.7	10.1	3.2	3.7
73	Bering Sea and Aleutian Islands	–	–	–	–	–	14.7	15.6	–	–	–	–	0.2	16.8	–	17.4	8.6	**19.0**	7.7
74	Bristol Bay Basin	–	–	<.1	–	–	8.5	**68.5**	0.3	0.2	–	1.1	9.8	3.0	–	0.7	7.0	1.0	<.1
75	Beringian Tundra	–	–	–	–	–	15.8	**43.4**	–	0.2	–	0.1	1.3	4.6	–	0.1	33.0	1.5	<.1
76	Alaska Range	–	–	–	–	–	<.1	4.0	–	<.1	–	0.1	14.6	0.4	–	9.6	**52.6**	<.1	18.5
77	Interior Alaska Taiga	<.1	–	–	–	<.1	0.4	27.6	–	1.7	–	2.8	**42.0**	0.9	–	<.1	24.4	0.1	<.1
78	Yukon Plateau and Flats	<.1	–	–	–	–	<.1	18.1	–	7.0	–	5.9	20.6	0.6	<.1	0.0	**47.7**	0.0	–
79	Alaska-Yukon Arctic	–	–	–	–	–	–	8.6	–	<.1	–	–	2.4	4.1	–	2.3	**73.4**	8.9	0.3
81	West Cascades	<.1	0.1	0.3	<.1	0.1	0.1	2.7	<.1	0.1	–	**94.9**	0.7	0.6	–	0.2	0.3	–	–
139	Boreal Cordillera	–	–	–	<.1	<.1	<.1	3.4	<.1	18.1	–	16.3	5.5	1.2	<.1	0.7	**54.4**	<.1	0.3
144	Montane Cordillera	<.1	<.1	<.1	0.2	0.2	0.5	1.3	<.1	21.6	–	**60.3**	4.1	3.1	–	0.4	8.0	<.1	0.2

Percent of ecoregions in the Northwest that fall within land-use or land-cover classes based on 1-km Advanced Very High Resolution Radiometer (AVHRR) satellite data collected April 1992 through March 1993 (Eidenshink and Faundeen 1994). See Anderson et al. (1976) for definitions of classes. The class "Mixed Shrubland/Grassland" did not occur in the Northwest. The bold numbers represent the dominant land-use/land-cover classes.

Bill Leonard

Tiger Whiptails are affected by invasive plants such as Cheatgrass that can result in dense ground cover, making running and hunting difficult.

What's in a name? The National Wetland Inventory (Cowardin et al. 1979) created standard names for all types of surface waters in the United States. The classification system involves a hierarchical structure of systems, subsystems, classes, and subclasses. In this book, we cover riverine, lacustrine, and palustrine systems. These more or less equate with rivers and streams (riverine), lakes (lacustrine), and ponds (palustrine). Subsystems, classes, and subclasses are simply modifiers that further explain the type of wetland. For example, in the photo below, we have a riverine and a palustrine system because the stream has overflowed its banks and created seasonally inundated pools. These can be important habitats for amphibians and reptiles.



This illustration outlines the distinguishing features of riverine and palustrine systems similar to the photograph below [Modified from Cowardin et al. (1979)].

Charlotte Corkran

This river has overflowed its banks creating a palustrine wetland. What is palustrine? Read "What's in a name?".


David Pilliod

MANAGEMENT GUIDELINES FOR CONSERVATION ISSUES

The primary land uses in the Northwest are timber production, livestock grazing, agriculture, recreation, urban/suburban development, and mining. Some of these land uses are more challenging to amphibian and reptile conservation than others.

In developing management guidelines for the 21 habitat types discussed in this document, several common management issues arose repeatedly. These are discussed in some detail here and will be presented briefly in subsequent sections where appropriate:

- Habitat Conversion
- Dirt Roads and Trails
- Major Roads and Highways
- Surface and Groundwater Use
- Agricultural Herbicides, Pesticides, and Nutrients
- Livestock Grazing
- Timber Harvesting
- Mining, Oil and Gas Exploration and Development
- Fire Management
- Exploitation (Collecting and Indiscriminate Killing)
- Non-native and Invasive Species
- Subsidized Predators
- Disease
- Climate Change

HABITAT CONVERSION

Habitat conversion has been identified as the greatest threat to native species in the United States and Canada. Most land uses alter habitats used by herpetofauna in some way, but habitat conversion for urban development and conventional production agriculture results in a large proportion of native vegetation being removed and changes to soil conditions. The impacts of habitat conversion are not equal across the landscape. For


Bill Leonard


Elke Wind

Gartersnakes often hibernate communally in underground dens, sometimes with other snake species. This den in Alberta was almost indistinguishable from the surrounding landscape.

Charlotte Corkran

The key factors in maintaining local amphibian and reptile populations include maintaining a variety of natural habitats and habitat elements, and ensuring connectivity among those areas.

example, over 4% of the Willamette Valley-Puget Trough-Georgia Basin ecoregion is Urban and Built-up Land (see map on page 15), more than four times higher than for any other ecoregion in the northwest. In these cases, management actions that benefit amphibians and reptiles include the preservation of undisturbed adjacent habitats for biodiversity values and the creation of suitable habitat adjacent to or within habitat conversion zones. Thus, it may be possible to mitigate some habitat loss that occurs in areas of intensive land use.

What can landowners and managers do?

- **Maintain some areas adjacent to habitat conversion areas as habitat for wildlife and provide buffer zones of low intensity use.** *Larger habitat patches will support healthy amphibian and reptile populations and reduce edge effects compared with smaller patches.*
- **In selecting areas to restore or maintain as wildlife habitat, choose patches that contain a variety of habitat features or provide some connectivity to lands managed for biodiversity.** *For example, an adult Northwestern Salamander will migrate to a wetland for breeding and then return to the surrounding forest to forage and overwinter. Similarly, a Prairie Rattlesnake may use a rock outcrop for basking and hibernating and an adjacent grassland for foraging.*
- **Maintain habitat patches that are close to other patches.** *Maintaining patches in close proximity will increase the chance of long-term population persistence because it allows individuals to move across the landscape and may increase gene flow among populations.*
- **Consider corridors that link habitat patches.** *Ideally, patches should be connected via corridors (e.g., along fencerows, vegetated swales and irrigation canals, or riparian areas). Some moderately disturbed areas can still serve as corridors if they are moist and vegetated.*
- **Avoid degrading intact habitats.** *For example, minimize the use of herbicides and pesticides and reduce fertilizer runoff near areas set aside as wildlife habitats.*

Elke Wind

Amphibians and reptiles react differently to edges. The increased exposure to sun (higher temperatures) and wind often create less suitable conditions for amphibians, whereas reptiles may be attracted to these areas for the combination of warmth, proximity to cover, and foraging opportunities they provide.

MANAGING FOR 'EDGE EFFECTS'

Naturally occurring transition areas or ecotones between one habitat type and another can often have high species diversity because of the combination of microhabitats and vegetation that are found there. However, hard boundaries or edges often created as a result of resource management or development can lead to 'edge effects,' which can have positive or negative effects for native amphibians and reptiles.

There are many negative effects associated with edges for amphibians and reptiles:

- *increased exposure to extreme microclimate conditions*—due to the loss of vegetative cover along the edge, amphibians and reptiles can be exposed to greater fluctuations and extremes in solar radiation, air temperature, and wind. For example, microclimatic changes along recent clearcut edges typically extend 98 to 787 feet (30 to 240 m) or more into old-growth Douglas-fir forests in the Northwest, especially along southwest-facing edges.
- *colonization by invasive plants*—reduced vegetative cover along edges and areas of ground disturbance provide opportunities for invasive plant species to quickly take hold, sometimes displacing native plants and creating inhospitable environments for amphibians and reptiles.
- *increased predation rates*—some predators, such as crows, raccoons, and coyotes may do well along edge habitats, exploiting these newly disturbed areas.

A number of management tools can be used to minimize or avoid the negative effects of edges:

- *reduce the amount of linear edge habitat*—in areas with intensive land use (e.g., housing developments, agriculture) use straight lines at boundaries with native habitats instead of curved or irregular edges.
- *buffer edges*—leave a transition area of low to mid height vegetation or shrubs along the edge to maintain microclimate conditions.
- *green up*—replant or encourage re-growth of native vegetation along edges as soon as possible and discourage non-native species from becoming established.
- *minimize microclimate extremes*—if possible, orient the longest edges away from sun and dominant wind directions.

DIRT ROADS AND TRAILS

The Northwest has a high number of dirt roads as a result of extensive timber development. Many of these roads become deactivated or gated, which is beneficial for wildlife as even low-traffic dirt roads can result in mortalities of amphibians and reptiles and pose a barrier to movement to some species and life stages. Amphibians are often attracted to water-filled tire ruts common along rural roads or to roadside pools for hydration and breeding, which exposes them to the risk of injury or death from passing vehicles. Roadside ditches provide marginal breeding habitat for amphibians due to their unpredictable hydroperiod and water quality. In many locations, dirt and gravel roads are sprayed with oil or hydroscopic salts to reduce dust. Dirt roads and trails facilitate human access, which can result in increased collection of amphibians and reptiles for the pet trade.

Elke Wind

It is estimated that 73 percent of all habitat types are located within a half mile (810 m) of a road. Forested areas of the Northwest have the highest density of roads. These roads were originally built for timber harvesting but are now used for access for recreation as well.

Unless properly designed, dirt roads can negatively impact stream habitats for years. Sediment from dirt or gravel roads, for example, can run into streams, ponds and wetlands during rain and snowmelt events. Improperly installed water conveyance structures such as culverts can increase sediment levels in streams affecting

eggs and larvae of amphibians as well as aquatic insects that are the prey base for amphibians. Large, open-bottomed culverts can provide a safe passageway for amphibians and reptiles under dirt roads, but small pipe culverts with downstream drops act as barriers to amphibians.

Elke Wind

David Pilliod

Bill Ruediger

An open bottom or box culvert is more suitable than a perched culvert for stream amphibians, but the bottom image with exposed stream bank and directive fencing allows for movements of a wide variety of amphibians, reptiles, and other wildlife.

What can landowners and managers do?

- **Minimize construction of new roads.** *New road construction fragments habitats and can cause additional sedimentation of streams. When roads must be constructed, locate them away from wetlands and streams and maintain natural water flow regimes.*
- **Conduct road construction when herpetofauna are inactive.** *Late spring to early fall is when most amphibian species are active. However, off-season construction may not be possible due to regulations associated with fisheries management (e.g., fish windows) and could result in increased impacts to other amphibian and reptile species (e.g., if snake hibernacula are disturbed).*
- **Deactivate roads no longer needed (e.g., post harvest), or close sections of permanent roads during specific times of the year to allow for seasonal migrations.** *This method allows for the maintenance of traditional migration routes without alteration of the surrounding habitat and reduces road mortality.*
- **Install amphibian and reptile underpasses (tunnels) and fencing designed specifically for these species.** *Incorporate crossing structures into new road plans and designs. Identify the location of known migration or chronic road-kill sites to facilitate correct placement of mitigation structures along existing roads.*

MAJOR ROADS AND HIGHWAYS

Paved roads and highways are common features of most landscapes. In the U.S., for example, there are 2.25 million miles (3.65 million km) of paved roads that ecologically influence about 15-20% of the total land area. Roadside areas are often intensively managed for

Kris Kendell

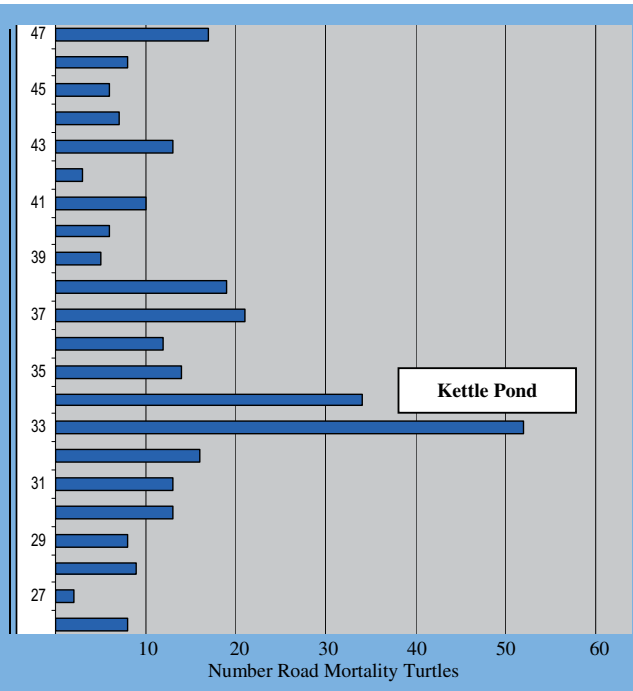
For the latest information on road effects on amphibians and reptiles see: Andrews, K.A., J.W. Gibbons, and D.M. Jochimsen. 2008. Ecological effects of roads on amphibians and reptiles: a literature review. In, Jung, R.E., and J.C. Mitchell (eds.). Urban Herpetology. Herpetological Conservation Vol. 3, Society for the Study of Amphibians and Reptiles, Salt Lake City, UT. ***www.webpages.uidaho.edu/~lukeh/denim/index.html***

Sara Ashpole

Snakes are frequently hit by vehicles while basking on roads. Posting "reduce speed for wildlife" or "animal crossing" roadside signs may reduce road mortality in parks or refuges, but has been shown to be ineffective (or even increase mortality) on most roadways.

motorist safety, and are therefore characterized by herbaceous vegetation instead of shrub or tree cover. They are also altered by increased dust, petrochemicals, noise, light, and water. Non-native and invasive plants are inadvertently and intentionally planted along roadsides, which are then treated with herbicides and subject to mowing.

Amphibians and reptiles are commonly observed on paved roads and along roadside habitats. As herpetofauna undergo seasonal movements to and from breeding sites, overwintering habitats, and foraging areas there is a high probability that they will encounter roads. Mortality risk is influenced by the location of these habitat features relative to roads. For example, roads located near wetland habitats are associated with high mortality rates of Tiger Salamanders, Western Toads, Spadefoot Toads, Gartersnakes, and other species. Some species (particularly snakes) are attract-



Kathy Griffin

Along Highway 93 in Montana, Painted Turtles were being hit by vehicles at a monthly rate of 10.8 turtles per kilometer of road per month during the 5-month active season as they moved between ponds in the Kickinghorse-Ninepipe region of the Mission Valley. In 2000, the Montana Department of Transportation, the Confederated Salish & Kootenai Tribes, and the Federal Highway Administration agreed to install 40 wildlife crossing structures along a 55-mile stretch of the highway to reduce wildlife mortality and increase driver safety. Additional wildlife crossing structures aimed at facilitating safe turtle crossing are being planned for the 18-km section of road where turtles are the primary group being hit by vehicles. The right graphic shows the total number of turtle road mortalities (2002-2004) corresponding to the mapped road markers along Highway 93 (left image), which are approximately 160m apart. The arrows correspond to the proposed location of two 18-m (60ft) bridges designed to allow reconnection of a kettle pond currently bisected by the road. See the following for more information: Griffin, K.A. and D.H. Pletscher. 2006. Potential effects of highway mortality and habitat fragmentation on a population of painted turtles in Montana. Final Report to the Montana Department of Transportation FHWA/MDT-06-010-8169. Helena, Montana. September 2006. 70 pp. Available at the following website: *www.mdt.mt.gov/research/docs/research_proj/turtle/final_report.pdf*

Terry Anderson

Joe Materi

Examples of underpass systems and fencing used in British Columbia to reduce road mortality impacts on migrating amphibians. Numerous agencies in Europe have been investigating and installing underpass systems for small animals for years. Important features of successful designs include fencing that directs animals towards the underpass, large diameter tunnels, natural substrates (e.g., earthen bottom), a source of light into the tunnel, and moist not wet conditions (i.e., little to no flowing water and/or escape routes out of water such as side ledges).

ed to the heat-absorbing characteristics of asphalt and concrete road surfaces during cooler periods.

In Europe and increasingly in North America, crossing structures have been installed to allow reptiles and amphibians to safely cross roads. Usually these structures are designed for highways, but they can be used on very low traffic roads where mortality is unacceptably high. Structures are designed with the target species in mind, and vary in design depending on the behavior and habitat needs of those species. For example, diurnal salamanders and frogs preferentially use open-trenched culverts. For burrowing species that tolerate dark or enclosed spaces, dry culverts are effective. Structures are most effective when used in combination with fencing to divert traveling animals into the intended structure.

What can be done to reduce the impacts of roads on amphibians and reptiles? In 2004, Glacier National Park closed one of their roads for two weeks to allow Western Toads to migrate from breeding ponds by the tens of thousands, and Waterton National Park constructed underpass tunnels for migrating Long-toed Salamanders in 2007.

What can landowners and managers do?

- **Install passages under roads.** *Identify amphibian and reptile movement corridors based on local knowledge of wetland location and species movement patterns, or look for places of frequent roadkill. Design culverts, underpasses, and overpasses to accommodate a variety of species.*
- **Minimize the use of contaminants such as salts, petrochemicals, and herbicides on and along roads.** *Create no-spray zones along roads adjacent to wetlands and streams.*
- **Minimize use of plastic mesh for erosion control.** *Snakes can become trapped and may die in plastic erosion control materials. Using materials that are biodegradable and less flexible may reduce mortality risk.*
- **Erect road signs that caution motorists to reduce speed because of migrating turtles, salamanders, or toads or temporarily close roads during mass migration periods.** *Alert motorists of predictable migrations and urge caution when traveling near areas prone to high incidence of road mortality. It is important to remove the signs when the critical season has ended so motorists do not get used to seeing the signs and ignore them.*

SURFACE AND GROUNDWATER USE

Fresh water flows across the land in the form of streams and rivers and collects in topographic depressions in the form of wetlands, which range from lakes to seasonally inundated pools. Most fresh water is underground and subsurface water is the source of more than 90% of community water supplies in the Northwest. Water systems above and below ground are hydrologically connected, and activities in either area can affect the other. For example, water removed at the surface for irrigation purposes can reduce the amount of water that percolates down and replenishes groundwater sources used for drinking and conversely, pumping water from wells can deplete wetlands.

Pumping groundwater and diverting the directional flow and rate of surface water for human consumption, agriculture, and industrial uses alter the natural flow regimes and water levels of streams and wetlands. Development of springs and associated pipelines designed for livestock use in the semi-arid interior west has impacted numerous springs and seeps. Impervious surfaces in urban and some rural areas (e.g., rooftops, asphalt roads and parking lots) change flow rates and wetland hydroperiods. Changes to water levels can also facilitate the establishment of invasive species (e.g., salt cedar, cattail), which can displace native species and reduce water quality and quantity.

Water issues arise for amphibians and reptiles when 1) **water quality** is degraded (e.g., input of contaminants, extreme temperatures, increased algae or nutrients, change in vegetative cover); 2) the amount of **water available** is reduced or not available at the right time of year (e.g., depth, hydroperiod); or 3) **water levels or flow rates** fluctuate extensively.

Charlotte Corkran

Large quantities of water are used for agriculture, even in arid regions. Pumping ground water and providing flood irrigation through canal systems may attract and even benefit some amphibians and reptiles in agricultural areas. Protecting water quality and maintaining cover in these areas may help provide suitable habitats for these animals.

David Pilliod

A study from Washington revealed that some amphibians (e.g., Northwestern Salamander, Red-legged Frog, and Pacific Treefrog) can breed in stormwater catchment ponds but prefer water bodies with low flow rates (less than 2 in/sec or 5.0 cm/sec). Species richness is lower when water levels or depths fluctuate extensively (more than 8 in or 20 cm change, on average) in a short period of time. Stormwater surges sometimes result in amphibian eggs being dislodged and washed into marginal locations or eggs being stranded as water levels rapidly drop, like these Columbia Spotted Frog eggs.

Elke Wind

Where numerous wetlands have been lost, amphibians and reptiles may benefit from the construction of ponds within and near green spaces. Within one year of being constructed, at least three amphibian species were breeding in these water storage ponds on Vancouver Island.

Some aquatic habitats used by amphibians and reptiles are at greater risk than others due to limited legal protection. For example, small, ephemeral ponds and headwater streams are not always afforded protection from certain land-use activities by federal or state/provincial governments. Although many of these areas are used by amphibians for breeding, they are also critical habitat features that facilitate movement and maintain connectivity among populations by providing sites for rehydration, cover, and foraging.

What can landowners and managers do?

- **Limit groundwater pumping in areas with springfed wetlands.** *Appropriate groundwater recharge is necessary to maintain many wetland*

habitats. Changes to water tables and subsurface hydrology have the potential to negatively affect associated wetlands.

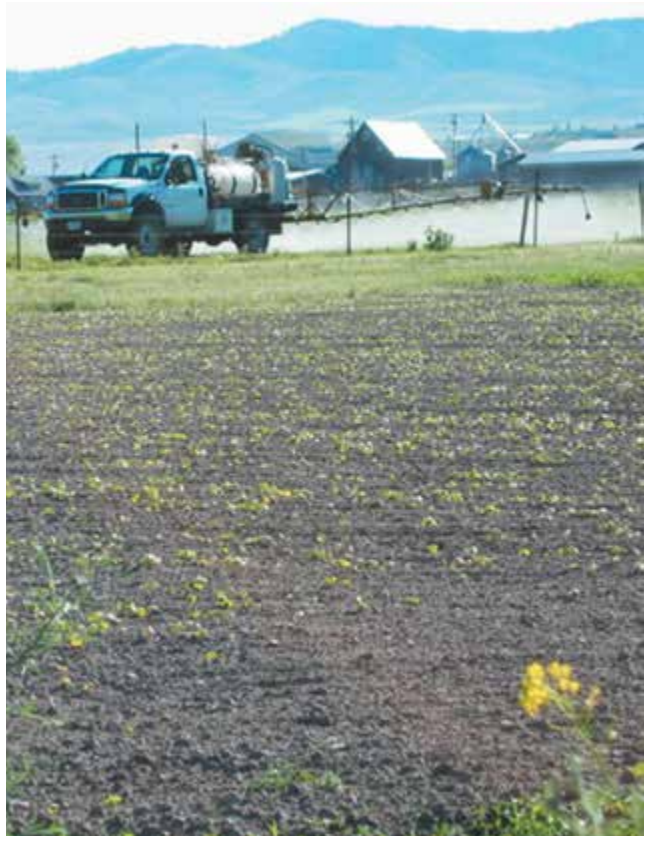
- **Maintain natural surface water flow rates and pathways.** *Streams that are allowed to meander provide better habitat for amphibians and reptiles, particularly if flow rates are not overly influenced by stormwater runoff from large areas of impervious surfaces, such as parking lots.*
- **Work closely with state wildlife agencies and reintroduce beaver to appropriate stream systems.** *Maintain adequate food sources and availability for beaver.*
- **Enact water-saving practices.** *Installing low-flow plumbing fixtures in homes and business, using drip systems to water gardens, watering lawns in early morning, catching and storing rainwater for gardens, and planting more drought resistant native species in landscaping are just a few practices that can greatly reduce human water consumption.*

AGRICULTURAL HERBICIDES, PESTICIDES, AND NUTRIENTS

Although habitats can sometimes benefit from chemical application (e.g., to eradicate invasive plants), water quality can be degraded by contaminants in runoff from agricultural areas, industrial sites, highways and roads, and urban areas. The permeable nature of amphibian skin makes these animals extremely vulnerable to contaminants in the environment.

What can landowners and managers do?

- **Limit use of agro-chemicals whenever possible.** *Many chemicals used in agriculture are either directly toxic to amphibians or degrade into compounds that are similar to synthetic estrogen or other endocrine hormones. These compounds can disrupt developmental and reproductive processes in amphibians and other wildlife. Investigate the potential existence and use of less harmful products to accomplish the same objectives.*
- **Follow the directions for appropriate concentrations and rates of application.** *Inappropriate use of fertilizers can result in excess nitrogen and phosphorus that is not taken up by plants. These chemicals enter wetlands and rivers and contaminate groundwater. Elevated nitrate-nitrogen levels pollute human drinking water and natural wetlands throughout the Northwest. Inappropriate use of pesticides can be toxic to wildlife and fish.*
- **Minimize use of broad spectrum pesticides.** *Many amphibians and reptiles depend on robust invertebrate populations as prey. Many pest issues involve single species that do not require broad spectrum pesticides for control and can be dealt with by more targeted means.*
- **Avoid spraying during the breeding or active season.** *Amphibians and reptiles have periods when they are particularly vulnerable to contaminants, such as during tadpole development and metamorphosis, and spring and early summer.*



Jim Story

Chemicals are often sprayed to control insect pests and weedy plant species. These chemicals can kill amphibians and reptiles directly, or result in mutations that reduce survival.

Charlotte Corkran

Runoff from agricultural fields can lead to high nutrient levels in water bodies used by breeding amphibians. Providing more shoreline vegetation around ponds and tilling fields such that water is less likely to run off can help reduce high nutrient loads in ponds near conventional production agricultural fields.

Salmon Challis National Forest

To maintain local amphibian and reptile populations, follow label directions closely and EPA guidelines (below) when applying pesticides and herbicides.

FROGS AND PESTICIDE HAZARDS

The U.S. Environmental Protection Agency produced a list of what you can do to help reduce the exposure of frogs and other amphibians to pesticides:

1. Keep pesticides out of water and areas near water.

2. Do not spray if heavy rain is expected – the pesticides may wash away from the area of application and into water bodies.

3. Implement an Integrated Pest Management (IPM) plan to use cultural, mechanical, and biological pest controls where you can.

4. Dispose of pesticides safely. Never dump pesticides down sink drains, storm drains, or on the ground. Take unused pesticides to your local Hazardous Waste Collection Center.

5. If you use pesticides, apply them in the early morning or in the evening, when winds are calm. This may help reduce spray drift.

6. Use a low pressure, large droplet sprayer, and spray close to the ground.

7. Please follow the instructions on the pesticide label!

Charlotte Corkran

Pieter Johnson

Pieter Johnson

The extra limb on this Bullfrog (top) and bony triangle on this Leopard Frog (middle) were caused by a trematode parasite that buries itself in the tadpole at the region of limb formation, resulting in limb abnormalities. Trematode populations are elevated in ponds heavily used by cattle or near agricultural areas. Snails (bottom) are the intermediate host of these parasites.

LIVESTOCK GRAZING

Areas used for livestock grazing can include important amphibian and reptile habitats. In some rural areas, livestock affect water quality and wetland habitat suitability through excessive removal of vegetation, by trampling in riparian areas, and by increasing nutrient loads from fecal waste. Livestock grazing practices that do not leave adequate vegetation cover, particularly in arid areas, may (1) result in increased erosion from areas adjacent to wetlands, (2) lead to increased predation of snakes and lizards by reducing vegetation cover, and (3) reduce prey populations, such as

David Pilliod

Livestock grazing practices where vegetation is seasonally eliminated from areas can reduce habitat quality for many snakes and amphibians.

ground-dwelling invertebrates and small mammals. A reduction in the number of small mammal burrows may affect species such as the Long-nosed Snake that use burrows for shelter and hibernation sites. However, livestock use in and around wetland habitats may be compatible for species that tolerate disturbed aquatic habitats and favor productive waters with high nutrient loads. For example, several healthy populations of Pacific Pond Turtles, Oregon Spotted Frogs, and Western Toads occur in heavily grazed sites. In some situations, low-level grazing may help keep wetlands from being overgrown with vegetation and thus provide open basking and breeding areas for turtles, frogs, and toads. Such prescribed grazing should be cautiously applied and carefully monitored.

What can landowners and managers do?

- **Control livestock access to wetlands and streams.** *Fencing streams and wetlands and creating restricted access points can reduce bank erosion and eliminate livestock impacts in sensitive riparian habitats. Seasonally restricting livestock access to wetlands or limiting duration and intensity of use may be sufficient to reduce negative effects of livestock on amphibians during the breeding period.*
- **Establish alternative water sources.** *Establishing water troughs with escape ramps for amphibians and reptiles can attract livestock away from riparian areas. Care should be taken to ensure that troughs are placed in locations that do not lead to unacceptable impacts to important upland habitats (e.g., near unique surface features, such as rock outcrops, dense stands of vegetation, or in washes or swales that may serve as movement corridors). See Bat Conservation International's "Water for Wildlife" publication for information on water structure improvements and escape ramps for wildlife (www.batcon.org/news2/pdf/bciwaterforwildlife.pdf).*
- **When developing springs to serve as a source for livestock water, design the system to maintain water in the spring through the use of float valves on troughs, shut-off valves (when water is not needed), minimal ground disturbance during construction, and fence spring heads where feasible.** *Many amphibian and reptile species depend on these sources of water, particularly in arid shrublands and grasslands. In pinyon-juniper forests throughout the interior Northwest, springs may serve as the primary overwintering areas for Columbia Spotted Frogs and other amphibians.*
- **Allow some areas to be ungrazed or minimally grazed.** *Amphibian and reptile habitat in grasslands, shrublands, and forests may be improved by following prescriptive grazing practices. In grazed riparian areas, maintaining a stubble height on herbaceous vegetation of 4-8 inches (10-20 cm) is recommended to preserve forage quality and reduce livestock impacts [e.g., browsing of willows (Salix spp.), trampling and destabilizing streambanks].*
- **Provide a buffer of woody vegetation around a portion of man-made earthen livestock watering ponds.** *Shrubs and trees will provide shade for livestock and cover for amphibian and reptile species that are attracted to the source of water.*

WATERING LIVESTOCK WHILE ON PASTURE – ACCEPTABLE PRACTICES

This Code of Practice has been developed by members of the Prince Edward Island Cattlemen's Association and the Prince Edward Island Dairy Producers' Association. This code is based on the premise that all livestock owners should water livestock from sources other than water courses, wherever it is practical to do so.

- When livestock are grazed in pastures close to an existing alternate water supply (well, power supply, and pump) and where livestock do not have to cross a stream to reach that water supply, then access to surface water streams should be eliminated. When livestock have to cross a stream, then a bridge, water-gap, or a streambed crossing should be constructed.
- In situations removed from conventional water sources, and where there is no easy way to provide electricity and water, then livestock should have restricted access to surface water courses. Restricted Access is defined as limiting livestock access to 33 feet (10 m) of one water course per pasture.
- Where meandering streams pass through a pasture, use fencing to control access to the stream wherever possible.

(Taken from: ***peigov.ca/af/agweb/index.php3?number=74094&lang=E***).

Virgil Hawkes

The Siskiyou Mountain salamander is a Survey and Manage species that occurs only in a small area along the border of Oregon and California. Placing conservation buffers around talus and rock outcrops in this species' range may help protect local populations.

TIMBER HARVEST

The United States has approximately 483 million acres (195 million ha) of merchantable timber, most of which is owned by small private landowners or by forest companies. Many states in the Northwest have adopted regulations governing timber harvest on those lands that, by default, help control land-use activities in amphibian and reptile habitats. Some, such as Washington and California, have buffer prescriptions designed for amphibian conservation, and continuing efforts are aimed at reducing impacts of ground disturbance (e.g., soil compaction, erosion, loss of cover) on amphibians and reptiles. Furthermore, despite a century or more of timber harvest in the Northwest, most amphibians and reptiles are currently widespread and common on lands managed for timber production.

The U.S. Department of Agriculture Forest Service manages the largest area of federal timber, about 85 million acres (34 million ha). Timber production in federal forests in the northwestern United States has changed dramatically in the last 15 to 20 years. Changes are mostly due to species habitat protection and the 1994 federal Northwest Forest Plan, which affected the management of about 20 million acres within 19 national forests in western Oregon, western Washington, and northern California. The Plan's goal is to produce a predictable and sustainable level of timber sales while protecting the long-term health of forests, wildlife, and waterways of the region. The Survey and Manage Mitigation Measure (referred to as "Program" in the blue box) in the Northwest Forest Plan greatly improved our understanding of the habitat needs of amphibians and reptiles on forested lands. The objectives of Survey and Manage standards and guidelines are to conserve rare and little-known species that are associated with late-successional and old-growth forests.

While there have been high costs and implementation challenges of the **Survey and Manage Program** (SMP) of the US Northwest Forest Plan, numerous elements of its approach for the conservation of rare and little-known species were highly effective (Raphael and Molina 2007). The species-specific approaches of the SMP blended well with the coarse-filter, systems-level approaches of riparian reserves and late-successional reserves to provide effective conservation for forest biodiversity. In particular, significant advances were made in the understanding of the biology and ecology of rare species due to the "strategic survey" element of the program (Olson et al. 2007). Many of the effective elements of the SMP have been incorporated into the ongoing conservation program for sensitive species on federal lands, the **Interagency Special Status and Sensitive Species Program (ISSSSP; *www.fs.fed.us/r6/sfpnw/issssp/*)**.
Although similar, these programs differ in their goals and capabilities. The SMP managed species to maintain well-distributed populations and attempted to advance the management of most of the 300 species in the program at once. The general guidance of ISSSSP is to avoid actions that lead to a species being listed under the US Endangered Species Act or loss of viability, a different type of conservation threshold. The ISSSSP also prioritizes species for focused management efforts every year.

References:
Olson, D.H., K.J. Van Norman, and R.D. Huff. 2007. The utility of strategic surveys for rare and little-known species under the Northwest Forest Plan. Gen. Tech. Rept. PNW-GTR-708, Portland, OR: US Dept. Agriculture, Forest Service, Pacific Northwest Research Station. 48 p.

Raphael, M.G. and R. Molina (eds.). 2007. Conservation of rare or little-known species: biological, social and economic considerations. Island Press, Washington, D.C. 375 p.

Elke Wind

Legislation requires buffers along fish-bearing streams in the Northwest. However, small headwater streams are not afforded this protection in some jurisdictions. Without forested buffers, headwater streams may experience elevated temperatures and sedimentation. All Northwest amphibian species are associated with streams in some way, with 12 species restricted to headwater environments.

In contrast to the U.S., over 90% of B.C.'s forestlands are publicly owned. The B.C. Forest Service is responsible for over 116 million acres (47 million hectares) of provincial forestlands. Over 90% of BC's forestlands are publicly owned, and less than 0.3% of the forest is logged each year. The annual timber harvest fluctuates around 2.8 billion cubic feet (80 million cubic meters), depending upon factors such as market prices and more recently the accelerated loss of beetle-killed wood in the interior of the province. In 1995, the provincial government enacted the Forest Practices Code of British Columbia Act, which was replaced by the Forest and Range Practices Act in 2004. During that time, the government created a category of species at risk that represents those species that may be affected by forest or range management on Crown land and are listed by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC). The 85 species included in this category of species at risk form the basis for the Identified Wildlife Management Strategy (IWMS). The documents associated with the IWMS contain the necessary information, procedures, practices, and guidelines to help government planners, foresters, and wildlife managers achieve effective management and conservation of Identified Wildlife under the Forest and Range Practices Act. A total of eight amphibian and three reptile species are managed under the IWMS.

Amphibians, more so than reptiles, can be negatively affected by forest harvesting. Terrestrial species prefer moderate climates and moist microsites, and stream species are sensitive to increased sedimentation and warm water temperatures. Loss of forest cover from timber harvest tends to create drier conditions with more variable temperatures. However, effects of these changes on amphibians vary greatly in relation to local conditions (e.g., across the Northwest) and are species specific. Salamander species that use large downed wood for moisture, stable temperatures, cover, and abundant prey (insects and spiders) may decline with a loss of large woody debris. However, other species have a positive initial response to harvesting under some circumstances. As a result, scientists do not fully understand the impacts of forest harvesting at broad scales (i.e., across the landscape). In response to wildlife issues such as these, stand-level forestry regulations [e.g., Forest and Fish Rules (FFR), Forest Practices Code Guidelines] have been put in place to ensure that downed wood and other habitat elements are maintained.

In contrast to amphibians, reducing canopy cover can improve habitat conditions for lizards and snakes, such as Northern Alligator Lizards, Rattlesnakes, and Gophersnakes.

What can landowners and managers do?

- **Minimize new road construction and design and maintain logging roads to reduce erosion.** *Erosion from unpaved roads can cause sedimentation of streams. Recent improvements to road networks have helped reduce this impact.*
- **Reduce ground compaction and ground disturbance by using newer timber harvesting technologies such as harvesters or cable systems.** *These practices may provide long-term benefits of faster regeneration and fewer environmental issues for cut-to-length, tree-length, and full-tree harvesting methods. Minimizing disturbance to the soil structure and ground vegetation benefits amphibians and reptiles.*

SUSTAINABLE FORESTRY CERTIFICATION PROGRAMS allow participants and others to ensure that wood and paper products come from forests that are managed according to a particular standard. Certification standards typically contain provisions that require participants to consider wildlife habitat, contribute to the conservation of biological diversity, and protect imperiled species, including imperiled reptiles and amphibians. The most commonly used standards in North America are:

The Canadian Standards Association's (CSA) Sustainable Forest Management (SFM) Standard (CAN/CSA Z809-02) accounts for a majority of the SFM certifications in Canada. The CSA standard uses a definition of sustainable forest management developed by Canadian Council of Forest Ministers (CCFM). This definition was an outcome of Canada's involvement in the Montreal Process, one of eight intergovernmental processes for developing global criteria and indicators for sustainable forest management. Within this framework locally adapted indicators were developed through a public consultation process. The CSA standard is recognized globally and endorsed by the Programme for the Endorsement of Forest Certification schemes (PEFC).

More on CSA: The Canadian Standards Association has been a leader in standards development since 1919. Over the years, CSA has published more than 3,000 codes and standards that address the needs of consumers, government, business and industry, and society at large. CSA develops national, bi-national and tri-national standards for North America and participates in the harmonization of standards for the global marketplace. See: ***www.csa-international.org/product_areas/forest_products_marking/Default.asp?language=english***.

The Forest Stewardship Council (FSC) is an international, non-profit organization that supports environmentally appropriate, socially beneficial, and economically viable management of the world's forests. FSC was founded in 1993 in Toronto, Canada, by representatives from environmental groups, the timber industry, the forestry profession, aboriginal organizations, and community forestry groups from more than 25 countries. FSC is a forest certification and labeling system for paper and wood products that come from responsibly managed forests and verified recycled sources. Under FSC certification, forests are certified against a set of strict environmental and social standards, and fibre from certified forests is tracked all the way to the consumer through the chain of custody certification system. The end result is products in the marketplace carrying the FSC 'check-tree' logo. About 55 million acres (22 million ha) of Canadian forests and 23 million acres (9 million ha) of US forests are FSC certified.

FSC certification is a voluntary and market-based mechanism for ensuring that our forests are healthy. Consumer demand for FSC-certified products encourages forest managers and owners to become FSC-certified. Independent third-party auditors conduct all FSC certification audits. See: ***www.fsccanada.org/***; ***www.fscus.org/***.

The Sustainable Forestry Initiative® (SFI) program is a comprehensive system of principles, objectives and performance measures developed by professional foresters, conservationists, and scientists that combines the perpetual growing and harvesting of trees with the long-term protection of wildlife, plants, soil, and water quality. SFI program participants practice sustainable forestry on all the lands they manage. They also influence millions of additional acres through the training of loggers and foresters in best management practices and outreach programs for landowners. The SFI Standard spells out the requirements of compliance with the program. It is based on nine principles that address economic, environmental, cultural, and legal issues, in addition to a commitment to continuously improve sustainable forest management.

SFI Inc. is the sole governing body of the SFI program and is a non-profit organization overseen by an independent board of directors that equally represents environmental, social, and economic stakeholders. See: ***www.sfiprogram.org***.

The American Tree Farm System (ATFS) promotes the sustainable management of forests through education and outreach to family-forest landowners. Private forest owners seeking ATFS certification must conform to the American Forest Foundation (AFF) Standards of Sustainability for Forest Certification. Under these standards and guidelines, private forest owners must develop a management plan based on strict environmental standards and verify their conformance to the Standards. Certified Tree Farmers are committed to protecting watersheds and wildlife habitat, conserving soil, and at the same time producing the wood America needs and uses. The AFF is a non-profit 501(c)3 conservation and education organization located in Washington, DC. It has sole responsibility for setting the AFF Standards. See: ***www.treefarmsystem.org***.

- **Use selective and variable retention harvesting techniques.** *Thinning with retention of habitat patches aims to mimic natural disturbance patterns. Remaining patches help ensure that some vestiges of populations remain on site and that population recovery is not solely dependent on recolonization. These patches may contribute to retaining connectivity (reducing fragmentation) between populations. Retention patches that include small ponds, seeps, and streams serve as good anchor points for population recovery sites.*
- **Recognize the importance and use of small, temporary ponds by pond-breeding amphibians.** *Studies on Vancouver Island have shown that pond-breeding species continue to breed in small, temporary ponds following timber harvest, with some species potentially attracted to reduced canopy-cover conditions. Although regulations do not require buffers on these small habitats, reducing ground disturbance and maintaining ground vegetation and shrubs along the periphery will provide some cover for recently metamorphosed amphibians traveling through clearcuts in midsummer.*
- **Maintain appropriate quantity of surface wood debris.** *Coarse woody debris is an important habitat component for most amphibians and reptiles. For specific guidelines on managing stands to produce woody debris, visit the British Columbia Ministry of Forests and Range website at* **www.for.gov.bc.ca/hre/deadwood/DTmod.htm**

MINING AND OIL AND GAS EXPLORATION AND DEVELOPMENT

Mining and oil and gas exploration and development have increased greatly in recent decades, especially in northern environments. The management of non-renewable resources from northern habitats, such as the Boreal Forests and Taiga of northern British Columbia, Yukon, and Alaska, and in the grasslands and shrublands of the Wyoming Basins has the potential to impact amphibian and reptile habitats. Since pond-breeding amphibians, such as Wood Frogs, are the major concern in these northern ecoregions, the majority of recommendations provided are directed at minimizing impacts on water bodies. Water produced from coalbed methane extraction is currently being dumped into streams, altering water temperature and chemistry, as well as the annual flow regime of both permanent and intermittent streams. Holding ponds are also created in areas where water bodies have not existed before. Increased road construction and traffic volume accompany mineral development. The effects of these intensive and widespread changes in land use and hydrology on grassland and shrubland amphibians and reptiles have only recently begun to be studied.

David Pilliod

Robert Arkle

Mining operations and associated infrastructure can affect water courses used by amphibians and reptiles in the Northwest. This stream channel was relocated and constructed to reduce leaching of contaminants from several kilometers of mine tailings in Idaho. The restored stream has simulated meanders, combinations of riffles, pools, and runs, natural substrate, and stream banks stabilized with burlap and willow seedlings. Three amphibian species began using the stream within two years of construction.

What can landowners and managers do?

- **Buffer water courses and lakes from mining areas and associated activities and infrastructure.** *Leave a buffer of at least 98 feet (30 m) between mining areas and associated roads and watercourses and lakes, except at crossing sites. Locate campsite and associated facilities, fuel storage caches, and the drilling fluid sump a minimum of 328 feet (100 m) from the high-water mark of any permanent water body or course. Locate any solid waste pits a minimum of 98 feet (30 m) from permanent water bodies and above the elevation of the ordinary high-water mark. Wastewater from kitchen and washing facilities should be disposed of in sumps at least 49 feet (15 m) from any water body.*

Virgil Hawkes

Wood frogs range throughout British Columbia, Yukon, and Alaska. This species has the ability to withstand freezing by flooding its cells with a natural antifreeze composed of glucose (sugar).

- **Maintain water quality and reduce erosion and sediment runoff.** *Use settling ponds and other wastewater treatment facilities to reduce sediment runoff and discharge of other contaminants. Control erosion at water crossings using culverts and bridges. Do not deposit materials such as gravel, soil, waste rock, or debris in streams or lakes and use non-toxic drilling fluids. Avoid spilling fuel and other contaminants at docks.*
- **Discourage the use of tailings ponds.** *Contaminants associated with some of these sites are harmful to amphibians and reptiles. To reduce the potential of attracting species to these areas for breeding or to forage, erect fine mesh fencing around the site that is buried into the ground and stands at least 3.5 feet (1 m) tall.*

Steve Corn

Javan Bauder

Toads are attracted to recently burned areas where they feed on ants and breed in open-canopy ponds. Efforts to restore natural fire regimes, through prescribed burning and wildland fire use, may benefit Western Toads.

Scott Shaff

Snake populations decline after sagebrush fires due to reduction of small mammal populations. Preventing or reducing cheatgrass in shrublands reduces fire frequency in sagebrush steppe communities and benefits reptiles.

- **Reduce habitat degradation and barriers to movement.** *Construction and maintenance of access roads and facilties, chemically-based vegetation control measures, and potential spills all pose risks to amphibians and reptiles. Pipelines that are placed directly on the ground or slightly below grade may isolate populations. Underpasses should be incorporated into the design to mitigate these effects.*

FIRE MANAGEMENT

Fire is an historic and important natural disturbance throughout the Northwest, particularly in dry coniferous forests and desert shrublands. Prior to intensive fire suppression, many ponderosa pine forests experienced low-intensity understory burns every 5 to 20 years. Lodgepole pine and other more moist forest types burned in catastrophic fires once every 50 to 500 or more years, depending upon periods of drought.

CAUTION! Excessive or poorly planned fires can do more harm than good. Before you strike a match, consult a qualified prescribed fire specialist. In the U.S., your local state forestry agency or a local NRCS, USFS, BLM, or The 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 not only build fire lines on your property for a reasonable fee, but may actually conduct the burn for you. This may be conducted in a NRCS or USFWS or other cost-share program (See Appendix D). In BC, the Wildfire Act puts the onus on individuals to use fire safely. Burning stubble or grass over an area exceeding 0.2 hectares (0.5 acres) in or within 1 km of forestland or grassland falls in considered a Category 3 open fire according to the Ministry of Forests and Range. Anyone wishing to conduct a burn under these circumstances must follow strict guidelines, obtain a fire burn number, and apply for a permit from the Ministry of Environment. Visit http://bcwildfire.ca/ for more information.

After nearly a century of successful fire suppression, many Northwest forests have become overgrown with shade-tolerant understory shrubs and trees. When these forests burn now, they often burn hotter and more completely than historic fires, and they extend into riparian areas associated with ponds and streams. Historically, sagebrush shrublands also burned somewhat infrequently, but fire frequency has increased dramatically with the invasion and spread of cheatgrass and other invasive annual plants.

The habitat changes that have occurred in Northwest forests due to years of fire suppression have resulted in altered conditions for resident amphibians and reptiles. Species that favor open-canopy conditions, such as many snakes, lizards, and perhaps Western Toads, may have suffered under current forest conditions. On the other hand, high severity fires have likely had negative effects on species that prefer more closed-canopy conditions, such as many salamanders. High severity fires can also result in increased sedimentation to streams, possibly smothering Tailed Frog eggs and reducing foraging areas of tadpoles in the substrate. Increases in stream temperatures from loss of canopy cover may also increase mortality rates or reduce reproductive success of amphibians adapted to cold water, such as Tailed Frog, Giant Salamander, and Torrent Salamander species. In some situations, fire benefits amphibian habitat for several years, by increasing solar radiation and nutrient influx that lead to increased stream productivity.

What can landowners and managers do?

- **Control the spread of cheatgrass in arid areas.** *Cheatgrass and other invasive plant species may alter natural fire patterns in arid areas and consequently change native plant communities and habitats. Consider prescribed burning to remove thatch, followed by the use of herbicides, and then seeding with perennial grasses, forbs and shrubs. Work closely with local land management agency or extension specialists or NRCS.*
- **Consult a prescribed fire specialist to implement a fire management plan.** *Consider the historic fire regime in your area, such as what time of year fires burned and how frequently and intensively. Avoid burning in spring and fall when conditions are moist and amphibians are active. Reptiles are more active during the hot, summer months when wildland fires typically occur in the Northwest.*

EXPLOITATION (COLLECTING AND INDISCRIMINATE KILLING)

Many amphibians and reptiles are popular and valuable in the pet trade. This exploitation has gone unchecked by many state and provincial agencies until recently. In some states, collecting native amphibians and reptiles is legal and even unrestricted. However, check with your state and provincial wildlife agency for current laws because half the species of amphibians in the Northwest are listed and permits may be required for handling them. Species at greatest risk of exploitation in the pet trade are the large lizard species, such as the Collared Lizard. Frogs and toads, particularly in the tadpole stage, are frequently collected by children. However, an appropriate balance needs to be struck between controlling commercial collection for the pet trade and allowing children to pick up and appreciate (temporarily) native amphibians and reptiles. Sadly, numerous snakes are killed even when they pose no danger to humans. For example, non-venomous species like the Gophersnake and Western Hog-nosed Snake are killed because they are confused with Rattlesnakes. Some private landowners seek out rattlesnake dens and destroy them even when risk to humans is minimal.

Gavin Hankes

Bill Leonard

Non-venomous species, such as Gopher Snakes (top), are often killed because they are confused with rattlesnakes (bottom). Many species are subject to persecution by people who fear them and have no understanding of the important role these animals play in the environment as both predators and prey.

What can landowners and managers do?

- **Enforce and obey state and provincial laws for collecting and keeping amphibians and reptiles.** *Some states have recently passed laws to protect native amphibians and reptiles from recreational collecting or sale in the pet trade. In BC, it is illegal to catch or possess native wildlife without a permit. Sensitive species may have handling restrictions. To find out which species have restrictions, contact your state wildlife agency (see Appendix C).*
- **Monitor and control any illegal collections.** *Many managers in nature preserves, national forests, and parks do not realize the number of amphibians and reptiles illegally removed each year by collectors.*

Idaho Department of Fish and Game

Many of our native amphibians and reptiles are susceptible to legal and illegal collecting for the pet trade.

- **Educate the public about amphibians and reptiles in your area.** *Provide information to help people identify venomous and non-venomous snakes and to appreciate and respect these misunderstood species. Ask the public to view these animals in nature and not take them home. Return animals to the exact location where they were captured. Translocated animals are likely to attempt to move back to their original site or may introduce disease to a different population.*

SLOWING THE PET TRADE IN AMPHIBIANS AND REPTILES IN IDAHO

Prior to recent legislation protecting amphibians and reptiles, state collecting permits and undercover law enforcement operations in Idaho indicated that thousands of snakes, lizards, toads, and frogs were collected annually for the pet trade. Lizards, such as Great Basin Collared Lizards and Desert Horned Lizards, as well as snakes, such as Gophersnakes and Rubber Boas, were targeted. Pet stores often bought these native, wild-caught amphibians and reptiles believing that they were captive bred. New state law prohibits the sale of any native amphibian or reptile and allows hobbyists to have no more than four individuals of a species in captivity.

NON-NATIVE AND INVASIVE SPECIES

Non-native species have been identified as one of the leading threats to biodiversity. Non-native species may prey directly upon native species, compete with them for food or cover, facilitate the spread of other non-

DON'T TURN IT LOOSE!

For PARC's policy on release of captive amphibians and reptiles, including those used as teaching aids, refer to the *Please, 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 managers who may be unaware of the problems with releasing animals into the ecosystem. For example, many pets or wild-caught animals held in captivity become diseased, and these pathogens can be transmitted to native species.

native species, introduce novel pathogens, degrade habitat quality, or hybridize with native populations. Appendix F provides a sample list of non-native and invasive species of concern to amphibians and reptiles and their habitats in the Northwest.

What is a non-native species? Species that occur in an area outside of their natural range are often referred to as exotic, introduced, alien, or non-native. Their occurrence may be from purposeful legal releases, illegal introductions, or escapements. Once non-native species have become established, they often have a high capacity to spread into other areas through natural migration or continued introductions by humans—these are often referred to as invasive species. Non-native species in the Northwest have been: 1) introduced from outside of their range (e.g., Red-eared Slider turtles from the southeastern U.S. and Brown Trout from Europe), and 2) native species that have been introduced to new areas within their natural range (e.g., Rainbow Trout stocked into mountain lakes).

Some environments are more sensitive to the introduction of non-native and invasive animal species. The introduction of non-native fishes has caused considerable ecological changes in freshwater systems. Non-native fishes, such as goldfish, mosquitofish, perch, bass, trout, and numerous other species, prey on amphibians and often suppress amphibian reproduction to the point of extirpation from a water body.

Invasive plants have dramatically altered vegetation structure in the open habitats of the arid Northwest where many lizard and snake species live. Dune complexes, juniper parkland, salt desert scrub, and other habitats that typically have barren patches among sparse vegetation are being invaded by cheatgrass, medusahead, and other non-native species. This colonization has degraded the habitats for some lizards that forage in the open and resulted in shifts in the distribution of several snake and lizard species.

Elke Wind

Elke Wind

The American Bullfrog, a non-native species that comes from eastern North America, is much larger than native Northwest ranid frogs (e.g., Red-legged Frog and Spotted Frog). This size difference allows them to outcompete and prey upon native species. Because Bullfrog tadpoles require 1 to 2 years to reach metamorphosis, they are abundant in permanent ponds. Efforts to remove Bullfrogs are generally unsuccessful, except in small ponds with limited vegetation. Preventative measures, such as avoiding the conversion of shallow wetlands that dry up or freeze each year to deep, permanent ponds, restricts the spread of Bullfrogs.

The public also facilitates the spread of many non-native plants and animals. The occurrence of non-native species is correlated with the extent of urban development. Anglers introduce species into water bodies when they release live bait (hellgramites, worms, minnows, crayfish, and "waterdogs"). Children catch American Bullfrog tadpoles and later release them into different water bodies, which has greatly contributed to the spread of this non-native species in the Northwest. Roads and trails create corridors for invasive plants and other species to access backcountry areas. New Zealand mudsnails are transported on boats, waders, and fishing gear.

Changing water levels can affect the suitability of a site for vegetation, potentially creating habitat for invasive species. For example, salt cedar (*Tamarisk sp.*) grows along riparian and floodplain areas of arid interior regions in Oregon, Montana, and Idaho. It consumes huge quantities of water; the roots of a single large plant can pull from the soil about 200 gallons (750 liters) of water a day, 10 to 20 times more than native species. The dense roots of this species can alter flow regimes and increase salt levels in the soil surface and litter. In some areas, goats are being used to control the growth of salt cedar.

What can landowners and managers do?

- **Adopt policies and regulations regarding non-native species that include prevention, early detection, control, and eradication measures.** *Non-native species eradication is an expensive, often losing battle in the Northwest. The best solution is prevention or immediate control of non-native species before they spread and become established.*

Jason Jones

Don't release your bait! Bait species are often not native to the Northwest and are definitely not native to your pond. Larval Tiger Salamanders from the midwestern U.S., also commonly called "waterdogs" by the bait industry, have been introduced into the Northwest where they hybridize with native Tiger Salamanders, thus altering the native gene pool. They are also known to spread a deadly virus to native populations.

Stephan Cooper

In arid regions, control the introduction and spread of invasive plants. Cheatgrass grows densely and fills in gaps that occur naturally between shrubs, reducing habitat suitability for reptiles.

- **Avoid planting (stocking) any fish in streams, lakes, and stock ponds where they do not naturally occur.** *Where fish stocking continues, use only native species from the immediate geographic area.*
- **Remove or eradicate non-native species.** *Salt cedar and Eurasian watermilfoil can displace native species and reduce water levels. Replace non-native plants with native vegetation. Consider eradicating non-native fishes, bullfrogs, and other non-native animals through safe, accepted means.*

Need more information about how to identify and control non-native plants?
State/provincial agencies and county weed control boards are excellent sources of local information. The Plant Conservation Alliance provides fact sheets on over 60 invasive plant species, including Eurasian watermilfoil, Canada thistle, yellow starthistle, purple loosestrife, leafy spurge, spotted knapweed, Russian-olive, and salt cedar. Check out: ***www.nps.gov/plants/alien***. The Nature Conservancy also has good information on ways to combat invasive species. Check out: ***www.nature.org/initiatives/invasivespecies***/.

SUBSIDIZED PREDATORS

Subsidized predators are a general problem for many amphibian and reptile species because of increased predation pressure near towns and adjacent wildlands. Examples of subsidized predators in the Northwest include: coyotes, raccoons, red foxes, opossums, ravens, crows, gulls, and domestic and feral pets (e.g., cats and dogs).

Subsidized predators are native or non-native species whose populations have increased due to resources provided directly or indirectly by humans. Subsidized mesopredators, including raccoons and coyotes, thrive in urban areas because there is abundant food and larger predators, such as wolves and cougars, are absent. In most cases, subsidized predators feed directly on human food waste or prey on other species that thrive in urban areas (e.g., rodents). They also find protection from predators and suitable nesting and denning sites near or within human dwellings.

Coyotes prey on a variety of animals as well, including mammals, birds, amphibians, and reptiles. However, their presence can also keep the populations of other subsidized predators in check, potentially reducing predation pressure on native species.

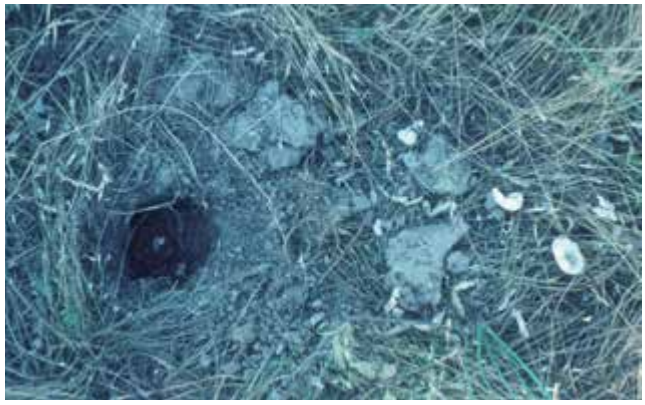
Debra Patla

New Zealand mud snails were discovered in the Snake River, Idaho in the 1980s, where they quickly spread to 8 other states in the West. Although the snails average 1/8" long, they can reach densities of over 50,000 per square foot, competing with native species for space and nutrients. Mud snails reproduce by cloning; one snail can start a new population. They can live in many aquatic habitats ranging from mountain streams to estuaries and can survive for days out of water. For more information about this invasive snail, including how to identify them and help track their spread, visit *www.esg.montana.edu/aim/mollusca/nzms*.

Snakes may be attracted to rural and urban areas because of the increase in rodent populations. Some species can be dangerous to humans, pets, and livestock (e.g., Rattlesnakes), but snakes can also be beneficial in helping to control rodents.

What can landowners and managers do?

- **Control subsidized predator populations by humane means.** *Consult your local animal damage control, animal services, or department of fish and game agency for advice.*
- **Reduce available refugia upon which these species depend.** *Eliminate any denning or nesting sites used by subsidized wildlife on your property. Animal control may provide services in your area to help with this.*
- **Develop and support urban wildlife programs in state/provincial wildlife management agencies.** *State/provincial wildlife management agencies in the Northwest do not necessarily have urban wildlife programs. Effective programs would provide guidance, enforcement, and mitigation for wildlife issues in urban landscapes.*



Charlotte Corkran

Raccoons are major nest predators, especially on eggs and hatchlings of turtles. Subsidized nest predators such as raccoons, skunks, domestic and feral cats, domestic dogs, and coyotes can destroy up to 100% of turtle eggs in some areas. Turtles also nest along roadsides and in powerline right-of-ways, areas that have a high proportion of edge habitat which many subsidized predators prefer. Although turtles are adapted to high levels of nest predation, complete loss of eggs will eventually lead to local extirpation.

Charlotte Corkran

Many amphibians and reptiles are largely defenseless from predators, especially during the breeding season. Although some amphibians and reptiles have toxins in their skin and others can bite, many predators have learned to get around those problems. Crows and ravens have learned to flip toads over to avoid skin toxins on their backs.

Wendy Robertson

Surveys around the San Diego area in California revealed that lizards accounted for 30% of the prey items returned by cats to their owners' homes. Each cat kills approximately 40 animals per year (birds, mammals, and herpetofauna).

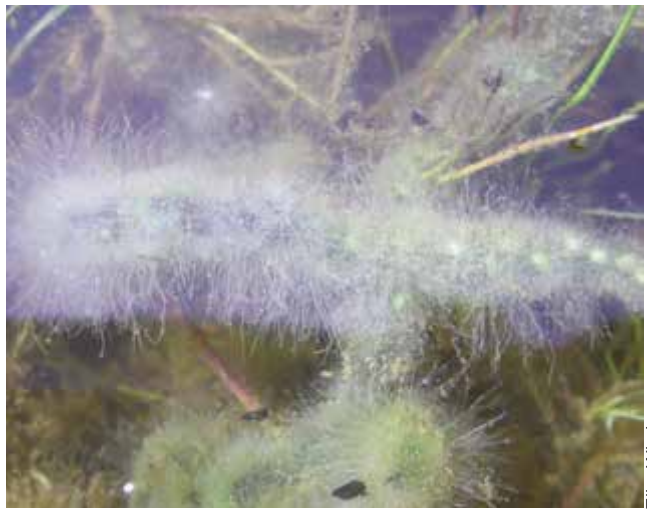
- **Institute garbage storage and collection programs that limit accessibility by wildlife.** *Make available garbage cans and dumpsters that are designed to exclude wildlife. Institute regulations that minimize opportunities for wildlife use of disposal sites. Rural homeowners can use garbage cans with locking lids or keep them in a closed garage.*
- **Develop and enforce regulations that minimize predation by domestic pets.** *Appropriate regulations can help control the incidence of predation by free-ranging pets and minimize feral animal populations.*
- **Restrain pets.** *Keep cats indoors or limit outdoor access. Establish or support spay and neuter programs for feral cats.*

DISEASE

Disease is a major conservation challenge facing some amphibian and reptile species. However, not much is known about many of these diseases, limiting our understanding of how land management practices influence their transmission. Still, the spread of pathogens, such as the amphibian chytrid fungus (*Batrachochytrium dendrobatidis*), may be partly influenced by human actions, such as the introduction of non-native American Bullfrogs to the Northwest. The amphibian chytrid fungus has caused massive die-offs of frogs and toads in the Northwest and other parts of the world. The Ambystoma tigrinum virus (ATV) is a type of iridovirus that attacks salamanders and can be spread from animals in the pet and bait trade to wild populations of Tiger Salamanders. Like the amphibian chytrid fungus, ATV can cause mass mortality in local populations. Landowners and resource managers should be aware of the movement of materials (boats, fishing waders, nets) and organisms (fish, bullfrogs, plants) between water sources. Various disinfection techniques have been studied to help control the spread of amphibian diseases. The USGS has developed a protocol that is a useful precautionary measure for anyone working in or near fresh water—see Appendix G.

What can landowners and managers do?

- **Do not release store-bought amphibians into the wild.** *Captive-raised animals can carry various diseases that are potentially harmful to native amphibians, reptiles, and other wildlife species. Avoid releasing live bait whenever possible.*



Elke Wind

Elke Wind

Some pathogens occur naturally in the environment, such as this water mold that infects dead amphibians. However, some diseases may be introduced and spread by human activities; stressors in the environment may make some amphibian populations more susceptible to infection.

Blake Hossack

Larval mortality can be a natural consequence for Northwest amphibians breeding in ephemeral water bodies. In a warming climate scenario, the timing and availability of water may be one of the biggest issues for amphibians and reptiles. Several long-term studies suggest that amphibians are breeding 1-2 weeks earlier, which can lead to increased mortality due to premature drying of temporary ponds. This has been observed for Columbia Spotted Frogs at Lost Horse pond in the Bitterroot Mountains in western Montana where egg masses were left high and dry.

- **Clean construction equipment, firefighting water containment and delivery equipment, boats, and even waders with a 10% bleach solution.** *Sterilizing equipment is standard practice for most federal firefighting operations, and it is also a good practice for anglers, boaters, and construction personnel. Mild bleach solution will kill most pathogens and prevent potential contamination of amphibian habitats (see Appendix G).*
- **Control the spread of invasive, non-native species.** *American Bullfrogs can transmit diseases to native amphibians, and populations should be controlled to reduce the likelihood of introduction and spread.*

CLIMATE CHANGE

Some researchers have suggested that climate change may be linked to amphibian declines and disease issues in some areas (e.g., Central America). In the Northwest, climate change is affecting terrestrial and aquatic habitats in northern latitudes and at high elevations. There is some evidence that amphibians are breeding earlier because of warmer winter temperatures and earlier spring conditions. The consequences of climate change for amphibians and reptiles are uncertain, but subtle changes in climatic conditions in combination with habitat alteration may be enough to push some at-risk species over the edge.

Landowners and resource managers may take steps to reduce potential impacts of climate change on animals and their habitats. The greatest impacts for amphibians and reptiles will likely be related to the availability of moisture, cover, and water, especially in more arid environments. As temperatures continue to rise, there may be changes to snowmelt hydroperiods of streams and seasonal wetlands. Warmer temperatures may facilitate the northward expansion of many species, or the local extirpation of those that cannot adapt. Given the uncertainties in local patterns of climate and environmental change in the future, we do not offer any specific habitat management guidelines, but feel that many measures recommended herein will help mitigate effects of climate change on amphibians and reptiles (e.g., managing critical habitat elements, following water conservation measures). We suggest initiating periodic monitoring of local habitats and species and adopting an adaptive management approach to respond to observed changes.


R. Chris Brodie

SUMMARY OF SELECT MANAGEMENT GUIDELINES FOR ALL HABITAT TYPES

Taking a proactive approach to improving conditions for amphibians and reptiles can be incorporated into all management plans whether or not the quality of their habitat is a priority objective. Many species can benefit greatly from the inclusion of relatively simple and inexpensive actions. The goal of developing these PARC Habitat Management Guidelines is to help landowners and land or resource managers implement whatever positive actions they can, with the knowledge that the cumulative impact will maintain or improve conditions for amphibians and reptiles, as well as many other wildlife species.

The guidelines in this section are pertinent to amphibian and reptile conservation in all or most habitat types. As such, this section serves as a summary of select management guidelines from individual habitat sections and provides a good overview or place to start.

This section contains two sets of guidelines: (1) Maximizing Compatibility and (2) Ideal

> **"Maximizing Compatibility"** guidelines are for landowners and resource managers who wish to contribute to the conservation and stewardship of these animals while primarily managing their land for other uses, such as timber production, grazing, agriculture, recreation, and residential or industrial development.

- **Identify and appropriately manage key habitats and sensitive habitat features, such as seasonal wetlands, seeps, and rock outcroppings.** *Many species require specific habitats for part of their life cycle or during migration. These habitats and features are often critical to the survival of individuals and long-term persistence of populations in some areas. Maintaining these features and habitat around them improves quality for all wildlife. Consult a herpetologist to help identify special habitat features and determine which management practices and conservation buffer sizes will best benefit your local amphibians and reptiles.*
- **In areas managed for recreation, locate regularly used roads, trails, landings, and facilities away from sensitive habitats and migration corridors used by amphibians or reptiles.** *Limit recreational access to as few points as is feasible. Vehicle-related mortality, illegal collecting and killing (e.g., Rattlesnakes), and noise-related disruptions of natural behaviors are unfortunate side effects of recreational access.*
- **Minimize disturbance of snake hibernacula.** *Where possible, plan the locations of hiking trails and access roads away from snake hibernacula. Consider relocating existing trails if human/snake interactions are frequently reported. If disturbance is inevitable, such as during construction, consider waiting until after snakes have left the hibernacula. However, this practice may not reduce negative population effects because snakes will return to the area in the fall. Consider working with a herpetologist to design an alternative conservation strategy.*

Elke Wind

Rock outcrops, talus, caves, dead trees and stumps provide important microhabitats. Crevices above and below ground are used by most amphibians and reptiles throughout the year.

- **Where possible, minimize construction of new roads and trails, and discourage off-trail motorized vehicle use.** *Develop and enforce travel plans that minimize or eliminate the need for off-highway vehicle (OHV) use, and encourage the use of designated trails and roads. Keep fragile habitats, especially wetlands and stream channels, free of vehicle traffic. Excessive off-trail use can compact and disturb soil, increase erosion and sediment delivery to streams, severely degrade seasonal wetlands, and provide corridors for invasive plants.*
- **Seasonally control vehicle access with gates.** *Seasonal road closures can provide a balance between species and habitat protection while maintaining access for traditional uses like hunting and fishing. Temporarily closing roads during periods when amphibians and reptiles are migrating to or dispersing from breeding and nesting sites can reduce vehicle-related mortality.*

Charlotte Corkran

The greater the access to back country areas, the greater the risk of habitat degradation through the introduction of non-native plants and animals (e.g., game fish), off-highway vehicle use that can degrade wetlands and streams and disturb wildlife, and illegal collecting and poaching.

- **To maintain appropriate habitats and corridors for amphibians, manage not only the wetlands you have today, but manage the predicted habitats you will have in twenty years.** *Climate change may result in rapid and extensive changes in wetland type, extent, quality, flow regime, and persistence. Anticipate the mosaic of habitats you are likely to have in future decades as you consider which areas to reserve for amphibian conservation.*
- **Avoid construction and habitat alteration during the months when amphibian populations are concentrated and vulnerable (including earth moving, general construction, and road building).** *For example, most pond-breeding amphibians concentrate in lakes, ponds, and wetlands to breed from April until June. Eggs and tadpoles remain in these water bodies until late August. Habitat alterations, especially short-term projects, are best done between September and March.*
- **Minimize or exclude agricultural, residential, and industrial waste near aquatic habitats.** *Chemical pollutants can poison aquatic fauna and may contribute to poor water quality or groundwater contamination.*
- **Where applicable in managed forests, meet or exceed state and provincial recommended Forest Practices Guidelines and Best Management Practices (BMPs) including recommendations for streamside Habitat Management Zones (HMZs, also called SMZs or RMZs) or watercourse setbacks.** *Where possible, establish wider HMZs. In some cases, HMZs are adequate to reduce land-use effects on stream-related amphibians and reptiles. In other cases, these practices may be inadequate, especially for species that migrate or disperse between riparian and upland habitats. For links to each state's BMPs, visit www.forestrybmp.net.*
- **Implement an integrated pest management plan. Where herbicides, pesticides, or fertilizers are needed, follow the label instructions carefully and precisely.** *Use the minimum amount required to achieve management objectives. Use only 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 banding or spot applications, and control drift of herbicides whenever possible. Improper or excessive use of chemicals can poison amphibians and reptiles and affect the availability of their prey species.*
- **Control livestock access to rivers, streams, and wetlands.** *Periodic, informal monitoring of vegetation and soil conditions (e.g., moisture, browse patterns) can improve decision-making and provide a flexible,*

adaptive approach to livestock grazing in riparian areas. If livestock use results in habitat degradation, adjust your grazing management plan to utilize water and shade sources. Try to keep livestock out of, or limit access to, wetlands during the amphibian breeding season (e.g., spring to mid summer). One benefit of appropriate grazing in riparian areas is the control of aquatic plants that may overrun the source and cause damage to reptile and amphibian resources as well.

- **In timber management areas, try to plan for connectivity between stands.** *Retaining some forested patches on harvested sites (especially of large trees) can provide "stepping stone" habitats for dispersing amphibians and reptiles.*
- **During timber stand establishment, plan for future prescribed burns.** *Devising firebreaks before planting can reduce the need for heavily plowed or bladed lines when prescribed burns are implemented.*
- **When feasible, harvest timber during seasons when amphibians and reptiles are dormant.** *Amphibians and reptiles are inactive during late fall and winter.*
- **In timber management areas, buffer wetlands to maintain water quality and try to leave some surrounding uplands undisturbed to provide habitat for amphibians and reptiles.**
- **Attempt to replant (preferably with native species) and reduce erosion in disturbed areas, especially around skidding and landing zones.** *Deactivate or restore temporary roads that are constructed during harvest to prevent further use. Amphibians are often attracted to the water that pools in these rutted, compacted soils. Northwestern Salamanders, Long-toed Salamanders, and Red-legged Frogs will occasionally use the pools for reproduction.*
- **During timber harvesting, leave woody debris on site to decompose.** *Stumps, tip-ups, logs, and other coarse woody debris can maintain soil moisture and provide nesting, foraging, and shelter habitats for amphibians and reptiles.*
- **Retain snags.** *Dead standing trees provide important habitat for some snake, lizard, and salamander species and provide a source of future downed wood.*
- **Minimize soil disturbance when using heavy equipment near amphibian and reptile habitat.** *Avoid operating heavy equipment in sensitive areas (e.g., near wetlands), or limit use to cool, dry seasons or when ground is frozen. Heavy equipment tends to cause soil compaction, increase erosion, and form tire ruts. Although some amphibian species may be able to breed in tire ruts on the edge of low-traffic roads, these breeding sites tend to have high mortality due to rapid drying and vehicle-related mortality.*
- **Where appropriate, use fire as a vegetation-management tool.** *Mechanical thinning and burning of piled debris may be effective at reducing fire risk in the wildland-urban interface, but a schedule of prescribed fire will also help with wildland fire control and benefit amphibians and reptiles by minimizing soil disturbance. The vegetation used by many amphibians and reptiles for foraging 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.*

Payette National Forest

Coupled with selectively used herbicides, fire can be an effective management tool to control invasive plants and create gaps and a mosaic of cover types for reptiles.

- **Provide conservation-related educational materials to boaters, fishermen, hunters, loggers, hikers, campers, farmers, and other people who are regularly outdoors.** *Discourage field personnel and the public from collecting or killing turtles, and snakes. An informed public benefits everyone. People are often interested in amphibians and reptiles but are unaware of conservation issues related to these species.*
- **Consider developing neighborhood partnerships.** *Work with neighbors to design a mix of land-management practices across adjacent land ownerships. This approach could increase habitat diversity and lead to shared contributions to habitat management (i.e., timing, intensity, frequency of management).*

IDEAL: Maintaining and Enhancing High Quality Habitat

Consider implementing the following guidelines when benefiting amphibians and reptiles is a primary objective, as within nature preserves, wildlife refuges, and on private or agency lands whose owners wish to restore, enhance, or maintain natural habitat conditions for native herpetofauna.

- **Ensure the availability of essential complementary habitat types.** *Most amphibians and reptiles require two or more habitats to survive and reproduce successfully, such as a seasonal wetland for breeding and larval development and adjacent upland forest for the adult life stage. Reducing the quality or eliminating any one of these complementary habitats, even if the others are in ideal condition, may lead to declines and even local extirpation.*
- **Maintain contiguous habitat gradients (unfragmented transition zones between adjacent complementary habitat types).** *Ensure that land-use practices do not disrupt or sever seasonal migration and dispersal pathways of amphibians and reptiles.*
- **Where appropriate, restore historic disturbance regimes.** *Restoration of natural processes and their natural seasonality of occurrence will likely benefit amphibians and reptiles. For example, careful planning and appropriate conditions may enable prescribed fires to be conducted during summer (the historic period for fires in the Northwest) instead of spring or fall. Restoring natural flood regimes to river and stream systems would favor aquatic system ecology and natural dynamics.*
- **Close unneeded roads and avoid construction of new roads whenever feasible.** *Vehicle-related mortality rates of amphibians and reptiles are often high, even on dirt and gravel roads.*
- **Wherever possible, prohibit off-road motorized vehicle use except for official management purposes.** *Motorized vehicles compact and disturb soil, increase erosion and sediment, provide corridors for invasive plant species along trails, elevate vehicle-related mortality rates, and often result in wetland impacts.*
- **Install open-bottom arch culverts or tunnels in conjunction with roadside barriers to direct animals under roads.** *Passageways should be placed where frequent roadkills indicate migratory pathways, often to or from a breeding site or hibernacula. Not all culverts are helpful for amphibian and reptile passage, and each site and culvert type should be evaluated carefully.*

Elke Wind

Off-highway vehicles can significantly damage water bodies and their associated fauna, killing eggs and larvae, eroding banks, introducing invasive species, and reducing water quality.

Elke Wind

Kayt Chambers

Volunteers help migrating toadlets unable to cross this highway because of concrete barriers located in the center. The health of amphibian and reptile populations is dependent on their ability to migrate and pass genes among populations.

- **Restore or retain the natural formation of stream meanders, bank dynamics, and associated vegetation.** *Natural water flow patterns and water level fluctuations are critical to maintaining the environmental conditions and vegetation communities in which amphibians and reptiles forage, breed, and bask.*
- **Maintain or restore natural hydrological cycles of wetlands by filling unused drainage ditches.**

- **Reduce or remove impermeable surfaces near wetlands.** *Chemical runoff from parking lots and road surfaces can contaminate wetlands. Stormwater runoff into wetlands can change water levels rapidly and disrupt amphibian breeding sites.*
- **Where feasible, reduce the use of fertilizers, herbicides, and pesticides.** *Where chemical application is desirable or unavoidable (e.g., to remove invasive plants), use selectively and follow instructions very carefully. Even small concentrations of some chemicals can be harmful to amphibians, especially aquatic larvae.*
- **Closely control livestock use near rivers, streams, wetlands, and other water bodies.** *Provide alternative water and shade sources. Heavy livestock use in and around water bodies can trample or denude native plants to the point where vital habitats are lost for amphibians, reptiles, and their prey. Excessive concentrations of nutrients from manure in aquatic systems may cause unnatural algae blooms, alter dissolved oxygen and carbon dioxide levels, and eliminate aquatic organisms.*

Sara Ashpole

These cattle are standing in a wetland used by Spadefoots for breeding.

- **Manage for a variety of stand ages and types to provide a variety of habitat conditions at the stand and landscape level.** Consider establishing some no-entry patches within harvesting areas and using forest density management (e.g., thinning to achieve variable canopy closure). Heterogeneous forest stands and landscapes provide a variety of habitat conditions for different amphibian and reptile species.
- **Consider scheduling log-hauling operations that are adjacent to amphibian areas in drier months or in late fall or winter.** *If possible, avoid log-hauling immediately adjacent to amphibian breeding ponds during critical times, such as breeding or juvenile-dispersal months.*
- **Use prescribed fire to restore natural fire regimes.** *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.*
- **Maintain or restore native vegetative structure and composition.** *Remove or contain the spread of invasive plant species. Many amphibian and reptile species may be better adapted to the environmental conditions provided by native vegetation. Thus, native vegetation will likely support robust populations of these animals.*
- **Maintain or restore fish-free wetlands.** *Restricting vehicular public access may discourage unauthorized fish stocking. Remove introduced game fish where necessary. Predatory fish feed on breeding amphibians and tadpoles.*

Idaho Department of Fish and Game

Introduced fish have negative effects on amphibians through direct predation, competition for food or resources, and introduction of diseases.

- **Remove old cars, tires, electrical appliances, and other items that may leak contaminants into wetlands and streams.** *Chemical contamination from such sources may be harmful to aquatic amphibians and reptiles.*
- **Do not remove eggs, tadpoles, or adult amphibians from wetlands.** *Handling animals increases their stress and may increase risk of disease and mortality. Removal may alter population structure and, if not replaced exactly where they were found, may affect population genetics.*
- **Develop education programs about local amphibians and reptiles.** *Conduct presentations, such as evening campfire programs or docent-led natural history programs, about the biology of amphibians and reptiles in the local area. Informational signs and brochures at trailheads are an effective way to increase awareness and appreciation of these fascinating but often misunderstood animals.*

EDUCATION PROGRAMS

There are several programs available in the Northwest that provide educational materials about amphibians and reptiles for educators. For example:

1. Alberta Conservation Association developed a program called "Alberta's Reptiles: Helping to Lend a Hand (or Two or Three). Teacher's Guide for Grade Seven Science: Interactions & Ecosystems". You can find this 110 page teaching guide at: ***www.ab-conservation.com*** or other educational material at the Environment Education website of Alberta Sustainable Resource Development at ***www.gov.ab.ca/env/resedu/wildlife.cfm***
2. The U.S. Department of Agriculture Forest Service offers a set of conservation and science teaching tools that can be downloaded for free at ***www.naturalinquirer.usda.gov/***
   Check out: *As the Frog Hops: What Routes Do Frogs Travel In Mountain Environments?* in Wilderness Benefits Edition (volume 7, number 1) and *Knocked Out By Trout: The Relationship Between Non-native Trout and Pacific Treefrogs* in Invasive Species Edition (volume 8, number 1)

Katharine Shick

Michele Jones

Elke Wind

Education is often the best first step towards conservation, especially of misunderstood and feared animals, such as snakes.

Jason Jones

MANAGEMENT GUIDELINES FOR SPECIFIC HABITAT TYPES

Each of the habitat sections contains two sets of guidelines: (1) Maximizing Compatibility and (2) Ideal.

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

"Ideal" guidelines are for landowners and land or resource managers who want to make amphibian and reptile conservation a primary objective, such as on nature preserves, wildlife refuges, and private or agency lands where optimizing the diversity and abundance of herpetofauna is desired.

Erin Muths

The Wyoming Toad is one of the most endangered species in the United States. Lake Mortenson is the last known location for the species in the wild. Managing habitat for amphibians and reptiles helps avoid the costly recovery efforts required to save species on the brink of extinction.

Erin Muths

Charlotte Corkran

MOIST CONIFEROUS FOREST

Deanna H. Olson

Although the Pacific Northwest is often stereotyped as having an abundance of moist coniferous forests, this habitat has a restricted distribution within the region. Classic wet, temperate coniferous forests dominate uplands along the west coast of the Northwest from Alaska down to California, in the Gulf of Alaska Mountains and Fjordlands, S.E. Alaska – B.C. Coastal Forest and Mountains, North Cascades, Pacific Northwest Coast, West Cascade, and California North Coast ecoregions. In inland areas, windward slopes of mountain ranges, such as the West Cascades and Canadian Rocky Mountains ecoregions also have moist coniferous forest types. Climate and vegetation in these forests vary in relation to elevation, aspect, latitude, and coastal versus interior location. As such, the term 'moist' (e.g., amount of precipitation received and retained) is relative to where you are within the Northwest. Moist coniferous forests are composed primarily of Douglas-fir, Sitka spruce, western red cedar, western hemlock. Moist coniferous forests in the Intermountain West contains a mixture of tree species that are commonly found in dry sites as well. Depending on stand age, unmanaged moist coniferous forests usually have fairly dense stands of large trees, an understory that inclused moss, ferns, and rich organic soils.

The herpetofauna most closely associated with moist coniferous forests include: 1) terrestrial lungless salamanders, 2) stream-breeding amphibians, and 3) pond-breeding amphibians. Terrestrial salamanders are typically found in moist refuges, such as downed wood or coarse substrates. Stream-breeding amphibians occupy cool mountain tributaries and the adjacent riparian and upslope forest areas. Pond-breeding amphibians

Elke Wind

Many Northwest amphibian species are associated with older forests, large downed wood, and small stream habitats that provide appropriate temperature, moisture, and cover. Timber-harvesting techniques, such as group selection and individual selection, and continuing efforts to leave stumps and downed wood, reduce soil compaction, and buffer streams help maintain these habitat elements and conditions for amphibians.

breed in standing water and then disperse into forested uplands for foraging and refuge. Many of these amphibians are endemic to the region and have specific habitat needs. Consequently, no matter where you are in the moist coniferous forest landscape, about half of the amphibians at that location are of conservation concern to state or federal resource agencies. Small streams, springs, and seeps are often embedded in these forest habitats and increase the diversity of amphibians found in the forest. Several reptile species occur in moist forests, although most use other habitat types as well.

The loss of tree canopy cover and ground disturbances from development and timber harvest activities are major challenges to herpetofauna conservation in Northwest moist coniferous forests. Loss of canopy cover changes the microclimate conditions required for many amphibian species, particularly in southern latitudes and on south-facing slopes. Ground disturbance affects both surface and subsurface microhabitats and can be harmful to species that are associated with duff, litter, and downed wood. Stream-dwelling amphibians in these forests are affected by increased siltation and water temperatures that may occur after timber harvest, as well as alteration of bank and streambed morphology

Bill Leonard

A large number of lungless, terrestrial-breeding salamanders are only found in moist coniferous forests in the Northwest. Maintenance of a cool, moist forest floor enhances their survival in these habitats.

CHARACTERISTIC SPECIES

Salamanders: Northwestern Salamander, Rough-skinned Newt, all species of Climbing, Slender, Ensatina, and Woodland Salamanders; **Frogs and Toads:** Red-legged Frog, Foothill Yellow-legged Frog, Cascades Frog, Columbia Spotted Frog; **Snakes:** Rubber Boa, Sharp-tailed Snake, Aquatic Gartersnake

MAXIMIZING COMPATIBILITY: Timberlands, Farmlands, Recreational Lands, and Other Integrated Land Uses

Consider the following options if benefiting amphibians and reptiles is secondary to other management objectives.

- **Whenever possible, conduct forest management activities and ground disturbances in dry summer or cold winter months.** *Forest amphibians are less active at the surface during these times. However, reptiles may still be active during dry summer months.*
- **Manage for a variety of stand ages and types to provide a variety of habitat conditions at the stand and landscape level.** *Consider establishing some no-entry patches within harvesting areas and using forest density management (e.g., thinning to achieve variable canopy closure).*
- **Consider the effects of site location, precipitation patterns, and topography on the retention of cool, moist microhabitats for forest-associated amphibians.** *For example, species may be more resilient to the loss of forest canopy cover on north-facing slopes in maritime climates near the coast compared to inland, south-facing slopes. However, these north-facing coastal areas may be species hotspots or source areas for recolonization.*
- **Retain downed wood.** *Amphibians and reptiles use downed wood as cover and sources of moist microhabitats during the dry season.*

Elke Wind

Many terrestrial salamander species lay their eggs in downed logs, and both amphibians and reptiles use downed wood for cover.

IDEAL: Refuges, Sanctuaries, and Preserves
Consider the following options if benefiting amphibians and reptiles is a primary objective and when landowners and managers wish to restore, enhance, or maintain natural habitat conditions for native herpetofauna.

- **Maintain or restore the specific habitat conditions with which resident species are associated.** *Due to the complex life histories of many forest-dwelling amphibians, they may rely on several microhabitat conditions within the terrestrial forest landscape such as large downed wood, talus, and cool microclimates provided by shading.*
- **Attempt to replant (preferably with native species) and reduce erosion in disturbed areas, especially around skidding and landing zones.** *Deactivate or restore temporary roads that are constructed for timber harvesting to prevent further use. Moving stumps and logs into these heavy use areas can provide cover and moisture for amphibians and reduce further use of these areas as roads.*
- **Retain large trees and conserve snags for future recruitment of downed wood used by amphibians and reptiles for cover and breeding.**
- **Maintain natural wetland habitats and nearby uplands through the use of buffers.** *Buffers at least 50-330 feet (15-100 m) wide will provide cooler, moister conditions near streams and wetlands and increase long-term recruitment of litter and wood to the forest floor.*

This is the "Moist Coniferous Forest" module of the PARC Publication HMG-4, ISBN 0-9667402-5-4. Please visit ***www.parcplace.org*** for further information, copies of the complete document, or a web-based version of the Guidelines.


Elke Wind


Elke Wind

Northwest amphibians associated with moist coniferous forests benefit from timber harvesting practices that retain cover and moist microsites.


Elke Wind

Charlotte Corkran

DRY CONIFEROUS FOREST

David S. Pilliod

Dry coniferous forests occur on the east side of the Cascade ranges and Coast Mountains in ecoregions East Cascades – Modoc Plateau, Klamath Mountains, and Okanagan, and throughout the Intermountain West (e.g., Canadian Rocky Mountains, Middle Rockies – Blue Mountains, and Utah – Wyoming Rocky Mountains ecoregions). These forests are typically found at low to mid-elevations and are characterized by warm, dry summers and cold, dry winters. Most precipitation falls as snow. These forests are dominated by ponderosa pine, Jeffrey pine, Douglas-fir, grand fir, and lodgepole pine.

Amphibians in dry coniferous forests are found in and around water and in terrestrial habitats with structures that retain moisture, such as decomposing downed wood. Columbia Spotted Frogs and Western Toads will travel up to a mile (1.6 km) or more from breeding sites to distant ponds and meadows in search of food. Some of these migrations occur through dry forest, but usually only at night, during rain events, or along stream corridors. Although capable of traveling long distances, most adult salamanders remain within a few hundred meters of ponds and streams. Western Rattlesnakes, Prairie Rattlesnakes, Gophersnakes, and Northern and Southern Alligator Lizards can be found in open, dry forests, particularly in areas near rock outcrops and on south-facing slopes. Rattlesnakes have been known to travel 1-2 miles (1.6-3.2 km) from rocky hibernacula in dry forests. Racers, Gartersnakes, and Rubber Boas are often found in small openings within dry forests.

The three primary disturbances in dry coniferous forests are fire, fire exclusion, and logging. However,

Payette National Forest

Fire plays an important role in the ecology of dry coniferous forests. Many species are adapted to fire as a natural disturbance.

more recently, Mountain Pine Beetle has become a serious concern in relation to dry coniferous forests in the Northwest as well. Historically, ponderosa pine forests had low severity, understory fires every 5-20 years. These fires removed downed wood and killed shrubs and young trees. Suppression of wildfires across the Northwest has resulted in an accumulation of downed wood and greater densities of young shade-tolerant trees and tall shrubs. Fires that burn in these forests tend to burn hotter (more fuel is available), move from the ground into the canopy (via ladder fuels like tall shrubs), and burn across larger areas. To

David Pilliod

Although the trees are severely burned, toads are attracted to recently burned forests where they forage for abundant insects and deposit eggs in open-canopy wetlands.

reduce the chance and slow the spread of future wildfires, current U.S. federal policies mandate reducing hazardous fuels by selective logging (thinning), prescribed fire, or both. Although still a common disturbance, harvesting of commercial timber in dry coniferous forests has been greatly reduced in the last decade. This may increase on public lands in the future as another mechanism of fire control or as a surrogate for fire disturbance patterns. In addition, thinning of stands in the wildland-urban interface is much more common as home-owners attempt to reduce fire risk. These practices likely have mixed effects on amphibians and reptiles depending on many factors.

CHARACTERISTIC SPECIES

Salamanders: Long-toed Salamander; **Frogs and Toads:** Rocky Mountain Tailed Frog, Coastal Tailed Frog, Western Toad, Columbia Spotted Frog, Wood Frog; **Lizards:** Western Fence Lizard, Sagebrush Lizard, Western Skink, Southern Alligator Lizard, Northern Alligator Lizard; **Snakes:** Rubber Boa, Smooth Greensnake, Eastern Racer, Gophersnake, Common Kingsnake, California Kingsnake, Western and Prairie Rattlesnakes

Charlotte Corkran

Downed wood provides important cover and moist microsites for salamanders, especially in dry forests. When possible, retain downed wood during timber harvesting and fuel-reduction activities.

Alan St. John

In the Northwest, Common Kingsnakes are found in dry coniferous forests of southern Oregon and northern California, usually near water and in areas with suitable cover, such as rocks and logs.

MAXIMIZING COMPATIBILITY: Timberlands, Farmlands, Recreational Lands, and Other Integrated Land Uses
Consider the following options if benefiting amphibians and reptiles is secondary to other management objectives.

- **Conduct prescribed fire activities late in the fall (after first frost).** *Spring and early fall burns may coincide with the timing of amphibian migrations to breeding or overwintering habitats or when snakes are moving to or from hibernacula.*
- **During fuel reduction activities, such as thinning and prescribed burning, retain some downed wood within stands.** *Several Northwest salamander species use downed wood for moisture and cover. Consult a wildlife biologist or herpetologist to determine appropriate levels of wood to retain while still meeting fuel reduction objectives.*
- **Prescriptively graze livestock among pastures or grazing allotments to avoid leaving inadequate vegetative cover in forest lands.** *Forests with inadequate ground vegetation provide less cover and poorer habitat conditions for amphibians and reptiles.*
- **Minimize logging on steep slopes.** *Steep slopes are more prone to erosion, resulting in stream sedimentation that can negatively affect species of Tailed Frogs, Torrent Salamanders, and Giant Salamanders.*

IDEAL: Refuges, Sanctuaries, and Preserves
Consider the following options if benefiting amphibians and reptiles is a primary objective and when landowners and managers wish to optimize herpetofauna diversity and abundance.

- **During fuel treatments, retain some unburned or unthinned areas to provide refugia.** *Patches of unburned or unthinned areas will provide a wider range of habitats in case fuel treatments result in high mortality or detrimentally alter habitat conditions for a species.*
- **Identify likely corridors among habitat features (ponds, seeps, rock outcrops) and maintain connectivity by minimizing activities in these areas.** *Undisturbed patches or corridors that have high cover and moisture can provide important migratory habitat. Retaining undisturbed buffers of at least 50-330 feet (15-100 m) on either side of streams is an effective way of accomplishing this for amphibians and some reptiles.*
- **Restore natural fire regimes using prescribed fire at the historic fire return interval and during the natural fire season.** *In dry forests, this will involve burning under dry conditions and thus may require repeated treatments over time to accomplish objectives safely.*
- **Closely manage livestock around forest ponds, riparian forests, and streams.** *As an alternative, create livestock watering troughs or provide restricted access points to streams.*
- **Retain large trees and conserve snags for future recruitment of downed wood.** *These structures provide important basking, foraging, and shelter habitats for many amphibians and reptiles.*
- **Maintain natural wetland habitats and nearby uplands through the use of buffers.** *Buffers at least 50-330 feet (15-100 m) wide will provide cooler, moister conditions near streams and wetlands and increase long-term recruitment of litter and wood to the forest floor*
- **Allow natural beaver activity where possible, or consider reintroducing beaver where they have been lost.** *Beaver create and maintain wetland habitats used by amphibians and aquatic or riparian reptiles. They may also help maintain water tables for livestock and wildlife species in arid lands.*
- **Attempt to replant (preferably with native species) and reduce erosion in disturbed areas, especially around skidding and landing zones.** *Deactivate or restore areas where temporary roads have been constructed during harvest to prevent further use by recreational users. Moving stumps and logs into these heavy use areas can provide cover and moisture for amphibians and reduce further use of these areas as roads.*

This is the “Dry Coniferous Forest” module of the PARC Publication HMG-4, ISBN 0-9667402-5-4. Please visit ***www.parcplace.org*** for further information, copies of the complete document, or a web-based version of the Guidelines.


Dona Naylor

MIXED CONIFEROUS AND DECIDUOUS FOREST

Elke Wind

Mixed coniferous and deciduous forests in the Northwest typically occur inland, primarily in the Willamette Valley – Puget Trough – Georgia Basin ecoregion from southern Oregon to British Columbia. In the south, a small belt of mixed forest also occurs on south-facing mountain slopes in the California North Coast ecoregion in northern California and southern Oregon. Some areas of the Canadian Rocky Mountains ecoregion also contain mixed coniferous and deciduous forest. In coastal areas, typical conifer species in these forests include western red cedar, western hemlock, and Douglas-fir, intermixed with big leaf maple, arbutus (or Madrone), and Oregon white oak (or Garry oak). In interior valleys, conifers become less dense and big leaf maple, Oregon ash, and black cottonwood are more common.

Mixed forest conditions provide a variety of microhabitat features important for amphibians and reptiles. Deciduous leaf litter contributes valuable nutrients to the forest floor supporting a variety of invertebrates, the prey base for many reptile and amphibian species like the terrestrial salamander Ensatina. Other common amphibians include Rough-skinned Newts, Long-toed Salamanders, and Red-legged Frogs. Small openings and south-facing rock outcrops are important basking and cover habitat for a variety of reptiles such as Northern Alligator Lizards, Ring-necked Snakes, Northwestern Gartersnakes, and Western Rattlesnakes.

The geographic locations that contain mixed forests correspond with areas of high species diversity. However, in the west, the mild climates have also made these areas attractive to human development, resulting in extensive resource management, urbanization, and agriculture. As a consequence, only very small patches of natural mixed forest habitat remain, consisting of largely isolated and often degraded remnant patches. A reduction in fire frequency has allowed conifers, shrubs, and non-native species to encroach on oak-dominated forests.


Elke Wind

Only five percent of the original mixed forest habitat remains within the Puget Lowlands, the majority of which consists of small, isolated areas surrounded by urban development and agriculture. In Oregon, only one-tenth of one percent of the Willamette Valley's native grasslands and oak savannas remains. In southwestern British Columbia, Garry oak habitats are considered one of the most threatened ecosystems in the province.

CHARACTERISTIC SPECIES

Salamanders: Northwestern Salamander, Rough-skinned Newt, Plethodon salamanders; **Frogs and Toads:** Pacific Treefrog, Red-legged Frog, Oregon Spotted Frog; **Lizards:** Western Fence Lizard, Alligator Lizards; **Snakes:** Rubber Boa, Sharp-tailed Snake, Northwestern Gartersnake, Terrestrial Gartersnake, Western and Prairie Rattlesnakes; **Turtles:** Pacific Pond

Christian Engelstoft

Sharp-tailed snakes are found in mixed-wood forests in northern parts of their range.

Turtle

MAXIMIZING COMPATIBILITY: Timberlands, Farmlands, Recreational Lands, and Other Integrated Land Uses

Consider the following options if benefiting amphibians and reptiles is secondary to other management objectives.

- **Manage for a variety of stand ages and types across the landscape to ensure that some mixed forest component exists.** *Avoid the conversion of large areas of mixed forest to pure coniferous stands where these forests historically did not occur. Native species are adapted to a variety of forest types across the landscape.*
- **Identify potentially threatened or increasingly rare mixed forest areas within the landscape that may require protective buffers or connective habitat corridors.** *Isolated patches and areas containing unique habitat features used by herpetofauna, such as aquatic breeding sites (e.g., ponds and streams), terrestrial nesting sites (e.g., for turtles), hibernacula, and rock outcrops or basking sites are often imbedded in these forest habitats and are particularly important.*
- **Consider alternatives to clearcut harvesting in dry Douglas-fir stands.** *These forest types are ideal candidates for alternative practices, such as uneven-aged management and selective logging. Oaks and arbutus (Madrones) will usually resprout naturally and result in mixed stands.*
- **Avoid encroachment of shrubs and invasive species into the understory by incorporating a fire management plan.** *This will help maintain the grass understory associated with oak-dominated forests. Although grazing may also help maintain grasses and forbs, it may contribute to the introduction and spread of invasive species such as Scotch broom.*

Elke Wind

Retention of even small amounts of mixed forest can increase biological diversity.

- **Retain downed wood.** *Amphibians and reptiles use downed wood as cover and sources of moist microhabitats during the dry season.*

IDEAL: Refuges, Sanctuaries, and Preserves

Consider the following options if benefiting amphibians and reptiles is a primary objective and when land owners and managers wish to optimize herpetofauna diversity and abundance.

- **Inventory, map, and appropriately manage for biodiversity values in remaining patches of mixed forest.** *Ideally, reserves should be as large as possible, connected to and in close proximity to other similar habitats. Priority should be given to those containing important habitat features for amphibians and reptiles (e.g.,*

breeding or nesting sites, hibernacula, and basking sites).

- **Maintain low stand densities of conifers and reduce shrub understory.** *To maintain oak dominance, implement prescribed burning, selective harvesting practices, or both.*
- **Remove or eradicate non-native plants.** *Scotch broom, spotted knapweed, leafy spurge, and other non-native and invasive plants can degrade upland habitats used by amphibians and reptiles.*
- **Retain large trees and conserve snags for future recruitment of downed wood.** *These structures provide important basking, foraging, and shelter habitats for many amphibians and reptiles.*
- **Maintain natural wetland habitats and nearby uplands through the use of buffers.** *Buffers at least 50-330 feet (15-100 m) wide will provide cooler, moister conditions near streams and wetlands and increase long-term recruitment of litter and wood to the forest floor.*
- **Do not discourage the activities of beavers whenever possible, or consider reintroducing beaver where they have been lost.** *Beaver create and*

David Pilliod

A year after beaver were introduced into this small stream in southwestern Idaho, Columbia Spotted Frogs colonized the newly created ponds and began breeding successfully in the stream for the first time in many years.

Charlotte Corkran

MOIST AND DRY DECIDUOUS FOREST

Elke Wind

maintain wetland habitats used by amphibians and aquatic or riparian reptiles. They may also help maintain water tables for livestock and wildlife species in arid lands.

- **Attempt to replant (preferably with native species) and reduce erosion in disturbed areas, especially around skidding and landing zones.** *Deactivate or restore areas where temporary roads have been constructed during harvest to prevent further use by recreational users. Moving stumps and logs into these heavy use areas can provide cover and moisture for amphibians and reduce further use of these areas as roads.*

This is the "Mixed Coniferous and Deciduous Forest" module of the PARC Publication HMG-4, ISBN 0-9667402-5-4. Please visit **www.parcplace.org** for further information, copies of the complete document, or a web-based version of the Guidelines.

Elke Wind

Red alder out-competes more valuable coniferous species and is actively controlled in forest management. However, red alder is beneficial in that it can fix nitrogen from the air and convert it into a form useful to other vegetation. Red alder harvest has become economically viable in cabinetry and pulp markets. Many companies allow alder to grow on sites not suitable for planting conifers or they maintain a small alder component in conifer stands.

Dona Naylor

In interior regions, aspen stands often grow on poorly drained sites and along riparian areas. Aspen groves are often found in association with a rich ground cover, making them attractive grazing areas for livestock. Avoiding or limiting grazing in some groves may help protect important habitat for four amphibian and five reptile species.

Although conifers are the most common trees in the Northwest, deciduous hardwoods occur in most ecoregions and form important habitats for amphibians and reptiles. For example, aspen, alder, cottonwood, and birch can be found on moist sites, along riparian areas, floodplains, and around wetlands (see Riparian Areas). Hardwood thickets can also be found in disturbed areas such as logging roads and landings, and along avalanche paths. Small isolated patches of aspen occur in upland areas of eastern slopes of the Cascades, often at higher elevations. Aspen stands are more common in northeastern Washington and the Intermountain West. Tanoak, white oak (or Garry oak) and other oak woodlands occur in inland valleys and slopes in hardpan or rocky soils from California to southern British Columbia.

Several amphibian species occur in deciduous forests. Studies in western Oregon found Rough-skinned Newts, Western Red-backed Salamanders, and Red-legged Frogs to be more common in deciduous stands than coniferous stands or shrub-dominated forests. For some amphibians and reptiles, the location or climate where hardwoods grow may be more of a determining factor than specific tree species. Compared to conifer-dominated forests, hardwood stands may contain unique invertebrate assemblages, the prey base of amphibians and many reptiles.

Hardwoods, such as black cottonwood, paper birch, red alder, and bigleaf maple are economically viable for timber harvesting. Demand for these species is largely driven by the pulp wood market, which fluctuates wildly. Past forestry practices resulted in a high proportion of hardwoods within the landscape in the early 1990s. However, recently the annual removal of hardwoods in Washington has exceeded the growth rate and the availability of some hardwoods, such as aspen and oaks, has declined. To counter this, commercial thinning prescriptions on the Olympic Peninsula outline the maintenance of all "minor species" (i.e., deciduous trees and shrubs), which contributes to other benefits associated with variable density thinning. In some areas, natural hardwood stands are most common along streams and around lakes and wetlands due to adherence to riparian management guidelines. The biologically diverse oak woodlands are becoming rare due to urban development, land conversion, grazing, fire suppression, disease, conifer encroachment, and increased recreation.

CHARACTERISTIC SPECIES

Salamanders: Northwestern Salamander, Long-toed Salamander, Giant Salamanders, Rough-skinned Newt, Clouded Salamander, Western Red-backed Salamander; **Frogs and Toads:** Western Toad, Red-legged Frog; **Lizards:** Western Fence Lizard, Northern Alligator Lizard; **Snakes:** Rubber Boa, Sharp-tailed Snake, Red-bellied Snake, Western and Prairie Rattlesnakes; **Turtles:** Pacific Pond Turtle, Painted Turtle

MAXIMIZING COMPATIBILITY: Timberlands, Farmlands, Recreational Lands, and Other Integrated Land Uses

Consider the following options if benefiting amphibians and reptiles is secondary to other management objectives.

- **Be aware of the tree species that naturally occur in your area, especially aspen stands and oak woodlands, and retain a representative proportion of deciduous species and stands within the landscape.** *Whenever possible, retain connective corridors of natural vegetation between these habitats.*

- **Allow recreation and low-impact livestock grazing only in early spring in oak woodlands.** *Native ground cover species associated with these woodlands are particularly sensitive to disturbance during the active growing and flowering season.*
- **Conduct prescribed burns where appropriate.** *Burning helps control invasive plant species and maintains suitable levels of ground cover and open areas used by amphibians and reptiles.*
- **Where chemical herbicide controls are needed, use spot removal treatments rather than broad applications.** *Avoid applying herbicides during amphibian breeding seasons and near ponds and streams.*
- **At hardwood pulpwood sites, leave some woody debris on the ground for thermal and protective cover and for input of nutrients.** *Woody debris provides amphibians and reptiles (and the invertebrates they prey upon) with moist microsites and cover from predators. This improves the suitability and biodiversity of the site, and adds nutrients for young trees.*

IDEAL: Refuges, Sanctuaries, and Preserves
Consider the following options if benefiting amphibians and reptiles is a primary objective and when landowners and managers wish to optimize herpetofauna diversity and abundance.

- **Locate and map deciduous stands on a landscape level and determine their status regarding size,**

Elke Wind

Virgil Hawkes

Numerous reptile species found west of the Cascade Mountains, such as Southern Alligator Lizards (bottom), are closely associated with oak woodlands, and Eastern Racers (top), where ground temperatures are warmer than in closed coniferous forests.

ALPINE AND SUBALBINE

David S. Pilliod

Alpine and subalpine habitats are found throughout the mountainous regions of the Northwest and in almost all ecoregions. Both terms refer to high-elevation areas, but the term alpine includes those areas above tree line. The climate of alpine and subalpine habitats is characterized by long, cold winters and short, cool summers. Most of the precipitation falls as snow, resulting in a pulse of surface water in the spring and early summer. Rains are infrequent in summer, but are occasionally heavy. Most lakes and ponds at high elevations thaw in May to July and begin to freeze again in October, resulting in a very short active season for amphibians. Some water bodies in north-facing basins may thaw for only a month or two in some years.

Frogs living in mountain lakes may have only 2 to 3 months to breed, feed, and prepare for another long winter. This Columbia Spotted Frog is basking in the sun to increase its body temperature in the cool mountain air.

Despite the harsh climate, a surprisingly large number of amphibians and a few reptiles are found in alpine and subalpine habitats. Frog and toad species commonly encountered in and around mountain lakes are the Columbia Spotted Frog in the Rocky Mountains and the Western Toad, Cascades Frog, and Pacific Treefrog in the Cascades and Coast Mountains. Long-toed Salamanders are widespread across the Northwest, whereas Northwestern Salamanders are found at some high elevation lakes along the coastal regions of Oregon, Washington, and British Columbia. The live-bearing Terrestrial Gartersnake, Common Gartersnake, Aquatic Gartersnake, and Sierra Gartersnake hunt amphibians in and along mountain lakes and ponds throughout the Northwest. The low average annual temperature prevents most egg-laying snakes from successfully reproducing in high-elevation environments, and thus, populations cannot become established despite occasional dispersers into these habitats.

The biggest threats to alpine and subalpine habitats are recreation use, pollution, disease, subsidized predators, and introduced species. Backpacking, stock packing, and off-highway vehicles all cause some level of harm to montane environments. Campsites are frequently established close to lakes or on the edge of meadows, resulting in trampling of sensitive vegetation, water pollution, and disturbance. These impacts are exacerbated with the use of horses, mules, llamas, and goats, which are increasingly being used to pack people into remote alpine areas. Stock animals also tend to spread invasive plant species into remote mountain areas where they are hard to control. Recent studies in Sierra Nevada lakes have found elevated levels of agricultural chemicals that appear to be carried from the Central Valley by wind currents and deposited into the lakes via rain and air-borne particulates. A prevalent

and persistent threat to aquatic habitats in alpine and subalpine areas is the occurrence of non-native fish.

Introduced Fish in Mountain Lakes

For over 100 years, fish have been stocked in mountain lakes throughout the Northwest for recreational fishing. Few people realize that nearly all mountain lakes were devoid of fish as a result of past glacial events and barriers to fish colonization. As a result, native herpetofauna species that were adapted to fishless conditions now encounter predators. Studies have revealed that fish predation has changed lake ecosystems and negatively affected amphibian and reptile populations throughout the Northwest. In lakes with fish, Long-toed Salamanders, Cascades Frogs, and Columbia Spotted Frogs have either been eliminated or their populations heavily suppressed. As a consequence, the reduction in amphibian numbers has also caused declines in amphibian predators, like Gartersnakes.

What Can Be Done?

Although mountain lake fishing is a popular pastime, compatible management necessitates that at least some lakes in each basin be restored to a fishless state. These fishless refugia need to be deep enough (at least 6.6 ft or 2 m) for frogs and salamander larvae to overwinter and to provide suitable breeding habitat. Further, they should not be connected to other fish-containing water bodies via creeks. If successful, these refugia could serve as source populations for surrounding lakes and reduce the threat of fish on amphibians and reptiles.

Carla Mingione

Management Success!

Researchers are currently working with state and federal agencies to understand how amphibians and reptiles will respond to non-native fish removal in the Klamath Mountains in northern California, Cascade Mountains in Washington, and Rocky Mountains in Wyoming. A consistent pattern is emerging: within 1-2 years after fish are removed, native frogs and salamanders deposit more eggs, and more individuals survive to reach metamorphosis, resulting in rapid population growth.

Bill Leonard

Elke Wind

Several amphibian and reptile species in the Northwest, including Common Gartersnakes (top) and Northwestern Salamanders (bottom), inhabit high elevation areas.

CHARACTERISTIC SPECIES

Salamanders: Northwestern Salamander, Long-toed Salamander; **Frogs and Toads:** Tailed Frogs, Western Toad, Cascades Frog, Columbia Spotted Frog, Wood Frog; **Lizards:** Western Fence Lizard, Northern Alligator Lizard; **Snakes:** Common Gartersnake, Terrestrial Gartersnake, Aquatic Gartersnake, Sierra Gartersnake

MAXIMIZING COMPATIBILITY: Timberlands, Farmlands, Recreational Lands, and Other Integrated Land Uses

Consider the following options if benefiting amphibians and reptiles is secondary to other management objectives.

- **Maintain recreational fisheries in only the very largest lakes most accessible by trails.** *Eliminating fish from off-trail lakes will affect fewer anglers because the most used lakes are close to trails and established campsites.*
- **Keep pack stock away from lakes, ponds, and streams.** *Fill drinking buckets for stock from lakes and streams to reduce trampling of riparian vegetation and to keep urine and fecal matter away from the water.*
- **High-line pack stock and pack in weed-free hay or pellets.** *High-lines reduce damage to tree roots, downed wood, and meadows.*
- **Where possible, eliminate or closely manage livestock to avoid grazing practices that leave inadequate vegetative cover on forest lands.** *Livestock grazing in subalpine areas on federal lands is often concentrated near wetlands because of sparse vegetation and low productivity elsewhere.*

IDEAL: Refuges, Sanctuaries, and Preserves

Consider the following options if benefiting amphibians and reptiles is a primary objective and when landowners and managers wish to optimize herpetofauna diversity and abundance.

- **Remove non-native fish from lakes and streams.** *Gillnets have been used to successfully remove fish from lakes up to 3 acres (1.2 ha) in size. In larger lakes, piscicides such as rotenone and antimycin-A may be needed, although these are harmful to amphibians as well. An alternative is to block spawning habitat in inlets and outlets. However, some trout species spawn in gravel at the edge of lakes with no inlets or outlets.*

Charlotte Corkran

Although popular to catch and cook over a campfire, trout are not native to most mountain lakes in the Northwest, and they readily eat frogs and salamanders.

NORTHERN BOREAL FOREST

Brian G. Slough

Boreal forests occur in northern British Columbia, southern Yukon, and central Alaska in the Boreal Cordillera, Yukon Plateau and Flats, and Alaska Peninsula and Bristol Bay Basin ecoregions. These forests are characterized by harsh climatic conditions including cold, long winters and a brief summer growing season. Snow and freezing temperatures are common between late September and late April. The interplay of latitude, elevation, permafrost, surface water, fire, and aspect creates an extensive patchwork of ecological types. Forests in the region may be evergreen, deciduous, or mixed in composition. Dominant tree species include white spruce, black spruce, lodgepole pine, subalpine fir, balsam poplar, paper birch, and quaking aspen. Tall willow and alder shrub communities occur along rivers, drainages, and near treeline. Bogs, consisting of low shrubs and shrub-grass/sedge communities, are common throughout the boreal forest and often form a savannah-like patchwork with small stands of black or white spruce. Willow shrubs and sedge meadows line riparian areas and balsam poplar and cottonwood are found on larger river floodplains.

Amphibian and reptile species found in the boreal forest are limited to a few that are adapted to harsh conditions, primarily species with rapid summer development (amphibians). Successful hibernation is also problematic as most wetlands freeze over and the frostline may be over 3.3 feet (1 m) below the surface. These limiting factors control the species present, the habitats that they are able to use, and their distribution over the landscape. Suitable hibernation sites ultimately limit snake distribution in the north; there is only one record of a Common Gartersnake from the Fort Nelson area of northern British Columbia. Conserving hibernacula is the most pressing conservation issue for the species in this area. Five pond-breeding amphibian species are found in northern boreal forests, each with adaptations to northern conditions. In this area, larvae of Long-toed Salamanders may have to overwinter since development is slower in cool water. Adults hibernate underground, a requirement that can only be met in high snowfall areas at lower elevations. Columbia Spotted Frogs hibernate under water, which must be deep enough and well insulated with snow to ensure their survival. Boreal Chorus Frogs and Wood Frogs are freeze-tolerant species. Boreal Chorus Frogs and Western Toads hibernate terrestrially in areas with adequate snowfall. Toads also make use of silty river backwaters, stream deltas and lagoons on lakes, and geothermal springs for breeding.

Natural disturbances are limited mainly to fires, insect infestations, annual flooding, and active stream channeling. Fire management allows for normal wildfire activity in most wilderness areas, with human property protected in more settled areas. Man-made disturbances are not as common on the landscape as in more southern areas, but logging and agriculture may be locally significant. Mining and oil and gas exploration developments dot the landscape.

CHARACTERISTIC SPECIES

Salamanders: Long-toed Salamander; **Frogs and Toads:** Western Toad, Boreal Chorus Frog, Columbia Spotted Frog, Wood Frog; **Snakes:** Common Gartersnake

MAXIMIZING COMPATIBILITY: Timberlands, Farmlands, Recreational Lands, and Other Integrated Land Uses
Consider the following options if benefiting amphibians and reptiles is secondary to other management objectives.

- **Avoid disturbing amphibian breeding areas, including shallow margins of ponds and lakes, geothermal springs, and river backwaters.** *Determine the species in your area and probable breeding habitats.*

- **Avoid draining or filling wetlands.** *Do not use wetlands as areas to deposit fill or other materials. All boreal forest amphibians are dependent on wetlands for reproduction and their distribution is closely associated with these habitats.*

- **Control erosion at crossings and minimize the amount of sediment, nutrients, and contaminants that enter wetlands.** *Take measures to maintain water quality at potential amphibian breeding sites. Amphibians, especially larvae, are particularly sensitive to water quality issues.*

- **Minimize soil disturbance when using heavy equipment *(soil compaction, tire ruts)*.** *Use low-pressure tires and limit equipment use to drier seasons or when the ground is frozen. Heavy equipment can disturb and compact soil, increase erosion and sediment, disrupt vegetative succession, and provide distribution corridors for exotic plants. Tire ruts that fill with water are sometimes used for breeding by amphibians, but rapid drying rates often lead to larval mortality.*

- **Minimize disturbance to riparian soils and vegetation.** *Establish buffers around wetlands where natural vegetation is maintained (see buffer section on pages 82 and 135). Riparian areas provide cover and foraging opportunities for amphibians, especially newly emerged metamorphs.*

- **Limit off-highway vehicle (OHV) use to areas away from amphibian breeding sites.** Driving trucks, dirt bikes, and OHVs through wetlands and riparian areas can lead to soil erosion and sedimentation, lowering water quality for developing amphibian larvae.

IDEAL: Refuges, Sanctuaries, and Preserves
Consider the following options if benefiting amphibians and reptiles is a primary objective and when landowners and managers wish to optimize herpetofauna diversity and abundance.

- **Maintain natural wetland habitats and adjacent uplands.** *Amphibians that breed in seasonal ponds spend the remainder of the active season in adjacent uplands. To maintain a portion of these habitats, leave 50-330 feet (15-100 m) buffers around wetlands.*

- **Identify important imbedded habitats in boreal forests (e.g., ponds, seeps, rock outcrops), and maintain connectivity by minimizing activities in these areas.** *Undisturbed patches or corridors that have high cover and moisture can provide important migratory habitat for amphibians, serving as stepping stones across the landscape.*

- **Closely manage livestock around ponds and along streams.** *As an alternative, create livestock watering troughs or provide restricted access points to streams.*

- **Retain large trees and conserve snags for future recruitment of downed wood.** *These structures provide important basking, foraging, and shelter habitats for many amphibians and reptiles.*

This is the “Northern Boreal Forest” module of the PARC Publication HMG-4, ISBN 0-9667402-5-4. Please visit ***www.parcplace.org*** for further information, copies of the complete document, or a web-

Hannah E. Anderson

Elke Wind

To escape freezing temperatures, Columbia Spotted Frogs overwinter at the bottom of lakes, ponds, streams, and springs.

Brian Slough

Brian Slough

Western Toads in some northern areas take advantage of geothermal pools for breeding and their distribution is greatly affected by the location of these unique habitat features. On the right side of this pool, you can see toad tracks in the snow leading to the water's edge.


Charles Peterson

JUNIPER AND PINYON-JUNIPER WOODLANDS

Charlotte Corkran and Elke Wind

In the Northwest, woodlands of juniper or mixed stands of pinyon and juniper are found primarily in southern areas of the East Cascades – Modoc and Columbia Plateau ecoregions, in areas that receive 10 to 20 in (25 to 50 cm) of annual precipitation. These stands only reach 30 to 50 ft (10 to 15 m) in height even though individual trees may be 800 to 1,000 years old. In the Northwest, the largest areas of juniper woodlands and savannahs cover parts of the Columbia Plateau in central Oregon and southwestern Idaho. In most of the region, these woodlands occur at elevations just above shrub communities in semi-arid areas.


Charlotte Corkran

The open canopy and the dry, rocky, exposed environment characteristic of many juniper and pinyon-juniper stands are ideal habitats for many reptile species.

Approximately 6 amphibian and 14 reptile species inhabit juniper stands, but their association is often more closely linked to specific habitat features such as rock outcrops, ant mounds, and water rather than vegetation. Exceptions are the Western Fence Lizard and Gophersnake that regularly climb juniper trees and snags in old-growth stands.

Since European settlement, junipers have invaded areas formerly dominated by shrub and herbaceous species, largely due to livestock grazing, fire exclusion, and climate change. Native understory helped maintain a mosaic of habitat types and held juniper regeneration in check. Infestations of non-native annual grasses now facilitate frequent fires that perpetuate the conversion of shrublands to invasive annual grasslands. In other areas, fire exclusion has encouraged the encroachment of junipers into shrub-steppes and grassland savannahs.

Areas recently invaded by juniper often become so dense that they contain little to no understory vegetation. Ranchers and land managers fear that junipers outcompete other vegetation for scarce water resources and have removed juniper as well as pinyon-juniper woodlands from some areas by mechanical, chemical, or prescribed fire treatments. Although juniper removal can increase both forage productivity and summer flows in small streams, it is only effective where rapidly growing junipers are encroaching into grassland or shrub-steppe habitats. In contrast, conversion of established woodlands, especially pinyon-juniper woodlands, increases forage for only a year or two and may have negative impacts on wildlife and on native grass and shrub species.

Charlotte Corkran

Several reptile species frequently bask on juniper logs or hide inside or under them.

Charles Peterson

Pygmy Short-horned Lizards are found in sunny open, sandy areas of juniper and pine woodlands. This small lizard, which rarely exceeds 6 cm (2.5") in length, has a high tolerance for cold climates compared to other native lizard species and has been found at elevations over 1,800 m (6,000 ft).

Charlotte Corkran

Large juniper and pinyon trees have economic value as small lumber, firewood, and a source of edible seeds. These woodlands provide extensive and important habitat for game animals and numerous non-game wildlife species.

CHARACTERISTIC SPECIES

Salamanders: Long-toed Salamander, Tiger Salamander; **Frogs and Toads:** Great Basin Spadefoot, Western Toad, Pacific Treefrog, Columbia Spotted Frog; **Lizards:** Western Fence Lizard, Common Sagebrush Lizard, Common Side-Blotched Lizard, Pygmy Short-horned Lizard, Western Skink, Tiger Whiptail Lizard; **Snakes:** Rubber Boa, Racer, Striped Whipsnake, Gophersnake, Common Gartersnake, Terrestrial Gartersnake, California Mountain Kingsnake, Nightsnake, Western and Prairie Rattlesnakes

MAXIMIZING COMPATIBILITY: Timberlands, Farmlands, Recreational Lands, and Other Integrated Land Uses

Consider the following options if benefiting amphibians and reptiles is secondary to other management objectives.

- **Manage for a variety of juniper stand densities, ages, and vegetation layers.** *Maintain a balance between wildflowers, grasses, shrubs, and trees. Avoid vast expanses of dense, mid-successional juniper stands that crowd out understory vegetation.*
- **Emphasize opportunities for prescribed burning and reintroduction of wildfire in currently dense juniper and pinyon-juniper plant communities.** *However, do not burn low quality juniper sites, especially below 5,000 feet (1,524 m) where invasive weedy species outcompete native plants unless provision is made for follow-up treatments with appropriate herbicides and seeding (where warranted). In such areas, explore the feasibility of other appropriate alternative mechanical treatment approaches, such as chaining, mastication, or hand-cutting.*
- **Manage livestock grazing in juniper and pinyon-juniper plant communities.** *Determine whether poor forage, weed-infested sites are the product of increased juniper dominance, past or current management practices, or lack of disturbance, such as fire or other factors. For example, if grazing is an issue, then thinning the stand will not restore it without concurrent grazing control. If understories are depleted, follow up treatments with herbicides and seeding may be necessary.*
- **Control recreational use of off-highway vehicles (OHVs) in juniper and pinyon-juniper plant communities.** *OHVs can displace lizards and snakes and alter habitats used by amphibians and reptiles. OHVs also tend to damage highly erodible soils resulting in increased sedimentation of streams and increase the spread of invasive weeds.*
- **Where pinyon-juniper woodlands are commercially logged, use selective cutting or small patch clearcuts to maintain open stands of both large and younger trees, rather than removing all larger trees down to a diameter limit.** *If strip cutting is used, cut areas should have feathered edges, be oriented perpendicular to the prevailing wind direction, and be less than 656 feet (200 m) wide. Leave some logs and slash piles for wildlife cover.*
- **Provide water sources by allowing spring-fed cattle troughs to overflow and form small wetlands.** *Water is a limiting factor for wildlife in western juniper areas; providing water will increase wildlife diversity and provide habitat for amphibians. Limit*

Charlotte Corkran

The management of juniper woodlands is a delicate balance. Dense stands need to be thinned, but complete removal is detrimental to wildlife and provides only short-term benefits.

new development of springs that may be providing habitat for amphibians.

IDEAL: Refuges, Sanctuaries, and Preserves
Consider the following options if benefiting amphibians and reptiles is a primary objective and when landowners and managers wish to optimize herpetofauna diversity and abundance.

- **Retain old-growth juniper trees, snags, and logs, especially very open stands and scattered groups of large-crowned trees in rocky and sandy soil areas.** *Patches of bare ground are desirable for some reptile species. A mixture of open areas with nearby cover is ideal habitat for reptiles and their prey.*
- **Where juniper woodlands have become overly dense, use mechanical cutting to thin out younger trees.** *Thinning can release residual understory growth of native shrubs, grasses and forbs, and can renew open stands of large trees. At the community level, maintain 5 to 12 full-sized trees per acre or less than 10% canopy cover (5% on less productive sites). Be conscious of adjacent stands in terms of their species composition and density.*
- **Where lizard species are common, regulate the cutting of trees.** *In areas with high lizard abundance, major changes in tree density may negatively affect lizard species.*
- **Avoid large-scale conversion of juniper and piny-on-juniper woodlands to grasslands to increase forage for livestock and big game.** *This practice is detrimental to reptiles and other wildlife, and is usually of short-term benefit to big game.*
- **Where dense, younger junipers are encroaching into mature juniper savannahs, aspen stands, or shrub/steppe plant communities, control measures should include prescribed fire and mechanical cutting.** *Use of herbicides is often ineffective and may harm valuable native plants as well as wildlife.*

Bill Leonard

Striped Whipsnakes may hibernate and lay eggs communally with other snake species. The identification of these denning and laying sites is beneficial for maintaining local populations.

- **Fence natural water features or portions of stock ponds to control use by livestock.** *Amphibian breeding habitat is often very limited in pinyon and juniper woodlands.*
- **Restore riparian areas.** *Cutting junipers that are encroaching near small streams, excluding livestock grazing, and replanting riparian zones with appropriate native plants can help rebuild water tables in riparian zones and maintain summer stream flows, while providing habitat for amphibians and water-associated reptiles.*
- **Maintain woodlands around rock outcrops.** *These sites are likely to be important to snakes and lizards. Controlling or excluding livestock grazing, recreational use of off-highway vehicles, firewood cutting, and camping in these areas will reduce snake-human conflicts and maintain habitat.*
- **Retain large trees and maintain snags for future recruitment of downed wood.** *These structures provide important basking, foraging, and shelter habitats for many amphibians and reptiles.*
- **Maintain natural wetland habitats and nearby uplands through the use of buffers.** *Buffers of at least 50-330 feet (15-100 m) in width will provide cooler, moister conditions near streams and wetlands and increase long-term recruitment of litter and wood to the forest floor.*

This is the “Juniper and Pinyon-juniper Woodlands” module of the PARC Publication HMG-4, ISBN 0-9667402-5-4. Please visit ***www.parcplace.org*** for further information, copies of the complete document, or a web-based version of the Guidelines.

Charles Peterson

SAGEBRUSH STEPPE/DESERT SHRUBLANDS

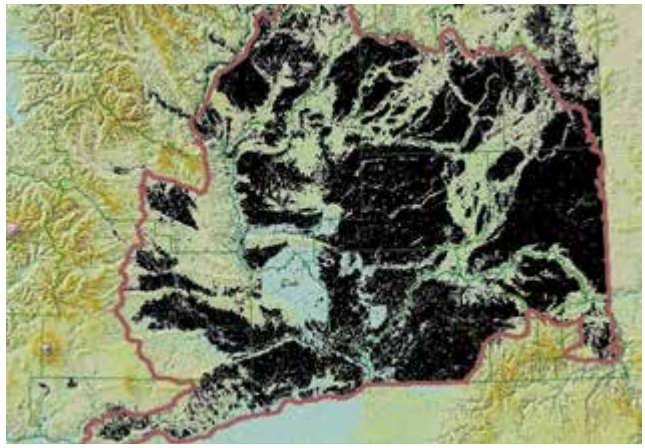
Christopher L. Jenkins, Charles R. Peterson, and John O. Cossel, Jr.

In the Northwest, sagebrush steppe/desert shrublands are found primarily in East Cascades – Modoc Plateau, Columbia Plateau, Wyoming Basins, and Okanagan ecoregions. Two major shrubland types exist in this region: sagebrush and salt desert shrub. Mountains are interspersed among shrub dominated valleys. Elevation varies from just above sea level to about 7000 feet (2134 m). The climate of desert shrublands is characteristic of high-latitude deserts, with low precipitation and dramatic daily and annual fluctuations in temperature. Depending on biogeographic regions and landscape position, desert shrublands may be dominated by mixtures of big sagebrush, three-tipped sagebrush, black sagebrush, low sagebrush, green rabbit brush, gray rabbit brush, mountain mahogany, greasewood, shadscale, and bitterbrush. Cacti and yucca can also be locally abundant and important for cover. Understory vegetation typically consists of sparse perennial grasses and forbs. Cryptogamic or biological crusts (symbioses of lichens and fungi) retain water in the soil and make atmospheric nitrogen available to plants.

Snakes and lizards are numerous in the desert shrublands of the Northwest. Amphibians are more restricted in distribution within desert shrublands because of the limited amount of aquatic habitat. The Great Basin Spadefoot is the only amphibian in the region that occurs primarily in shrubland and grassland habitats. This toad is adapted to arid environments, surviving by burrowing underground for long periods of time. For a few weeks to months each spring, individuals come to the surface to breed in a variety of temporary (rain-filled) and permanent wetlands.

John Cossel

Plains and Great Basin Spadefoots live in the dry shrublands, but are rarely seen. Most of their life is spent in a water-tight "cocoon" inside a self-dug burrow in sand. During periods of rain these species can be heard calling in loud choruses at seasonal pools of water that form for brief periods each spring. During drought, these species may not come to the surface to breed or feed. Recognizing that these toads are buried in the soil near seasonal pools can help minimize impacts.



WA Department of Fish and Wildlife

A high proportion of shrubland habitat has been converted to cropland and urban land, as this example from eastern Washington demonstrates. This results in fragmented habitat and isolated reptile populations that would benefit from the identification and maintenance of connective corridors. See: *http://wdfw.wa.gov/wlm/research/papers/shrubsteppe_map/*.

One of the greatest threats to desert shrublands in the Northwest is the synergistic effect of soil disturbance (e.g., grazing practices that leave inadequate ground cover and off-road vehicle use) and invasive plants. These factors are accelerating natural fire regimes, resulting in wide-spread conversion of native shrublands to stands of non-native annuals, such as cheatgrass, Russian thistle, tumble mustard, halogeton, knapweed, and medusahead rye. Even in the absence of fire, some areas are being overgrown with these invasive plants. These species often colonize the open, barren areas that normally occur between shrubs, which reduces the suitability of the habitat for many lizards that are adapted to habitat with sparse vegetation.

CHARACTERISTIC SPECIES

Salamanders: Long-toed Salamander, Tiger Salamander; **Frogs and Toads:** Great Basin Spadefoot, Western Toad, Woodhouse's Toad, Pacific Treefrog, American Bullfrog (Introduced), Columbia Spotted Frog, Northern Leopard Frog; **Lizards:** Great Basin Collared Lizard, Long-nosed Leopard Lizard, Western and Eastern Fence Lizard, Common Sagebrush Lizard, Common Side-blotched Lizard, Ornate Tree Lizard, Desert Horned Lizard, Pygmy Short-horned Lizard, Western Skink, Tiger Whiptail; **Snakes:** Rubber Boa, Eastern Racer, Striped Whipsnake, Gophersnake, Long-nosed Snake, Common Gartersnake, Terrestrial Gartersnake, Groundsnake, Nightsnake, Western and Prairie Rattlesnakes

John Cossel

Great Basin Collared Lizards bask on large rocks in the Snake River Plain and Northern Great Basin. These large lizards are sensitive to rock removal, off-highway vehicle use, and illegal collecting for the pet trade.

MAXIMIZING COMPATIBILITY: Timberlands, Farmlands, Recreational Lands, and Other Integrated Land Uses

Consider the following options if benefiting amphibians and reptiles is secondary to other management objectives.

- **Closely control livestock through use of prescriptive grazing management.** *Livestock can damage sensitive habitats used by amphibians and reptiles, including springs and streams that occur in arid lands. Livestock grazing practices that leave inadequate vegetative cover may eliminate important herbaceous cover for these animals.*
- **Plan prescribed burning to avoid times when amphibians and reptiles are especially active.** *Animals are particularly vulnerable during migration, such as when snakes are dispersing from hibernacula, or when amphibians are migrating to or from breeding sites.*
- **Prevent the spread of weeds, particularly invasive, non-native species such as cheatgrass.** *Control weeds in disturbed areas such as roadsides, fencerows, and field edges. Mandate and enforce the use of weed-free feed in the backcountry.*
- **Keep motorized vehicles on designated routes.** *Off-trail use of off-highway vehicles in rangelands damages sensitive plants and soils and degrades reptile habitats.*
- **Avoid mining or collecting of rocks that are important as basking or retreat sites for reptiles.** *Attractive rocks used in landscaping may provide important thermal cover and be critical to the survival of snakes and lizards in an area.*
- **Manage important habitat elements such as snake overwintering sites (e.g., cliff faces, talus slopes, and caves) and wetlands used by amphibians.** *A buffer of at least 330 ft (100m) is a minimum recommended to maintain the unique ecological function of these areas (see buffer section on pages 82 and 135).*

Charles Peterson

Non-native annual grasses like cheatgrass have increased the fire frequency in desert shrublands resulting in prolonged changes in habitat conditions.

- **Plan development and modification of springs for livestock in ways that are compatible with amphibians and reptiles.** *Do not alter water levels such that breeding or overwintering sites become unsuitable. Water livestock away from natural water sources.*
- **Allow natural beaver activities to occur where possible, or consider reintroducing beaver where they have been lost.** *Beaver create and maintain wetland habitats used by amphibians and aquatic or riparian reptiles. They may also help maintain water tables for livestock and wildlife species in arid lands.*

IDEAL: Refuges, Sanctuaries, and Preserves
Consider the following options if benefiting amphibians and reptiles is a primary objective and when landowners and managers wish to optimize herpetofauna diversity and abundance.

- **Avoid livestock grazing.** *If livestock grazing is permitted, consider keeping livestock away from amphibian and reptile aggregations, such as those occurring during breeding or overwintering periods.*
- **Restore areas dominated by invasive plants to native, shrub-dominated systems.** *Use seed mixtures that contain native grasses and forbs. Native vegetation will support a greater diversity of snakes and lizards, partly because of a greater abundance of prey (invertebrates and small mammals).*
- **Restore natural fire regimes.** *Although this can be difficult, consider burning in patches to maintain a variety of vegetation successional stages in an area. Habitat heterogeneity tends to increase snake and lizard species because of increased structural complexity and prey abundance.*
- **Maintain water quality in ponds used as a water source for livestock.** *Maintain a zone of vegetation around the pond from 100-330 ft (30-100 m) wide to provide shade and capture runoff of fertilizers and pesticides.*


John Cossel

Off-highway vehicle use should be restricted to designated areas to protect native species and sensitive desert shrubland habitat.

- **Maintain and restore wetlands used by amphibians for breeding.** *Wetlands are critical habitats in arid shrublands where available surface water limits the timing and length of the amphibian breeding season.*
- **Develop travel plans that do not require or that minimize the need for off-highway vehicle (OHV) use.** *OHVs can displace lizards and snakes and alter habitats used by amphibians and reptiles. OHVs also tend to damage highly erodible soils resulting in increased sedimentation of streams and increase the spread of invasive weeds.*

HOW CAN LANDOWNERS MAINTAIN SUSTAINABLE RANGELANDS?
Humans depend on the natural resources provided by rangelands (shrublands and grasslands). Yet, intensive land use (agriculture, urban sprawl) and land change (invasive plants, wildfire) threaten the 'goods and services' provided by these lands. The U.S. Department of Agriculture Natural Resources Conservation Service (***www.nrcs.usda.gov***) and the Sustainable Rangelands Roundtable (***sustainablerangelands.cnr.colostate.edu***) provide resources to landowners to improve rangeland health and sustainability.

Lowell Diller

A reptile study site located in the Snake River Birds of Prey Area (SRBPA), Idaho. Notice that although the shrub community was intact, there were already non-native annuals established in the understory.

John Cossel

At the same location as the photo above. Fire has destroyed the native shrubs, leaving mostly non-native annuals and some native perennials.

This is the "Sagebrush-Steppe/Desert Shrublands" module of the PARC Publication HMG-4, ISBN 0-9667402-5-4. Please visit ***www.parcplace.org*** for further information, copies of the complete document, or a web-based version of the Guidelines.

Charlotte Corkran

GRASSLANDS

Elke Wind

Grasslands are found in numerous ecoregions in the northwest, including the Montane Cordillera, Okanagan, Canadian Rocky Mountains, Columbia Plateau, East Cascades – Modoc Plateau, Middle Rockies – Blue Mountains, Fescue-Mixed Grass Prairie, and Northern Great Plains Steppe. Grassland habitats become larger and more prevalent as one moves eastward in the Northwest, into areas where conditions are too dry for tree and shrub growth. Grassland habitat occurs in two distinct landscapes: plateau or steppe grassland, and canyon grassland. Grasslands may occur as pockets in the landscape from British Columbia south to California in alpine areas or on south-facing aspects, or as the dominant feature of vast landscapes such as the Palouse or Plains Grassland of eastern Washington, Oregon, Idaho, Montana, and Wyoming. Grasslands are characterized as having grasses as the dominant vegetation type, such as bluebunch wheatgrass (*Pseudoroegneria spicata*) on drier sites and Idaho fescue (*Festuca idahoensis*) on more moist sites. They are dominated by short to medium-tall grasses growing in an irregular arrangement of clumps rather than as a continuous sod cover in most cases. Grasslands in canyons are dominated by bunchgrasses growing in lower densities than on deep-soil prairie sites. Native forbs may co-occur with grasses or they may be absent. The soil of native bunchgrass-type grasslands is deep, dark, and fertile from the growth and decay of deep, multi-branched grass roots. Grasslands naturally occur in areas of the Northwest outside the range of bitterbrush and sagebrush species. However, grassland exists in the shrub-steppe landscape

Bill Leonard

Eric Dallalio

Tiger salamanders and Plains Spadefoot Toads are relatively widespread grassland species. They survive dry, hot conditions by spending the majority of their time underground. They are less likely to persist in areas where the ground has been regularly plowed.

today as a result of brush removal, chaining or spraying, and fire.

In grassland ecosystems, all water bodies, even those occurring for only short periods, can provide important habitat for frogs, toads, turtles, and snakes. The distribution of amphibians and reptiles is closely associated with the location of these aquatic features. To escape the relatively harsh climatic conditions found in grassland habitats, amphibians such as Tiger Salamanders and Plains Spadefoot Toads spend much of their time underground, in or close to water, or dormant. Reptiles, such as the Western Hog-nosed Snake and Prairie Rattlesnake use the burrows, dens, and tunnels dug by prairie dogs and pocket gophers for cover and as places to search for food. Rock outcrops in grassland areas provide important cover and basking sites for lizards and snakes such as the Western Skink and Eastern Racer. In areas where grasslands are only a minor component of the landscape, such as British Columbia, grasslands and their associated species are at risk.

Few natural prairie regions remain in the Northwest largely due to extensive land conversion—prairies are attractive for agriculture and grazing because they are relatively flat, treeless, covered with grass, and contain rich soil. In the last 200 years, native Northwest grasslands and many of their inhabitants have declined due to livestock grazing, intensive agriculture, and the establishment of vineyards, orchards, golf courses, and housing developments. For example, the Palouse prairie is one of the most endangered ecosystems in the U.S. with only 1% of the original habitat remaining; it is highly fragmented with most sites <10 acres in size. Seasonal drought and occasional fires are important to biodiversity in grassland habitats, and fire suppression has resulted in the expansion of pinyon-juniper and ponderosa pine stands into what was previously native grassland habitat. Native Northwest bunchgrasses are less resistant to continuous growing-season grazing compared to Great Plains and Eurasian grasses. Heavily grazed steppe grassland areas have been invaded by spotted knapweed, cheatgrass, and crested wheatgrass, especially where grazing has been followed by fire or where repeated, early-season fires are employed. The delicate cryptogamic crust found in grassland areas, which consists of a combination of lichens, mosses, liverworts, and cyanobacteria, is a critical component of the bunchgrass ecosystem and can easily be degraded by trampling from livestock. The deep roots of native grasses stabilize soil, increase water infiltration, and recycle nutrients. Appropriate management and restoration of grasslands can reap these benefits.

Charlotte Corkran

Sara Ashpole

There is increasing pressure on grassland ecosystems from housing developments and agriculture. The conditions here are excellent for growing fruit, and the vineyard industry has grown dramatically, straining an already limited water supply.

CHARACTERISTIC SPECIES

Salamanders: Long-toed Salamander, Tiger Salamander; **Frogs and Toads:** Plains Spadefoot, Great Basin Spadefoot, Woodhouse's Toad, Great Plains Toad, Boreal Chorus Frog, Northern Leopard Frog; **Lizards:** Lesser Earless Lizard, Common Sagebrush Lizard, Pygmy Short-horned Lizard, Greater Short-horned Lizard, Six-lined Racerunner, Tiger Whiptail, Many-lined Skink, Western Skink; **Snakes:** Gophersnake, Western Hog-nosed Snake, Eastern Racer, Milksnake, Terrestrial Gartersnake, Plains Gartersnake, Western and Prairie Rattlesnakes; **Turtles:** Ornate Box Turtle, Painted Turtle, Snapping Turtle, Spiny Softshell

MAXIMIZING COMPATIBILITY: Timberlands, Farmlands, Recreational Lands, and Other Integrated Land Uses

Consider the following options if benefiting amphibians and reptiles is secondary to other management objectives.

Bryce Maxell

Maintaining connectivity among isolated water bodies is important in this relatively dry environment. Many amphibians depend on these small, ephemeral water bodies for breeding and the surrounding native grassland habitat for foraging and underground shelter. Trampled, plowed, or otherwise compacted soils present likely barriers to connectivity between wetlands.

- **Maintain water quality in ponds used as a water source for livestock.** *Maintain a zone of vegetation around the pond (i.e., a buffer zone) to benefit wildlife, and use fencing, pipelines, storage tanks, and troughs to direct cattle to water sources. Even a narrow buffer zone of vegetation of 3-30 feet (1-9 m) wide can provide shade and help reduce runoff of fertilizers and pesticides into water bodies.*
- **Maintain suitable movement corridors between moist habitats.** *Leaving areas of tall grass or shrubs between moist areas will help maintain connectivity among key habitat resources for amphibians and reptiles, particularly during the dry season.*
- **Where grazing is allowed, closely monitor conditions to maintain vegetation, soil, and water quality.** *Reducing grazing increases the amount of above-ground plant litter, as stems and leaves reach full size, mature, and die. Below-ground root production is also increased. Over time, this accumulation enhances soil moisture retention, soil microbial activity, nutrient cycling, and temperature buffering. Fence and rotate livestock through smaller pastures during the growing season. The timing of livestock rotations should be based on grass utilization observed in pastures and species tolerance to grazing—e.g., grazing native bunchgrasses in spring has a greater negative impact than grazing in summer or fall. Prescribed grazing can increase forage quality over the long-term, including periods of drought, and provides better habitat conditions for wildlife.*
- **Where possible, restore native grassland vegetation, including abundant flowering plants (forbs, legumes).** *Flowering plants attract pollinators that provide abundant insect prey for lizards, small mammals, and birds that are prey for snakes.*
- **Evaluate disturbance regimes for grassland maintenance.** *Manage fire frequency, intensity, and seasonality to limit shrubby vegetation encroachment. Some snakes are adapted to grassland conditions and disappear when shrubs or trees invade.*
- **Discourage alteration of the land where healthy stands of native grasses still exist.** *Undisturbed areas with native grasses are relatively uncommon, and these areas provide unique habitats for several snake species.*
- **Minimize off-highway vehicle (OHV) traffic, especially in healthy stands of native grasses.** *If OHVs compact soils and disturb vegetation, habitat quality for grassland reptiles is reduced.*
- **Encourage the planting of native grasses in urban landscapes.** *Native grasses are low-maintenance, drought-tolerant, and can filter polluted runoff.*

Salmon Challis National Forest

Off-highway vehicles are often used to apply herbicides. To reduce impacts to amphibians and reptiles, apply chemicals outside of the amphibian breeding season and clean vehicles thoroughly between applications to reduce the potential spread of non-native plants.

IDEAL: Refuges, Sanctuaries, and Preserves
Consider the following options if benefiting amphibians and reptiles is a primary objective and when landowners and managers wish to optimize herpetofauna diversity and abundance.

- **Identify and manage important habitat for amphibians and reptiles.** *Wetlands, ravines, washes, burrows, rock outcrops, and talus are special features within grasslands that are important for many species.*
- **Use existing, or renovate degraded landscape features to create new habitat structure for species that could be, or were historically, present.** *Borrow-pit depressions, windmill stockponds, hedgerows, stone walls and rock piles, check dams, marshlands, cienegas, and on-site downed tree trunks and branches all provide unique habitats for amphibians and reptiles in grasslands. Maintaining*

these structures or features, even if human created, may help provide breeding, foraging, and shelter habitats for these animals.

- **Restore eroded or disturbed washes, stream and wetland banks to redevelop the native vegetative structure required by reptiles and amphibians.** *Amphibians and reptiles will return to these wetland habitats if they provide appropriate cover and breeding conditions.*
- **Manage grassland habitat surrounding amphibian breeding ponds for biodiversity values.** *Provide a core upland area of at least 100-330 feet (30-100 m) from the wetland consisting of native grasses and un-plowed, un-trampled native grassland where amphibians can exist in underground refugia during the non-breeding season.*
- **Maintain water quality in ponds used as a water source for livestock.** *Maintain a zone of vegetation around the pond from 100 to 330 ft (30-100 m) wide to provide shade and capture runoff of fertilizers and pesticides.*
- **Consider restricting some human activities within a 330 ft (100 m) buffer zone around rocky slopes used by snakes.** *These areas are often associated with denning or communal gestation sites. Human presence alone could alter habitat or lead to persecution of the snakes.*
- **Maintain or restore habitat in draws and ravines as migration corridors.** *Use culverts or bridges where roads cross these corridors. Intact migration corridors will help maintain amphibian and reptile populations and increase the chance that a population will be recolonized if it becomes extinct locally.*
- **Where applicable, consider enhancing habitat for or re-establishing prairie dogs or pocket gophers.** *These mammal species help control the encroachment of shrubby vegetation, and they are a food source for snakes. Their abandoned dens and extensive sub-surface tunnels provide refugia for amphibians and reptiles in hot, arid landscapes.*
- **Identify and manage turtle migration corridors to reduce road mortalities.** *Female turtles will nest and lay eggs in the ground on south-facing, sandy, and sparsely vegetated slopes usually during May-July each year. Where roads pass between wetlands and nesting sites, turtle mortality may occur. Installing or using underpass systems such as culverts with directive fencing will help keep turtles off roads at key migration points. Posting signs to alert drivers to the presence of turtles on the road may be effective at reducing mortality.*
- **Maintain standing dead trees (i.e., snags) and downed wood.** *These structures provide important basking sites and cover, as well as habitat for prey species.*
- **Allow natural beaver activity to occur, or consider reintroducing beaver where they have been lost.** *Beaver create and maintain wetland habitats used by amphibians and aquatic or riparian reptiles. They may also help maintain water tables for livestock and wildlife species in arid lands.*

GRAZING LANDS STEWARDSHIP

Grazing is the largest use of privately-owned land in North America. The Grazing Lands Conservation Initiative (GLCI) is encouraging private landowners to assume a stewardship role of their lands, including practicing conservation for long-term sustainability. GLCI is a nationwide partnership of individuals and organizations that work together to maintain and improve the management, productivity, and health of the nation's privately-owned grazing land. For more information: ***www.glci.org***

Kris Kendell

This is the "Grasslands" module of the PARC Publication HMG-4, ISBN 0-9667402-5-4. Please visit ***www.parcplace.org*** for further information, copies of the complete document, or a web-based version of the Guidelines.


David Tessler

ARTIC AND COASTAL TUNDRA

David Tessler

This habitat includes the low-lying, Arctic Coastal Plain (Beringian Tundra ecoregion) and the drier uplands of the Arctic Mountains north of tree line (Interior Alaska Taiga ecoregion), as well as the Subarctic Coastal Plain of western Alaska and the Alaska Peninsula Mountains (Alaska Peninsula and Bristol Bay Basin ecoregion). Permafrost is continuous, except in southern parts of the region, and surface water dominates the landscape in lowlands (20–50% of the coastal plains). Freeze-thaw cycles form a patterned mosaic of polygonal ridges and ponds, and the plains are dissected by rivers, sloughs, and deltas emptying into the Bering Sea and the Arctic Ocean. Wet and mesic graminoid (grasses and grass-like plants such as sedges) herbaceous communities dominate the lowlands, and numerous ponds, lakes, and rivers dot the landscape. Tall shrub communities are found along rivers and streams, and low shrub communities occupy uplands. Patchy forests of white spruce and paper birch penetrate the region on the eastern and southern edges.


David Tessler

Wetlands dominate lowland areas of the coastal plains.

Only a single amphibian species, the Wood Frog, is known to occur in this habitat, owing to its advanced freeze tolerance. Wood Frogs in this region show a high background level of physical abnormalities. It is uncertain whether abnormalities are caused by the stress of living very close to the frog's physiological limitations or by external environmental factors. As climatic conditions continue to ameliorate, the species may expand its range and distribution rapidly owing to prevalence of surface water. However, climate change is also causing surface water to disappear rapidly across much of the region, and may cause local extirpations of both recently colonized and long occupied areas.

Natural disturbances are limited mainly to fires, and annual flooding as the ice breaks up on the rivers. Wildfires are frequent and extensive: Over 2,500,000 acres (1,000,000 ha) of this habitat burned in 2004 and 2005. Fire management allows "burnout" of wildfires in most areas without human infrastructure. Human settlements are small, scattered, and not connected by roads. Man-made disturbances are not as common on the landscape as in more southern areas, but mining and petroleum exploration and developments occur over the landscape. Other environmental issues include: atmospheric deposition of mercury and other heavy metals from industrial practices in Asia and Northeastern Europe; the potential for large contami-

nant spills and downstream acidification or heavy metal contamination; and the development and ongoing operation of large open-pit mineral mines. In addition, available surface water may decline with the disappearance of permafrost, decreases in precipitation, and increases in evaporation as northern temperatures increase.

Tara Chestnut and Hannah E. Anderson

Recent studies in Alaska have found that Wood Frogs frequent tundra areas (e.g., more than 1 km from the boreal forest), as long as shrubby vegetation is available in the riparian area.

CHARACTERISTIC SPECIES

Frogs and Toads: Wood Frog

MAXIMIZING COMPATIBILITY: Timberlands, Farmlands, Recreational Lands, and Other Integrated Land Uses

Consider the following options if benefiting amphibians is secondary to other management objectives.

- **Avoid draining or filling wetlands.** *Do not deposit materials in wetlands where Wood Frogs may be breeding.*
- **Minimize the amount of sediment, nutrients, and contaminants that enter wetlands.** *Wood Frogs breed in wetlands and tadpoles are sensitive to water quality.*
- **Minimize disturbance to wetland soils and vegetation.** *Establish 100 to 330 ft (30-100 m) buffers around wetlands where natural vegetation is maintained so that Wood Frogs have foraging and terrestrial overwintering habitat (see buffer section on pages 82 and 135).*
- **Avoid construction and habitat alteration (including earth moving, general construction, and road building) during the months when the Wood Frog population is concentrated and vulnerable.** *Adults concentrate in wetlands to breed in early spring; eggs and tadpoles remain in water bodies until late summer.*

IDEAL: Refuges, Sanctuaries, and Preserves

Consider the following options if benefiting amphibians is a primary objective and when landowners and managers wish to optimize herpetofauna diversity and abundance.

- **Maintain natural wetland habitats and nearby uplands through the use of buffers.** *Buffers of at least 50-330 feet (15-100 m) in width will help reduce the effects of point-source contamination.*
- **Identify corridors of possible colonization (valleys and flowing waters from areas where Wood Frogs are present) and maintain connectivity by minimizing activities in these areas.** *Undisturbed patches or corridors that have high cover and moisture can provide important migratory habitat.*
- **Monitor the presence and absence of Wood Frogs in your area, as well as the apparent rate of physical abnormalities.** *Changes in occupancy or physical appearance in Wood Frogs may signal other changes in the immediate environment.*
- **To maintain appropriate habitats and corridors for Wood Frogs and other amphibians, manage not only the wetlands you have today, but manage the habitats you will have in the future.** *Climate change may result in rapid and extensive changes in wetland type, extent, quality, flow regime, and persistence. Anticipate the mosaic of habitats you are likely to have in future decades as you consider which areas to reserve for amphibian conservation.*

Tara Chestnut and Hannah E. Ander-

Harsh climates, low vegetative cover, and permafrost affect the suitability of arctic areas for amphibians and reptiles. Changes that result from climate change may affect the distribution of these species in the area in the future.

ROCK OUTCROPS, TALUS, CLIFFS, AND CAVES

Rich Nauman

Rock outcrops and cliffs are areas where bedrock is exposed at the surface. These habitat features can be imbedded within forests, grasslands, or deserts in all ecoregions. At the base of outcrops and cliffs are often piles of rocks referred to as talus. Talus forms over long periods as pieces of the outcrop are eroded and fall down the slope. Talus may support limited vegetation, especially in drier areas. In the wet portions of the Northwest, forests cover many talus piles. Older talus tends to have more developed vegetation than younger talus. Talus often does not have a definite edge, and transitions from areas of all rock, to rock mixed with soil, and to soil mixed with little rock. Both rock outcrops and talus are typically found in areas of steep slopes, and their presence may alter fire patterns. Poorly vegetated outcrops and talus can serve as natural fire breaks. Caves in the Northwest are either subterranean drainage channels formed by or enlarged by dissolution of the soluble rock, pockets and fissures formed by the erosive action of water on rock, or old lava tubes. Seeps, springs, and waterfalls are often associated with rock outcrops in wet areas.

Rock outcrops are used by some snakes as natal areas. Female rattlesnakes, such as the mother of these young snakes, remain with their young until they have completed their first molt.

Rock outcrops, talus, cliffs, and caves provide a wide variety of habitats for reptiles and amphibians. Cracks, interstitial spaces, and other openings in rock outcrops and cliffs provide refugia for various species of frogs, salamanders, snakes, and lizards. While no Northwest amphibian or reptile lives exclusively in caves, several snake species use caves as hibernacula. Gartersnakes den communally underground in rock crevices and caves. Rattlesnakes, Gophersnakes, Eastern Racers, and Striped Whipsnakes have been found to overwinter together in collapsed lava tubes. The high thermal inertia of rock creates stable temperatures that may be warmer or cooler than the surrounding area. Exposed outcrops and cliffs provide basking sites for reptiles. A warm microclimate on open, south-facing slopes may provide denning habitat for snakes, while cool forested talus in coastal areas are used by salamanders. Many species are associated with the springs and seeps found within talus and rock outcrops.

Rock outcrops, talus, cliffs, and caves are threatened by encroachment (e.g., rural and urban development)

and can become further isolated from one another within a developed or managed landscape. In addition, their physical structure can be destroyed or altered by quarry and mining activities. Vegetation will change the microclimate of these areas. Over time the amount of vegetation will determine which amphibian and reptile species find a particular rock feature favorable. Rock outcrops sometimes act as natural barriers to livestock, which can result in trampling of surrounding vegetation as livestock congregate through travel corridors.

CHARACTERISTIC SPECIES

Salamanders: Rough-skinned Newt, Shasta Salamander, Scott Bar Salamander, Coeur d'Alene Salamander, Larch Mountain Salamander, Siskiyou Mountains Salamander; **Frogs and Toads:** Red-legged Frog, Foothill Yellow-legged Frog; **Lizards:** Great Basin Collared Lizard, Ornate Tree Lizard, Sagebrush Lizard, Eastern and Western Fence Lizard, Western Skink, Southern Alligator Lizard, Northern Alligator Lizard; **Snakes:** Common and Terrestrial Gartersnakes, Nightsnake, Western and Prairie Rattlesnakes

Charles Peterson

Elke Wind

Virgil Hawkes

Caves, talus, rock outcrops, dead trees, and stumps contain important microhabitats and crevices above and below ground that are used by amphibians and reptiles throughout the year for cover, moist microsites, basking areas, and as overwintering dens.

MAXIMIZING COMPATIBILITY: Timberlands, Farmlands, Recreational Lands, and Other Integrated Land Uses

Consider the following option if benefiting amphibians and reptiles is secondary to other management objectives.

- **Be aware of the distribution of rare species so that development and resource management projects can avoid areas where they occur.** *The Shasta Salamander and Scott Bar Salamander, for example, are known from only a few rock outcrop locations in northern California.*
- **Maintain vegetation for shading around rock outcrops and talus used by amphibians.** *Vegetation provides stable, cool, moist habitats required by woodland salamanders. However, be aware that this may reduce basking sites for snakes and lizards.*
- **Focus development projects (impacts) in areas where these rock outcrop features are common rather than where they are rare.**
- **Locate intensive disturbance away from rock features.** *Locate fencing, mineral licks, and water sources away from rock faces and other features that would promote intensive livestock use and human activities.*
- **Limit off-highway vehicles to areas well away from biologically significant sites, such as Rattlesnake dens.** *Such management actions will minimize destruction and alteration of these sensitive sites.*
- **Limit hardrock mining and quarry development in the vicinity of overwintering or birthing sites used by snakes.** *Mining can severely impact or eliminate snake populations in these areas.*

IDEAL: Refuges, Sanctuaries, and Preserves

Consider the following options if benefiting amphibians and reptiles is a primary objective and when landowners and managers wish to optimize herpetofauna diversity and abundance.

- **Reduce or eliminate disturbance to rock outcrops and other rock substrates.** *Mining, quarrying, and road building reduce habitat quality for amphibians and reptiles.*
- **Identify and manage key talus habitats, such as snake dens and moist areas occupied by salamanders, and minimize publicity of where they are located.** *Different rock outcrops, talus areas, cliffs, and caves may appear similar, but animals are often selecting them for specific microhabitat conditions (e.g., temperature and moisture) and thus one is not necessarily interchangeable for another. Reduce the potential of poaching by restricting access to den and rare species location information.*
- **Maintain a buffer of vegetation around outcrops occupied by salamanders to maintain temperature and moisture regimes.** *For forested areas, a buffer width of 50 - 330 feet (15 – 100 m) is recommended to maintain microclimates and provide for future inputs of downed woody material to the site.*
- **Remove invasive plant species and use fire management to maintain sun-exposed rock outcrop areas for reptiles.** *Unlike salamanders, snakes and lizards prefer the warmth of exposed rock areas for basking and overwintering sites.*
- **Maintain hydrological regimes.** *Subsurface flows of water provide conditions necessary for several species of amphibians. In particular, areas such as seeps and springs are often associated with outcrops of bedrock and associated soils. These locations provide important habitat for species of Torrent Salamander and the Van Dyke's Salamander.*
- **Restrict or manage recreational access to rock outcrops, cliffs, and talus sites to minimize dis-**

Virgil Hawkes

Charles Peterson

Numerous salamander, snake, and lizard species in the Northwest, such as the Shasta Salamander and the Western Skink, are closely associated with and dependent upon rock outcrops and talus habitat for cover, foraging, and breeding. Certain rock outcrops may need protection in the form of buffers or fencing to protect rare or sensitive amphibian or reptile species.


Elke Wind

BEACHES AND DUNES

Rich Nauman and David S. Pilliod

Beaches and their associated coastal dunes can be found in areas of Alaska, British Columbia, Washington, Oregon, and California. For example, an extensive dune system stretches from Coos Bay to Florence on the Oregon coast in the Pacific Northwest Coast ecoregion and small dune systems are continuous with the sandy beaches that are interspersed along the rocky coastline of the region. Other less known dunes occur inland in the Columbia Plateau ecoregion.

Inland Dune Areas Used by Amphibians and Reptiles in the Northwest:

St. Anthony Dunes, ID	11,000 acres	(445 ha)
Bruneau Dunes, ID	4,800 acres	(1,940 ha)
Christmas Valley Dunes, OR	11,000 acres	(445 ha)
Moses Lake and Beverly Dunes, WA	300 acres	(120 ha)
Juniper Dunes, WA	7,000 acres	(2,833 ha)

Dunes are generally open areas but they may also be vegetated. Cool annual temperatures in the Northwest limit the diversity of reptile species associated with interior dunes relative to those occurring in the hot deserts of the southwestern U.S. and northern Mexico, for example. Nonetheless, Long-nosed Leopard Lizards, Desert Horned Lizards, and Tiger Whiptails are common inhabitants of inland dunes, as well as Gophersnakes, Striped Whipsnakes, and Western Rattlesnakes. Some dunes have ponds at their base that provide breeding habitat for amphibians, such as the Pacific Treefrog and introduced American Bullfrog.

Inland and coastal dunes are threatened by direct and indirect human use and invasive species. Human trampling, horseback riding, and off-highway vehicle use directly affect dune communities. Anything that alters sand-stabilizing plants affects dune structure and dynamics. Introduced plants, such as European beachgrass or dune grass, thistles, French and scotch broom, cape-ivy, pampas grass, and iceplant in coastal areas and cheatgrass and tumble mustard at inland dunes, have dramatically reduced sand movement and facilitated establishment of other plants. Increasing water table levels due to adjacent agriculture may also contribute to invasive plant establishment, shifts in plant communities, and the formation of ponds that attract amphibians.


Charles Peterson

The tallest dune in the Northwest is 470 feet (143 m) high, situated above a small lake in Bruneau Dunes State Park near Mountain Home, Idaho. The lake is a breeding site for Great Basin Spadefoots and Woodhouse's Toad.

CHARACTERISTIC SPECIES

Frogs and Toads: Great Basin Spadefoot, Woodhouse's Toad, Pacific Treefrog, Red-legged Frog, American Bullfrog (introduced), Columbia Spotted Frog; **Lizards:** Long-nosed Leopard Lizard, Common Sagebrush Lizard, Desert Horned Lizard, Tiger Whiptail; **Snakes:** Eastern Racer, Striped Whipsnake, Gophersnake, Longnosed Snake, Common and Terrestrial Gartersnakes, Groundsnake, Western and Prairie Rattlesnakes

MAXIMIZING COMPATIBILITY: Timberlands, Farmlands, Recreational Lands, and Other Integrated Land Uses

Consider the following options if benefiting amphibians and reptiles is secondary to other management objectives.

- **Reduce the spread of non-native plants.** *Point Reyes National Seashore recommends adjacent landowners avoid planting non-native invasive plants, especially if they live next to wildlands. They should also compost garden waste instead of dumping even seemingly "dead" plant material beyond their property line.*
- **Restrict recreational access near beaches and dunes to minimize disturbance to sensitive vegetation.** *To reduce disturbance to habitats used by reptiles, allow off-highway vehicles in designated areas only. Keep trails back from ponds used by amphibians.*
- **Minimize livestock access.** *Livestock can be important vectors for weed introduction, and dune habitat does not typically offer important forage for livestock.*

IDEAL: Refuges, Sanctuaries, and Preserves

Consider the following options if benefiting amphibians and reptiles is a primary objective and when landowners and managers wish to optimize herpetofauna diversity and abundance.

- **Identify and manage areas important to breeding amphibians.** *Avoid human-induced changes to sand flow and vegetation that would result in the loss of ponds. The dynamic nature of beaches and dunes make this a difficult task.*
- **In coastal dune habitats, maintain native plants and reduce or eradicate non-native plant species.** *It is critical to maintain natural flows of sand, vegetation patterns, and the hydrological regimes that create freshwater ponds used by amphibian populations.*
- **Maintain or restore ponds in sand dune areas. Amphibian and reptile occurrence may depend on the availability of ponds.**

This is the "Beaches and Dunes" module of the PARC Publication HMG-4, ISBN 0-9667402-5-4. Please visit ***www.parcplace.org*** for further information, copies of the complete document, or a web-based version of the Guidelines.

Larry Jones

Long-nosed Leopard lizards inhabit arid, sandy-gravelly areas and dunes in the Northwest.

RIPARIAN AREAS

Deanna H. Olson

Riparian areas occur adjacent to aquatic habitats, and as such, occur in all ecoregions. They are the transition zones between land and water, where these systems interact. The width and character of riparian areas depend on a suite of site conditions including topography, geology, soils, hydrology, climate, and disturbance history. In the Northwest, especially in arid regions, you can easily recognize many riparian areas; they are the ribbons of green along rivers and streams and the lush belts around wetlands, lakes, and ponds.

Riparian forests often create a unique microclimate of cool temperatures and moist air conditions, which enable certain plants and animals to exist within drier landscapes that they would normally not tolerate. Wetland riparian areas similarly host distinct vegetation communities and herpetofauna. Plants that tolerate wet soils and typify riparian areas include alder, cottonwood, and willow. Forbs, sedges, and grasses may proliferate along stream banks and lake shores in areas prone to inundation.

Over 70 reptile and amphibian species may be routinely sighted in riparian areas of the Northwest. Species occurring in riparian areas are those that are: 1) either aquatic or terrestrial obligates that can also occur in riparian zones; or 2) associated with riparian areas for some or all of their life history requirements such as breeding, foraging, hydro- and thermoregulation, and dispersal. Obligate riparian species, at least for part of their life cycle, include Dunn's Salamanders, Rocky Mountain and Coastal Tailed Frogs, the Giant Salamander species, most true frogs of the genus Rana, and all three Gartersnakes. Turtles rely on sparsely vegetated patches within riparian zones for their terrestrial nests or are transient through riparian areas to nest up to 1300 feet (400 m) from the water's edge. More than 30 pond-breeding amphibians migrate to still water habitats for mating and oviposition, and disperse into upland areas for their non-breeding season. These include Rough-skinned Newts, Long-toed and Northwestern Salamanders, Western Toads, Columbia and Oregon Spotted Frogs, Pacific Treefrogs, and Boreal Chorus Frogs. Adults may or may not linger in riparian areas, but their newly metamorphosed young may spend weeks in riparian areas upon emergence in mid to late summer. Adults may also become more closely associated with riparian areas during periods of hot, dry weather.

Riparian areas play an important role in the ecological processes and functions of all water bodies. Riparian vegetation filters surface and groundwater, and traps sediment. Overhanging trees and shrubs create shade, which moderates water temperatures. When dead leaves fall into streams and lakes they provide an important food source for invertebrates, and nutrients for aquatic organisms. Invertebrates provide abundant prey for aquatic amphibians and reptiles, as well fish. Emerging insects and amphibians that have transformed from aquatic eggs and larvae that move onto land provide a food source for birds and other terrestrial predators. As trees die and fall into streams, they create pools that provide habitat for amphibians, reptiles, and fish, and slow sediment movement downstream.

Bill Leonard

Riparian areas are biodiversity hotspots, often containing more species than the adjacent upland. Maintenance of these zones would enhance the diversity of amphibians and reptiles.

Elke Wind

Leaf litter, wood, and shade have been used as criteria for riparian reserves. These inputs extend 340-400 feet (about 100-120 m) away from the wetted edge of streams and up to 500 feet (about 150 m) in productive forestlands. The width of riparian habitats required by all species is not well documented, but may be greater than this.

HEALTHY RIPARIAN AREAS BENEFIT EVERYONE!

Healthy watersheds and riparian-wetland areas are critical to providing communities with the economic, ecological, and social benefits that come from the reliable availability of adequate supplies of clean water.

The U.S. Department of Agriculture (USDA) Forest Service and the U.S. Department of Interior Bureau of Land Management, in partnership with the USDA Natural Resources Conservation Service, has created a strategy for accelerating cooperative riparian restoration and management. This is accomplished by developing a critical mass of people who interact with and manage riparian-wetland resources based on shared knowledge of the attributes and processes that constitute sustainability.

For more information about how you can participate as a landowner, go to the National Riparian Service Team's website at ***www.blm.gov/or/programs/nrst***

Riparian areas are prone to natural disturbance, including fluctuating water levels, high flows, treefalls, and slope failures. Riparian areas are also sensitive to human-caused disturbances, with amphibians and reptiles being particularly vulnerable to riparian habitat alteration. Changes may result from vegetation removal, stream channelization, hydrological changes, mining, road construction, livestock grazing, and chemical applications. Timber harvest activities (including associated road networks) may negatively affect some resident amphibians by altering surface microclimates, refugia (e.g., loss of downed wood and soil compaction), and stream sediment loads. Livestock grazing can similarly alter vegetation and microclimate, disturb substrates, change water flow patterns, and may cause direct mortality of amphibians by trampling. When inappropriately used, chemical applications including many fertilizers, herbicides, pesticides, and fire retardants may adversely affect amphibians and reptiles.

How much upland habitat should be appropriately managed around wetlands and streams to maintain viable amphibian and reptile populations? When asked this question, a wildlife biologist might respond with, "It depends." It depends on the species, the wetland or stream characteristics, and the surrounding landscape. However, to maintain viable populations of amphibians and reptiles, it is important to provide at least some upland habitat around each water body, and more is usually better.

A general approach based on indirect evidence* of buffer widths:

1. At the very least, maintaining some riparian vegetation and minimizing shoreline disturbance within 3 – 30 feet (1-9 m) could allow some amphibian and reptile species to use the water body.
2. Providing 30 - 50 foot (9 – 15 m) of mostly intact riparian and upland habitats (referred to as "riparian buffers" or "buffer zones") along all or part of a wetland or stream is usually considered a minimum buffer for habitats managed for wildlife or water quality protection.
3. Establishing a mostly contiguous 50 to 330-foot (15 - 100 m) buffer zone around or along the water body and the core terrestrial habitat will help maintain many ecological characteristics and functions of the wetland or stream, including some amphibian and reptile species, despite surrounding land use.
4. When managing habitat specifically for turtles, salamanders, and other semi-aquatic species that use uplands, an additional "core habitat" area should extend to a distance of about 540 to 900 feet (165 m - 275 m) from the water's edge. These surrounding upland habitats are necessary for population persistence of these species, and may require additional "buffering" themselves.

*A word of caution: Few studies have looked at the relationship between population performance and buffer widths, so a complete understanding of appropriate buffer widths for amphibians or reptiles is lacking and the distances provided are mostly based on habitat use patterns of amphibians around water bodies and relative changes in habitats observed with various buffer widths. In addition, the geographic area (e.g., climate) and surrounding land use affects buffer effectiveness; a buffer in an agricultural, forestry, or urban setting is not equivocal. See Appendix H for more information on buffers.

CHARACTERISTIC SPECIES

Salamanders: Giant Salamanders, Torrent Salamanders, Dunn's Salamander, Coeur d'Alene Salamander, Van Dyke's Salamander, Western Red-backed Salamander; **Frogs and Toads:** Rocky Mountain Tailed Frog, Coastal Tailed Frog, Western Toad, Pacific Treefrog, Red-legged Frog, Foothill Yellow-legged Frog, Cascades Frog, Columbia Spotted Frog, Oregon Spotted Frog; **Lizards:** Six-lined Racerunner, Western Skink; **Snakes:** Common Gartersnake, Terrestrial Gartersnake, Aquatic Gartersnake; **Turtles:** Pacific Pond Turtle, Painted Turtle, Pond Slider (introduced), Snapping Turtle (introduced, except for eastern Montana and Wyoming)

MAXIMIZING COMPATIBILITY: Timberlands, Farmlands, Recreational Lands, and Other Integrated Land Uses

Consider the following options if benefiting amphibians and reptiles is secondary to other management objectives.

- **Consider applying a mix of riparian protective measures, such as different buffer widths.** *Buffer widths used may depend on the upslope management scenario, landscape and site conditions, resident species and species of concern, and buffer objectives. A tiered approach might be employed with a smaller no-entry zone and a larger limited-entry zone, or interspersed larger and smaller zones. The benefits of alternative riparian management designs are not well-documented, hence monitoring is recommended to advance our knowledge of their efficacy relative to retention of species and riparian functions.*
- **Consider connectivity of aquatic and terrestrial habitats in management plans.** *Consider the habitat requirements of species using riparian areas as a corridor through an inhospitable landscape (e.g., pond-breeding amphibians that forage or overwinter in uplands, or streamdwellers that must pass through culverts), and potential linkages across watersheds by relative proximity of headwater riparian areas and across adjacent ridgelines.*
- **Carefully manage activities and ground disturbances in or near riparian areas.** *Timing of activities needs to reflect the annual life cycle of species. Generally, riparian-dependent gartersnakes are active during drier warmer conditions, many amphibians are surface active or breed during a narrow window in spring or fall,and turtle activities will include nesting (spring-early summer) and hatching (late summer).*

Bill Leonard

Charlotte Corkran

Bill Leonard

The Coeur d'Alene Salamander, Pacific Pond Turtle, and Cascades Frog are all obligate riparian species, meaning that they spend the majority of their time in or very close to water bodies.

- **Avoid development activities such as road construction in riparian areas.** *Roads intersecting riparian zones can increase sunlight and sedimentation, adversely affecting the aquatic and riparian habitats required by amphibians and reptiles. If the location of new road construction projects along streams cannot be changed, provide passageways for amphibians and reptiles such as culverts with natural substrates that provide banks and full wetted channel widths to allow instream movements of animals.*
- **Minimize the use of chemicals, such as fertilizers, pesticides, and fire retardants in or near riparian areas.** *This is especially important in riparian areas during amphibian breeding seasons. Follow the directions on the label as to where these chemicals can be applied.*
- **Reduce access to riparian areas that may facilitate the spread of invasive and nonnative plants.** *Limit access points for trails used by both people and animals (pack animals, dogs) to streams and wetlands. Construct viewing platforms and boardwalks on sensitive soils and steep banks to reduce erosion and sediment runoff.*
- **Avoid orienting trails and roads parallel to riparian areas.** *This reduces the magnitude of potential impacts from habitat fragmentation, movement barriers, mortality during migration, erosion, and sediment runoff.*

IDEAL: Refuges, Sanctuaries, and Preserves
Consider the following options if benefiting amphibians and reptiles is a primary objective and when landowners and managers wish to optimize herpetofauna diversity and abundance.

- **Identify areas for protection or restoration priority.** *Managing adjacent uplands and aquatic-riparian areas together is ideal, because riparian conditions are highly associated with both aquatic and upslope habitat conditions. Focus on areas around unique habitats (e.g., isolated seeps or wetlands, the only known breeding site for a species within a watershed) or used by unique biota (e.g., watersheds with species of concern or distinct populations). Other priority areas may include riparian areas with high disturbance potential (e.g., unstable riparian slopes due to geology or topography that increase likelihood of scour or sedimentation) caused by invasive nonnative vegetation, road construction, grazing, mining, or other human-caused disturbances.*
- **Provide aquatic-riparian linkages via delineation of riparian buffers.** *Retain or restore aquatic-riparian habitat conditions, functions, and processes. Con-*

Bill Leonard

Dunn's (left) and Van Dyke's (right) Salamanders are associated with riparian areas.

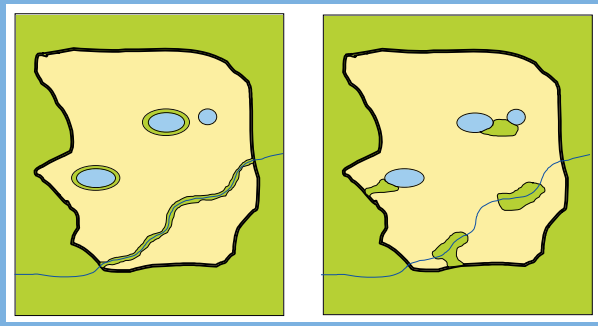
sider buffer widths needed to retain riparian microsites and microclimates used by herpetofauna, including distances from water needed to provide terrestrial subsidies to water (shading, litter, wood), aquatic subsidies to land (transformed aquatic invertebrates and amphibians), and critical upslope habitats for species' life histories (nests, food resources, overwintering hibernacula). Buffer widths may depend on the upslope management scenario, landscape and site conditions, resident species or species of concern, and buffer objectives. Buffer widths of 50-330 feet (15-100 m) may be needed to maintain habitat conditions used by many riparian-dependent herpetofauna. A mix of buffer widths may be considered to integrate local knowledge of habitats or to hedge uncertainties. For example, a buffer may be expanded to include a known turtle nesting site that is 500 feet (>152 m) from water.

- **Maintain or restore large downed wood, interstitial spaces in substrates, vegetation, temperature, and hydrological patterns.** *Suitable microhabitat refugia and microclimates are important for both aquatic and riparian-occurring species. In areas where water flow has been regulated or altered, consider management activities that will lead toward natural flow regimes (timing and extent of peak flows, reduced water diversion).*
- **Replace culverts that fail to provide adequate aquatic organism passage, such as perched culverts.** *Open arch culverts that have natural substrates provide easier passage for salamanders, frogs, and toads, as well as snakes (see Dirt Roads and Trails page 20).*

THINK BEYOND THE DONUT: CORRIDOR APPROACHES

One concern with recommending fixed-width core habitat areas around wetlands is that they give the impression that wetlands will continue to provide habitat for wildlife as long as they are surrounded solely by a buffer and core habitat. However, this donut-style buffer approach to habitat management may result in wetland isolation and fail to provide for landscape connectivity, genetic exchange, and movement of animals between populations. It is important to consider the needs of the population at a site and in a landscape. It may not always be necessary to provide a fixed width zone that completely encircles a wetland. Perhaps a landowner can only afford to maintain upland vegetation around half of a wetland. In that case, the side of the wetland that is most likely to serve as both core upland and as a corridor to other wetlands might be the better side to select.

Elke Wind



Riparian buffers have traditionally encircled wetlands and followed the length of streams. These minimum buffers often result in relatively narrow strips of trees that are often vulnerable to windthrow. Research into alternative buffer designs may be useful in meeting specific objectives for amphibians and reptiles under some circumstances.

David Pilliod

RESERVOIRS

Don Ashton

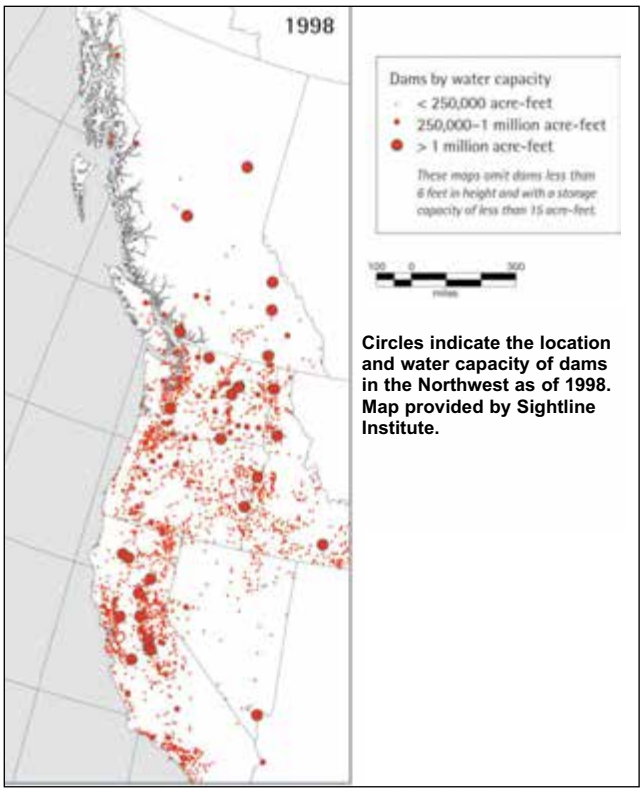
Dams occur within all ecoregions within the Northwest. The United States and Canada have about 76,000 and 10,000+ large and small dams respectively that were constructed mainly for electricity, irrigation, drinking water, and flood control. Most of these dams are smaller earthen dams with small reservoirs behind them. Dams on larger rivers create massive reservoirs, some of which cover many millions of acres with standing water. Five of the ten largest reservoirs in the U.S. occur in the Northwest, including Ft. Peck Lake and Lake Koocanusa in Montana, FD Roosevelt Reservoir in Washington, Shasta Lake in California, and Flaming Gorge Reservoir in Utah. Williston Lake is the largest reservoir in British Columbia with a surface area of 683 square miles (1,773 square kilometers).

Reservoirs provide habitat for a number of amphibian and reptile species, especially in the arid west. Gartersnakes hunt for frogs and fish along the reservoir edge. Painted Turtles, introduced Snapping Turtles, and perhaps Pacific Pond Turtles will use sheltered coves, provided there is some shallow water and emergent vegetation. Western Skinks, Northern and Southern Alligator Lizards, and Western Fence Lizards frequent the shoreline of reservoirs. Small reservoirs, such as those

Charlotte Corkran

Charlotte Corkran

Reservoirs provide open space, recreational opportunities, and wildlife habitat. Fluctuating water levels, introduced predatory fish, and lack of shoreline vegetation often limit use of reservoirs by amphibians and reptiles.



Circles indicate the location and water capacity of dams in the Northwest as of 1998. Map provided by Sightline Institute.

created as stock ponds, provide breeding habitat for Tiger Salamanders, Long-toed Salamanders, Pacific Treefrogs, Boreal Chorus Frogs, Columbia and Oregon Spotted Frogs, and Western Toads. Stock ponds that dry seasonally, are preferred by amphibians because non-native American Bullfrogs and predatory fish cannot survive in these temporary wetlands. In larger reservoirs, amphibian breeding habitat is limited to hydrologically connected wetlands, coves, and channels that retain water when the reservoir is drawn down or filled during spring runoff.

Modern dams and the resulting reservoirs produce large-scale changes in aquatic ecosystems. Miles of rivers and streams and numerous wetlands are lost (flooded) when reservoirs are created, affecting pond- and stream-breeding amphibians. Reservoirs can create habitat for waterfowl, game fishes, invertebrates, and countless microorganisms, though often to the detriment of native species that once lived in the river. Reservoirs tend to provide ideal habitat for non-native predators of amphibians, such as warmwater fishes and non-native turtles. Dams fragment populations of amphibians and reptiles that once moved up and down free-flowing rivers and streams. In some cases, the aerial extent of reservoirs may create barriers across valleys for stream-breeding species. Amphibians and reptiles that colonize reservoir habitats are exposed to dangers associated with dam operations. Flood protection, hydroelectric power, and water delivery for agricultural and domestic users often result in large, unnatural fluctuation of reservoir water levels. Fluctuating water levels can flood turtle nests, flood or desiccate amphibian eggs, and leave wide barren shorelines with little cover for riparian species. Water regulation can have significant impacts downstream through changes in flow regime and sediment deposition, two processes that influence breeding habitat for riverine amphibians. Altered hydrograph timing and thermal regime can interfere with behavior and growth of riverine ectotherms.

CHARACTERISTIC SPECIES

Salamanders: Long-toed Salamander, Tiger Salamander, Rough-skinned Newt; **Frogs and Toads:** Western Toad, Woodhouse's Toad, Pacific Treefrog, Red-legged Frog, American Bullfrog (introduced), Northern Leopard Frog, Wood Frog; **Snakes:** Gartersnakes; **Turtles:** Pacific Pond Turtle, Painted Turtle, Pond Slider (introduced), Snapping Turtle (introduced, except for eastern Montana and Wyoming)

Elke Wind

Charlotte Corkran

Downstream of dams, the altered hydrologic regime of a river can adversely affect the fisheries and aquatic and riparian herpetofauna. Some dams have resulted in the loss of as much as 95% of the cobble bar habitat used for reproduction by the Foothill Yellow-legged Frog, and cold water released from the dams has resulted in reduced growth rates of Pacific Pond Turtles.

MAXIMIZING COMPATIBILITY: Timberlands, Farmlands, Recreational Lands, and Other Integrated Land Uses
Consider the following options if benefiting amphibians and reptiles is secondary to other management objectives.

- **If stocking of reservoirs is a desired recreational goal, use native riverine fauna.** *For example, rainbow trout from native stocks will provide a good fishery and potentially fewer negative impacts on amphibians compared with perch, bass, and brook trout.*
- **Use only fish from state/province-tested sources.** *Introduced fish and hatchery waters can carry diseases that can be transmitted to amphibians, such as iridoviruses, chytrid fungus, and water molds that can harm amphibians.*
- **Create fish exclosures to provide native amphibians with refugia in reservoirs with non-native fishes.** *Aquatic fences could be used to block small coves or shallow areas along the reservoir margin that fill when reservoirs are at high water during the spring (coincides with amphibian breeding).*

Virgil Hawkes

Creating shallow water wetlands that contain emergent vegetation along the shoreline of reservoirs, and/or installing exclosure fencing within the reservoir where appropriate habitat exists (e.g., along gently sloping, shallow areas) may provide suitable and 'safe' places for native amphibians, away from non-native fish.

- **If motorboats are a major recreational feature of the reservoir, consider setting exclusion zones *in areas with high densities of native turtle use.*** *Turtles are occasionally killed by collisions with motorboats, and motorboats may displace turtles from preferred basking, resting, and foraging areas.*

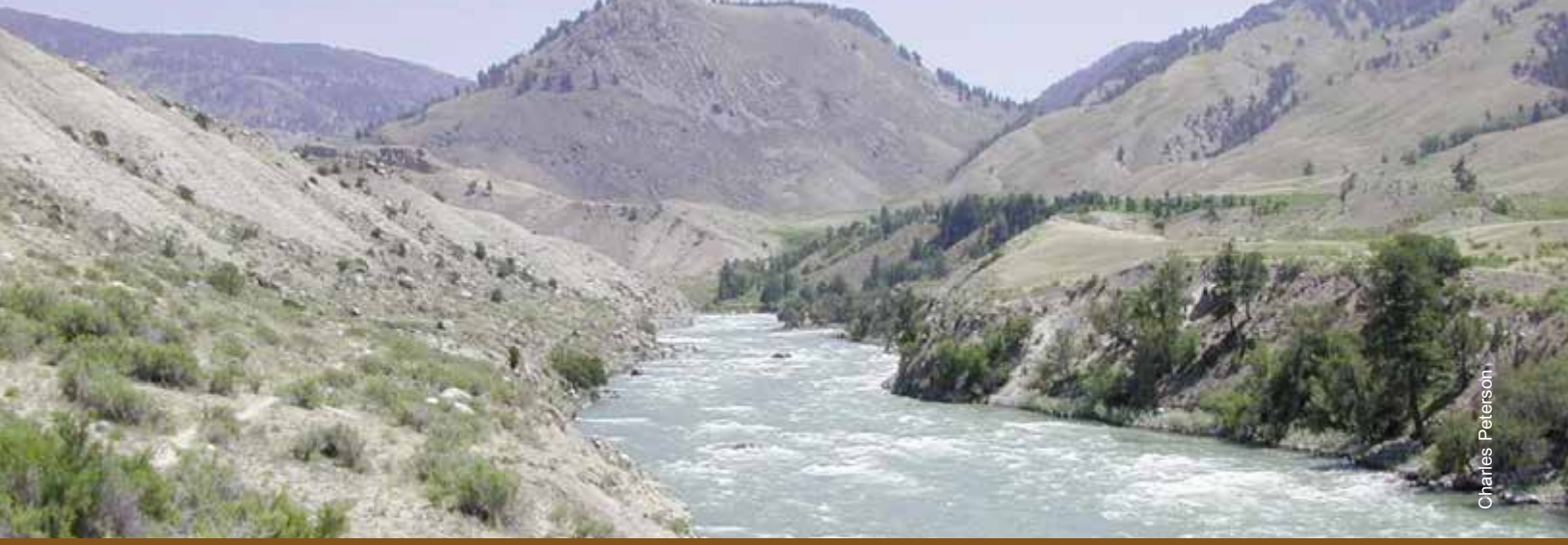
IDEAL: Refuges, Sanctuaries, and Preserves
Consider the following options if benefiting amphibians and reptiles is a primary objective and when landowners and managers wish to optimize herpetofauna diversity and abundance.

- **Consider "headstarting" programs for Pacific Pond Turtles.** *Headstarting programs allow turtles to hatch in captivity and then they are released under optimal conditions. This could offset impacts of the altered riverine condition of a reservoir and counteract additive mortality caused by non-native species impacts. If used, it should be in conjunction with the establishment of seasonal wetlands adjacent to reservoir (bullet below). Work with local herpetologists to determine whether such a plan is feasible or appropriate for the circumstances.*
- **Create seasonal wetlands adjacent to reservoirs or shallow areas with emergent vegetation to accommodate native turtle and amphibian rearing habitat.** *These habitats have often been lost as a result of reservoir creation and flooding. Maintaining existing backwater habitats will benefit amphibians and reptiles when reservoir levels change over a season.*
- **Monitor the timing of water level changes of reservoirs in relation to local amphibian breeding and egg mass development.** *If possible, stabilize reservoir levels (and shoreline position) during this time to reduce potential risks to amphibian egg masses and larvae that can become stranded or flooded when reservoir levels change. Creating shallow shoreline egg laying and rearing areas for amphibians (see above) will help reduce impacts of water level changes.*
- **Add snags, anchored logs, and other basking structures that allow turtles to thermoregulate and seek cover.** *Many reservoir shorelines are bare and do not have brush piles and other structures for turtles that provide cover for hatchlings from predatory fish and wading birds.*
- **Plant vegetation along the shorelines of coves and backwater areas that can become inundated at high water and provide cover and oviposition sites for amphibians.** *Structural complexity (e.g., shrubs and logs) may benefit amphibians, reptiles, and fishes by creating attachment structures for eggs, cover from predators, and basking sites.*

David Pilliod

- **Discontinue stocking fishes and remove non-native fishes, such as bass.** *Game species such as largemouth bass are voracious predators and vectors of aquatic pathogens to native herpetofauna.*
- **Control agricultural and recreational development in the vicinity of key aquatic habitats around the reservoir.** *Chemical runoff from conventional agriculture accumulates in reservoirs (in water and trapped in sediments) and can be harmful to amphibian and turtle development and health. Agrochemicals can increase productivity of reservoirs resulting in degraded water quality and poorer habitat conditions for many aquatic organisms.*
- **Provide educational material at public recreational areas (boat ramps) to improve public understanding of native species.** *Much of the public is not aware of the occurrence of amphibians and reptiles in the areas they use for recreation. Increased awareness can contribute to enhanced conservation and stewardship.*

This is the "Reservoirs" module of the PARC Publication HMG-4, ISBN 0-9667402-5-4. Please visit ***www.parcplace.org*** for further information, copies of the complete document, or a web-based version of the Guidelines.


Charles Peterson

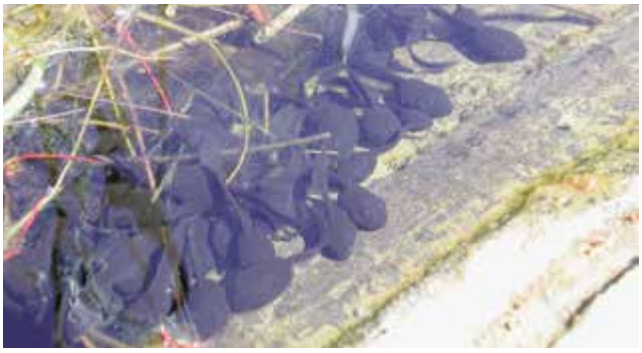
RIVERS AND LARGE STREAMS

R. Bruce Bury

Large streams in the Northwest are usually about 6-16 feet (2 to 5 m) wide, and join to form larger rivers. Although large streams are prominent features on the landscape, they make up approximately 25% or less of the stream length in watersheds. In areas influenced by snow melt, flow rates peak in May and June. In coastal areas, flow rates are less predictable as they are driven by rain events from late fall to spring. Wide, shallow creeks and rivers are highly productive ecosystems because of abundant light and nutrients. As river depth increases, productivity decreases. However, downstream transport of organic matter, nutrients, and macroinvertebrates from smaller tributaries supports large predators, like salmonid fishes. Tributaries provide large quantities of sediment and downed wood during debris flow events, which are deposited along areas of slower moving water creating sandbars and river meanders.

Several species of amphibians and reptiles use rivers and large streams, but the number of species appears to decrease with increasing size of the stream. Downstream from smaller tributaries, large creeks and small rivers may have Giant Salamanders or Tailed Frogs. Larger creeks and rivers support Foothill Yellow-legged Frogs. Western and Woodhouse's Toads frequently breed in slow waters along the edge of rivers. Backwaters are used by Columbia Spotted Frogs, Red-legged Frogs, and Long-toed Salamanders for hydrating, foraging, and occasionally breeding. Several species of Gartersnakes, and especially the Aquatic Gartersnake, occur near or along edges of large streams and rivers. Painted Turtles and Pacific Pond Turtles frequent slow-moving portions of large creeks and rivers, but are rarely found in deep waters away from shore.

There are many threats to free-flowing rivers and streams, including shoreline development, recreation, non-native species, altered hydrological patterns, dams and other water diversions, and adjacent land use that increases water temperatures, sediment, and anthropogenic chemical inputs. Most recently, there has been a high influx of medium megawatt run-of-the-river projects (i.e., less than 10MW of generating power) being constructed on small rivers throughout the Northwest. Effects of these developments on stream amphibians have not been studied and remain unclear.


Elke Wind

Sediment deposits along rivers create backwater areas that are used by Western Toads for breeding, as well as by other amphibians and reptiles. Downstream of dams, the reduction in sediment appears to be altering this required habitat.


Elke Wind

Terrestrial, Common, and Aquatic Gartersnakes are common along large creeks and rivers where they hunt for amphibians and fish.

Bill Leonard

Foothill Yellow-legged Frogs breed in large creeks and shallow rivers in Oregon and California.

CHARACTERISTIC SPECIES
Salamanders: Long-toed Salamander; **Frogs and Toads:** Western Toad, Woodhouse's Toad, Red-legged Frog, Foothill Yellow-legged Frog, Columbia Spotted Frog; **Snakes:** Terrestrial Gartersnake, Common Gartersnake, Aquatic Gartersnake; **Turtles:** Pacific Pond Turtle, Painted Turtle, Snapping Turtle (introduced, except for eastern Montana and Wyoming)

MAXIMIZING COMPATIBILITY: Timberlands, Farmlands, Recreational Lands, and Other Integrated Land Uses
Consider the following options if benefiting amphibians and reptiles is secondary to other management objectives.

- **Educate river users about amphibians and reptiles.** *Encourage jet boaters, rafters, or other river users to avoid shoreline areas where frogs and turtles may be present (e.g., emergent logs, shallow areas).*
- **Align the mix of land ownerships in watersheds.** *Building partnerships (e.g., BLM, USFS, BC Hydro, First Nations (American Indian), and private timber owners) may improve protection of large streams and rivers through cooperative watershed analyses.*
- **Maintain riparian buffers.** *Riparian vegetation traps sediment and chemicals generated from adjacent land uses from entering rivers. This can help improve water quality for amphibians and other aquatic organisms.*
- **Identify and carefully manage reaches or segments of large streams and rivers that remain in natural or minimally disturbed watersheds.** *Undisturbed reaches of rivers and streams may provide unique habitat conditions for amphibians and reptiles that are not found in managed areas of watersheds.*
- **Limit recreational development (e.g., parks, golf courses) along the channel downstream of dams.** *Ideally, retain the ability to conduct high flow scouring releases to maintain dynamic channel morphology that provides habitat for river-breeding amphibians like Foothill Yellow-legged Frogs and Western Toads.*
- **Locate new development such as recreation facilities away from important habitat areas.** *Campgrounds and boat launching areas should be located away from important breeding or nesting sites for amphibians and reptiles.*
- **Reduce disturbances in headwaters.** *Reducing or preventing road construction and intensive land uses (e.g., mining, timber harvest) in headwaters will help maintain water quality (e.g., appropriate temperature and sediment levels) and habitat attributes (e.g., downed wood) for amphibians and other aquatic wildlife that live in downstream reaches.*
- **Retain large pieces of wood (e.g., tree trunks) in large streams and rivers.** *These objects provide cover for wildlife, help to reduce flow rates, and maintain channel structure.*

IDEAL: Refuges, Sanctuaries, and Preserves
Consider the following options if benefiting amphibians and reptiles is a primary objective and when landowners and managers wish to optimize herpetofauna diversity and abundance.

- **Remove dams.** *This is the ideal management plan for restoring running waters that will benefit the native herpetofauna of large river systems.*
- **Restore natural stream flows, including timing and extent of peak flows.** *This will help maintain natural river morphology and provide habitat for native species.*
- **Avoid late-season dam releases into rivers.** *Dam releases in the early to mid- summer can negatively affect breeding success of Foothill Yellow-legged Frogs and other species that breed along large streams.*
- **Reduce or prevent management actions that disturb wetlands that are typically associated with rivers and large streams.** *Representative habitats include backwaters, oxbows, slow waters at the end of pools and shallow areas of rocky shoreline that are often used by amphibians and Gartersnake species.*
- **Integrate river management and riparian management.** *Manage riparian habitat beyond the minimum BMP requirements, so that habitats used by amphibians and reptiles are included in protective measures.*

This is the "Rivers and Large Streams" module of the PARC Publication HMG-4, ISBN 0-9667402-5-4. Please visit ***www.parcplace.org*** for further information, copies of the complete document, or a web-

Charles Paterson

SMALL STREAMS

R. Bruce Bury

Small streams or creeks less than 6 feet (2 m) wide make up about 75% of the total length of streams in a watershed. Headwaters begin as trickles or seeps that accumulate groundwater and form small streams. Water volume and flow increases as it moves downstream forming waterfalls and riffles, interspersed with pools. As the water tumbles over rocks it becomes highly oxygenated, an important condition for gilled animals like tadpoles and salamander larvae. Full or partial canopies overhang most of these small streams. Leaf litter falling into the streams serves as an important food source for aquatic insects, primary prey for amphibians. When creeks enter broad valleys, they become slow-moving and meander through open meadows, grasslands, desert shrublands, and forests. Even here, they are vital breeding areas for several amphibian species and used by some reptiles (e.g., Gartersnakes). In arid areas, there is usually a narrow riparian zone of shrubs and trees along streams that may provide the primary cover for many reptiles.

Small creeks are teeming with life and provide excellent habitat for amphibians. In the Northwest, there are three families of amphibians that are found nowhere else in the world and all breed and deposit eggs in small streams: Torrent Salamanders (4-5 species), Giant Salamanders (4 species), and Tailed Frogs (2 species). For the most part, these species require rocky, fast-flowing streams within forests where stream temperatures remain cool most of the year. There are also several lungless salamanders that live near creeks, such as Dunn's, Van Dyke's, and Coeuer d'Alene Salamanders. Columbia Spotted Frogs, Western Toads, and other frogs and toads use small streams as habitat or as travel corridors. Painted Turtles and Pacific Pond Turtles occur in ponds but may be found in deeper pools of small streams. Sometimes, Terrestrial, Aquatic, and Common Gartersnakes are present in small streams.

CHARACTERISTIC SPECIES

Salamanders: Idaho Giant Salamander, Cope's Giant Salamander, Coastal Giant Salamander, Torrent Salamanders, Dunn's Salamander, Van Dyke's Salamander; **Frogs and Toads:** Rocky Mountain and Coastal Tailed Frog, Western Toad, Red-legged Frog, Columbia Spotted Frog, Wood Frog; **Snakes:** Terrestrial Gartersnake, Common Gartersnake, Aquatic Gartersnake

Virgil Hawkes

Streams in forests are highly dependent on the condition of upland slopes as well as adjacent riparian zones. Intact forests and riparian zones provide cool temperatures and moist conditions resulting in the highest density and biomass of amphibians in any part of a forest ecosystem. Riparian zones also serve as dispersal corridors for many species.

Elke Wind

Many Northwest species breed in small, cool, fast flowing streams.

Bill Leonard

Columbia Torrent Salamanders are most common in small, steep streams that contain high cover of cobbles and gravel.

MAXIMIZING COMPATIBILITY:
Timberlands, Farmlands, Recreational Lands, and Other Integrated Land Uses
Consider the following options if benefiting amphibians and reptiles is secondary to other management objectives.

- **Consider connectivity of stream, riparian, and terrestrial habitats in management plans, as these systems are tied together functionally.** *Several species of stream amphibians forage or overwinter on land, whereas others occur on land but use streams and ponds for breeding.*
- **Review the bigger picture because of the mix of land ownership in many areas.** *Neighborhood partnerships (e.g., BLM, USFS, First Nations (American Indian), and private timber lands) may be required to design a plan to better manage stream systems that cross human-imposed boundaries.*
- **Consider the effects of roadways on streams.** *Although few new roads are being constructed in forested lands, there exist thousands of miles of older roads. Some of these lack properly designed stream crossings, blocking upstream passage by amphibians and fishes occurring downstream of the road. Efforts should continue to make perched and otherwise impassable culverts open to fish passage by replacing them with open bottomed box culverts. This will influence resident amphibian species, by both interspecies interactions and possible passage of amphibians through improved crossings.*
- **Focus management activities on accomplishing desired outcomes for streams.** *Shift focus from criteria such as buffer widths to paying greater attention to the desired outcomes for streams such as: (1) cool water temperature (e.g., <60^{o}F or <15^{o}C year round); (2) little or no sedimentation; and (3) long-term input of large woody debris. These are essential elements for a host of stream biota (invertebrates to salmonid stocks) that depend on the same suite of stream conditions. Habitat quality indicators can include accurate tracking of stream temperatures (via automated recorders) and rapid habitat assessment of sedimentation levels and presence of sensitive species (e.g., Torrent Salamanders,Tailed Frogs).*

IDEAL: Refuges, Sanctuaries, and Preserves
Consider the following options if benefiting amphibians and reptiles is a primary objective and when landowners and managers wish to optimize herpetofauna diversity and abundance.

- **Remove dams.** *This is the ideal management plan for restoring running waters that will benefit the native amphibians and other aquatic species that live in streams.*
- **Restore natural stream flows, including timing and extent of peak flows.** *This will help maintain natural stream morphology and provide habitat for native species.*
- **Locate areas with the most abundant or diverse species, and consider managing these areas for biodiversity values.** *Representative microhabitats include isolated seeps, headwalls, headwaters, and small cascading streams.*
- **Manage riparian zones for biodiversity.** *See riparian habitat section.*
- **Maintain input of large pieces of wood into small streams.** *Large wood provides more structurally complex in-stream and riparian habitat, including cover, habitat for prey, cascades, pools, and dams that reduce flow rates. Downed wood also contributes nutrients.*
- **Maintain rocky substrates in streams and identify unstable slopes.** *Rocky substrates need to be maintained, as they provide critical cover and egg-laying habitat for amphibians. However, slopes that are unstable due to geology or steepness of terrain are subject to debris flows and high sedimentation of streams. Loss of interstitial spaces usually leads to the decrease or elimination of sensitive species.*
- **Prevent application of fertilizers, pesticides, and fire retardants directly into small creeks.** *Identify and map sensitive sites prior to management activity or reacting to fire suppression. It may be illegal to allow these chemicals to enter water.*
- **Replace culverts that fail to provide adequate aquatic organism passage, such as perched culverts.** *Open arch culverts that have natural substrates provide easier passage for salamanders, frogs, and toads, as well as snakes.*

This is the “Small Streams” module of the PARC Publication HMG-4, ISBN 0-9667402-5-4. Please visit ***www.parcplace.org*** for further information, copies of the complete document, or a web-based version of the Guidelines.


Bill Leonard


Jason Jones


Elke Wind

Tailed frogs live in cold, fast-moving creeks in the Northwest. The tadpoles have a suction type mouth that allows them to adhere to boulders and cobbles in the fast-flowing current. Tailed frog tadpoles seldom occur in streams that are warm or full of sediment.

Virgil Hawkes

SPRINGS AND SEEPS

Elke Wind

Springs and seeps are areas where water contained in aquifers and groundwater emerges at the land surface. Springs have free-flowing water, whereas seeps usually keep soils moist or boggy. These habitats can occur in a variety of settings. For example, a classification system for central and southern California recognizes nine types of seeps: drainage head, bluff and slope, canyon, stream bank/bed, river bank/bed, montane, foothill, valley and plain, and lake. Seeps and springs are often associated with the headwaters of streams, or talus and coarse substrates that allow water to flow through.

Charles Peterson

Water is often a limiting factor critical for wildlife occupying arid regions.

Springs and seeps are important habitats for wildlife, including amphibians and reptiles, because they provide a reliable source of water and moisture. In a survey of 244 seeps in Olympic National Park, Washington, scientists found 270 individuals of 8 species, including Tailed Frogs, Giant Salamanders, Van Dyke's Salamanders, Western Red-backed Salamanders, and Olympic Torrent Salamanders. In coastal and southern regions, the Southern Torrent Salamander is closely associated with both springs and seep habitats with gravel substrates that provide cover. The Coeur d'Alene Salamander is found in seep habitats in northern Idaho, western Montana, and southern British Columbia. Frogs, toads, and other salamander species also use springs and seeps to hydrate. In the cool northern climate of the British Columbia-Yukon border, Western Toads use geothermal springs of all temperatures for hibernation and breeding. With the abundant prey, Gartersnakes frequent seeps and springs as well.

Spring and seep habitats are threatened by development practices that reduce underground water tables and flows, as well as those that result in surrounding forest overstory and ground disturbance. Agriculture (irrigation and cattle troughs) and urban development have led to the extensive loss and degradation of springs and seeps in the Northwest. In general, forest practices do not provide adequate protection for springs and seeps, as many occur in zero-order basins in montane environ-

ments that do not require buffers. In Washington and California, seeps and springs are often protected in harvest unit plans and, in general, most operators try to avoid these areas whenever possible. Also, springs and seeps are on the list of special sites for SFI and FSC programs (see Appendix D).

CHARACTERISTIC SPECIES
Salamanders: Dunn's Salamander, Western Redbacked Salamander, Van Dyke's Salamander, Coeur d'Alene Salamander, Torrent Salamanders;
Frogs and Toads: Columbia Spotted Frog, Cascades Frog, Wood Frog, Western Toad;
Snakes: Common Gartersnake, Terrestrial Gartersnake, Aquatic Gartersnake

MAXIMIZING COMPATIBILITY: Timberlands, Farmlands, Recreational Lands, and Other Integrated Land Uses
Consider the following options if benefiting amphibians and reptiles is secondary to other management objectives.

- **If possible, utilize alternative water sources in lieu of developing springs or seeps.** *Springs and seeps provide critical overwintering habitats for amphibian species in forested and shrubland ecosystems in the Northwest.*

- **Retain patches of high quality habitat in headwater basins where seeps, springs, and headwater streams begin.** *This will help maintain important moist microsites for amphibians and reptiles. See buffer section on pages 82 and 135 for recommended widths and management approaches.*

Charlotte Corkran

Springs and seeps indicate areas where groundwater is close to the surface. Some land management practices can threaten these resources for humans, livestock, and wildlife by lowering the water table or contaminating drinking water sources.

- **Avoid practices that result in sedimentation and slumping.** *Slope failure, burning, and road building can result in the filling of important interstitial spaces used by amphibians for breeding and cover. Maintaining riparian vegetation can help reduce the chances of slope failure or sedimentation.*

- **Maintain natural underground and surface water flow rates.** *Water diversion can result in the loss of moist microsites, especially in seeps that have low flow rates. Increased water flows can result in flooding and make habitats unsuitable for some amphibian species.*

- **Avoid dragging logging materials across springs and seeps.** *This practice can damage sensitive vegetation and alter flow patterns that are important for amphibian use of these areas.*

- **Cover wells and other holes to avoid having them act as wildlife traps.** *Provide 'escape ladders' where cover is not possible (e.g., well designed ramps)*

- **Limit access for livestock and big game to undeveloped springs and seeps.** *Fence areas around springs and seeps to maintain water quality, flow patterns, and amphibian microhabitats.*

Charlotte Corkran

Seeps and springs provide important moist habitats for terrestrial salamanders like the Coeur d'Alene Salamander. Although not always protected, Washington Forest and Fish regulations require a 0.5-acre buffer around headwater springs and seeps. Studies have shown that approximately 85% of seeps in WA are located within 50' of stream channels in headwater systems so these areas are captured within stream buffers.

- **If pesticides or herbicides must be used, avoid spraying near springs or seeps.** *Fertilizers, pesticides, herbicides, road salts, and other chemicals easily contaminate springs and seeps. Follow label instructions for proper use.*

IDEAL: Refuges, Sanctuaries, and Preserves
Consider the following options if benefiting amphibians and reptiles is a primary objective and when landowners and managers wish to optimize herpetofauna diversity and abundance.

- **Create reserves that encompass entire headwater basins.** *This will help conserve amphibian habitats associated with springs, seeps, and headwaters and provide connectivity across ridgelines. These basins are usually relatively small and in steep areas not usually considered for management activities.*
- **Restore developed springs and seeps by removing pipes, pumphouses, and pumps.** *Amphibians, reptiles, and other wildlife rely on springs and seeps for water, particularly in arid lands. In northern latitudes, some springs serve as overwintering habitats. Evaluate potential use carefully before implementing restoration.*
- **Avoid the use of chemicals and fuels around springs and seeps.** *Chemical contamination of these low-flow water sources will be harmful to amphibian development and health.*

This is the "Seeps and Springs" module of the PARC Publication HMG-4, ISBN 0-9667402-5-4. Please visit ***www.parcplace.org*** for further information, copies of the complete document, or a web-based version of the Guidelines.

Bill Leonard

As their name implies, Aquatic Gartersnakes are very closely tied to water.

Charles Peterson

SEMI-PERMANENT AND SEASONAL WETLANDS

Elke Wind

Semi-permanent and seasonal wetlands provide important habitat for many amphibian species, as well as some reptiles. Semi-permanent wetlands usually become dry for a few months each year, but may hold water year-round in wet years. Seasonal wetlands are only wet during snowmelt or during the rainy season, which generally occurs in winter or early spring for most of the Northwest. Depending on their characteristics, seasonal wetlands may also be referred to as vernal pools, ephemeral ponds, playas, or prairie potholes. The hydroperiod, or length of time that a wetland retains water each year, is determined by the type of soil, the amount of snowmelt or rainfall, the duration of the rainy season, and other factors. The hydroperiod will also be important in determining which amphibian species successfully reproduce at each wetland. Typically, non-permanent wetlands originate on poorly drained sites. These wetlands are common in the low lying areas along the coast and in the interior.

Elke Wind

Long-toed Salamanders commonly breed in semi-permanent and seasonal wetlands.

In the U.S., there are 43.6 million hectares (about 107.7 million acres) of wetlands. Of these, 95% are freshwater and 5% are marine or estuarine. The freshwater wetlands are dominated by semi-permanent and seasonal wetlands such as forested wetlands (51%), emergent wetlands (25.5%), and shrub wetlands (17%). Wetland creation, enhancement, and restoration on agricultural and other lands have resulted in a slight net gain in wetland area in the last few years. However, these gains in wetland area are offset by decades of wetland losses mostly due to urban and rural development. In addition, compensation and mitigation often result in the creation of permanent versus semi-permanent wetlands.

Many amphibian species breed in semi-permanent wetlands instead of permanent wetlands, ponds, and lakes, because permanent water bodies often contain larger and more abundant predators, such as fish, American Bullfrogs, and crayfish. These predators cannot persist in water bodies that dry up. Amphibian larvae will die if they do not make it to metamorphosis before a wetland dries. As a result, species that breed in seasonal wetlands often have fast growth rates, which are enhanced by warm water temperatures. These species include Long-toed Salamanders, Tiger Salamanders, Pacific Treefrogs, Boreal Chorus Frogs, and the Great Basin Spadefoot. Outside of the breeding season, semi-permanent and seasonal wetlands may also be used by several other species for hydration, foraging, and cover.

A major concern for northwestern herpetofauna is the lack of protection for small, semi-permanent and seasonal wetlands. Wetland legislation in North America is based largely on wetland size and the presence of fish, but studies have found no relationship between wetland size and the species richness of amphibians and the protection of primarily fish-bearing habitats may be counterproductive for amphibians. Seasonal wetlands are disappearing at a dramatic rate, especially in urban and rural areas, often being replaced by permanent wet areas that harbor and facilitate the spread of fish and non-native amphibians, such as American Bullfrogs that prey upon and outcompete native species.

CHARACTERISTIC SPECIES

Salamanders: Long-toed Salamander, Tiger Salamander, Rough-skinned Newt; **Frogs and Toads:** Great Basin Spadefoot, Western Toad, Boreal Chorus Frog, Pacific Treefrog, Cascades Frog, Wood Frog; **Snakes:** Common Gartersnake, Terrestrial Gartersnake, Aquatic Gartersnake

MAXIMIZING COMPATIBILITY: Timberlands, Farmlands, Recreational Lands, and Other Integrated Land Uses

Consider the following options if benefiting amphibians and reptiles is secondary to other management objectives.

- **Develop and encourage the use of incentive programs for landowners who wish to improve wetland habitats on their lands.** *Contact your state or provincial Fish and Wildlife Department, the U.S. Fish and Wildlife Service, Natural Resource Conservation Service (NRCS), or Ministry of Environment.*

- **Consider planting native species.** *Thin-stemmed sedges, rushes, and grasses may be most appropriate in or around a seasonal wetland as they are used as attachment sites during egg laying.*

- **Control grazing in or near seasonal wetlands during the wet season.** *Livestock can trample or consume wetland vegetation that provides important cover and egg-laying habitat for amphibians and decrease water quality for developing amphibian larvae.*

- **If pesticides or herbicides must be used, limit use to upland areas away from seasonal wetlands.** *This is particularly important from early to late spring when amphibians are breeding and larvae are developing.*

- **Design trails well back from seasonal wetlands or construct boardwalks and fencing to minimize disturbance.** *Be aware that trails constructed during the dry season may be built mistakenly across seasonal wetlands, resulting in perpetual disturbance of amphibian breeding sites.*

Elke Wind

Charles Peterson

Semi-permanent and seasonal wetlands are small (often less than 0.6 acres or 0.25 ha in size) but numerous. These small pools provide pockets of suitable breeding habitat within a sometimes harsh terrestrial environment. They help to maintain connectivity among amphibian populations.

- **Maintain a buffer of natural vegetation around seasonal wetlands.** *Maintaining at least some natural vegetation (30-50 ft or 9-15 m) around a wetland can improve water quality, provide habitat for prey, and provide some cover for amphibians and reptiles. Consult the regulations in your area.*

IDEAL: Refuges, Sanctuaries, and Preserves
Consider the following options if benefiting amphibians and reptiles is a primary objective and when landowners and managers wish to optimize herpetofauna diversity and abundance.

- **Provide a map of all wetland habitats for use by managers during project planning.** *Cooperate with government, land managers, developers, and the public to ensure they are aware of the location of all wetlands in relation to development projects.*

- **Maintain seasonal wet areas by retaining a buffer of native vegetation for terrestrial functions of wetland-associated species.** *Depending on wetland size, type, and other topographic features, maintaining the integrity of the wetland for amphibian species may require 540-900 feet (100 – 275 m) of riparian and upland vegetation to maintain natural hydrological regimes and temperature ranges, reduce sediments, and provide for terrestrial habitat needs of the amphibians and reptiles that use the wetland for breeding.*

- **Maintain connectivity between seasonal wetlands and surrounding habitats.** *As wetlands dry, animals move into other wetlands that have not yet dried, permanent lakes and streams, or uplands to aestivate. Maintaining upland habitats around seasonal wetlands is very important as is maintaining habitat corridors between wetlands that facilitates amphibian movement. This will minimize fragmentation and isolation of populations and reduce the chances for local extirpations.*

- **Locate and carefully manage seasonal wetlands on forested lands.** *Do not fill in wetlands (regardless of size), keep roads and logging landings away from wetlands when planning harvest activities, and reduce soil compaction, which can impact subterranean refugia, alter hydrologic flow regimes, and create conditions for invasive plant species. Limit the use of heavy equipment to the dry season or winter where the ground is frozen, and keep equipment out of wetland areas.*

Charlotte Corkran

Wetlands can be difficult to identify, as some may appear very dry in mid-to-late summer. Many activities in wetlands are regulated by state and federal laws, such as filling, excavation, timber harvest, ditching, draining, bulldozing or grading.

Elke Wind

The loss and conversion of temporary wetlands to permanent water bodies have negatively affected native species and facilitated the spread of non-native species like the American Bullfrog and warm water game fish. Bullfrogs are common in golf course ponds, garden ponds, stock ponds, and storm water ponds.

- **Maintain natural hydrological processes and flow rates of seasonal wetlands.** *Restoring or maintaining the seasonal patterns of wetland inundation and drying is important for amphibian reproduction and use, particularly for wetlands that have been ditched or drained. Consult with wetland restoration experts.*

- **When mitigation is required, design wetland habitats so the wetland will dry or can be drained in some years.** *Install weirs and pipes to facilitate drainage. This will make the habitat unsuitable for fish and invasive amphibians, such as American Bullfrogs, which have a tadpole stage that requires 1-2 years to complete metamorphosis.*

- **Eradicate non-native plant species from seasonal wetland areas.** *These species often alter habitat conditions by growing in dense monocultures and altering the vegetative structure of the wetland so that it is not favorable for resident amphibians and reptiles. Consult with wetland experts to determine if use of prescribed fire is an appropriate management tool for particular seasonal wetlands.*

- **Keep off-highway vehicles (OHVs) and foot traffic away from seasonal wetlands.** *OHVs that travel through seasonal wetlands, especially during the wet season, can degrade water and breeding habitat quality for amphibians. Foot traffic can also degrade water quality and may result in collecting or indiscriminate killing of some amphibian and reptile species.*

- **Control grazing in or near seasonal wetlands, even during the dry season.** *Seasonal wetlands are sometimes perched on relatively thin impervious soils. Trampling by livestock can penetrate this layer, which can lead to shorter periods of inundation. Use alternate watering systems for livestock, such as tanks, or use fencing to restrict access to natural wetlands.*

- **Avoid the use of fertilizers, pesticides, and herbicides in areas with seasonal wetlands.** *This is especially important during the dry season when seasonal wetlands are difficult to identify and delineate. Although some of these chemicals will break down prior to the wetland filling, amphibian larval development is sensitive to even low concentrations of some chemicals and nutrients.*

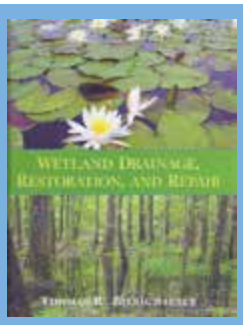
- **Golf courses – maintain or create seasonal wetlands instead of permanent ponds.** *A study in the southeastern U.S. found that seasonal wetlands located near golf courses had greater species diversity than permanent golf course ponds. Permanent human-created ponds provide habitat for invasive American Bullfrogs and other non-native amphibian predators (e.g., fish) and reduce the likelihood that golf course ponds will be used by native amphibians.*

Stemming The Tide of Wetland Loss

Have we really destroyed that many wetlands in the Northwest? Approximately 75% of wetlands have been lost to urban development and agriculture in the Greater Vancouver Lower Mainland and Victoria areas of British Columbia. In Oregon and Washington, 40-50% of original wetlands have been lost, largely to agriculture and urban development. The remaining wetlands have been significantly degraded and continue to be lost at an alarming rate. The Willamette Valley loses more than 500 acres (200 ha) of wetland habitat per year. In the Portland area, 40% of wetlands were lost over a 10-year period (1981–1992) from urbanization and agriculture, with seasonally flooded wetlands experiencing the greatest change.

David Pilliod

Wetlands are constructed for water gardens, as features in golf courses, as watering stations for livestock, for stormwater management, and to compensate for lost habitat. Many native amphibians benefit from the construction of temporary wetlands that retain water until late summer, as they contain fewer predators and do not support nonnative fish and amphibians.



Thomas Biebighauser has constructed over 1,000 wetlands over the past two decades. His latest book "Wetland Drainage, Restoration and Repair" can be ordered from *www.kentuckypress.com/viewbook.cfm?Category_ID=1&Group=197&ID=1396.*

Wetland Mitigation Actions and Design Guidelines

Occasionally, proposed development projects will result in impacts to wetlands. The Clean Water Act (CWA) prohibits the discharge of dredged or fill material into waters of the U.S. unless a permit is issued by the Army Corps of Engineers or the approving State under CWA section 404. The three-part process used to determine the type of mitigation required, called Mitigation Sequencing, includes avoid, minimize, and compensate. Where impacts cannot be avoided or minimized, compensatory mitigation is required to replace the loss of wetland function within the watershed. Types of compensatory wetland mitigation include restoration, enhancement, creation, and under certain circumstances protection or maintenance.

Restoration of a wetland means the re-establishment of wetland conditions, including hydrologic conditions or native hydrophytic vegetation, to an area where a wetland had previously existed.

Enhancement of a wetland means the alteration of an existing wetland to increase its specific functions and values. Enhancement includes new capabilities, management options, structures, or other actions that influence one or more functions and values.

Creation of a wetland means the development of the hydrologic, geochemical, and biological components necessary to support and maintain a wetland where a wetland did not previously exist. Any wetland established on a non-hydric soil will be considered a created wetland.

Protection/Maintenance of ecologically important wetlands or other aquatic resources through legal and physical mechanisms (e.g., conservation easements). Preservation does not result in a net gain of wetland acreage.

On a site level, limitations around the type, location, and timing of development projects may be required to minimize impacts. For example, heavy machinery operations and clearing in some areas may be prohibited until after the amphibian breeding season. Where development plans include the infilling of wetlands, salvage operations may be implemented to relocate as many amphibians and reptiles as possible from the development site into suitable habitat within the surrounding environment. Recommendations for salvage operations for amphibians and reptiles at wetlands include:

1. A salvage plan prepared before any work begins. The plan should include an estimate of person-hours required (effort), layout and construction of exclusion fencing, identification of suitable relocation sites (e.g., contains the same species assemblage), a handling and disinfection protocol, disease testing, and a monitoring plan.
2. Initiation of salvage after all aspects of the relocation plan have been completed, and the exclusion fencing has been constructed and tested. Continue salvage efforts until zero individuals are detected during three sweeps of an area within a 48-hour period (L. Dupuis, pers comm.).

When compensatory mitigation requires the creation of wetlands, things to consider when designing a wetland for native amphibians and reptiles include: (1) Habitat requirements of local species for breeding, foraging, basking, and overwintering, (2) hydroperiod of the existing and constructed wetland, (3) species composition of the existing wetland and constructed site and the potential for non-native species introductions.

The effects of mitigation and compensation measures on amphibian and reptile populations have had little to no testing. Effectiveness monitoring is required to determine whether these techniques are meeting the objectives of maintaining local species and populations.

For information on Compensatory Mitigation and Mitigation Banking see: ***www.epa.gov/owow/wetlands/pdf/CMitigation.pdf***
www.epa.gov/owow/wetlands/facts/fact16.html

This is the "Semi-permanent and Seasonal Wetlands" module of the PARC Publication HMG-4, ISBN 0-9667402-5-4. Please visit ***www.parcplace.org*** for further information, copies of the complete document, or a web-based version of the Guidelines.


Elke Wind

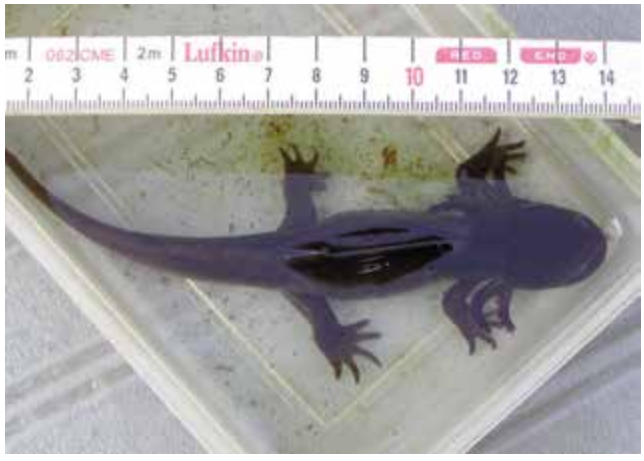
PERMANENT WETLANDS, PONDS, AND LAKES

David S. Pilliod

Permanent bodies of standing water are generally called wetlands, ponds, or lakes. These water bodies vary in their size and depth, but they generally do not dry, even during drought years. Canada has about 25% of the world's wetlands, 463,000 square miles (1.2 million square kilometers). However, only about 3% of British Columbia is wetland habitat. Of the 102 million acres (41 million ha) of freshwater wetlands in the United States, about 6.5% are permanent water bodies. The number of permanent water bodies has increased over the years due to the creation of reservoirs, stock ponds, stormwater catchment ponds, and landscaping features at golf courses and housing development projects. For example, there are about 155,000 dugouts and 21,500 reservoirs in western Canada to supply sufficient water for rural areas. Dugouts are typically artificial ponds that are 13 to 20 feet (4 to 6 m) deep with a capacity of 0.5 to 1.6 million gallons (2000 to 6000 m3), designed to provide a 2-year water supply with allowances for evaporation and ice formation.

Several amphibian species that breed in permanent water bodies, include the Long-toed Salamander, Northwestern Salamander, Rough-skinned Newt, and many northwestern species of frogs and toads. Species whose larvae take more than a year to reach metamorphosis are restricted to permanent lakes and ponds. This includes such species as the Northwestern Salamander, but also the non-native American Bullfrog. Other species take advantage of available water for breeding and to regain lost moisture. Gartersnakes are found in and along permanent lakes where they hunt for amphibians and fish. Turtle populations are also associated with permanent wetlands and ponds.


Elke Wind



Elke Wind

Northwestern Salamanders lay their eggs in permanent water bodies. The larvae require at least one full year before transforming into the terrestrial form, while some remain permanently aquatic (neotenic).

Elke Wind

Constructed, permanent ponds, such as golf course ponds, often end up containing non-native species that prey on or compete with native amphibians and reptiles.

The greatest threat to native species that inhabit permanent lakes and ponds is the introduction of non-native species, such as the American Bullfrog, several crayfish species, and numerous fish species (e.g., mosquitofish, bass, bluegill, pumpkinseed, crappie, perch, brook trout, and brown trout). These predators consume amphibian eggs and larvae, and often eliminate amphibian reproduction in lakes and ponds where adequate refugia or cover habitat is unavailable.

CHARACTERISTIC SPECIES

Salamanders: Northwestern Salamander, Long-toed Salamander, Tiger Salamander, Rough-skinned Newt; **Frogs and Toads:** Western Toad, Boreal Chorus Frog, Pacific Treefrog, Red-legged Frog, Cascades Frog, American Bullfrog (introduced), Columbia Spotted Frog, Oregon Spotted Frog, Wood Frog; **Snakes:** Common Gartersnake, Terrestrial Gartersnake, Aquatic Gartersnake; **Turtles:** Pacific Pond Turtle, Painted Turtle, Pond Slider (introduced), Snapping Turtle (introduced, except for eastern Montana and Wyoming)

MAXIMIZING COMPATIBILITY: Timberlands, Farmlands, Recreational Lands, and Other Integrated Land Uses

Consider the following options if benefiting amphibians and reptiles is secondary to other management objectives.

- **Maintain the integrity of shoreline areas.** *To the extent possible, buffer southwest shorelines to provide shade during hot, dry periods and provide shallow areas that contain emergent vegetation (e.g., maintain a naturally vegetated shoreline buffer – some sedges and shrubs can provide some cover for herpetofauna).*

- **Reduce the level of fish stocking or avoid stocking fish in ponds and lakes, except in areas where recreational fishing is a primary activity.** *Predatory fish can reduce numbers of amphibians, sometimes to the point of local extinction.*

- **Prohibit the use of non-native bait species.** *Minnows, waterdogs (larval Tiger Salamanders), crayfish, and numerous invertebrate species have been inadvertently introduced into permanent lakes and ponds by anglers. Bait species sold in local bait shops are usually non-native species and many carry diseases that may affect native amphibians and fishes.*

- **For artificial ponds, let the area dry out or drain completely in late fall or early winter.** *This will help prevent the establishment of non-native species such as introduced species of fish, crayfish, and American Bullfrogs.*

- **For irrigation, stormwater mitigation, or other water bodies that have specific function other than wildlife habitat, consider whether use by amphibians and reptiles should be discouraged or whether design modifications can be implemented to benefit herpetofauna.** *In some circumstances, these human water sources may attract amphibians and reptiles, but result in high mortality and reproductive failure (amphibians). Fencing, vertical or steep-sided concrete edges, and lack of vegetation may discourage use. In cases where amphibian and reptile use may be warranted, such as with irrigation and stormwater basins with relatively stable water levels, design modifications may increase use by these animals. Providing occasional shallow areas, gently tapered edges, and emergent or shoreline vegetation can provide suitable breeding areas for amphibians, foraging areas for snakes, predator escape cover, and access points into and out of the water body.*

Chris Rombough

Chris Rombough

Painted Turtles (left) appear similar to the introduced Slider Turtle (right). However, the underside or plastron of the Painted Turtle is bright red with dark markings on the center, and the head and legs have numerous bright yellow stripes. The head also lacks the red stripe often seen on Slider Tur-

- **Use clean fills, minimize the amount of fill used, and install suitable crossing structures when roads are built in or near a permanent pond or lake.** *Consider the size, spacing, and orientation of culverts, especially where water levels fluctuate extensively.*

IDEAL: Refuges, Sanctuaries, and Preserves
Consider the following options if benefiting amphibians and reptiles is a primary objective and when landowners and managers wish to optimize herpetofauna diversity and abundance.

- **Remove non-native species, such as American Bullfrogs and non-native fishes.** *This can be a difficult task, and consultation with state fish and game agencies would be helpful.*

- **Retain or restore ponds and lakes in a mosaic or cluster because they tend to have higher species diversity and abundance than isolated sites.** *These areas should be a priority for protection. If possible, retain a riparian buffer around the entire area to maintain connectivity among habitats.*

- **For artificial ponds designed for amphibian habitat, create shallow shelf areas favoring northwest shoreline areas.** *Amphibians often breed along the north and west shore of lakes. If possible, minimize water-level fluctuations during the breeding season to avoid stranding egg masses.*

This is the "Permanent Wetlands, Ponds, and Lakes" module of the PARC Publication HMG-4, ISBN 0-9667402-5-4. Please visit ***www.parcplace.org*** for further information, copies of the complete document, or a web-based version of the Guidelines.

Jeff Arnold

Jeff Arnold

Removing non-native fish species is a difficult task. Here managers are carefully removing fish from a mountain lake using chemical piscicides dispensed from a boat and from backpack sprayers. Although piscicides such as antimycin-a and rotenone are harmful to some amphibians and invertebrates, the impacts are short-lived compared to the persistent predation pressure of introduced predatory fish.


Sara Ashpole

CONVENTIONAL PRODUCTION AGRICULTURAL LANDS

Christine A. Bishop, Mike Sarell, D. Jason Emery, and René Martin

Agricultural lands of the Northwest are diverse due to the large variety of agricultural commodities produced. These lands include cultivated cropland, managed and unmanaged pasture, vineyards, orchards, nurseries, and associated dwellings (barns, sheds). Most agricultural land is located in broad river valleys and gently rolling landscapes, often near watercourses. These lands are imbedded within many ecoregions, but primarily in Willamette Valley – Puget Trough – Georgia Basin, Okanagan, Columbia Plateau, and Northern Great Plains Steppe. Agricultural areas are typically characterized by regular landscape patterns, and have abrupt edges between wildlands and crops. In most cases, agricultural fields are harvested on a regular basis, leading to a changing vegetation base and a high disturbance rate within managed areas. However, many farmers have taken measures to reduce their impacts on the environment by practicing sustainable agricultural practices. For example, organic farmers may use integrated pest management techniques to reduce the use of chemicals, such as planting resistant crop varieties, crop rotation, optimal use of biological control organisms, disease-free transplants or rootstock, and timeliness of crop cultivation.

Because of the regular pattern of disturbance associated with agricultural lands, many amphibian and reptile species using these areas are habitat generalists, capable of using a wide variety of cover types, with fluctuations in temperature and moisture. The species encountered often depends on elevation, proximity to uncultivated lands, availability of standing water, and type of cultivation. Long-toed Salamanders, Pacific Treefrogs, Western Toads, Columbia Spotted Frogs, and American Bullfrogs are often found in agricultural ponds. Gophersnakes, Eastern Racers, and Gartersnakes hunt along edges of agricultural fields.

Agricultural lands contain a large amount of edge habitat (areas that border two different habitat types) and are frequented by edge predators such as crows, raccoons, opossums, foxes, and coyotes. Species that are sensitive to predation and human disturbance often disappear. These include woodland salamanders, some lizards, and large snakes. Frequent use of pesticides and herbicides can negatively affect amphibian and reptile development, growth, and survival. Excess nutrients that wash into agricultural ponds and nearby streams increase primary production and tend to degrade water quality.


Charlotte Corkran

Many agricultural areas are associated with habitat elements, such as shelterbelts, windbreaks, field borders, hedge and fence rows, and roadsides. These elements provide permanent cover, structural diversity, and potential movement corridors for some wildlife species, however, most hedgerows are too narrow to provide good corridors for amphibians and reptiles.

Javan Bauder

Snakes can be helpful predators in agricultural areas, feeding on small mammals and other potential pests. To keep them away from buildings, reduce the amount of cover available, such as woodpiles, boards, and dense vegetation.

CHARACTERISTIC SPECIES

Salamanders: Long-toed Salamander, Tiger Salamander; **Frogs and Toads:** Great Basin Spadefoot, Western Toad, Pacific Treefrog, Red-legged Frog, American Bullfrog (introduced), Green Frog (introduced), Columbia Spotted Frog, Northern Leopard Frog, Wood Frog; **Lizards:** Common Sagebrush Lizard, Western Fence Lizard; **Snakes:** Ring-necked Snake, Eastern Racer, Gophersnake, Common Kingsnake, California Mountain Kingsnake, Milk Snake, Common Gartersnake, Terrestrial Gartersnake, Western and Prairie Rattlesnakes; **Turtles:** Pacific Pond Turtle, Painted Turtle

MAXIMIZING COMPATIBILITY: Timberlands, Farmlands, Recreational Lands, and Other Integrated Land Uses

Consider the following options if benefiting amphibians and reptiles is secondary to other management objectives.

- **Increase cover of flowering plants whenever possible.** *These plant species help diversify the invertebrate population of an area, the prey base of a variety of wildlife including amphibians and reptiles.*
- **Place structures that can serve as cover for amphibians and reptiles along fence rows and in conservation buffers and small patches of natural habitat around and between fields and pastures.** *Objects made from natural materials (i.e., not imbedded or treated with chemicals), such as rock, wood, roofing tiles, cardboard, and sheet metal, can provide basking, cover, and overwintering habitat for amphibians and reptiles. These features can then increase the potential of these areas to act as amphibian and reptile habitat and as travel corridors.*
- **Avoid draining farm ponds during the spring and summer months.** *Amphibians and reptiles use ponds in spring and summer for breeding and larval development. However, draining ponds in late fall or winter can help eliminate the introduced American Bullfrog and non-native fish.*
- **Keep pesticide spray and drift away from water, and do not wash spraying equipment in ponds, watercourses, or lakes.** *If spraying pesticides is necessary, do not spray any closer than 60 feet (20 m) from a water body. Avoid spraying pesticides on windy days to avoid drift into water bodies. Comply with guidelines on the label.*
- **Where pesticides are mixed with water from local ponds, ensure that the pump used to take water from ponds is not susceptible to backwashing into the pond.** *Place a sieve or mesh cover over the end of the pipe to avoid sucking tadpoles into the tank.*

IDEAL: Refuges, Sanctuaries, and Preserves

Consider the following options if benefiting amphibians and reptiles is a primary objective and when landowners and managers wish to optimize herpetofauna diversity and abundance.

- **Maintain or create wetlands and ponds on farms.** *These provide valuable habitat for a variety of organisms such as birds, bats, amphibians, and reptiles.*
- **Provide a buffer zone of vegetation around ponds.** *See Riparian Habitat section on page 82 for buffer width recommendations. Information on creating conservation buffers in agricultural lands can be found in Appendix H.*
- **Reduce or avoid pesticide use.** *An integrated pest management program that reduces spraying also reduces the potential of exposing wildlife to pesticides. Pesticides that are relatively harmless to people can still be toxic to amphibians.*
- **If irrigation is practiced, use water conservation strategies.** *Water at night or in early morning. This will allow more water to be available for developing larvae in irrigation ponds and reduce runoff.*
- **Increase mowing or baling heights.** *Increasing mowing height to 6 inches (15 cm) can reduce mortality of snakes that forage in hay fields.*
- **Avoid night mowing.** *Most snakes are nocturnal predators and some large amphibians like Northern Leopard Frogs, Western Toads, and Tiger Salamanders will move into fields to forage for invertebrates at night.*

- **Identify and manage sensitive habitats used by herpetofauna.** *Because most conventional agricultural lands are not suitable for amphibians and reptiles, it is particularly important to provide or maintain some adjacent habitats and landscape features such as breeding areas, ravines, washes, burrows, rock elements, wetlands, and non-tilled land.*
- **Remove American Bullfrogs and non-native fish from agricultural ponds whenever possible.** *Introduced American Bullfrogs and predatory fish can suppress or eliminate amphibian and reptile populations. Removal of these species can be a difficult task, and consultation with state and provincial fish and game agencies would be helpful.*

This is the "Conventional Production Agricultural Lands" module of the PARC Publication HMG-4, ISBN 0-9667402-5-4. Please visit ***www.parcplace.org*** for further information, copies of the complete document, or a web-based version of the Guidelines.

Sara Ashpole

Numerous amphibians and reptiles can live in agricultural areas, especially if important habitat features such as wetlands are retained and protected from livestock trampling, chemical contaminants, excess nutrients, and non-native species. This small, temporary pond in the BC Okanagan is used by Spadefoots for breeding.

David Pilliod

URBAN AND SUBURBAN AREAS

Elke Wind

Large areas of the Northwest have experienced rapid growth and development, resulting in the extensive loss and fragmentation of natural environments in some ecoregions (e.g., Pacific Northwest Coast, Willamette Valley – Puget Trough – Georgia Basin, North Cascades, Okanagan, East Cascades, and Columbia Plateau). Urban and suburban areas include residential areas, commercial zones, golf courses, and city parks.

Species found in urban environments have life histories that allow them to live close to humans. They have the ability to adapt to, and sometimes even exploit, conditions found in urban and suburban areas. Those that cannot adapt will become locally extirpated. The ability to maintain native species depends on the degree of urbanization, protection of natural habitats, and the specific habitat requirements of the species. For example, species that can find food and shelter among human features may flourish. In the Northwest, Pacific Treefrogs and Gartersnakes appear to survive in areas of human development due to their ability to breed in a variety of habitats and find shelter in parks and gardens. Snakes benefit from sunlit openings for basking and the high numbers of small mammals present in urban and rural settings (e.g., mice and rats). In contrast, the majority of terrestrial salamanders are uncommon in urban and suburban areas due to their need for forest cover and more importantly, undisturbed forest soil structure.

Urbanization generally results in permanent habitat loss with little chance of returning to a natural state. Urbanization also results in a large influx of non-native species, so that the unique ecological character of an area is lost. Along with urbanization, come impacts from pets and other subsidized predators, contaminants, roads, agriculture, and recreation. Connectivity among remaining patches of natural habitat in suburban and urban areas is the key to protecting native wildlife, including amphibians and reptiles. Some northwestern states, such as Oregon and Washington, have growth management plans to avoid urban sprawl.

CHARACTERISTIC SPECIES

Salamanders: Long-toed Salamander, Tiger Salamander, Rough-skinned Newt, Western Red-backed Salamander; **Frogs and Toads:** Western Toad, Woodhouse's Toad, Pacific Treefrog, American Bullfrog (introduced), Green Frog (introduced), Columbia Spotted Frog, Wood Frog; **Lizards:** Western Fence Lizard; **Snakes:** Sharp-tailed Snake, Terrestrial Gartersnake, Northwestern Gartersnake; **Turtles:** Painted Turtle, Pond Slider (introduced)

Elke Wind

About half the species of plants, birds, mammals, and insects are found in an urban environment compared with the surrounding rural areas. Species loss is largely related to decreased amounts of native vegetation and wetlands, which affects all wildlife including amphibians and reptiles.

Sara Ashpole

The United States Golf Association (USGA) has sponsored an independent wildlife conservation research program to investigate how golf course ponds can be made more wildlife-friendly. Since 1995, they have sponsored 17 projects, some of which studied effects on amphibians. Temporary wetlands on golf courses likely support a diverse herpetofauna in the region.

Charlotte Corkran

Urban areas are characterized as having a high proportion of impervious surfaces and little natural vegetation or habitat; more than 80% of most urban areas are covered with impervious surfaces. This results in altered flow regimes in urban streams and wetlands and degraded habitat for amphibians and reptiles. Using gravel paths instead of pavement can help increase infiltration in parks or urban/suburban landscaping.

David Pilliod

David Pilliod

Small changes to residential development design and maintenance practices can create environments more suitable for amphibians and reptiles. For example, the use of gravel trails (top) versus asphalt trails (bottom) allow water to follow natural flow regimes.

Encourage the public to create backyard environments attractive to native species:

1. Create a variety of physical features and micro-habitats desirable to native species (e.g., water, cover).
2. Plant a variety of native species, especially flowering plants, and avoid the introduction of non-native species.
3. Avoid or limit the use of pesticides and herbicides.
4. Keep pets under control (e.g., prevent cats from killing snakes and lizards).
5. Provide a source of water, but be aware that "if you build a pond, they will come." The cacophony of chorusing frogs is soothing to some, but might drive you or your neighbors crazy. Consult with neighbors before creating ponds in your backyard.
6. Drain backyard garden ponds in late fall to avoid the establishment of non-native amphibians.

Christian Engelstoft

HOME OWNERS CONTRIBUTE TO ENDANGERED SNAKE HABITAT MANAGEMENT

Sharp-tailed Snakes are rare in British Columbia, occurring in only a small number of locations on the Gulf Islands and southern Vancouver Island, an area under high development pressure. Conservation efforts for the species have focused on finding new populations and working with homeowners on or near known Sharp-tailed Snake locations to locate snakes and maintain or enhance the species' habitat. With funding from the Habitat Stewardship Program, one example of such a project was conducted on a property on Pender Island near a relatively large population of Sharp-tailed Snakes. Initially, six artificial cover objects were placed on the property and monitored during spring, summer, and fall. The first adult snake was found under one of the cover objects a year later. After the snake was found on the property, a project was initiated to improve the habitat and potentially increase the population of this endangered species. This involved building two hibernacula and a nursery on the property adjacent to where the snakes had been observed. The hibernacula consisted of piles of flat rocks placed on a south-facing slope adjacent to a bank; small spaces preferred by the snakes were left between the rocks. The nursery, a site that the snakes might use for egg laying, consisted of a hole dug in the ground shaped like a chimney in which mesh trays filled with wood shavings and Perlite were stacked and covered with flat rocks (see above); the trays allow the nursery to be searched for evidence of nesting activity. A year and a half after construction, Sharp-tailed Snakes have been found under cover objects adjacent to both hibernacula, but there is no indication that the nursery has been used. Further monitoring will determine if these microsites will be used in the future and if their construction will increase the population of Sharp-tailed Snakes at this site.

Pat Haugh and Christian Engelstoft

David Pilliod

In partnership with the National Wildlife Federation® (NWF), Animal Planet presents BACKYARD HABITAT, a show that teaches people to make the planet a better place for animals — one back yard at a time: *animal.discovery.com/fansites/backyard/about/about.html*. You can also apply to the NWF to have your yard certified as Wildlife Habitat, allowing you to display a NWF sign letting your neighbors know that you provide critical elements that let wildlife thrive: water, food, cover, and places to raise young: *www.nwf.org/backyard/*.

MAXIMIZING COMPATIBILITY: Timberlands, Farmlands, Recreational Lands, and Other Integrated Land Uses
Consider the following options if benefiting amphibians and reptiles is secondary to other management objectives.

- **In urban parks and golf courses, maintain native vegetation as much as possible and limit human disturbance in and around important habitats.** *Breeding ponds, turtle nesting sites, and reptile basking areas are sensitive to human disturbance. Keep pets away from critical habitats (e.g., dogs in breeding ponds). If possible, do not retrieve golf balls from water hazards, especially during the amphibian breeding season.*
- **Protect or create seasonal wetlands instead of permanent ponds in residential and recreational areas.** *A study in the southeastern U.S. found that off-course seasonal wetlands had greater species diversity than permanent golf course ponds. Permanent human-created ponds provide habitat for American Bullfrogs and other non-native species (e.g., plants and fish).*
- **Reduce snake presence near homes and other buildings if venomous snakes are a concern.** *Keep rodent populations low and lawns trimmed. Remove cover such as boards and dense vegetation around structures. Seal cracks and holes in and under buildings.*
- **Provide environmental education and encourage volunteer-based research in urban areas.** *Learning about native wildlife can help conserve species. Citizens of urban areas tend to be strong supporters of conservation-focused legislation.*
- **Discourage subsidized predators that prey on native herpetofauna.** *Do not intentionally or unintentionally feed raccoons, crows, and other predators. Prevent these predators from gaining access to garbage.*
- **Use bridges and culverts under roads and trails to encourage movement among natural habitats.** *Properly designed passage structures maintain connectivity between habitats.*
- **If putting fish in man-made ponds, use species that do not prey on tadpoles.** *Predatory fish will effectively eliminate the reproductive potential of frogs that breed in ponds and thus reduce the number of young frogs in an area.*
- **Use stumps, rocks, and other appropriate materials to create basking, hunting, and escape substrate when those elements are missing.**

IDEAL: Refuges, Sanctuaries, and Preserves
Consider the following options if benefiting amphibians and reptiles is a primary objective and when landowners and managers wish to optimize herpetofauna diversity and abundance.

- **Careful planning and regulation are needed to control urban sprawl.** *Plan for open space (greenspaces, wildlife corridors, natural parks, and trails) on a landscape level (across counties and incorporating existing natural areas, parks, and reserves). This requires inventories and evaluations, and may involve transfer rights for landowners, taxation or incentive programs, education, and land purchases or easements.*
- **Maintain remnant patches of native vegetation and connect them via corridors.** *Encourage the retention of remnant patches of native vegetation within urban centers. Keeping these areas connected to natural movement corridors (e.g., riparian areas) will increase the likelihood that they can sustain native species.*
- **Balance recreation with wildlife needs; protect some natural areas as roadless and inaccessible**. *Avoid placing roads and trails through or near specific habitat features such as breeding and basking sites, and hibernacula.*
- **Keep development away from riparian habitats.** *Manage rare ecosystems and hotspots for wildlife (basking sites, breeding ponds and streams, talus, hibernacula).*
- **Maintain or create small, ephemeral wetland habitats.** *Avoid creating permanent wetlands and ponds that facilitate the introduction and spread of fish and American Bullfrogs.*

- **Provide shallow, shoreline areas with emergent vegetation.** *These habitats provide ideal conditions for amphibian breeding and Gartersnake foraging.*
- **Support and initiate Integrated Pest Management practices.** *Avoid using chemical pesticides or use them only as a last resort or part of a larger program.*
- **Reduce the area of impervious surfaces (roofs, parking lots, roads).** *These contribute to runoff, erosion, water-level fluctuations, and habitat degradation (e.g., use gravel parking lots where possible, keep alleys and driveways unpaved).*
- **Buffer riparian areas (streams and wetlands), habitat features (rock outcrops), and parks and reserves.** *Providing a soft edge between critical habitats or habitat features and more heavily managed or manicured areas (e.g., mowed lawns) can increase use by amphibians and reptiles. Most importantly, these buffer or transition areas may need to be landscaped in ways to provide cover through vegetation, logs, and rocks. See buffer section on pages 82 and 135 for more information.*
- **Treat wastewater, in terms of the quality and quantity released (temperature, oxygen, nutrients).** *Most municipal wastewater plants monitor and regulate this closely, although exceptions are often made during storm events. The effects on downstream water quality can have negative effects on amphibian development and health.*
- **Remove or eradicate non-native species.** *Non-native predators such as American Bullfrogs and warm-water fish can reduce numbers or even eliminate populations of native amphibians. Non-native plants can dramatically alter the character of amphibian and reptile habitats.*
- **Learn to distinguish between venomous snakes and non-venomous snakes.** *To remove venomous snakes, use a snake hook, long stick, or shovel (or call a local expert). Snakes tend to move back to the areas they know and feed in, so create a separate area away from buildings or on the edge of the property that will attract rodents for snakes to feed on to reduce the incentive for snakes to move in or near human living areas.*
- **Educate the public about the importance of herpetofauna and the need to create and protect remaining natural habitats in urban and suburban areas.** *Effective amphibian and reptile conservation hinges on people having a greater awareness and respect for the needs of these little understood and often feared creatures.*
- **Avoid the use of rodenticides to kill rodents.** *Secondary poisoning is a concern for rodent predators such as snakes.*

Charlotte Corkran

Vegetated swales are stormwater catchments that may provide habitat or corridors for amphibians and reptiles, such as Pacific Treefrogs and Gartersnake species. Unpredictable water availability makes these features poor breeding locations for most amphibians.

- **Install culverts or other animal underpasses where a high frequency of snakes, turtles, or amphibians are observed dead on roads.**

STORMWATER MITIGATION: WHAT IS A VEGETATED SWALE?

A vegetated swale (i.e., grassed channel, dry swale, wet swale, or biofilter) is a constructed open-channel drainageway used to convey stormwater runoff. Vegetated swales can be used as an environmentally sensitive alternative to conventional stormwater sewers in common areas of residential subdivisions and along property boundaries. They can also be used in landscaping islands within parking lots. Vegetation in swales allows for filtering of pollutants and infiltration of runoff into groundwater. Densely vegetated swales can be designed to add visual interest to a site and may attract amphibians and reptiles or serve as migratory corridors for some species. Native plants and wetland vegetation are preferred to turf grasses as swale liners. Swales planted with native vegetation offer higher resistance to flow and provide a better environment for filtering and trapping pollutants from stormwater. Grass-lined swales need to be mowed regularly to maintain a grass height of approximately 4-6 inches (10-15 cm). Naturalized swales reduce the mowing requirements and provide better wildlife habitat.

Source: ***www.greenworks.tv/stormwater/index.htm***

This is the “Urban and Suburban Areas” module of the PARC Publication HMG-4, ISBN 0-9667402-5-4. Please visit ***www.parcplace.org*** for further information, copies of the complete document, or a web-based version of the Guidelines.

The following is a list of suggestions that can be helpful when developing a comprehensive management plan for amphibians and reptiles. Not all steps are required for successfully implementing the Guidelines.

1. **Know what you have.** Identify current conditions before initiating changes. This includes an inventory of habitat types, maps of their relative locations, sizes, and 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 differences between current and expected 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 actions 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 land. Maps and imagery for the U.S. may be available from the Natural Resources Conservation Service (NRCS), the US Geological Survey, the USDA Forest Service, and on the Internet, such as at Google Earth. Maps for British Columbia can be found at the Integrated Land Management Bureau of the provincial government (visit: ***www.nric.ca/***). 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 (that is, what the habitats used to look like). Aerial photographs are available for some areas dating back to the 1930s. 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 important amphibian and reptile habitats. Management needs may include buffers along waterways, construction of artificial wetlands, corridors between disconnected habitats, and reintroduction of natural fire regimes. With some forethought, private landowners can achieve all of their land-use goals while simultaneously benefiting amphibians, reptiles, and wildlife in general.
3. **Determine what factors are likely limiting amphibian or reptile populations in the area and determine what specific conservation or management actions are needed to address those factors.** Develop a schedule for implementation of the measures. Estimate costs of implementation and monitoring, and identify potential partners who may be able to help with funding. Possible partners on private lands might include NRCS, USFWS, and state and provincial wildlife agencies (see Conservation Programs and Options in Appendix D).
4. **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 at little cost.
5. **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. Land managers who know the local ecosystems and habitats may also be valuable sources of information and insights. See Appendix E for state and provincial representatives that can put you in touch with someone in your area that has experience with amphibians and reptiles.
6. **Measure your success.** Management plans should 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

David Pilliod

Wetland where juniper were removed in the upland to control their encroachment and maintain suitable riparian areas for Columbia Spotted Frogs.

Elke Wind

The majority of amphibians and reptiles are active at night or spend much of their time underground or under cover. As such, it is often surprising to some landowners to discover the wide variety of species that may occur in their area.

amphibian and reptile populations will gauge whether 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. Keep in mind that herpetofauna are greatly affected by climatic conditions (e.g., amount of precipitation in winter or spring), so that years with extreme conditions (e.g., drought) can alter population sizes beyond the impacts of newly implemented habitat management practices.

Elke Wind

Windstorms and blow down are common weather issues on the west coast. Leaving some wood on the ground helps provide important cover for amphibians and reptiles.

Elke Wind

Salamander larvae can be top predators in some aquatic environments. They prey heavily on aquatic invertebrates, including the larvae of pest species, such as mosquitoes.

David Pilliod

Retrofitting existing culverts to serve as underpasses for amphibians and reptiles may not be effective, as the presence of water can be a deterrent, especially fast-flowing water.

APPENDIX B: AMPHIBIAN AND REPTILE SPECIES OF THE NORTHWEST

Steve Corn

Amplexed Boreal Chorus Frogs. Except for tailed frogs, Northwest frogs and toads have external fertilization. The male grasps the female under the forelimbs and waits for her to release her eggs usually in shallow water amongst vegetation.

The Northwest supports at least 93 taxa of amphibians and reptiles: 20 frogs and toads, 27 salamanders, 5 turtles, 19 lizards, and 22 snakes. The following table presents species occurrence information for each state, province, and habitat covered in this book. We have used the most recent taxonomic information available (Crothers et al. 2001), 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 P (preferred), 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 or province within which it occurs. This numeric system is not regulatory and does not indicate federal, state, or provincial 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 global range. An S rank is also assigned for each species' state or provincial occurrence (blank fields in the table below indicate the species does not occur in the state or province). The definitions provided below apply to both global and state/provincial 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 or province, 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—For various reasons, a species' status is unknown and awaiting further scientific information.

NA = Conservation Actions Not Applicable within a state or province

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

U = Unknown.

X = Species regarded as Extirpated.

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

U.S. and Canadian Federal Status: Endangered Species Act protection, according to U.S. Fish and Wildlife Service, as of November 2006. E = Endangered, T = Threatened, C = Candidate. Federally listed subspecies or populations are indicated with an *. Species listed under Schedule 1 of the Canadian Species at Risk Act are given in boldface red under each province. Information about Federally protected species in the U.S. and Canada can be found at ***www.fws.gov/endangered*** and ***www.speciesatrisk.ec.gc.ca/***.

State and Provincial Protection Status: Each state and province has laws and/or regulations protecting certain amphibians and reptiles. These may appear on state or provincial lists as Special Concern, Endangered, or Threatened. NatureServe state ranks for any species that has regulatory protection within a state is given in boldface red. Introduced/non native species to a state or province are indicated in blue bold. Check with your state or provincial natural resource agency for the most up-to-date information on legal status.

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 landowners and managers for evaluating the positive effects of their habitat management actions. These ranks and protected status listings were accurate as of May 2007. 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.

Bill Leonard

Woodhouse's Toad

		NATURESERVE GLOBAL RANKS	FEDERAL (USFWS) STATUS	NatureServe State-level Rank and State Protection: ALBERTA	BRITISH COLUMBIA	YUKON	ALASKA	WASHINGTON	OREGON	CALIFORNIA	NEVADA	UTAH	WYOMING	MONTANA	IDAHO	MOIST CONIFEROUS FOREST	DRY CONIFEROUS FOREST	MIXED CONIFEROUS AND DECIDUOUS FOREST	MOIST AND DRY DECIDUOUS FOREST	ALPINE AND SUBALPINE	NORTHERN BOREAL FOREST	JUNIPER AND PINYON-JUNIPER WOODLANDS	SAGEBRUSH STEPPE/DESERT SHRUBLANDS	GRASSLANDS	ARCTIC AND COASTAL TUNDRA	"ROCK OUTCROPS, TALUS, CLIFFS, AND CAVES"	BEACHES AND DUNES	RIPARIAN AREAS	RESERVOIRS	RIVERS AND LARGE STREAMS	SMALL STREAMS	SPRINGS AND SEEPS	SEMI-PERMANENT AND SEASONAL WETLANDS	"PERMANENT WETLANDS, PONDS, AND LAKES"	CONVENTIONAL PRODUCTION AGRICULTURAL LANDS	URBAN AND SUBURBAN AREAS	An image of this species can be found on the following pages
AMPHIBIANS: Frogs and Toads																																					
Ascaphus montanus	Rocky Mountain Tailed Frog	4			1			NR	2					4	3	S	S			S								P			P						95
Ascaphus truei	Coastal Tailed Frog	4			3			4	3	2						S	S	S		S								P			P						95
Bufo baxteri	Wyoming Toad	1	E										1											P				P					P	P			46
Bufo boreas	Western Toad	4		4	4	NR	2?	3	3	5	4	2	1	2	3	S	S	S	S	S		S	M	M				S	S	S	S	S	P	P	M	M	5, 32, 64
Bufo cognatus	Great Plains Toad	5		2							2	H	3	2									P	P				P	S		P		P		M		v
Bufo hemiophrys	Canadian Toad	4		4									1						P					P				P			S		P	P			
Bufo woodhousii	Woodhouse's Toad	5						3	2	4	5	2	4	4	2		S		S				P	P				P	S	S	S	S	P	P	M	M	118
Pseudacris regilla	Pacific Treefrog	5			5		NA	5	5	5	5	H		4	5	S	S	S	S	S		S	S	S		S		P	S		S	S	P	P	M	M	vi, 121
Pseudacris maculata	Boreal Chorus Frog	5		5	4	NR						4	5	4	4		S	S	S					S				S			S	S	P	P	M	M	117
Rana aurora	Red-legged Frog	4	*		3		NA	4	3	2	NA					P		P	P									S	S	S	S	S	P	P	M	M	48
Rana boylii	Foothill Yellow-legged Frog	3							2	2								S	S	S								P		P	P						88, 92
Rana cascadae	Cascades Frog	3						4?	3	3						S		S		S								P			P		P	P			85
Rana catesbeiana	American Bullfrog	5			NA			NA	NA	NA	NA	NA	5	NA	NA	M	M	M	M			M	M	M				S	S	S			S	P	S	S	26, 35, 101
Rana clamitans	Green Frog	5			NA			NA				NA				M			M									S						P	S	S	
Rana luteiventris	Columbia Spotted Frog	4	*	3	4	NR	2?	4	2		2	1	3	4	3		S		S	S		S	S	S				P		S	S	S	S	P	M		46, 59, 63
Rana pipiens	Northern Leopard Frog	5		2	1			1	1	2	2	3	3	3	2		S	S	S				S	S				S	S	S		S	P	P	M	M	26
Rana pretiosa	Oregon Spotted Frog	2	C		1			1	2	1							S	S				S		S				P		S				P	M	M	46, 59, 63
Rana sylvatica	Wood Frog	5		5	5	NR	3						1		H	P	P	P	P		P				S			S			S	S	P	P	M	M	32
Spea bombifrons	Plains Spadefoot	5		3								1?	4	3									P	P				P					P	P	S		71, 76
Spea intermontana	Great Basin Spadefoot	5			3			5	5	5	4	5	3		4							P	P	P		S	S			S	S	P	P	P	S	M	6, 68
AMPHIBIANS: Salamanders																																					
Ambystoma gracile	Northwestern Salamander	5			4		2?	5	5	4						P		P	S	S								S	S			S	S	P	M	M	60, 104
Ambystoma macrodactylum	Long-toed Salamander	5		3	5		2?	5	5	3				4	5	P	P	P	S	S		S	S	S				S			S	S	P	P	M	M	4, 99
Ambystoma tigrinum	Tiger Salamander	5		4	2			3	2?		NA	4	4	4	5		P	S	S			P	P	P				S	S	S		S	S	P	S	M	36, 71
Aneides ferreus	Clouded Salamander	3							3	2						P		P										S								M	8
Aneides flavipunctatus	Black Salamander	4							2	4						P		P								P											
Aneides vagrans	Wandering Salamander	4			4					4						P		P										S								M	vi
Batrachoseps attenuatus	California Slender Salamander	5							2	5						P		P																			8
Batrachoseps wrightorum	Oregon Slender Salamander	2							2							P										P											
Dicamptodon aterrimus	Idaho Giant Salamander	3												1	3	P	P			M								P		P	P			S			
Dicamptodon copei	Cope's Giant Salamander	3						3	2							P	P	P		S								P			P			S			
Dicamptodon tenebrosus	Coastal Giant Salamander	5			2			5	4	NR						P		P		S								P		P	P			S			v
Ensatina eschscholtzii	Ensatina	5			4			5	5	5						P		P	P							S		S				S				M	8
Hydromantes shastae	Shasta Salamander	1								1/2							P									P											8, 79
Plethodon asupak	Scott Bar Salamander	1								1							S	S	S							P											
Plethodon dunni	Dunn's Salamander	4						2	4	3						S		S								P		P				P					86
Plethodon elongatus	Del Norte Salamander	4							4	4								P	S							S		S									48
Plethodon idahoensis	Coeur d'Alene Salamander	4			3									2	2	S	S			M						P		P			P	P					85, 97
Plethodon larselli	Larch Mountain Salamander	3						3	2							S		S		S						P											
Plethodon stormi	Siskiyou Mountains Salamander	2							2	1								P		S						P											28
Plethodon vandykei	Van Dyke's Salamander	3						3								P												P			P	P					86
Plethodon vehiculum	Western Red-backed Salamander	5			4			5	5							P		P	S							S		S			S					M	8
Rhyacotriton cascadae	Cascade Torrent Salamander	3						3	3							S												P			P	P					8
Rhyacotriton kezeri	Columbia Torrent Salamander	3						3	3							S												P		S	P	P					94
Rhyacotriton olympicus	Olympic Torrent Salamander	3						3								S												P			P	P					94
Rhyacotriton variegatus	Southern Torrent Salamander	3							3	2						S		S										P			P	P					
Taricha granulosa	Rough-skinned Newt	5			4		2?	5	5	5				NA	NA	P		P	S	S						S		S	S	S	S	S	P	P		M	ii
Taricha rivularis	Red-bellied Newt	4								5						S		S	S	S								P		P	P						

Bryce Maxell

Milksnake

		NATURESERVE GLOBAL RANKS	FEDERAL (USFWS) STATUS	NatureServe State-level Rank and State Protection												MOIST CONIFEROUS FOREST	DRY CONIFEROUS FOREST	MIXED CONIFEROUS AND DECIDUOUS FOREST	MOIST AND DRY DECIDUOUS FOREST	ALPINE AND SUBALPINE	NORTHERN BOREAL FOREST	JUNIPER AND PINYON-JUNIPER WOODLANDS	SAGEBRUSH STEPPE/DESERT SHRUBLANDS	GRASSLANDS	ARCTIC AND COASTAL TUNDRA	"ROCK OUTCROPS, TALUS, CLIFFS, AND CAVES"	BEACHES AND DUNES	RIPARIAN AREAS	RESERVOIRS	RIVERS AND LARGE STREAMS	SMALL STREAMS	SPRINGS AND SEEPS	SEMI-PERMANENT AND SEASONAL WETLANDS	"PERMANENT WETLANDS, PONDS, AND LAKES"	CONVENTIONAL PRODUCTION AGRICULTURAL LANDS	URBAN AND SUBURBAN AREAS	An image of this species can be found on the following pages
				ALBERTA	BRITISH COLUMBIA	YUKON	ALASKA	WASHINGTON	OREGON	CALIFORNIA	NEVADA	UTAH	WYOMING	MONTANA	IDAHO																							
REPTILES: Turtles																																					
Actinemys marmorata	Pacific Pond Turtle	3			X			1	2	3	3						S	S	S					S				P	S	P	M			P	M	M	5, 85
Apalone spinifera	Spiny Softshell	5								NA	NA	NA	4	3													P	P		P	P			P			135
Chelydra serpentina	Snapping Turtle	5						NA			NA	NA	4	3	3									S				P	S	S	M			P	M	S	
Chrysemys picta	Painted Turtle	5		1	3			5	2				4	4	4	S	S	S	S				S	S				P	S	S				P	M	M	1, 22, 106
Terrapene ornata	Ornate Box Turtle												1											P													
Trachemys scripta	Pond Slider	5			NA			NA								S		S	S									P	S	S				P	M	S	106
REPTILES: Lizards																																					
Aspidoscelis sexlineata	Six-lined Racerunner	5											2											P				P									
Aspidoscelis tigris	Tiger Whiptail	5							4	5	5	5			4				S			P	P	S		P	P										16
Aspidoscelis velox	Plateau Striped Whiptail	5							NA													P	P			P											
Crotaphytus bicinctores	Great Basin Collared Lizard	5							3	5	4	4			1							S	P			P											69
Elgaria coerulea	Northern Alligator Lizard	5			4			5	5	5	2			3	2		P	P	S	S			P			P									S	S	116
Elgaria multicarinata	Southern Alligator Lizard	5						4?	5	5							P	P	P			P	P			P		S									58
Eumeces multivirgatus	Many-lined Skink	5										1	2				P	P	P			P	P	P				P							S	S	
Eumeces skiltonianus	Western Skink	5			2			5	5	5	4	4		3	5		P		P			P	P	P		P											79
Gambelia wislizenii	Long-nosed Leopard Lizard	5							4	5	4	4			5								P				P										81
Holbrookia maculata	Lesser Earless Lizard	5										H	2				P					P	P	P			P	P							S		
Phrynosoma douglasii	Pygmy Short-horned Lizard	5			SX			3	4	4	NR				5							P	P			P											66
Phrynosoma hernandesi	Greater Short-horned Lizard	5		2							3	4	4				S	S	S	S			P	P													121
Phrynosoma platyrhinos	Desert Horned Lizard	5							3	5	4	4			4								P			P	P										137
Podarcis muralis	Common Wall Lizard	5			**NA**													S								P										P	
Sceloporus graciosus	Sagebrush Lizard	5						2	5	5	4	5	5	3	**5**							P	P			P											
Sceloporus occidentalis	Western Fence Lizard	5						5	5	5	5	3		NA	4		S		S			P	P			P									S		66
Sceloporus undulatus	Eastern Fence Lizard	5										4	3				P	P	P				P	P		P	P	P							S	S	
Urosaurus ornatus	Ornate Tree Lizard	5										4	2				P	P	P			P	P			P		P							M	M	
Uta stansburiana	Common Side-blotched Lizard	5						2	5	5	5	5			5							P	P			P											
REPTILES: Snakes																																					
Charina bottae	Rubber Boa	5			4			4	4	4	3	2	2	4	5		P	S	S			P	S	S		S		S									4
Coluber constrictor	Eastern Racer	5		U	3			5	4?	5	5	4	5	5	5		S		P			P	P	P		P		S							S	M	58
Contia tenuis	Sharp-tailed Snake	5			1			2	4	5						S	S	P	P				S	S				P									54
Crotalus oreganus	Western Rattlesnake	5			3			5	5	5	5	5			5		P	P	S			P	P	P		P									S	S	3, 34, 77
Crotalus viridis	Prairie Rattlesnake	5		3								NR	5	4	NR		S	S	S				P	P		P		S							S		108
Diadophis punctatus	Ring-necked Snake	5						3	4?	5	3	2			2		P	P	S			P	P	P		P		P							S		9
Heterodon nasicus	Western Hog-nosed Snake	5		2									4	2					P				P	P				S							M		
Hypsiglena torquata	Nightsnake	5			1			2	3	5	5	4			5			P				P	P			P											1
Lampropeltis getula	Common Kingsnake	5							3	5	5	2					S	S	S			P	P	P		P		P							S		52
Lampropeltis triangulum	Milksnake	5										2	3	2			P	P	P				P	P		S	P	P					P	M		119
Lampropeltis zonata	California Mountain Kingsnake	4						1	4	4							P	P		P						P		P									
Masticophis taeniatus	Striped Whipsnake	5						1	4	4	5	5			4			P				P	P	S		P											67
Opheodrys vernalis	Smooth Greensnake	5										2	2	2			P	P	P				P	P				P					P	M			
Pituophis catenifer	Gophersnake	5		3	3			5	5	5	5	5	4	5	5		S		S			P	P	P		P	S								S	S	34, 120
Rhinocheilus lecontei	Long-nosed Snake	5								5	5	4			2								P			P											
Sonora semiannulata	Groundsnake	5							3	4	5	2			2								P			P											
Storeria occipitomaculata	Red-bellied Snake	5											3				P	P	P					P			P						S	M	M	98
Thamnophis atratus	Aquatic Gartersnake	5							4?	4								S	S							P		P		P	P					
Thamnophis elegans	Terrestrial Gartersnake	5		4	5			5	5	5	4	5	5	5	5	S	P	P	S	S		P	P	S		P		P		S	S		S	S	S	S	
Thamnophis ordinoides	Northwestern Gartersnake	5			4			5	5	3						P	S	P	S					S		P									S	S	136
Thamnophis radix	Plains Gartersnake	5					4						5	4								S		P				P		P	P		P	P	P	S	1, 60, 91
Thamnophis sirtalis	Common Gartersnake	5		4	5			5	5	4	3	2	5	4	3	S	S	S	S			S	S	S		P		P		P	P		P	P	S	S	

GENERAL HABITAT MANAGEMENT REFERENCES

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

Adair, S., M.L. Dereske, J. Doyle, A. Edwards, S. Jacobson, R. Jemison, L. Lewis, W. Melgin, C. Napper, T. Ratcliff, and T. Warhol. 2002 Management and Techniques for Riparian Restorations – Roads Field Guide, Volume I. General Technical Report RMRS-GTR-102. U.S. Department of Agriculture Forest Service, Rocky Mountain Research Station, Ft. Collins, CO.

Blaustein, A.P., J.J. Beatty, D.H. Olson, and R.M. Storm. 1995. The biology of amphibians and reptiles in old-growth forests in the Pacific Northwest. General Technical Report PNW-GTR-337. U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station, Portland, OR.

Campbell, B.H. 2004. Restoring rare native habitats in the Willamette Valley: A landowner's guide for restoring oak woodlands, wetlands, prairies, and bottomland hardwood and riparian forests. Defenders of Wildlife, West Linn, OR.

Cates, D., J. Olson, and N. Allen. 2002. Attract reptiles and amphibians to your yard. The Wildlife Garden. EC 1542. July 2002. Oregon State University Extension Service. Corvallis, OR. Available electronically at *4hwildlifestewards.org/pdfs/reptiles.pdf*

Cerovski, A.O., M. Grenier, B. Oakleaf, L. Van Fleet, and S. Patla. 2004. Atlas of birds, mammals, amphibians, and reptiles in Wyoming. Wyoming Game and Fish Department Nongame Program. Lander, WY.

Chambers, J.C. and J.R. Miller. 2004. Great Basin Riparian Ecosystems: Ecology, Management, and Restoration. Island Press, Washington, D.C.

Daris, D.C. 2005. Seed production and establishment of Western Oregon native grasses. In: Dumroese, R.K., L.E.; Riley, and T.D. Landis (technical cooridators). National proceedings: Forest and Conservation Nursery Associations. Proceedings RMRS-P-35, U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station, Fort Collins, CO. Available electronically at *www.fs.fed.us/rm/pubs/rmrs_p035/rmrs_p035_119_128.pdf*

Hallock, L.A., R.D. Haugo, and R. Crawford. 2007. Conservation Strategy for Washington State Inland Sand Dunes. Washington Natural Heritage Program Report 2007-05. Report Prepared for the Bureau of Land Management, Spokane, WA.

Harrington, T.B. and G.E. Nicholas (editors). 2007. Managing for wildlife habitat in west-side production forests. U.S. Department of Agriculture Forest Service General Technical Report PNW-GTR-695.

Holland, D.C. 1994. The Western Pond Turtle: Habitat and History. Oregon Department of Fish and Wildlife, Portland, OR.

Johnson, D.H., and T.A. O'Neil. 2001. Wildlife-habitat relationships in Oregon and Washington. Oregon State University Press, Corvallis, OR.

McKinstry, M.C., W.A. Hubert, and S.H. Anderson. 2004. Wetland and Riparian Areas of the Intermountain West: Ecology and Management. University of Texas Press, Austin, TX.

Miller, R.F., J.D. Bates, T.J. Svejcar, F.B. Pierson, and L.E. Eddleman. 2007. Western juniper field guide: asking the right questions to select appropriate management actions. U.S. Geological Survey Circular 1321, Reston, VA. Available electronically at *pubs.usgs.gov/circ/1321/*.

Montana, Utah, Wyoming Weed Management Handbook 2006-2007. See the following website for details *ces.uwyo.edu/News/Weed_Handbook.htm*

Ouren, D.S., C. Haas, C.P. Melcher, S.C. Stewart, P.D. Ponds, N.R. Sexton, L. Burris, T. Fancher, and Z.H. Bowen. 2007, Environmental effects of off-highway vehicles on Bureau of Land Management lands: A literature synthesis, annotated bibliographies, extensive bibliographies, and internet resources: U.S. Geological Survey, Open-File Report 2007-1353. Available electronically at www.fort.usgs.gov/Products/Publications/22021/22021.pdf

Gavin Hankes

Snakes sense their environment largely through vibrations and smell. However, snakes 'smell' through their tongue, which they flick out regularly to pick up chemicals from the air.

Szaro, R.C., K.E. Severson, and D.R. Patton (technical coordinators). 1988. Management of amphibians, reptiles, and small mammals in North America. Proceedings of a symposium, 1988 July 19-21 in Flagstaff, AZ. General Technical Report RM-166, U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station, Fort Collins, Co.

Tanner, W.W. 1978. Zoogeography of reptiles and amphibians in the Intermountain Region. Great Basin Naturalist Memoirs No. 2, Intermountain Biogeography: A Symposium. Brigham Young University, Provo, UT.

Vander Haegen, W.M., S.M. McCorquodale, C.R. Peterson, G.A. Green, and E. Yensen. 2001. Wildlife communities of eastside shrubland and grassland habitats. In: D.H. Johnson and T.A. O'Neil, (editors) Wildlife habitats and species associations in Oregon and Washington. University of Oregon Press, Corvallis, OR.

Vesely, D. and G. Tucker. 2004. A landowner's guide for restoring and managing Oregon white oak habitats. Bureau of Land Management, Salem, OR. Available electronically at *www.oregonoaks.org.*

Wisdom, M.J., R.S. Holthausen, B.C. Wales, C.D. Hargis, V.A. Saab, D.C. Lee, W.J. Hann, T.D. Rich, M.M. Rowland, W.J. Murphy, and M.R. Eames. 2000. Source habitats for terrestrial vertebrates of focus in the Interior Columbia Basin: Broad scale trends and management implications. U.S. Department of Agriculture Forest Service Technical Bulletin PNW-GTR 485, Portland, OR.

Wisdom, M.J., Rowland, M.M., and L.H. Suring. (editors). 2005. Habitat threats in the sagebrush ecosystem: methods of regional assessment and applications in the Great Basin. Alliance Communications Group, Lawrence, KS.

Elke Wind

Color is often not a reliable basis for species identification in frogs, as seen with this Pacific Treefrog, which can be green, brown, beige, and even blue. Experts in the field are more likely to use other characteristics, such as body length, toe shape, and eye orientation.

Andrew Munson

Amphibians and reptiles play an important role in the environment as both predator and prey. The greater Short-horned Lizard relies on camouflage to avoid predators. It may squirt blood from its eyes when captured or threatened.

The Institute for Fisheries Resources Klamath Resource Information System (KRIS) website (*www.krisweb.com/*). The background information about the topics in KRIS provides information on regulations, guidelines, and maps.

AMPHIBIAN AND REPTILE IDENTIFICATION AND NATURAL HISTORY RESOURCES

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

Baxter, G.T. and M.D. Stone. 1980. Amphibians and Reptiles of Wyoming. Wyoming Game and Fish Department, Cheyenne, WY.

Corkran, C.C. and C. Thoms. 2006. Amphibians of Oregon, Washington and British Columbia. Lone Pine Publishing, Edmonton, AB, Canada.

Groves, C. 1994. Idaho's amphibians and reptiles: description, habitat, and ecology. Nongame Wildlife Leaflet #7, Idaho Nongame and Endangered Wildlife Program, Boise, ID.

Hoberg, T. and C. Gause. 1992. Reptiles and amphibians of North Dakota. North Dakota Outdoors 55:7-19.

Hodge, R.P. 1976. Amphibians and reptiles in Alaska, the Yukon, and Northwest Territories. Alaska Northwest Publishing Company, Anchorage, AK.

Jones, L.C., W.P. Leonard, and D.H. Olson. 2005. Amphibians of the Pacific Northwest. Seattle Audubon Society, Seattle, WA.

Koch, E.D. and C.R. Peterson. 1995. The Amphibians and Reptiles of Yellowstone and Grand Teton National Parks. University of Utah Press, Salt Lake City, UT.

David Pilliod

Greater awareness of conservation issues related to amphibians and reptiles has resulted in a number of stewardship initiatives.

Matsuda, B.M., D.M. Green, and P.T. Gregory. 2006. Amphibians and Reptiles of British Columbia. Royal BC Museum, Victoria, Canada.

Mitchell, J.C. and R.E. Jung Brown (editors). 2008. Urban Herpetology. Herpetological Conservation, Vol. 3, Society for the Study of Amphibians and Reptiles, Salt Lake City, UT.

Nussbaum, R.A., E.D. Brodie, Jr. and R.M. Storm. 1983. Amphibians and Reptiles of the Pacific Northwest. University Press of Idaho, Moscow, ID.

Slough, B.G. and R.L. Mennell. 2006. Diversity and range of amphibians of the Yukon Territory. Canadian Field-Naturalist 120: 87-92.

Stebbins, R.C. 2003. A Field Guide to Western Reptiles and Amphibians, 3rd edition. Houghton Mifflin Company, Boston, MA.

St. John, A. 2002. Reptiles of the Northwest: California to Alaska, Rockies to the Coast. Lone Pine Publishing, Renton, WA.

Elke Wind

Amphibians and reptiles are an excellent educational resource because they are relatively easy to study, many species are accessible in rural and urban environments, and they can be used as examples for numerous subjects.

Storm, R.M. and W.P. Leonard. 1995. Reptiles of Washington and Oregon. Seattle Audubon Society, Seattle, WA.

Werner, J.K., B.A. Maxell, P. Hendricks, and D.L. Flath. 2004. Amphibians and Reptiles of Montana. Mountain Press Publishing Company, Missoula, MT.

State and Provincial Agencies

Alaska Department of Fish and Game	*www.adfg.state.ak.us/*
Alberta Sustainable Resource Development	*www.srd.gov.ab.ca/*
British Columbia Ministry of Environment	*www.env.gov.bc.ca/fw/*
California Department of Fish and Game	*www.dfg.ca.gov/*
Idaho Department of Fish and Game	*fishandgame.idaho.gov/*
Montana Fish, Wildlife, and Parks	*fwp.mt.gov/default.html*
Nevada Department of Wildlife	*www.ndow.org/*
Oregon Department of Fish and Wildlife	*www.dfw.state.or.us/*
Utah Department of Natural Resources	*www.nr.utah.gov/*
Washington Department of Fish and Wildlife	*wdfw.wa.gov/*
Wyoming Game and Fish	*gf.state.wy.us/*
Yukon Department of Environment	*www.environmentyukon.gov.yk.ca/*

Species Identification and Natural History Websites:

Alaska Amphibians and Reptiles Field Handbook
aknhp.uaa.alaska.edu/herps/index.htm

California Reptiles and Amphibians:
www.californiaherps.com/index.html

Idaho Digital Atlas
imnh.isu.edu/digitalatlas/index.htm

Montana Fish, Wildlife, and Parks Field Guide
fwp.mt.gov/fieldguide/

Oregon Amphibians and Reptiles
darkwing.uoregon.edu/~titus/herp/herp.html

Washington Herp Atlas
www.dnr.wa.gov/nhp/refdesk/herp/herpmain.html

British Columbia Reptiles
www.bcreptiles.ca/

NatureServe online encyclopedia of wildlife
www.natureserve.org/explorer/

Snakes of North America
www.pitt.edu/~mcs2/herp/SoNA.html

Amphibians of Yukon
www.environmentyukon.gov.yk.ca/pdf/Yukon Amphibians_final05.pdf

Canadian Amphibian and Reptile Conservation Network
www.carcnet.ca/

BC Frogwatch Program
www.env.gov.bc.ca/wld/frogwatch/

Conservation Organizations:

- Partners in Amphibian and Reptile Conservation
  www.parcplace.org
- AmphibiaWeb
  amphibiaweb.org/
- Canadian Amphibian and Reptile Conservation Network
  www.carcnet.ca/english/carcnethome.html
- Frogwatch
  www.naturewatch.ca/english/frogwatch/on/
- Herpetology Northwest
  www.herpetologynorthwest.org/

State and Federal Programs:

- U.S. Geological Survey Amphibian Research and Monitoring Initiative
  armi.usgs.gov

Sara Ashpole

The spade on the hind limb of the Spadefoot is an example of how amphibians and reptiles in the Northwest have a wide variety of adaptations for living in this environment. Amphibians in arid regions need to escape drying conditions at the surface. Spadefoots dig down into loose soil and remain underground until rainy weather returns.

- National Park Service — Alaska Region Inventory and Monitoring Program
  www.nature.nps.gov/im/units/AKRO/Amphibians/ak_amphibs.htm
- Montana Natural Heritage Tracker
  mtnhp.org
- Alaska Wood Frog Monitoring Project
  www.akfrogs.net
- Alaska Natural Heritage Program Tracking
  aknhp.uaa.alaska.edu/zoology/Zoology_Amphibs_track07.htm
- Federal Conservation Assessments
  www.fs.fed.us/r6/sfpnw/issssp/planning-documents/assessments.shtml

Professional Scientific Societies:

- American Society of Ichthyologists and Herpetologists
  www.asih.org/
- The Herpetologists League
  herpetologistsleague.org/
- Society for the Study of Amphibians and Reptiles
  www.ssarherps.org/
- Society of Northwestern Vertebrate Biology
  www.snwvb.org

Local Herpetological Societies:

- Northern California Herpetological Society
  www.norcalherp.com/
- Idaho Herpetological Society
  idahoherps.org
- Pacific Northwest Herpetological Society
  www.pnwhs.org/index.php?page=home

Charles Peterson

Water affects the distribution of amphibians and some reptiles, especially in arid regions.

Many opportunities are available to help you protect and improve natural resources on your property. Many programs include incentives such as annual rental payments, cost-share payments, tax relief, and technical assistance. Deciding which program 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*

The 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*

The 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: *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. 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 LIP is a federal grant program, through the U.S. Fish and Wildlife Service (USFWS), recently established within state fish and wildlife agencies. The 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 to promote and execute projects. The USFWS requires a minimum 25% non-federal matching funds for LIP grants.

WETLAND RESERVE PROGRAM (WRP)

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

The 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*

The 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, neotropical songbirds, amphibians, and plant communities and habitats associated with isolated wetlands. Technical and cost-share assistance up to 75% for conservation practices are 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) that 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, AGRICULTURE, AND URBAN AND RURAL DEVELOPMENT

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. For urban and rural development BMPs, see the BC Ministry of Environment website: *www.env.gov.bc.ca/wld/BMP/herptile/bmpherptile.html*

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.

ENDANGERED SPECIES PROGRAMS – WORKING WITH LANDOWNERS

Website: *www.fws.gov/endangered/landowner/index.html*

Many federally listed amphibian and reptile species in the Northwest occur on private lands. Working with private landowners is essential to protecting and recovering endangered species. To recover species on non-federal lands, the USFWS acknowledges that it is critical to protect landowners' interests in their land while providing incentives to manage those lands in ways that benefit endangered species. The USFWS is committed to finding this balance between private property rights and endangered species protection, and several of the conservation options below are available.

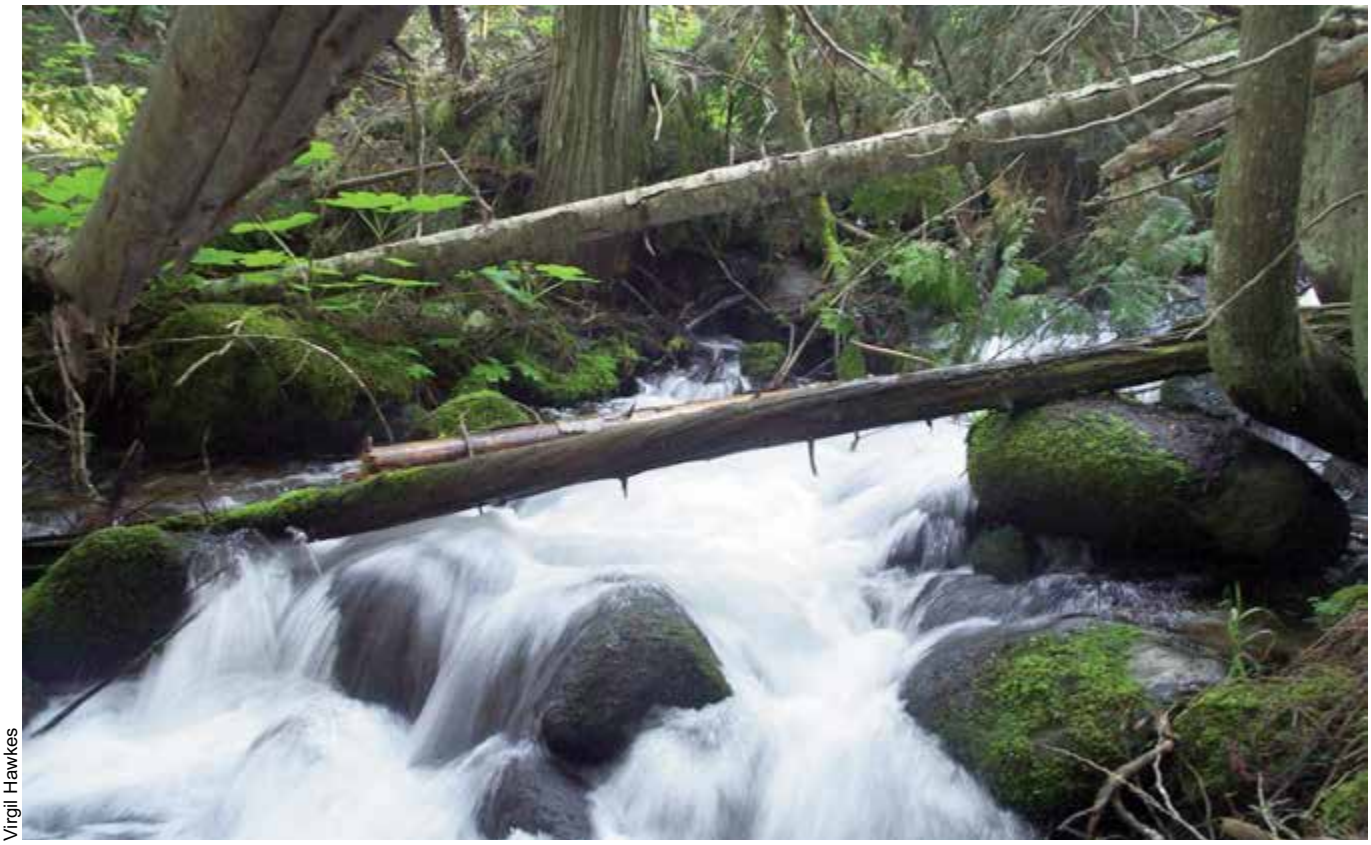
SAFE HARBOR AGREEMENTS

Factsheet: *www.fws.gov/endangered/recovery/harborqa.pdf*

Safe Harbor Agreements are voluntary arrangements between the USFWS and cooperating non-federal landowners. This policy's main purpose is to promote voluntary management for listed endangered and threatened species on non-federal property while giving assurances to participating landowners that no additional future regulatory restrictions will be imposed. Fol-

Elke Wind

Some terrestrial salamanders may live their entire life within one log, especially large logs that take many years to break down.



Virgil Hawkes

Many stream amphibians require stable creeks that have enough flow to flush out sediments.

lowing development of an agreement, the USFWS will issue an "enhancement of survival" permit to authorize any necessary future incidental take.

CANDIDATE CONSERVATION AGREEMENTS (CCA)

Factsheet: *www.fws.gov/endangered/landowner/CCAAs%20(Non-Federal).pdf*

CCAs are formal agreements between the USFWS and one or more parties to address the conservation needs of proposed or candidate species, or species likely to become candidates, before they become listed as endangered or threatened. The participants voluntarily commit to implementing specific actions that will remove or reduce the threats to these species, thereby contributing to stabilizing or restoring the species so that listing is no longer necessary. The USFWS has entered into many CCAs over the years, primarily with other federal agencies, state and local agencies, and conservation organizations, such as The Nature Conservancy. Some of these have successfully removed threats to species and listing was avoided.

CONSERVATION BANKING

Factsheet: *www.fws.gov/endangered/landowner/banking.7.05.pdf*

Conservation banks are permanently protected privately or publicly owned lands that are managed for endangered, threatened, and other at-risk species. A conservation bank is like a biological bank account. Instead of money, the bank owner has habitat or species credits

to sell. The USFWS approves habitat or species credits based on the natural resource values on the bank lands. In exchange for permanently protecting the bank lands and managing them for listed and other at-risk species, conservation bank owners may sell credits to developers or others who need to compensate for the environmental impacts of their projects.

PRIVATE STEWARDSHIP GRANTS PROGRAM

Website: *www.fws.gov/endangered/grants/private_stewardship/index.html*

The Private Stewardship Program provides grants and other assistance on a competitive basis to individuals and groups engaged in local, private, and voluntary conservation efforts that benefit federally listed, proposed, or candidate species, or other at-risk species. Diverse panels of representatives from state and federal government, conservation organizations, agriculture and development interests, and the science community assess applications and make recommendations to the Secretary of the Interior, who awards the grants.

CONSERVATION SECURITY PROGRAM (CSP)

Website: *www.nrcs.usda.gov/programs/csp/*

CSP is a voluntary program that provides financial and technical assistance to promote the conservation and improvement of soil, water, air, energy, plant and animal life, and other conservation purposes on Tribal and private working lands. Working lands include cropland, grassland, prairie land, improved pasture, and range land, as well as forested land that is an incidental part of an agriculture operation. The program is available in all 50 States, the Caribbean Area and the Pacific Basin area. The program provides equitable access to benefits to all producers, regardless of size of operation, crops produced, or geographic location.

FAMILY FORESTS PROGRAM

Website: *www.fsc.org/slimf*

In 2004, the **Forest Stewardship Council (FSC)** launched its new requirements for small and low intensity managed forests seeking FSC forest certification. Known at the international level as SLIMF, for Small and Low Intensity Managed Forests, in the U.S. it is called the Family Forests Program. Worldwide, this policy applies to forests that are 100 hectares or less. However, in the U.S., this policy applies to all forest management certifications covering less than 1,000 hectares (approximately 2,470 acres). Small-scale, indigenous peoples' and community forests form a significant part of forestry worldwide. In the U.S., 6.4 mil-

NRCS

NRCS

Numerous programs exist to provide incentives for landowners to maintain habitats and follow practices beneficial for amphibians and reptiles.

APPENDIX E: STATE AND PROVINCIAL AMPHIBIAN AND REPTILE BIOLOGIST CONTACTS

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David Pilliod

Amphibians can be easy to observe when they congregate to breed, but outside of the breeding season they may rarely be seen.

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Elke Wind

To help with identification, photograph amphibians and reptiles from a variety of angles and include details of various body parts.

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Elke Wind

Elke Wind

Wetlands provide important habitat for a variety of species that prey on and are food for amphibians and reptiles. Many wetland-associated species prefer aquatic habitats that contain a combination of open water and areas with emergent vegetation. When invasive species like reed canary grass (Phalaris arundinacea) spread into an area, the amount of open water habitat available to many species is reduced or lost, and the wetland habitat becomes unsuitable.

APPENDIX F. NON-NATIVE AND INVASIVE SPECIES OF CONCERN TO AMPHIBIANS AND REPTILES AND THEIR HABITATS IN THE NORTHWEST

Species:	Effect:
AMPHIBIANS	
American Bullfrog (*Rana catesbeiana*)	Preys upon many native wildlife species, including Red-legged Frogs and Oregon Spotted Frogs; this species is implicated as a significant factor in their regional decline. American Bullfrogs are highly effective at colonizing new areas with suitable habitat (i.e., permanent ponds and wetlands).
REPTILES	
Snapping turtle *(Chelydra serpentina)* and Pond Slider *(Trachemys scripta)*	Snapping Turtles and Pond Sliders are native to eastern North America. They have been released into waters of the Northwest where they prey upon and compete with native fish, reptiles, crayfish, amphibians, insects, small mammals, young birds, carrion, and aquatic plants. They also pose a competitive threat to native Pacific Pond Turtle and Painted Turtle populations.
FISH	
Green Sunfish *(Lepomis cyanellus)*	Predation by Green Sunfish and other non-native fish contributes to the regional decline of amphibians.
Western Mosquitofish *(Gambusia affinis)*	This species has been intentionally distributed for mosquito control and has negative impacts on Leopard Frog populations and other native species, including fish.
Red Shiner *(Cyprinella lutrensis)*	Red Shiners are omnivorous and known to consume and compete with other aquatic species.
Brook Trout *(Salvelinus fontinalis)* and other game fish	Brook Trout, a char native to the eastern U.S., has been widely introduced into mountain lakes and low-elevation river systems throughout the west. Like other non-native salmonids in the west (e.g., brown trout), this large predator has suppressed amphibian populations. Char species used in stocking programs (e.g., Rainbow Trout, Kokanee, Arctic Char, Chinook Salmon) have all likely had similar effects on native amphibians.
CRAYFISH	
Northern Crayfish *(Orconectes virilis)* Red Swamp Crayfish *(Procambarus clarkii)* Rusty Crayfish *(Orconectes rusticus)*	Crayfish are known to alter and deplete aquatic vegetation, and prey upon native invertebrates. Non-native crayfish have been associated with declines of native frogs and garter snakes in some areas. Originally introduced for aquatic weed control, forage for sport fish, or accidentally released as live bait, non-native crayfish are now widespread in rivers, streams, and lake margins in the Northwest.
SNAILS	
New Zealand Mudsnail *(Potamopyrgus antipodarum)*	This tiny freshwater snail is approximately 0.2 inches (5 mm) long. It was first discovered only 20 years ago in the Northwest, where it now occurs in most states. Populations are easily established, and reproduction is rapid, covering the bottom of streams, lakes, and estuaries. Dense snail populations replace native invertebrate species that serve as prey for fish and other wildlife species. It is suspected to have little nutritional value for native wildlife.

Debra Patla

VEGETATION

Eurasian Watermilfoil *(Myriophyllum spicatum)*	This attractive plant is native to Europe and Asia and is often sold as an aquarium plant in North America. In the Northwest, it occurs from British Columbia to California. Watermilfoil spreads rapidly creating dense mats that can completely cover lakes within 2 years, choking out native plants and making the habitat unsuitable for many wildlife species. The mats also affect recreational activities (e.g., swimming and boating) and power generation. Lakes and wetlands with Watermilfoil become stagnant with poor water quality. Watermilfoil costs states and provinces millions of dollars each year to control.
Purple Loosestrife *(Lythrum salicaria)*	Purple Loosestrife is native to Europe and Asia. Since its introduction into North America as a horticultural species, it has spread to all states except Florida. This species invades a variety of wetland habitats. This invasive species rapidly expands and replaces native plants, forming dense, homogeneous stands.
Salt Cedar *(Tamarix spp.)*	This non-native shrub is present or abundant in most watersheds of the interior Northwest and rapidly takes over riparian areas and spring ecosystems. Some areas have been altered to the point that native plant species can no longer survive. Salt Cedar can dry up water sources, eliminating wetland habitat for amphibians. However, Salt Cedar thickets provide cover for lizards and other species.
Buffelgrass *(Pennisetum ciliare)* Lehmann Lovegrass *(Eragrostis lehmanniana)*, Red Brome *(Bromus rubens)* Downy Brome (Cheatgrass) *(Bromus tectorum)*	Non-native grasses crowd out native grasses and compete for scarce water. Where these species dominate, increased frequency and intensity of fires has occurred resulting in the loss of many native plant species, with a cascading effect on wildlife. The high seed count of grasses, their fire tolerance, and resiliency enables their expansion into niches that cannot withstand fire. Burning often encourages their proliferation. A combination of herbicide application, seeding with native grasses and forbs, and short-term irrigation may be the most effective approach to combating invasive grasses.

Elke Wind

Vegetation often sold for watergardens and landscaping, such as water lilies and iris, can become problematic, invasive species in local wetlands and lakes, spreading rapidly and reducing the amount of open water habitat.

Suggested reading:

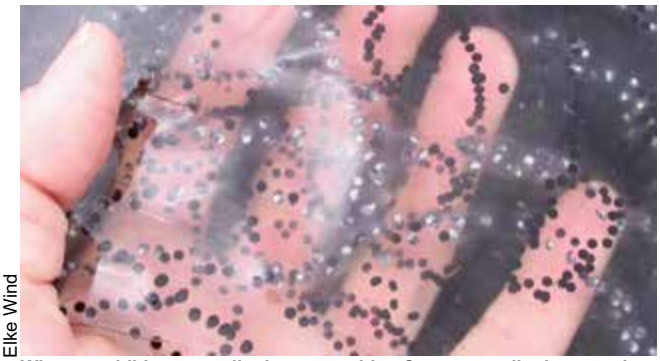
William, R.D., D. Ball, T.L. Miller, R. Parker, J.P. Yenish, T.W. Miller, D.W. Morishita, and P.J.S. Hutchinson. 2008. Pacific Northwest Weed Management Handbook. Oregon State University, Corvallis, OR. Available electronically at ***weeds.ippc.orst.edu/pnw/weeds***.

APPENDIX G. DISINFECTION GUIDELINES FOR INDIVIDUALS WORKING IN FRESHWATER HABITATS

To prevent the potential introduction and spread of two of the main diseases affecting amphibian populations in the Northwest and elsewhere, we encourage all individuals that work in freshwater to consider following a disinfection protocol. Some of the various disinfection techniques that have been tested are listed below.

Purpose	Disinfectant	Concentration	Time	Pathogen killed
Disinfecting surgical equipment and other instruments (e.g., scales)	Ethanol	70%	1 min	*B. dendrobatidis* Ranaviruses
	Vircon	1 mg/ml	1 min	*B. dendrobatidis* Ranaviruses
	Benzalkonium chloride	1 mg/ml	1 min	*B. dendrobatidis* Ranaviruses
Disinfecting collection equipment and containers	Sodium hypochlorite (bleach)	1%	1 min	*B. dendrobatidis*
	Sodium hypochlorite (bleach)	4%	15 min	Ranaviruses
	Didecyl dimethylammonium chloride	1 in 1000 dilution	0.5 min	*B. dendrobatidis*
	Complete drying		3 hrs or greater	*B. dendrobatidis*
	Heat	60°C	5 min	*B. dendrobatidis*
			15 min	Ranaviruses
	Heat	37°C	4 hrs	*B. dendrobatidis*
	Sterilizing UV light		1 min	Ranaviruses only
Disinfecting footwear	Sodium hypochlorite (bleach)	1%	1 min	*B. dendrobatidis*
	Sodium hypochlorite (bleach)	4%	15 min	Ranaviruses
	Didecyl dimethylammonium chloride	1 in 1000 dilution	0.5 min	*B. dendrobatidis*
	Complete drying		3 hrs or greater	*B. dendrobatidis*
Disinfecting cloth (e.g., bags, clothes)	Hot wash	60°C or greater	5 min	*B. dendrobatidis*
			15 min	Ranaviruses

The above table was taken from Speare et al. (2004). These disinfection strategies are suitable for killing *Batrachochytrium dendrobatidis* and ranaviruses in field studies. Where concentrations and time are given, these are the minimum shown to be effective. Values for *B. dendrobatidis* are based on Berger (2001) and Johnson et al. (2003) and for ranaviruses on Langdon (1989) and Miocevic et al. (1993). For a list of these citations and a complete bibliography of amphibian diseases, go to ***www.jcu.edu.au/school/phtm/PHTM/frogs/ampdis.htm***.



Elke Wind

When amphibian eggs die they turn white. Some mortality is normal, but a consistently high proportion may lead to local declines and should be reported to your local fish and wildlife agency.

HYGIENE PROTOCOL

For control of disease transmission between amphibian study sites (USGS Feb. 2005) the following protocol should be completed between any sites that are not "water-connected" or that amphibians don't freely move between. The procedure should be completed on all gear/equipment that may have touched site water or used to handle amphibians, including but not limited to

- Waders
- Shoes/boots
- Dip nets
- Rulers and other instruments
- Specimen bags/containers
- Traps

Materials that will be needed for disinfecting equipment include:

- Plastic bucket with handle for sterilization and holding cleaning gear
- Gallon of chlorine bleach (6% concentration of sodium hypochlorite)
- Two stiff scrub brushes with handles, one for sterilization, and one for cleaning off mud/dirt
- Rubber dishwashing gloves
- Spray bottle

Procedure:

1) Before leaving the site, wash off as much of the mud/dirt on equipment and gear, in the site water and remove any vegetation or detritus attached to gear by shaking, rinsing in water, and hand picking.
2) Do all sterilizing well away from streams or ponds.
3) Fill bucket with two gallons (eight quarts) clear water (from pond or spigot).
4) Add 12 capfuls (6 Tablespoons or 1/3 cup) of bleach (for a 1% concentration).
5) Stir to mix with brush.
6) Clean off any remaining vegetation or mud with brush that may have been missed earlier.
7) Dip and rotate folded Minnow traps in solution, shake off, open, and lay out in sun/wind to dry.
8) Dip shoes in solution and scrub, shake off and let dry in sun.
9) Either dip and scrub waders in bucket or lay waders on ground and pour solution on them while scrubbing. Spray bottle (with same solution concentration) can also be used to apply solution where needed.
10) Sterilize brushes in solution.
11) If possible, save any remaining sterilization solution in a sealable container for future use. If solution must be discarded, dispose of on asphalt, cement or hard roadbed, well away from any water bodies.
12) If at all possible, allow all gear and equipment to dry completely before reuse at next site. Alternatively, use a spray application of isopropyl alcohol (70%) or dry completely for over 3 hours.

For further reading:

NSW National Parks and Wildlife Service. 2001. Hygiene protocol fo the control of disease in frogs. Information Circular Number 6. NSW NPWS, Hurstville, New South Wales, Australia. Available electronically at ***www.environment.nsw.gov.au/resources/nature/hyprfrog.pdf***.

Speare, R., L. Berger, L.F. Skerratt, R. Alford, D. Mendez, S. Cashins, N. Kenyon, K. Hauselberger, and J. Rowley. 2004. Hygiene protocol for handling amphibians in field studies. Unpublished report by the Amphibian Diseases Group, James Cook University, Australia. Available electronically at ***www.jcu.edu.au/school/phtm/PHTM/frogs/control.htm#quarantine***.

DEH Australia. 2006. Threat abatement plan: infection of amphibians with chytrid fungus resulting in chytridiomycosis. Department of Environment and Heritage, Commonwealth of Australia. Available electronically at ***www.environment.gov.au/biodiversity/threatened/publications/tap/chytrid/***.

Elke Wind

All equipment that touches site water or amphibians must be disinfected to prevent the introduction and spread of disease.

APPENDIX H. MORE INFORMATION ABOUT RIPARIAN BUFFERS

The USDA Forest Service defines a riparian buffer as follows:

> "The aquatic ecosystem and the portions of the adjacent terrestrial ecosystem that directly affect or are affected by the aquatic environment. This includes streams, rivers, lakes, and bays and their adjacent side channels, floodplain, and wetlands. In specific cases, the riparian buffer may also include a portion of the hillslope that directly serves as streamside habitats for wildlife."

Lowrance, Leonard, and Sheridan (1985) define riparian buffers as follows:

> "A complex assemblage of plants and other organisms in an environment adjacent to water. Without definitive boundaries, it may include stream banks, floodplain, and wetlands, as well as sub-irrigated sites forming a transitional zone between upland and aquatic habitat. Mainly linear in shape and extent, they are characterized by laterally flowing water that rises and falls at least once within a growing season."

Useful references on agricultural and forest buffers:

Mayer, P.M., S.K. Reynolds, M.D. McCutchen, and T.J. Canfield. 2006. Riparian buffer width, vegetative cover, and nitrogen removal effectiveness: A review of current science and regulations. EPA/600/R-05/118. U.S. Environmental Protection Agency, Cincinnati, OH. Available electronically at *www.epa.gov/nrmrl/pubs/600R05118/600R05118.pdf.*

Schultz, R.C., T.M. Isenhart, and J.P. Colletti. 1995. Riparian buffer systems in crop and rangelands. p. 13-27 In: Agroforestry and Sustainable Systems: Symposium Proceedings. USDA Forest Service General Technical Report RM-GTR-261.

Schultz, R.C. J.P. Colletti, T.M. Isenhart, W.W. Simpkins, C.W. Mize, and M.L. Thompson. 1995. Design and placement of a multi-species riparian buffer strip. R.C. Agroforestry Systems 29: 201-226.

Useful websites on buffer design and benefits:

www.nrcs.usda.gov/FEATURE/buffers/
www.unl.edu/nac/riparianforestbuffers.htm
waterhome.brc.tamus.edu/projects/riparian.html
www.ext.vt.edu/pubs/forestry/420-151/420-151.html
www.buffer.forestry.iastate.edu/
www.riparianbuffers.umd.edu/

Bryce Maxell

As its name indicates, the shell of the Spiny Softshelled Turtle is relatively soft and leathery compared to the hard carapace of other turtles. Essential habitat elements that can be maintained within water bodies and adjacent riparian areas for this species include sand or gravel nesting areas (close to the water and relatively clear of vegetation); shallow muddy or sandy areas to bury in; deep pools for hibernation; basking areas; and suitable habitat for crayfish and other food species.

Scientific Literature on Riparian Buffers for Amphibians and Reptiles:

Burke, V.J. and J.W. Gibbons. 1995. Terrestrial buffer zones and wetland conservation: a case study of freshwater turtles in a Carolina bay. Conservation Biology 9:1365-1369.

Buhlmann, K.A. and J.W. Gibbons. 2001. Terrestrial habitat use by aquatic turtles from a seasonally fluctuating wetland: implications for wetland conservation boundaries. Chelonian Conservation and Biology 4(1): 115-127.

Chen, J., S.C. Saunders, T.R. Crow, R.J. Naiman, K.D. Brosofske, G.D. Mroz, B.L. Brookshire, and J.F. Franklin. 1999. Microclimate in forest ecosystem and landscape ecology. BioScience 49(4):288-297.

Crawford, J.A. and R.D. Semlitsch. 2007. Estimation of core terrestrial habitat for stream-breeding salamanders and delineation of riparian buffers for protection of biodiversity. Conservation Biology 21(1):152-158.

Dodd, C.K. and B.S. Cade. 1998. Movement patterns and the conservation of amphibians breeding in small, temporary wetlands. Conservation Biology 12:331-339.

Dupuis, L. and D. Steventon. 1999. Riparian management and the tailed frog in northern coastal forests. Forest Ecology and Management 124(1):35-43.

Gamble, L.R., K. McGarigal, C.L. Jenkins, and B.C. Timm. 2006. Limitations of regulated "buffer zones" for the conservation of marbled salamanders. Wetlands 26:298-306.

Goates, M.C., K.A. Hatch, and D.L. Eggett. 2007. The need to ground truth 30.5-m buffers: a case study of the boreal toad (*Bufo boreas*). Biological Conservation 138: 474-483.

Guerry, A.D. and M.L. Hunter Jr. 2002. Amphibian distributions in a landscape of forests and agriculture: an examination of landscape composition and configuration. Conservation Biology 16:745-754.

Hairston-Strang, A.B. and P.W. Adams. 1998. Potential large woody debris sources in riparian buffers after harvesting in Oregon, U.S.A. Forest Ecology and Management 112 (1-2): 67-77.

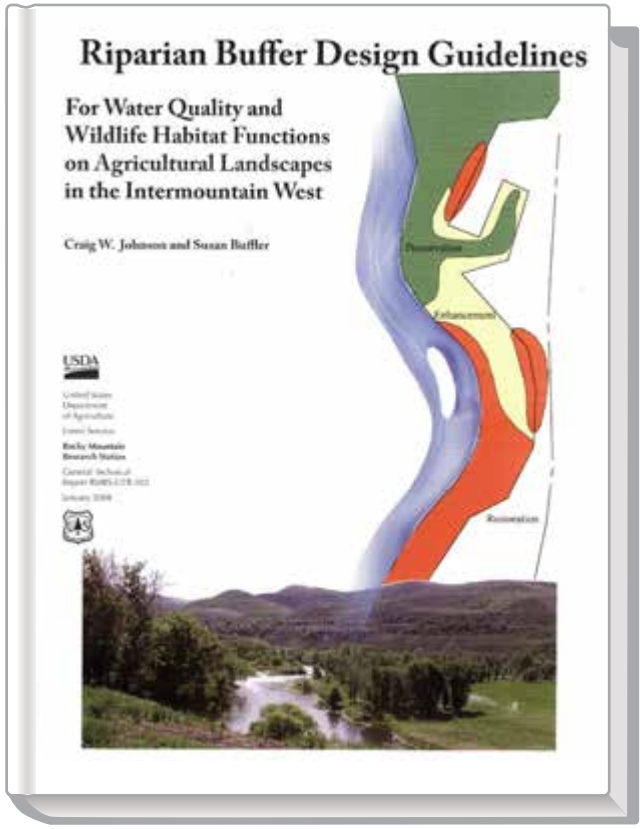
Bryce Maxell

Gartersnakes, such as the Plains Gartersnake, often forage in riparian areas throughout the Northwest. Maintaining wetland-associated populations of amphibians and invertebrates ensures that gartersnakes will have abundant prey.

Houlahan, J.E. and C.S. Findlay. 2003. The effects of adjacent land use on wetland and amphibian species richness and community composition. Canadian Journal of Fisheries and Aquatic Sciences 60:1078-1094.

Johnson, C.W., and S. Buffler. 2008. Riparian buffer design guidelines for water quality and wildlife habitat functions on agricultural landscapes in the Intermountain West. Gen. Tech. Rep. RMRS-GTR-203. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station. 53 p. *www.treesearch.fs.fed.us/pubs/29201*.

Kiffney, P.M., J.S. Richardson, and J.P. Bull. 2004. Establishing light as a causal mechanism structuring stream communities in response to experimental manipulation of riparian buffer width. Journal of the North American Benthological Society 23(3):542–555.



This document reviews the riparian buffer literature, including protocols used to determine optimum buffer widths for water quality and wildlife habitat functions. To access it visit www.fs.fed.us/rm/pubs/rmrs_gtr203.html

Kreutzweiser, D.P. and S.S. Capell. 2001. Fine sediment deposition in streams after selective forest harvesting without riparian buffers. Canadian Journal Forestry Research 31(12):2134–2142.

Lee, P., C. Smyth, and S. Boutin. 2004. Quantitative review of riparian buffer width guidelines from Canada and the United States. Journal of Environmental Management 70(2):165-180.

Macdonald, J.S., E.A. MacIsaac, and H.E. Herunter. 2003. The effect of variable-retention riparian buffer zones on water temperatures in small headwater streams in sub-boreal forest ecosystems of British Columbia. Canadian Journal Forestry Research 33(8): 1371–1382.

Naiman, R.J. and H. Décamps. 1997. The ecology of interfaces: riparian zones. Annual Review of Ecology and Systematics 28:621-658.

Olson, D.H. and C. Rugger. 2007. Preliminary study of the effects of headwater riparian reserves with upslope thinning on stream habitats and amphibians in western Oregon. Forest Science 53(2):331-342.

Olson, D.H. and G. Weaver. 2007. Vertebrate assemblages associated with headwater hydrology in western Oregon managed forests. Forest Science 53 (2): 343-355.

Olson, D.H., P.D. Anderson, C.A. Frissell, H.H. Welsh Jr., and D.F. Bradford. 2007. Biodiversity management approaches for stream–riparian areas: Perspectives for Pacific Northwest headwater forests, microclimates, and amphibians. Forest Ecology and Management 246 (1): 81-107.

Rothermel, B.B. and R.D. Semlitsch. 2002. An experimental investigation of landscape resistance of forest versus old-field habitats to emigrating juvenile amphibians. Conservation Biology 16:1324-1332.

Rundio, D.E. and D.H. Olson. 2007. Influence of headwater site conditions and riparian buffers on terrestrial salamander response to forest thinning. Forest Science 53 (2):320-330.

Semlitsch, R.D. 1998. Biological delineation of terrestrial buffer zones for pond-breeding salamanders. Conservation Biology 12:1113-1119.

Semlitsch, R.D. and J.R. Bodie. 2003. Biological criteria for buffer zones around wetlands and riparian habitats for amphibians and reptiles. Conservation Biology 17 (5):1219–1228.

Vesely, D.G. and W.C. McComb. 2002. Salamander abundance and amphibian species richness in riparian buffer strips in the Oregon Coast Range. Forest Science 48 (2):291-297.

Bill Leonard

Desert Horned Lizards prefer open, sunny habitats with loose sandy or gravely soils where they use their flattened bodies to press against the ground, shuffle into the sand, and hide from predators.

Elke Wind

Many wetlands and streams have been drained and channelized as a result of development. Restoration projects, such as planting riparian areas, can benefit many wildlife species.

Elke Wind

In rural and urban areas, potential impacts of development projects are usually assessed on a site by site basis ignoring cumulative landscape-level effects on wildlife, such as amphibians and reptiles.

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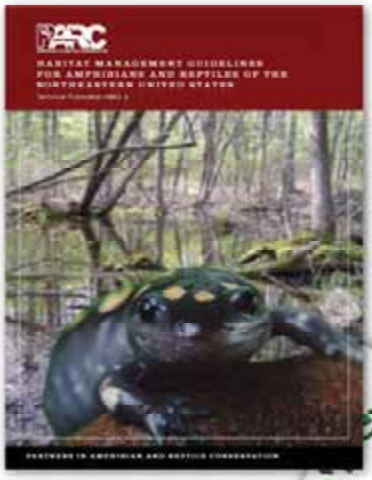

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