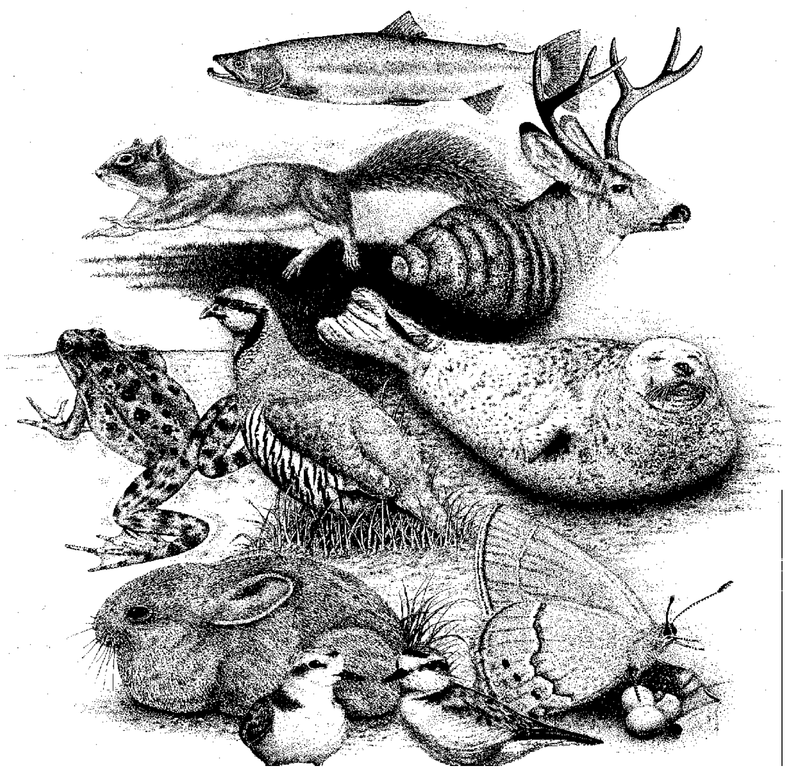
Washington Department of Fish and Wildlife

Management Recommendations for Washington's Priority Species

Volume III: Amphibians and Reptiles



Eric. M. Larsen, Technical Editor

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Eric M. Larsen, Technical Editor

November, 1997

Washington Department of Fish and Wildlife
600 Capitol Way N
Olympia, WA 98501-1091

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INTRODUCTION

Fish and wildlife are public resources. Although the Washington Department of Fish and Wildlife is charged with protecting and perpetuating fish and wildlife species, the agency does not have authority over the habitat on which animals depend. Landowners, agencies, governments, and members of the public have a shared responsibility to protect and maintain these resources for present and future generations.

The department has developed management recommendations for Washington's priority habitats and species to provide planners, elected officials, landowners, and citizens with comprehensive information on important fish, wildlife, and habitat resources. These management recommendations are designed to assist in making land use decisions that incorporate the needs of fish and wildlife. Considering the needs of fish and wildlife can help prevent species from becoming increasingly threatened or extinct and may contribute to the recovery of species already imperiled.

Priority habitats are those habitat types with unique or significant value to many fish or wildlife species. Priority species are those fish and wildlife species requiring special efforts to ensure their perpetuation because of their low numbers, sensitivity to habitat alteration, tendency to form vulnerable aggregations, or because they are of commercial, recreational, or tribal importance. Descriptions of those habitats and species classified as priority are published annually in the Priority Habitats and Species (PHS) List.

Agency biologists develop management recommendations for Washington's priority habitats and species through a comprehensive review and synthesis of the best scientific information available. Sources include professional journals and publications, symposia, reference books, and personal communications with experts on specific habitats or species. Management recommendations are reviewed within the agency and by other resource experts and potential users of the information. The recommendations are revised when scientists learn more regarding a priority habitat or priority species.

Goals

Management recommendations for Washington's priority habitats and species are guidelines based on the best available scientific information and are designed to meet the following goals:

- Maintain or enhance the structural attributes and ecological functions of habitat needed to support healthy populations of fish and wildlife;
- Maintain or enhance populations of priority species within their present and/or historical range in order to prevent future declines;
- Restore species that have experienced significant declines.

Application

Management recommendations are generalized for statewide application. In many cases, a qualified biologist may be required to provide additional detail on specific projects.

In summary, management recommendations for Washington's priority habitats and species...

Are:	Are not:
Guidelines	Regulations
Generalized	Site specific
Updated with new information	Static
Based on fish and wildlife needs	Based on other land use objectives
To be used for all occurrences	To be used only for mapped occurrences

Format

Management recommendations for priority species are written in seven sections:

GENERAL RANGE AND WASHINGTON DISTRIBUTION	Summarizes information on the geographic extent of the species in Washington and throughout its range.
STATUS	Identifies the species' State and Federal status.
RATIONALE	Outlines the basis for classifying the species as priority.
HABITAT REQUIREMENTS	Delineates the species' known habitat associations.
LIMITING FACTORS	Specifies factors that may limit the species' distribution or abundance in Washington.
MANAGEMENT RECOMMENDATIONS	Provides management guidelines based on a synthesis of the best available scientific information.
KEY POINTS	Summarizes the most important elements of the species' biology and associated management recommendations.

Management recommendations for Washington's priority habitats and species are intended to be used in conjunction with mapped and digital data which display important fish, wildlife, and habitat occurrences statewide. Mapped data can be obtained by calling the PHS Data Request Line at (360)902-2543. For more information, visit the PHS web site at www.wa.gov/wdfw/hab/phspage.htm, or contact:

Eric Larsen
WDFW Habitat Management Program
600 Capitol Way N
Olympia, WA 98501-1091

SPECIES STATUS DEFINITIONS

State Listed and Candidate Species

State Endangered - Any wildlife species native to the state of Washington that is seriously threatened with extinction throughout all or a significant portion of its range within the state. Endangered species are legally designated in WAC 232-12-014.

State Threatened - Any wildlife species native to the state of Washington that is likely to become endangered within the foreseeable future throughout a significant portion of its range within the state, without cooperative management or the removal of threats. Threatened species are legally designated in WAC 232-12-011.

State Sensitive - Any wildlife species native to the state of Washington that is vulnerable or declining and is likely to become endangered or threatened in a significant portion of its range within the state, without cooperative management or the removal of threats. Sensitive species are legally designated in WAC 232-12-011.

State Candidate - Wildlife species that are under review by the Department for possible listing as endangered, threatened or sensitive. A species will be considered for State Candidate designation if sufficient evidence suggests that its status may meet criteria defined for endangered, threatened or sensitive in WAC 232-12-297. Currently listed State Threatened or State Sensitive species may also be designated as State Candidate species if evidence suggests that their status may meet criteria for a higher listing of State Endangered or State Threatened. State Candidate species will be managed by the Department, as needed, to ensure the long-term survival of populations in Washington. They are listed in Appendix A of WDFW Policy POL-M-6001.

WASHINGTON DEPARTMENT OF FISH AND WILDLIFE REGIONAL CONTACTS

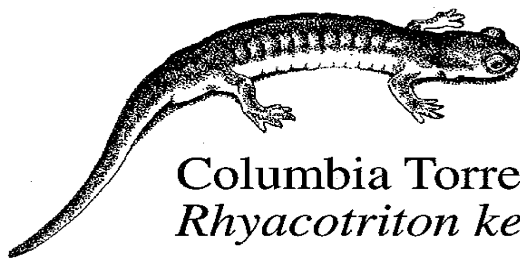
For Assistance with PHS Information Specific to Your County, Contact the Following WDFW Representative.

If you live in...	Contact...
Asotin, Columbia, Ferry, Garfield, Lincoln, Pend Oreille, Spokane, Stevens, Walla Walla, Whitman	John Andrews 8702 N. Division St. Spokane, WA 99218-1199 Phone: (509) 456-4082
Adams, Chelan, Douglas, Grant, Okanogan	Tracy Lloyd 1550 Alder St. NW Ephrata, WA 98823-9699 Phone: (509) 754-4624
Benton, Franklin, Kittitas, Yakima	Ted Clausing 1701 24th Ave. Yakima, WA 98902-5720 Phone: (509) 575-2740
Island, King, San Juan, Skagit, Snohomish, Whatcom	Ted Muller 16018 Mill Creek Blvd. Mill Creek, WA 98012-1296 Phone: (206) 775-1311
Clark, Cowlitz, Klickitat, Lewis, Skamania, Wahkiakum	Bryan Cowan 2108 Grand Blvd. Vancouver WA 98661 Phone: (360) 696-6211
Clallam, Grays Harbor, Jefferson, Kitsap, Mason, Pacific, Pierce, Thurston	Steve Keller 48 Devonshire Rd. Montesano, WA 98563-9618 Phone: (360) 249-4628

Management Recommendations for Washington's Priority Species

Volume III: Amphibians and Reptiles

Cascade Torrent Salamander
Rhyacotriton cascadae

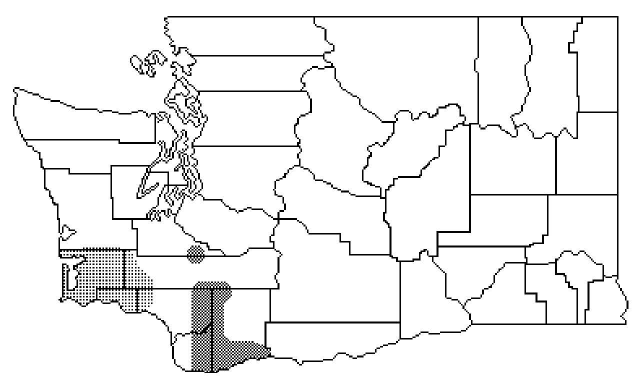


Columbia Torrent Salamander
Rhyacotriton kezeri

Prepared by Noelle Nordstrom

GENERAL RANGE AND WASHINGTON DISTRIBUTION

The Cascade torrent salamander (*Rhyacotrition cascadae*) and the Columbia torrent salamander (*Rhyacotrition kezeri*) are two of four salamanders that until 1992, were collectively considered one species, the Olympic salamander (*Rhyacotrition olympicus*) (Good and Wake 1992). Sources written before 1992 refer to all torrent salamanders as Olympic salamanders.



Areas in Washington where the Columbia (light shading) and Cascade (dark shading) torrent salamanders (*Rhyacotriton kezeri* and *R. cascadae* respectively) are known to occur. Map derived from the literature.

The Cascade torrent salamander occurs on the western slopes of the Cascade Mountains from a point just north of Mount Saint Helens, Washington, south to northeastern Lane County, Oregon. The Columbia torrent salamander occurs in the Coast Ranges of Washington and Oregon from south of the Chehalis River in Washington, southward to the Little Nestucca River and Grande Ronde Valley in Polk, Tillamook, and Yamhill counties, Oregon (Good and Wake 1992, Leonard et al. 1993).

STATUS

Cascade torrent and Columbia torrent salamanders are both State Candidate species.

RATIONALE

The Cascade torrent salamander and the Columbia torrent salamander are vulnerable to population decline and fragmentation, due to the narrow range of environmental conditions they require, and human impacts to their habitat (Welsh 1990). Torrent salamanders are slow maturing, sedentary amphibians that require cold seeps and streams with sediment-free substrate and stable microclimates (Leonard et al. 1993). These headwater habitats are often non-fish bearing, and consequently receive little protection from current forest practice activities. The lack of protection for headwater habitats in current forestry regulations further fragments populations that are naturally slow to disperse and limited in distribution (Welsh 1990).

HABITAT REQUIREMENTS

Life History Needs

Evidence suggests that Columbia and Cascade torrent salamanders have essentially the same habitat requirements within their distinct ranges. Both of these long-lived salamanders inhabit cold seeps and streams with rocky or gravelly substrate and low sediment loads. They are specialized for life in cold water, and cannot live in areas where water temperatures exceed 27.8-29.0 C (81.0-82.4°F) (Brattstrom 1963). Stebbins (1951) found torrent salamanders (reported as Olympic salamanders) living in Washington streams with water temperatures ranging from 5.9-8.0 C (42.0-46.4°F).

Adults are found in or near small streams, spring heads, and seepages within humid coniferous forests, from sea level to about 1,200 m (3,937 ft) in elevation. Because these salamanders prefer rapidly-flowing water, they are restricted to high gradient (steep) areas and are absent from flat areas or areas with gentle slopes (Good and Wake 1992). Both species inhabit the splash zones of rocky, tumbling brooks in shady canyons, and the spray zones of waterfalls where a thin film of water runs between and under rocks. Large roaring streams are avoided. Areas where water seeps through moss-covered gravel or talus provide excellent habitat (Nussbaum et al. 1983). These seeps are often on a headwall, upslope from where a small perennial headwater stream emerges from underground (N. Wilkins, pers. comm.).

During rainy periods, torrent salamanders will sometimes stray some distance from their source of water (Leonard et al. 1993), but since they are poor at resisting desiccation (Ray 1958), they should only be expected to be found within streams and in saturated streamside areas**.** Torrent salamanders are among the Pacific Northwest’s terrestrial salamanders most sensitive to loss of body moisture (Nussbaum et al. 1983).

Adults often occur side-by-side with larvae under stones in streams. Larvae are abundant where water percolates through loose gravel, and in moss-covered, gravelly seeps adjacent to streams (Nussbaum et al. 1983, Good and Wake 1992). Seeps may be particularly important to larval salamanders by providing a nursery habitat, and egg-laying may occur in these areas as well (N. Wilkins pers. comm.). The larval period lasts about 3.5 years, with an additional 1.0-1.5 years until sexual maturity. Both larvae and adults are opportunistic feeders. Larvae eat an assortment of small aquatic invertebrates, and metamorphosed adults eat aquatic and semi-aquatic invertebrates (Nussbaum et al. 1983, Leonard et al. 1993).

Torrent salamanders seem to have a prolonged courting season. Peak egg laying occurs in May, though egg-laying occurs throughout the year. The large, white eggs are deposited loosely in deep narrow cracks in rocks, where cold water flows slowly around them (Nussbaum and Tait 1977, Nussbaum et al. 1983).

Historically, the presence of torrent salamanders has been linked to old-growth forests, though forest age is probably an indirect measure of what these salamanders require: a stable environment with consistently cold water temperatures, high humidity, and sediment-free stream substrate (Diller and Wallace 1996). Mature to old-growth forests have greater microclimatic and soil stability, maintained for longer periods of time than in younger forests (Welsh 1990). This suggests that streams in older forests are more likely to contain well-established populations of torrent salamanders.

LIMITING FACTORS

The abundance of Cascade and Columbia torrent salamanders is limited by the availability of streams and seeps with stable microclimates that include cold water, and rocky or gravelly substrate free of fine sediments. Vegetation along streams controls sedimentation by stabilizing the soil and provides shade that contributes to cool water temperatures (Bury and Corn 1988).

Human impacts on torrent salamanders and their habitat are related primarily to forest management activities. Timber harvest can impact torrent salamander habitat by increasing sedimentation and water temperatures in headwater streams. Cascade and Columbia torrent salamanders are typically absent from areas logged up to 15 years previously, and there is no current evidence of these salamanders breeding in areas denuded of forest (Good and Wake 1992).

Several studies have shown that densities of the closely related southern torrent salamander (*Rhyacotriton variegatus*) are much smaller in younger forests than in old-growth (Bury 1983, Bury and Corn 1988, Corn and Bury 1989, Welsh 1990). However, a study by Diller and Wallace (1996) compared two different age-classes of second growth forests, and found more southern torrent salamanders in forests with an average age of about 39 years than in those that were about 80 years old. The younger forests were in an area that received high rainfall and that had underlying consolidated rock (e.g., basalt), whereas the older stands were in a drier area where sedimentary rock predominated (e.g., sandstone). Similarly, Columbia torrent salamanders have been found in second growth stands of comparable ages in Washington (N. Wilkins pers. comm.) and it is likely that these findings apply to the Cascade torrent salamander as well.

Comparisons between these studies should be made carefully, as should their application to situations in Washington. Each examines different forest age-classes, and most involve the southern torrent salamander, which does not occur in Washington. This salamander is closely related to, and shares the same habitat requirements as the Columbia and Cascade torrent salamanders, but is a different species nonetheless. These studies do show similar trends, however. Populations of torrent salamanders decline sharply after timber harvest. As forest age increases, so do the chances of finding torrent salamanders. Furthermore, these studies suggest that once a forest reaches the age of at least 30 years, slope, aspect, and the type of underlying rock in the area are more likely to predict the presence of torrent salamanders than is the age of the trees. However, streams with shallow gradients (<9%) are less resistant to sedimentation (Steele 1996). In these streams, forest age may be a significant indicator of torrent salamander habitat for a much longer period of time (Corn and Bury 1989).

Sedimentation

Sedimentation can render a stream's substrate uninhabitable for torrent salamanders by restricting their movement and limiting areas suitable for egg-laying. Sandy sediment can fill in the spaces between rocks, and sometimes causes gravel to cement into a hardened surface through which salamanders cannot burrow (Steele 1996, Welsh and Lind 1996). Stream gradient, and the presence and amount of sedimentary rock in a watershed influences the degree of sedimentation in an area (Bury and Corn 1988). The primary causes of siltation in managed forests are road-grade failures, surface erosion from both roads and logging, and mass wasting (the movement of soil, rock and vegetation downslope), all of which are more likely to occur on steep terrain (N. Wilkins pers. comm.).

In uncut forests, Bury and Corn (1988) and Corn and Bury (1989) found that densities of torrent salamanders were unrelated to stream gradient (steepness), whereas in logged areas, the salamanders were absent from all streams with shallow gradients of less than 11%. Sediment is eventually flushed from high gradient streams but not from those with low gradients. This suggests that the disruptive effects of increased sedimentation are greatest in low-gradient streams, which receive silt delivered to them from higher-gradient reaches upstream (Welsh and Lind 1996, N. Wilkins pers. comm.). If sedimentation is a major negative impact on torrent salamander populations, those inhabiting low-gradient streams can be put at risk by sediment generating activities on higher gradient reaches upstream. Additionally, logging reduces large woody debris (LWD) in the streambed over the long term, which helps trap and filter sediments from streams (Bury and Corn 1988).

Water Temperature and Evaporation

Bury (1983) found that there was a distinct change in amphibian species composition following logging, as well as a decrease in abundance of individuals. Logging opens the forest canopy and creates conditions detrimental to the majority of forest-dependant amphibian species by increasing light penetration, soil temperature, and evaporative water loss, as well as increasing the daily fluctuations of these conditions (Chen et al. 1993, 1995; Bury 1983). Increased water temperatures and fluctuations in humidity caused by canopy removal can be significant, and undoubtedly have a negative impact on torrent salamanders. Brown and Krygier (1970) reported the temperature of a second-order Coast Range stream increased from 14 C to 22 C (57.2°F to 71.6°F) after the entire drainage was clearcut, and that the maximum temperature reached 30 C (86°F).

Recolonization of Logged Areas

The survival of amphibians in managed forests may depend on the ability of species to re-invaded logged areas after habitat conditions recover. The sedentary nature of torrent salamanders may limit their ability to recolonize areas where resident populations were extirpated (Corn and Bury 1988). Also, the tendency of torrent salamanders to be patchily distributed along streams increases the risk of inadvertently eliminating source populations of these species (Diller and Wallace 1996). Though canopy cover and cold stream temperatures can be reestablished in about 10 years, it may take much longer for torrent salamanders to recolonize an area. Recolonization may be more likely in high-gradient streams where sediment is flushed away within a relatively short period of time (Bury and Corn 1988, Corn and Bury 1988). The likelihood of recolonization is probably also influenced by the distance to the nearest source population unaffected by timber harvest, and the level of disturbance sustained to seeps and wet rock outcrops adjacent to streams in harvested areas.

Conclusion

It is important to keep regional differences in mind when assessing the effects of forest management on torrent salamanders and their habitat. Cascade streams are sediment poor compared to those in Coastal Oregon and California, where most of these studies took place. The moist, cool conditions in Washington may make logging less stressful to amphibians in general, than in the comparatively warmer and dryer climates of Oregon and California (Bury and Corn 1988, N. Wilkins pers. comm.).

MANAGEMENT RECOMMENDATIONS

We do not know for certain what management actions will ensure adequate protection of these salamanders in Washington. At this time, The Washington Department of Fish and Wildlife (WDFW) suggests protecting the habitat features with which torrent salamanders are most commonly found. The following management recommendations focus on forest management, since these are the primary adverse human activities occurring within the ranges of the Columbia and Cascade torrent salamanders. Though there is disagreement on just how incompatible timber harvest is with the long-term survival of torrent salamanders, forest practices certainly affect the physical features needed to sustain them. In areas where these salamanders occur, forest management should be conducted so that impacts to their habitats are minimized. Timber harvest and associated road building increases the accumulation of sediments in streams, and removes canopy cover that helps maintain low water temperatures.

Steele (1996) and N. Wilkins (pers. comm.) suggest that current forest practices do not necessarily have to destroy the stream habitat of torrent salamanders. With consideration of the habitat requirements and locations of torrent salamanders within a harvest unit, forest management plans can probably be designed to minimize impacts to them. Forest management plans should address shade retention over seeps and stream corridors, retaining downed woody debris within stream corridors, and minimizing sedimentation. Plans need to address maintaining source populations of torrent salamanders within drainages for re-populating logged areas once they have stabilized.

Within the ranges of these species, planned harvest units and associated drainages should be surveyed for Columbia and Cascade torrent salamanders. Surveys should include seeps upslope and adjacent to streams, wet rock outcrops, and stream channels. This will provide information on important areas to protect within the harvest unit, and on any source populations elsewhere in the drainage.

Throughout managed forests within the ranges of these species, stands should be distributed across the landscape so that clearcuts and very young stands are adjacent to older tracts of forest. Uncut areas may help reduce substrate temperature fluctuations and stream sedimentation, and may also provide a source of amphibians for recolonization of clear-cut areas (Bury and Corn 1988, Gomez and Anthony 1996). Careful harvest scheduling that retains mature stands in and adjacent to riparian areas can compliment planned riparian protection.

Riparian Areas

Protected riparian areas along headwater streams help ensure relatively stable moisture regimes and increased erosion protection for Cascade and Columbia torrent salamanders, as well as for other amphibian species (Welsh 1990). Riparian and instream protection is usually achieved by retaining a linear buffer on each side of a watercourse, and is required by state law along all fish-bearing streams and rivers in Washington. The habitats of torrent salamanders however, are likely to include many small, non-fish-bearing streams that require little or no protection under these regulations. Protecting salamander habitat along headwater streams may be accomplished by applying standardized buffers across the landscape (Fig. 1), or by designing refugia (Fig. 2) and/or linear buffers with nodes (areas where the buffer width expands to encompass high quality habitat as well as negotiate the topography) (Fig. 3) on a site by site basis. Refugia are discontinuous, protected portions along a stream corridor that would otherwise receive no protection.

Because these salamanders have small home ranges, relatively small patches of high quality riparian habitat within refugia may contain viable populations, and may be able to support salamander populations until the surrounding landscape recovers from timber harvest. In some situations, refugia along small streams in the form of discontinuous clumps of trees large enough to encompass all known habitat requirements of these salamanders may be a viable alternative to leaving a continuous, narrow strip of marginal riparian habitat (Bury and Corn 1988).

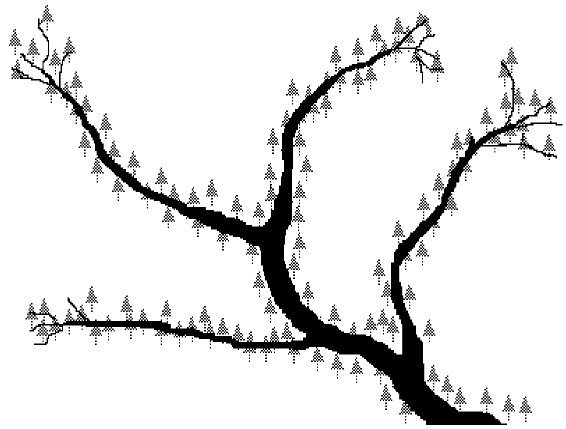


Figure 1. Linear buffers along headwater streams.

Whether standardized linear buffers, refugia, or customized linear buffers with nodes are used along a stream depends on which species are present and in what landscape/land-use arena the buffers will be used. Adopting standardized buffers is an efficient, predictable, low risk method for protecting riparian habitat. Designing site-specific buffers or refugia that effectively protect salamander habitat may be more labor intensive, but may also allow greater flexibility for the land owner.

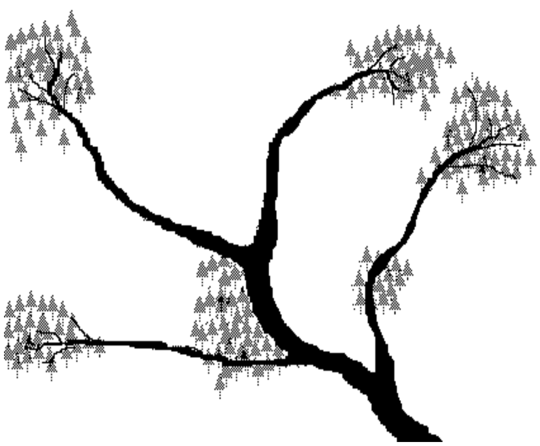


Figure 2. Refugia protecting sensitive areas along headwater streams.

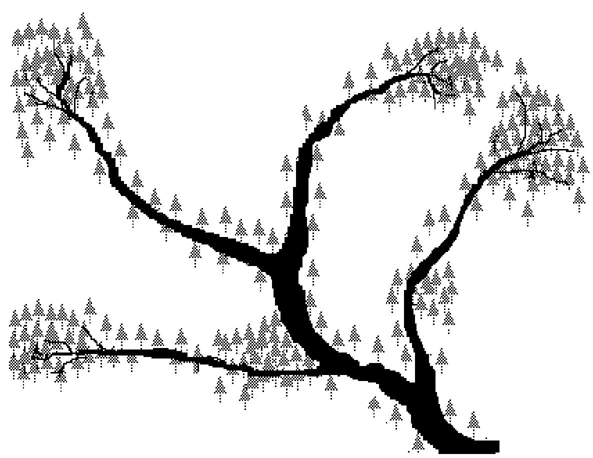


Figure 3. Linear buffers with nodes protecting sensitive areas of headwater streams.

Formulating riparian area protection - The WDFW suggests the following guidelines to protect the riparian features currently thought to be important to Cascade and Columbia torrent salamanders. They are not proven to conserve stream-dwelling or riparian associated amphibians specifically. In the future it may become evident that alternative strategies provide equal or better protection or that certain important habitat features have been overlooked and need to be addressed. At this point in time, an adaptive approach to management aimed at understanding the effects of typical forest management activities on salamanders is encouraged.

Site-specific protection of riparian areas should take into account the physical features of a drainage. These include slope and aspect, geologic history, blowdown potential, and the canopy density and composition over the stream. Buffer distances discussed in the literature for riparian features important to torrent salamanders are summarized in Table 1. These distances are meant to be general guidelines for planners designing site-specific habitat protection. Designing site-specific buffers or refugia should be accomplished with the assistance of WDFW or other professional biologists.

Retain shade - In wet seeps, stream corridors, and riparian areas containing Cascade or Columbia torrent salamanders, shade should be retained so that stable humidity and substrate temperatures are maintained. Leaving understory plants and noncommercial trees in gravel and rock seepage areas during logging operations helps prevent habitat desiccation (Bury et al. 1980), but alone may not be sufficient to maintain required habitat conditions. Distances reported in the literature as providing adequate shade in riparian areas range between 11-30 m (35-100 ft) (Brown and Krygier 1970, Brazier and Brown 1973, Steinblums et al. 1984). Brazier and Brown (1973) found that 60 to 80% shading on stream surfaces controlled stream temperature. They found that to maintain instream temperatures, the maximum shading capability of an average buffer strip was reached within 25 m (82 ft), and 90% of that maximum was reached within 17 m (56 ft).

Retain woody debris - Woody debris should be retained where these salamanders occur. Coarse woody debris should not be removed from streams because it helps prevent erosion and sedimentation. Leaving stream buffers between 30-55 m (100-180 ft) wide ensures long-term woody debris recruitment (Bottom et al. 1983, Harmon et al. 1986, Murphy and Koski 1989, McDade et al. 1990, VanSickle and Gregory 1990).

Control sedimentation - Land use practices contributing to stream sedimentation (both instream and along stream margins) should be avoided. Sediment fills the spaces between rocks where torrent salamanders reside. Substrate composition, and channel and side-slope gradients influence how susceptible a stream is to sedimentation, and should be taken into account when formulating a protection strategy.

- Roads should be located and constructed in a manner that minimizes sedimentation. Road networks in upland areas are a significant source of sediment to aquatic habitats (Ice 1985, Swanson et al. 1987). The construction of new roads within sensitive areas such as riparian areas, seeps, talus, and unstable areas should be avoided except in situations where other roading alternatives would be even more damaging. Refer to the Washington Forest Practice

Rules (Wash. For. Practice Board 1995) for road building specifications.

- Vegetation removal on steep slopes and other unstable areas contributes to sedimentation (Swanson et al. 1987) and should not occur. Stream buffers presented in the literature for controlling sediment range from 30-88 m (100-289 ft) (Erman et al. 1977, Lynch et al. 1985, Terrell and Perfetti 1989, Johnson and Ryba 1992).

Table 1. Summary of stream buffer distances needed to retain riparian features important to Cascade torrent and Columbia torrent salamanders.

Function	Distances	References
shade retention	11-30 m (35-100 ft)	Brown and Krygier 1970, Brazier and Brown 1973, Steinblums et al. 1984
woody debris recruitment	30-55 m (100-180 ft)	Bottom et al. 1983, Harmon et al. 1986, Murphy and Koski 1989, McDade et al. 1990, VanSickle and Gregory 1990
sediment control	30-88 m (100-289 ft)	Erman et al. 1977, Lynch et al. 1985, Terrell and Perfetti 1989, Johnson and Ryba 1992

Standardized buffers - The following recommendations are intended for planners requiring standardized linear buffers suitable for broad application. We do not know precisely how much riparian habitat adjacent to streams is necessary to provide protection for Cascade and Columbia torrent salamanders. Therefore, WDFW suggests retaining the following riparian habitat widths in order to protect riparian features and functions thought to be important to these species. On each side of permanent and intermittent headwater streams (Type 4 and 5 Waters), riparian habitat should be retained that is at least 30 m (100 ft) wide or the distance equal to one site potential tree height, whichever is greater (Erman et al. 1977, Bottom et al. 1983, Steinblums et al. 1984, Budd et al. 1987). Unstable portions of riparian areas should receive additional protection to avoid mass wasting. Based on a recommendation by Cederholm (1994), WDFW recommends protecting unstable portions of riparian areas with an additional 38 m (125 ft), for a total distance of 68 m (225 ft). Any timber harvest within these areas should address the features outlined in the previous section, *Formulating riparian area protection*, and should be planned with the help of a WDFW or other professional biologist.

Whether site-specific or standardized protection is employed in riparian areas, current Forest Practice Regulations provided by the Washington Department of Natural resources should be reviewed, as they are periodically updated to provide for the needs of specific species. In addition, yarding and heavy equipment operation should be avoided within the established no-harvest zones of riparian buffers, except in cases where minimal yarding through these areas prevents excessive roading. Timber should be felled away from streams to avoid damaging trees remaining within buffers (Bury and Corn 1988, Wash. Dept. Nat. Resour. 1996).

Surveys and Collection

The WDFW encourages individuals working in Washington's forests to learn to identify these salamanders and their habitats so that additional populations can be located and protected (Aubry et al. 1987). Within their known ranges, planned timber harvest units and associated drainages should be surveyed for Cascade and Columbia torrent salamanders. Surveys should include downed woody debris, wet rock outcrops, and areas containing gravel or talus that is upslope or adjacent to streams. Before undertaking any intensive survey efforts, particularly those employing traps or that involve the removal of substrate or handling specimens, WDFW should be contacted to determine whether a permit is necessary. Destructive collecting methods, such as tearing apart logs or removing moss from rocks or talus, should be avoided. Disturbed rocks and woody debris should be replaced in their original positions (Bury et al. 1980, Larsen and Schaub 1982, Corkran and Thoms 1996).

RESEARCH NEEDS

Information specific to Columbia and Cascade torrent salamanders in Washington is lacking. The majority of published studies on torrent salamanders and their relationship to forest age and timber harvest have taken place in Oregon and California, and involve the southern torrent salamander.

The extent of Cascade and Columbia torrent salamander populations in Washington needs to be determined.

Variation between each species needs to be examined: ecology, habitat needs and tolerances, breeding habits, and territories (Good and Wake 1992).

What defines the southern edge of the Columbia torrent salamander's range, and how does it relate to the northern edge of the southern torrent salamander's range? Why is there no geographic or genetic overlap between these two species (Good and Wake 1992)?

The potential of these salamanders as biological indicators for the recovery of degraded habitats should be investigated (Good and Wake 1992).

The roles seeps and streams play as habitats throughout the torrent salamander's life cycle should be examined. Seeps upslope of headwaters may provide important nursery habitat (N. Wilkins, pers. comm.).

Do managed forests restrict the torrent salamanders to streams with higher gradients by rendering historically occupied streams at the lower gradients uninhabitable? In Washington, what is the lowest habitable gradient in undisturbed forests versus managed forests?

Do culverts affect the distribution and dispersal of torrent salamanders?

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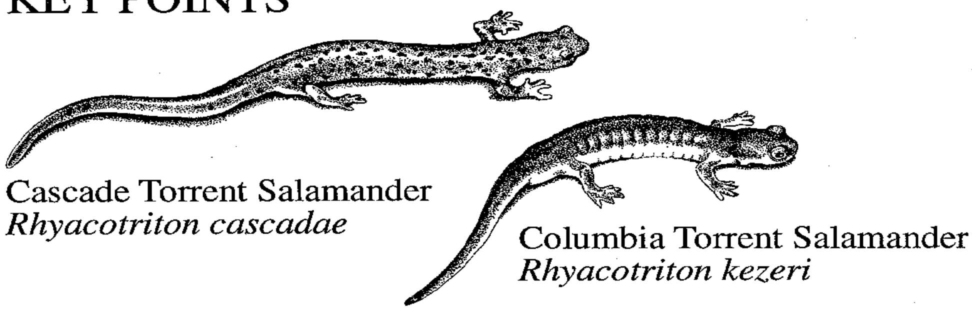
KEY POINTS



Habitat Requirements

- Columbia and Cascade torrent salamanders require cold water.
- These salamanders typically inhabit shady seeps and high gradient streams.
- Loose rock or gravel substrate provides optimal habitat.
- Stream substrate needs to be free of fine, sandy sediments.

Management Recommendations

- Forest management plans should address shade retention over seeps and stream corridors, retaining downed woody debris within stream corridors, and minimizing sedimentation. Plans need to address maintaining source populations of torrent salamanders within drainages for repopulating logged areas once they have stabilized.

- Within the ranges of these species, planned harvest units and associated drainages should be surveyed for Columbia and Cascade torrent salamanders. Surveys should include seeps upslope and adjacent to streams, wet rock outcrops, and stream channels.

- Throughout managed forests within the ranges of these species, stands should be distributed across the landscape so that clearcuts and very young stands are adjacent to older tracts of forest. Uncut areas may help reduce substrate temperature fluctuations and stream sedimentation, and may also provide a source of amphibians for recolonization of clear-cut areas.

- The habitats of torrent salamanders are likely to include many small, non-fish-bearing streams that have little or no required protection under these regulations. Protecting salamander habitat along headwater streams can be accomplished by applying standardized buffers across the landscape, or by designing refugia and/or linear buffers with nodes, on a site-by-site basis.

- Site-specific protection of riparian areas should take into account the physical features of a drainage. These include slope and aspect, geologic history, blowdown potential, and the canopy density and composition over the stream. The following riparian features important to torrent salamanders are presented with buffer distances discussed in the literature. These distances are meant to be general guidelines for planners designing site-specific habitat protection, and are summarized in Table 1. Designing site-specific buffers or refugia should be accomplished with the assistance of a WDFW biologist.

- *Retain shade* - In wet seeps, stream corridors, and riparian areas containing Cascade or Columbia torrent salamanders, shade should be retained so that stable humidity and substrate temperatures are maintained. Leaving understory plants and noncommercial trees in gravel and rock seepage areas during logging operations helps prevent habitat desiccation. Distances reported in the literature as providing adequate shade in riparian areas range between 11-30 m (35-100 ft).

- *Retain woody debris* - Woody debris should be retained where these salamanders occur. Coarse woody debris should not be removed from streams because it helps prevent erosion and sedimentation. Leaving riparian areas between 30-55 m (100-180 ft) wide ensures long-term woody debris recruitment.

- *Control sedimentation* - Land use practices contributing to stream sedimentation should be avoided.
  - Roads should be located and constructed in a manner that minimizes sedimentation. Road networks in upland areas are a significant source of sediment to aquatic habitats. The construction of new roads within sensitive areas such as riparian areas, seeps, talus, and unstable areas should be avoided except in situations where other roading alternatives would be even more damaging. Refer to the Washington Forest Practice Rules for road building specifications.
  - Vegetation removal on steep slopes and other unstable areas contributes to sedimentation and should not occur. Stream buffers presented in the literature for controlling sediment range from 30-88 m (100-289 ft).

Table 1. Summary of stream buffer distances needed to retain riparian features important to Cascade torrent and Columbia torrent salamanders.

Function	Distances	References
shade retention	11-30 m (35-100 ft)	Brown and Krygier 1970, Brazier and Brown 1973, Steinblums et al. 1984
woody debris recruitment	30-55 m (100-180 ft)	Bottom et al. 1983, Harmon et al. 1986, Murphy and Koski 1989, McDade et al. 1990, VanSickle and Gregory 1990
sediment control	30-88 m (100-289 ft)	Erman et al. 1977, Lynch et al. 1985, Terrell and Perfetti 1989, Johnson and Ryba 1992

- The following recommendations are intended for planners requiring standardized linear buffers suitable for broad application. We do not know precisely how much riparian habitat adjacent to streams is necessary to provide protection for Cascade and Columbia torrent salamanders. Therefore, WDFW suggests retaining the following riparian habitat widths in order to protect riparian features and functions thought to be important to these species. On each side of permanent and intermittent headwater streams (Type 4 and 5 Waters), riparian habitat should be retained that is at least 30 m (100 ft) wide or the distance equal to one site potential tree height, whichever is greater. Unstable portions of riparian areas should receive additional protection to avoid mass wasting. Based on a recommendation by Cederholm (1994), WDFW recommends protecting unstable portions of riparian areas with an additional 38 m (125 ft), for a total distance of 68 m (225 ft). Any timber harvest within these areas should address the features outlined in the previous section, *Formulating riparian area protection*, and should be planned with the help of a WDFW or other professional biologist.

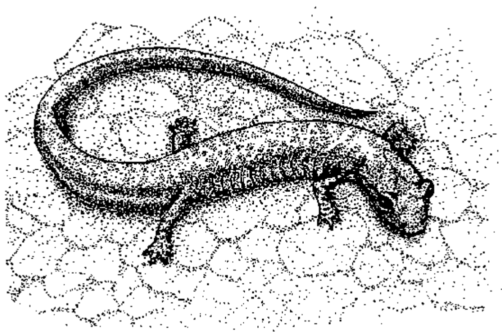
- Whether site-specific or standardized protection is employed in riparian areas, current Forest Practice Regulations provided by the Washington Department of Natural Resources should be reviewed, as they are periodically updated. Additionally, yarding and heavy equipment operation should be avoided within established no-harvest zones, except in cases where minimal yarding through these areas prevents excessive roading. Timber should be felled away from streams to avoid damaging trees remaining within buffers.

- Individuals working in Washington’s forests are encouraged to learn to identify these salamanders and their habitats so that additional populations can be located and protected.

- Within their known ranges, planned timber harvest units and associated drainages should be surveyed for Cascade and Columbia torrent salamanders. Surveys should include downed woody debris, wet rock outcrops, and areas containing gravel or talus that is upslope or adjacent to streams.

- Before undertaking any intensive survey efforts, particularly those employing traps or that involve the removal of substrate or handling specimens, WDFW should be contacted to determine whether a permit is necessary.

- Destructive collecting methods, such as tearing apart logs or removing moss from rocks or talus, should be avoided. Disturbed rocks and woody debris should be replaced in their original positions, and logs taken apart should be pieced together.



Dunn's Salamander
Plethodon dunni

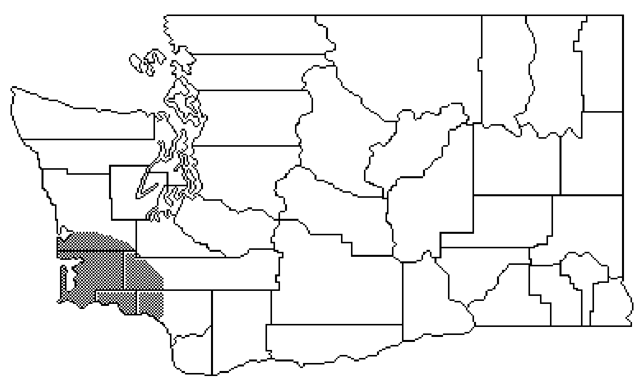
Van Dyke's Salamander
Plethodon vandykei

Prepared by Noelle Nordstrom and Ruth Milner

GENERAL RANGE AND WASHINGTON DISTRIBUTION

Dunn's Salamander

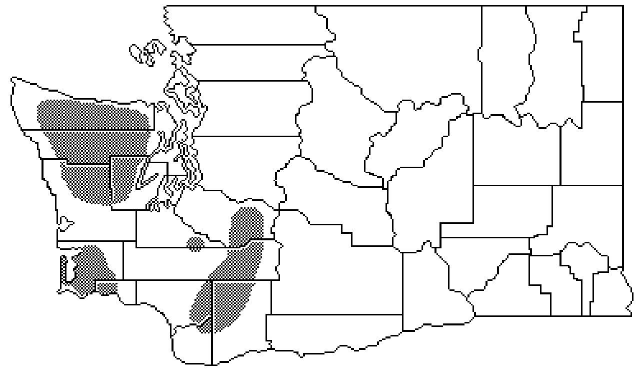
The range of the Dunn's salamander extends from northeastern California to western Oregon and southwestern Washington (Brodie 1970). In Washington they are found only in the Willapa Hills in the southwest corner of the state (Leonard et al.1993, McAllister 1995). This area includes the western edges of Cowlitz and Lewis counties, all of Pacific and Wahkiakum counties, and the southern edge of Gray's Harbor County.



Range of Dunn's salamander, *Plethodon dunni*, in Washington. Map derived from the literature.

Van Dyke's Salamander

Van Dyke's salamanders are endemic to western Washington (Leonard et al. 1993), and their distribution is unusually fragmented compared to other Pacific Northwest *Plethodons* (Brodie 1970, Wilson et al. 1995). Populations of these salamanders occur in the Olympic Mountains in Clallam, Jefferson, Mason, and Grays Harbor counties; the southern Cascade Mountains in Pierce, Lewis, and Skamania counties; and the Willapa Hills in Pacific and Wahkiakum counties (Brodie and Storm 1970; Nussbaum et al. 1983, 1995; Leonard et al. 1993; McAllister 1995).



Range of the Van Dyke's salamander, *Plethodon vandykei*, in Washington. Map derived from the literature.

STATUS

Dunn's and Van Dyke's salamanders are State Candidate species.

RATIONALE

In Washington, populations of Dunn's and Van Dyke's salamanders are small or fragmented. Van Dyke's salamanders are endemic to our region, and the Washington distribution of Dunn's salamander represents the northernmost tip of their range. Amphibian populations are most vulnerable at the margins of their ranges. Fragmentation, narrow habitat tolerances, endemism, and range extremes make species more prone to extinction, especially when they are faced with rapid habitat change or loss (Wassersug 1992, Dobson et al. 1997, Pulliam and Babbit 1997).

HABITAT REQUIREMENTS

Salamanders of the genus *Plethodon* are considered forest-dwelling salamanders. Dunn's and Van Dyke's salamanders inhabit cool, moist habitats in forested areas. The forest canopy maintains the microclimactic stability required by these salamanders.

Dunn's Salamander

Dunn's salamanders are found in forested areas from sea level to 1,006 m (3,300 ft). Both juveniles and adults inhabit wet, rocky substrates that are heavily shaded, including wet talus slopes, seepages, and stream borders (Leonard et al. 1993, Corkran and Thoms 1996). During periods of high humidity, these salamanders can tolerate moist as opposed to wet substrates and may be found some distance from wet locations (Dumas 1956). Though usually associated with rock, Dunn's salamanders also use downed logs and woody debris for cover and feeding (Leonard et al. 1993, Corkran and Thoms 1996). In these situations, the ground is usually covered with several inches of duff (Dumas 1956, Nussbaum et al. 1983).

Dunn's salamanders do not live in flowing water (Corkran and Thoms 1996), though Gomez and Anthony (1996) found them more often in riparian than upslope areas, and consider them to be riparian associates. Stebbins (1951) found Dunn's salamanders occurring in soils that were moist but not saturated, with daytime soil temperatures ranging from 7-11 C (45-52°F). Dumas (1956) found the mean temperature of forested sites with Dunn's salamanders was 10.4 C (50°F) and the mean humidity was 92.4%.

Van Dyke's Salamander

Of all the western salamanders, Van Dyke's are one of the least studied, and factors that influence their occurrences are not well understood (Jones 1989, Wilson et al. 1995). Information on habitat conditions represent a sampling of sites where these salamanders have been found, and may not represent the full range of conditions they will occupy. Van Dyke's salamanders inhabit rocky seeps and stream banks or moist, north-facing rocky habitats in forested areas from sea level to 1,097 m (3,600 ft) (Leonard et al. 1993, Corkran and Thoms 1996). They have been found in areas with an average annual precipitation of at least 150 cm (59 in) (Wilson et al. 1995). Stebbins (1951) found Van Dyke's salamanders at a site with a soil temperature of 6 C (43°F).

Both juveniles and adults inhabit the splash zones of streams where they can be found under cobbles and woody debris and in cracks in rock faces. Though typically found along stream margins, Van Dyke's salamanders have been found far from water on moss-covered talus slopes and fractured rock outcrops with northerly exposures (Leonard et al. 1993, Corkran and Thoms 1996). Aubry et al. (1987) found Van Dyke's salamanders among loose rocks on the moist floor of a lava tube near Mount St. Helens.

This species is also associated to some degree with riparian habitats in mature and old-growth coniferous forests (Jones and Atkinson 1989) where they are thought to use downed logs (Jones 1989, Jones and Atkinson 1989). At several sites near the Washington coast, Wilson et al. (1995) found Van Dyke's salamanders associated with large wood fragments on deep soil, well removed from any rocky substrates. At all other sites, they found Van Dyke's salamanders near rock outcrops or accumulations of rock downslope from steep embankments.

Jones (1989) found ten Van Dyke's salamanders and an egg mass of this species in a mature forest in Mason County Washington. The eggs and all but one salamander were found in or under large logs near a small headwater stream. The temperature of the nest cavity containing eggs was 11 C (52°F), while the air temperature near the creek was 29 C (84°F). The nest was located on a 14° slope facing NNE. None of these salamanders were found within the splash zone of the creek or in the talus seep where the creek originated.

LIMITING FACTORS

Dunn's and Van Dyke's salamanders depend on moist, well-shaded substrates with stable microclimates. Human activities impacting these salamanders are related primarily to timber management. The habitats of Dunn's and Van Dyke's salamanders are likely to include many streamsides that are not used by significant numbers of resident fish. Under current Washington Forest Practice Rules, non-fish bearing streams typically receive little or no protection in the form of riparian buffers unless they are located in unstable areas.

Though it is unknown to what degree specimen collecting impacts salamander populations, locating specimens by disturbing or destroying habitat features may have some localized negative effects on Dunn's and Van Dyke's salamanders.

Dunn's Salamander

Consistently cool temperatures and high humidity are the environmental conditions most important to Dunn's salamanders (Dumas 1956), and they are more easily met in mature to old-growth forests than in younger forests (Welsh 1990). In a study of headwater streams in the Coast Range of Oregon, Corn and Bury (1989) found that Dunn's salamanders occurred more often in forests that were more than 60 years old than in forests younger than 40 years.

Habitat disturbances that increase substrate temperatures and decrease moisture are detrimental to populations of Dunn's salamanders (Gomez and Anthony 1996). Forest practices can remove the canopy that maintains a cool microclimate, and may disturb the substrate in which this species lives. Timber harvest can increase water and soil temperatures and exacerbates temperature fluctuations (Chen et al. 1993, 1995; Bury 1983). Higher temperatures increase evaporation from the soil and understory (Bury 1983).

Brown and Krygier (1970) compared temperatures of small, fish-bearing streams in two watersheds of Oregon's Coast Range one year after timber harvest. In the watershed that was clearcut without retaining stream buffers, the average maximum water temperature increased nearly 8 C (14°F). The annual maximum temperature increased from just below 14 C (57°F) before clearcutting, to almost 30 C (85°F), after clearcutting. In a nearby watershed where buffers at least 30.5 m (100 ft) wide were retained, no temperature changes occurred that could be attributed directly to clear-cutting.

Van Dyke's Salamander

Van Dyke's salamanders are rare in regions underlaid by unconsolidated deposits such as glacial outwash (Wilson et al. 1995). Occurrences of Van Dyke's salamanders in coastal areas with a sedimentary geologic history could be due to the stable maritime climate and the species' ability to use woody debris. (Jones 1989, Jones and Atkinson 1989). Washington's geologic history may have played a part in determining the distribution of this salamander.

Clearcutting has the potential to eliminate populations of Van Dyke's salamanders where woody debris is the primary source of shelter and nesting sites, and may have contributed to fragmenting populations along the coast (Wilson et al. 1995). On a larger scale, rapid timber harvest of the lowlands between the three population centers of Van Dyke's salamanders may have exacerbated their isolation (Wilson et al. 1995).

The restricted occurrence of the Van Dyke's salamander suggests it has relatively sedentary habits and narrow ecological tolerances. These two factors can limit a species' ability to survive or colonize disturbed habitats, which may put the Van Dyke's salamander at risk in managed forests (Dumas 1956, Wilson et al. 1995). N. Wilkins (pers. comm.), however, notes that some location data for this salamander come from second growth forests that are 30-60 years old, suggesting this species has some ability to persist within or recolonize disturbed habitats. How disturbance type or method of timber harvest may affect persistence of, or recolonization by Van Dyke's salamanders is unknown.

MANAGEMENT RECOMMENDATIONS

We do not know for certain what management actions will ensure adequate protection of these salamanders in Washington. At this time, the best that can be done is to protect the habitat features with which Dunn's and Van Dyke's salamanders are most commonly associated. In areas where Dunn's and Van Dyke's salamanders occur, forest management should be conducted so that impacts to their habitats are minimized. Measures to protect riparian areas and moist talus should be employed throughout the ranges of these salamanders. Forest management plans should address shade retention over seeps, stream corridors, and talus; retaining downed woody debris of all size and decay classes; minimizing stream sedimentation; and avoiding the disturbance of rocky habitat areas, such as moss- and duff-covered talus.

Throughout managed forests within the ranges of these species, stands should be distributed across the landscape so that clearcuts and very young stands are adjacent to older tracts of forest. Bury and Corn (1988) found that when Dunn's salamanders occurred in logged areas, they were more common in areas near mature forest than in logged areas far from uncut timber. Uncut areas may help reduce substrate temperature fluctuations and stream sedimentation, and may also provide a source of amphibians for recolonization of clear-cut areas. Gomez and Anthony (1996) suggested that maintaining some mature coniferous timber in riparian areas would benefit Dunn's salamanders in managed areas of the Oregon coast. Careful harvest scheduling that retains mature stands in and adjacent to riparian areas can compliment planned riparian protection.

Riparian Areas

Protected riparian areas along headwater streams help ensure relatively stable moisture regimes and increased erosion protection for Dunn's and Van Dyke's salamanders, as well as for other amphibian species (Welsh 1990). Riparian and instream protection is usually achieved by retaining a linear buffer on each side of a watercourse, and is required by state regulations along all fish-bearing streams and rivers in Washington. The habitats of Dunn's and Van Dyke's salamanders however, are likely to include many small, non-fish-bearing streams that require little or no protection under these regulations. Protecting salamander habitat along headwater streams may be accomplished by applying standardized buffers across the landscape (the widths of these sometimes vary according to the topography) (Fig. 1), or by designing refugia (Fig. 2) and/or linear buffers with nodes (areas where the buffer width expands to encompass high quality habitat as well as to negotiate the topography) (Fig. 3) on a site by site basis. Refugia are discontinuous, protected portions along a stream corridor that would otherwise receive no protection. Because these salamanders have small home ranges, relatively small patches of high quality riparian habitat within refugia may contain viable populations, and may be able to support salamander populations until the surrounding landscape recovers from timber harvest. In some situations, refugia along small streams in the form of discontinuous clumps of trees large enough to contain all of the habitat components these salamanders require, may be a viable alternative to leaving a continuous, narrow strip of marginal riparian habitat (Bury and Corn 1988). Whether standardized linear buffers, refugia, or customized linear buffers with nodes are used along a stream depends on which species are present and in what landscape/land-use arena the buffers will be used. Adopting standardized buffers is an efficient, predictable, low risk method for protecting riparian habitat. Designing

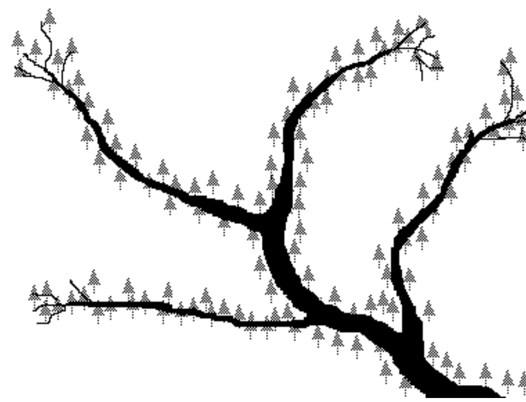


Figure 1. Linear buffers along headwater streams.

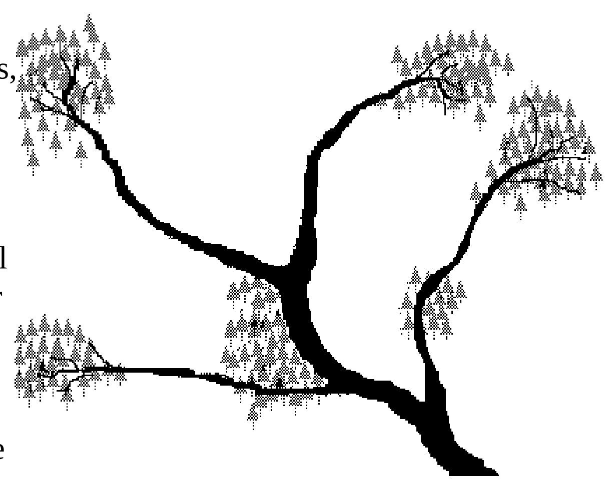


Figure 2. Refugia protecting sensitive areas of headwater streams.

site-specific buffers or refugia that effectively protect salamander habitat may be more labor intensive, but may allow greater flexibility for the land owner.

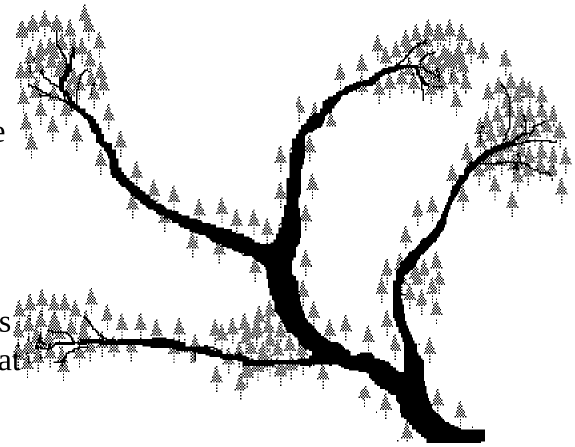


Figure 3. Linear buffers with nodes protecting sensitive areas of headwater streams.

Formulating riparian area protection -
The Washington Department of Fish and Wildlife (WDFW) suggests the following guidelines for protecting the riparian features currently thought to be important to Dunn's and Van Dyke's salamanders. They are not proven to conserve stream-dwelling or riparian associated amphibians specifically. In the future it may come to light that alternative strategies provide equal or better protection, or that certain upland features have been overlooked as important habitat components. At this point in time, the WDFW encourages an adaptive management approach aimed at understanding the effects of forest management activities on salamanders.

The WDFW suggests the following for maintaining habitat features important to Dunn's and Van Dyke's salamanders. Site-specific protection of riparian areas should take into account the physical features of a drainage, including slope and aspect, geologic history, blowdown potential, and canopy density and composition over the stream. Buffer distances discussed in the literature for riparian features important to Dunn's and Van Dyke's salamanders are summarized in Table 1. These distances are meant to be general guidelines for planners designing site-specific habitat protection. Designing site-specific buffers or refugia should be accomplished with the assistance of WDFW or other professional biologists.

Retain shade - In wet seeps, stream corridors, and riparian areas, shade should be retained so that stable humidity and substrate temperatures are maintained. In undisturbed situations, these salamanders have been found at temperatures up to 11 C (52°F). Leaving understory plants and noncommercial trees in gravel and rock seepage areas during logging operations helps prevent habitat desiccation (Bury et al. 1980), but alone may not be sufficient to maintain required habitat conditions. Distances reported in the literature as providing adequate shade in riparian areas range between 11-30 m (35-100 ft) (Brown and Krygier 1970, Brazier and Brown 1973, Steinblums et al. 1984). Brazier and Brown (1973) found that 60-80% shading on stream surfaces is needed to maintain a stream's water temperature. They found that for maintaining instream temperatures, the maximum shading capability of an average buffer strip was reached within 25 m (82 ft), and 90% of that maximum was reached within 17 m (56 ft).

Retain woody debris - Woody debris of all size and decay classes should be retained where these salamanders occur. Removing dead and downed woody debris alters the moist micro-habitat and eliminates habitat structures used by Dunn's and Van Dyke's salamanders. Where logging occurs, a minimum of 5 uncharred hard logs at least 30 cm (12 in) in diameter and 7 m (23 ft) long per hectare (2.5 acres) should be retained, as should all soft logs of the same size (Bartels et al. 1985). Coarse woody debris should not be removed from streams because it helps prevent erosion and sedimentation. Leaving stream buffers between 30-55 m (100-180 ft) wide ensures long-term woody debris recruitment (Bottom et al. 1983, Harmon et al. 1986, Murphy and Koski 1989, McDade et al. 1990, VanSickle and Gregory 1990).

Control sedimentation - Land use practices contributing to stream sedimentation (both instream and stream margins) should be avoided. Sediment fills the spaces between rocks where Dunn's and Van Dyke's salamanders reside. Substrate composition, and channel and side-slope gradients influence how susceptible a stream is to sedimentation, and should be taken into account when formulating a protection strategy.

- Roads should be located and constructed in a manner that minimizes sedimentation. Road networks in upland areas are a significant source of sediment to aquatic habitats (Ice 1985, Swanson et al. 1987). The construction of new roads within sensitive areas such as riparian areas, seeps, talus, and unstable areas should be avoided except in situations where other roading alternatives would be even more damaging. Refer to the Washington Forest Practice Rules (Wash. For. Practice Board 1995) for road building specifications.
- Vegetation removal on steep slopes and other unstable areas contributes to sedimentation (Swanson et al. 1987) and should not occur. Stream buffers presented in the literature for controlling sediment range from 30-88 m (100-289 ft) (Erman et al. 1977, Lynch et al. 1985, Terrell and Perfetti 1989, Johnson and Ryba 1992).

Table 1. Summary of stream buffer distances needed to retain riparian features important to Dunn's and Van Dyke's salamanders.

Function	Distances	References
shade retention	11-30 m (35-100 ft)	Brown and Krygier 1970, Brazier and Brown 1973, Steinblums et al. 1984
woody debris recruitment	30-55 m (100-180 ft)	Bottom et al. 1983, Harmon et al. 1986, Murphy and Koski 1989, McDade et al. 1990, VanSickle and Gregory 1990
sediment control	30-88 m (100-289 ft)	Erman et al. 1977, Lynch et al. 1985, Terrell and Perfetti 1989, Johnson and Ryba 1992

Standardized buffers - The following recommendations are intended for planners requiring standardized linear buffers suitable for broad application. We do not know precisely how much riparian habitat adjacent to streams is necessary to provide protection for Dunn's and Van Dyke's salamanders. Therefore, WDFW suggests retaining the following riparian habitat widths in order to protect riparian features and functions thought to be important to these species. On each side of permanent and intermittent headwater streams (Type 4 and 5 Waters), riparian habitat should be retained that is at least 30 m (100 ft) wide or the distance equal to one site potential tree height, whichever is greater (Erman et al. 1977, Bottom et al. 1983, Steinblums et al. 1984, Budd et al. 1987). Unstable portions of riparian areas should receive additional protection to avoid mass wasting. Based on a recommendation by Cederholm (1994), WDFW recommends protecting unstable portions of riparian areas with an additional 38 m (125 ft), for a total distance of 68 m (225 ft). Any timber harvest within these areas should address the features outlined in the previous section, *Formulating riparian area protection,* and should be planned with the help of a WDFW or other professional biologist.

Whether site-specific or standardized protection is employed in riparian areas, yarding and heavy equipment operation should be avoided within the established no-harvest zones of riparian buffers, except in cases where minimal yarding through these areas prevents excessive roading. Timber should be felled away from streams to avoid damaging trees remaining within buffers (Bury and Corn 1988, Wash. Dept. Nat. Resour. 1996).

Talus

Talus slopes are sometimes used by Dunn's and Van Dyke's salamanders. Logging and development on talus slopes inhabited by these salamanders should not occur (Bury et al. 1980). Operations occurring near forested or open talus should be designed and carried out in a way that avoids its disturbance. Dragging logs or operating heavy machinery across talus should be avoided (Herrington and Larsen 1985).

When timber harvest or other land use activities occur adjacent to occupied talus slopes, a border of trees should be retained along the periphery of the talus fields. Shade and downed slash should be retained as much as possible to help keep the ground cool and moist (Bury et al. 1980). Leaving an uncut zone helps maintain populations of these salamanders in logged areas. Herrington and Larsen (1985) recommend a buffer of 30-50 m (98-164 ft) along the perimeter of talus fields. Isolated patches of trees growing within talus slopes should be left undisturbed (Herrington and Larsen 1985). Gravel required for road construction and maintenance or other uses should be acquired from sources other than the talus supporting populations of Dunn's or Van Dyke's salamanders. Moss- and duff-covered talus within the ranges of these species should be considered occupied until surveys show otherwise.

Surveys and Collection

The WDFW encourages individuals working in Washington's forests to learn to identify these salamanders and their habitats so that additional populations can be located and protected (Aubry et al. 1987). Within their known ranges, planned timber harvest units and associated drainages should be surveyed for Dunn's and Van Dyke's salamanders. Surveys should include downed woody debris, wet rock outcrops, and areas containing gravel or talus that is upslope or adjacent to streams. Before undertaking any intensive survey efforts, particularly those employing traps or that involve the removal of substrate or handling specimens, WDFW should be contacted to determine whether a permit is necessary.

Destructive collecting methods, such as tearing apart logs or removing moss from rocks or talus, should be avoided. Disturbed rocks and woody debris should be replaced in their original positions, and logs taken apart should be pieced together (Bury et al. 1980, Larsen and Schaub 1982, Corkran and Thoms 1996).

RESEARCH NEEDS

Research on the distribution and habitat requirements of these species should continue.

Research on the effects of typical forest management activities, as well as experimental or "low impact" techniques on these and other forest-dwelling salamanders should be conducted in Washington.

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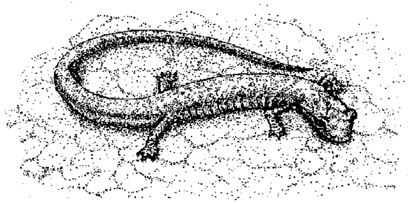
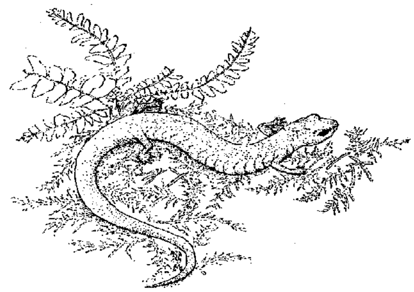
KEY POINTS



Dunn's Salamander
Plethodon dunni



Van Dyke's Salamander
Plethodon vandykei

Habitat Requirements

- Dunn's and Van Dyke's salamanders require moist, shady habitats with cool temperatures and high humidity.
- A sufficient overstory is needed to maintain microclimactic stability.
- Dunn's salamander inhabits wet, heavily shaded, rocky substrates in forested sites from sea level to 1,006 m (3,300 ft). It is most often associated with riparian areas but has also been found in talus with high humidity.
- Van Dyke's salamander is found in wet talus and forest litter from sea level to 1,097m (3,600 ft). It is found in both riparian and upland habitats, but occurs most often within the splash zones of streams.

Management Recommendations

- Harvest plans should minimize impacts to salamander habitat by addressing shade retention over stream corridors and talus slopes, retaining downed woody debris of all size and decay classes, and avoiding the disturbance of important rocky habitat areas, such as moss- and duff-covered talus slopes.
- In managed forests, uneven aged stands should be promoted across the ranges of these species. Uncut areas may help reduce temperature fluctuations and sedimentation, and may also provide a source of amphibians for recolonization of clear-cut areas.
- In wet seeps, stream corridors, and riparian areas containing Dunn's and Van Dyke's salamanders, shade should be retained to maintain stable humidity and substrate temperatures no higher than 11 C (52°F). Leaving understory plants and noncommercial trees in gravel and rock seepage areas during logging operations helps prevent habitat desiccation. Sixty to 80% shading on stream surfaces is needed for temperature control. Distances reported in the literature as providing adequate shade ranged between 11-30 m (35-100 ft).

- Woody debris of all size and decay classes should be retained. Removing dead and downed woody debris alters the moist micro-habitat used by Dunn's and Van Dyke's salamanders and should be avoided where these salamanders are found. Where logging occurs, a minimum of 5 uncharred hard logs at least 30 cm (12 in) in diameter and 7 m (23 ft) long per hectare (2.5 acres) should be retained, as should all soft logs of the same size. Coarse woody debris should not be removed from streams because it helps prevent erosion and sedimentation. Stream buffers between 30-55 m (100-180 ft) wide ensure long-term woody debris recruitment in riparian areas.

- Land-use practices contributing to stream sedimentation should be avoided. A stream's substrate composition, and channel and side-slope gradients influence how susceptible it is to sedimentation, and should be taken into account when formulating a protection strategy.
  - Road networks in upland areas are a significant source of sediment to aquatic habitats. Roads should be located and constructed in a manner that minimizes sedimentation. Refer to the Washington Forest Practice Rules for road building specifications.
  - Vegetation removal on steep slopes and other unstable areas contributes to sedimentation, and should not occur. Stream buffers presented in the literature for controlling sediment range from 30-88m (100-289 ft).

Table 1. Summary of stream buffer distances needed to retain riparian features important to Dunn's and Van Dyke's salamanders.

Function	Distances	References
shade retention	11-30 m (35-100 ft)	Brown and Krygier 1970, Brazier and Brown 1973, Steinblums et al. 1984
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sediment control	30-88 m (100-289 ft)	Erman et al. 1977, Lynch et al. 1985, Terrell and Perfetti 1989, Johnson and Ryba 1992

- The following recommendations are intended for planners requiring standardized linear buffers suitable for broad application. We do not know precisely how much riparian habitat adjacent to streams is necessary to provide protection for Dunn's and Van Dyke's salamanders. Therefore, WDFW suggests retaining the following riparian habitat widths in order to protect riparian features and functions thought to be important to these species. On each side of permanent and intermittent headwater streams (Type 4 and 5 Waters), riparian habitat should be retained that is at least 30 m (100 ft) wide or the distance equal to one site potential tree height, whichever is greater (Erman et al. 1977, Bottom et al. 1983, Steinblums et al. 1984, Budd et al. 1987). Unstable portions of riparian areas should receive additional protection to avoid mass wasting. Based on a recommendation by Cederholm (1994), WDFW recommends protecting unstable portions of riparian areas with an additional 38 m (125 ft), for a total distance of 68 m (225 ft). Any timber harvest within these areas should address the features outlined in the previous section, *Formulating riparian area protection*, and should be planned with the help of a WDFW or other professional biologist.

- Yarding and heavy equipment operation should not occur within established no-harvest zones, and timber should be felled away from streams to avoid damaging trees remaining within buffers.

- Logging and development on talus slopes inhabited by Dunn's and Van Dyke's salamanders should not occur. Moss- and duff-covered talus within the ranges of these salamanders should be considered occupied until surveys show otherwise. Operations occurring near talus should be designed and carried out in a way that avoids its disturbance. Dragging logs or operating heavy machinery across talus should not occur.

- When timber harvest or other land use activities occur adjacent to occupied talus slopes, a border of trees should be retained along the periphery of the talus fields. As much shade and downed slash should be retained as possible to help keep the ground cool and moist. Leaving an uncut zone 30-50 m (98-164 ft) wide helps maintain populations of these salamanders in logged areas.

- Isolated patches of trees growing within talus slopes should be left undisturbed.

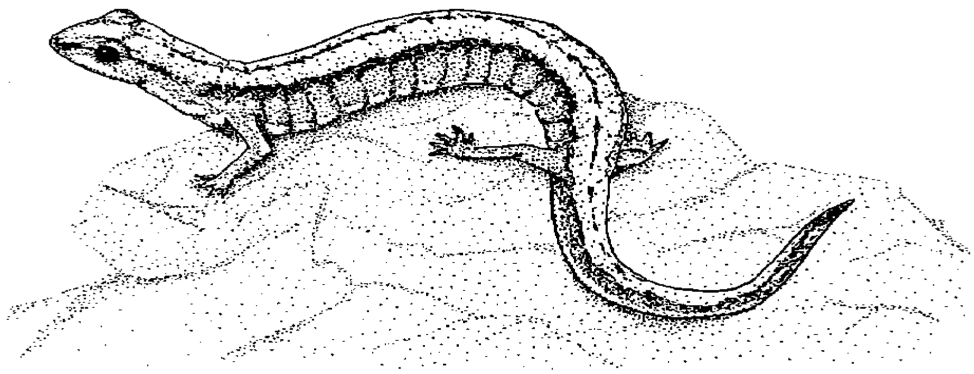
- Gravel required for road construction and maintenance or other uses should be acquired from sources other than the talus supporting populations of Dunn's or Van Dyke's salamanders.

- People working in forested areas of Washington should learn to identify these salamanders and their habitats so that additional populations can be located and protected.

- Within their known ranges, planned harvest units and associated drainages should be surveyed for Dunn's and Van Dyke's salamanders. Surveys should include downed woody debris, wet rock outcrops, and areas containing gravel or talus that is upslope or adjacent to streams.

- Avoid destructive collecting methods such as tearing apart logs or removing moss from rocks or talus. When searching for amphibians, replace disturbed rocks and woody debris in their original positions, and piece together logs that have been taken apart.

- Before undertaking any intensive survey efforts involving these salamanders, contact WDFW to determine whether a permit is necessary.

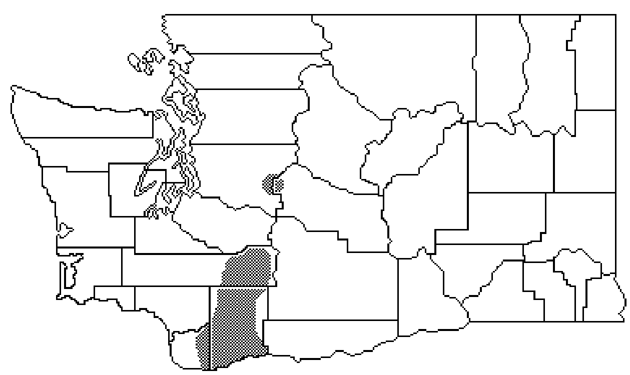


Larch Mountain Salamander
Plethodon larselli

Prepared by Noelle Nordstrom and Ruth Milner

GENERAL RANGE AND WASHINGTON DISTRIBUTION

The Larch Mountain salamander occurs only in Washington and Oregon. Its range is long and narrow, with the southernmost edge roughly defined by the towns of Hood River and Troutdale, Oregon. The range extends northward from the lower Columbia River gorge into the central Cascade Range of Washington (Nussbaum et al. 1983, Aubry et al. 1987, Leonard et al. 1993, McAllister 1995, Corkran and Thoms 1996). Larch Mountain salamanders have been found from sea level to 1,200 m (3,937 ft) throughout their range (Herrington and Larsen 1985, Corkran and Thoms 1996).



Range of the Larch Mountain salamander, *Plethodon larselli*, in Washington. Map derived from the literature.

In Washington, this salamander occurs from the Washougal River basin in Skamania County, eastward to the Klickitat River in Klickitat County. Its range extends north to the vicinity of Snoqualmie Pass, where two isolated populations have been found (K. McAllister, pers. comm.). A disjunct population has also been found inside a lava tube cave within the Mount St. Helen National Volcanic Monument (Aubry et al. 1987).

STATUS

The Larch Mountain salamander is a State Listed Sensitive species.

RATIONALE

In Washington, populations of Larch Mountain salamanders are small, isolated, and occur in a limited area. The habitats where they are found are naturally discontinuous, and vulnerable to human activities such as timber harvest, road building, and commercial and residential development. Larch Mountain salamanders are endemic to our region, which may make them more prone to extinction (Dobson et al. 1997, Pulliam and Babbit 1997).

HABITAT REQUIREMENTS

Larch Mountain salamanders depend on cool, moist environments. Nearly all populations of these salamanders have been found on steep talus slopes in forested areas, though they have also been found on steep slopes in old-growth forests, under woody debris on the forest floor or in piles of detritus beneath snags (Corkran and Thoms 1996). Aubry et al. (1987) found two specimens under rocks at a lava tube entrance. Larch Mountain salamanders may be the most terrestrial of the western *Plethodon* salamanders, and are usually found some distance from streams (Brodie 1970).

In talus areas, a suitable combination of slope, rock size, shade, and organic debris must occur to provide habitat for Larch Mountain salamanders. There may be only a small portion of any given talus field where all required conditions are present. These salamanders have been found within the top 30 cm (12 in) of talus where substrate temperatures ranged between 5.0 C and 14.5 C (41-58°F) and moisture values averaged between 35% and 64%. Increased temperatures and reduced moisture during summer months may cause the salamanders to retreat deeper into the talus (Herrington and Larsen 1985). Most talus slopes known to be occupied by Larch Mountain salamanders have a mixed overstory of bigleaf maple (*Acer macrophyllum*), Douglas-fir (*Pseudotsuga menziesii*), and sometimes Oregon ash (*Fraxinus oregona*) (Larsen and Schaub 1982, Herrington and Larsen 1985). Suitable talus generally consists of rocks with a diameter of 1-6 cm (0.4-2.4 in), contains large quantities of decaying plant matter and small amounts of soil, and is often covered by a layer of moss (Herrington and Larsen 1985, Corkran and Thoms 1996). Organic matter is important for sustaining the salamander's invertebrate prey base and for maintaining moisture within the talus. Herrington and Larsen (1985) found that sites with all habitat requirements except organic debris lacked salamanders, and that over half the sites they found with Larch Mountain salamanders had substrates that contained less than 10% soil. Most inhabited sites had a slope greater than 30°. Too much soil, the accumulation of which is influenced by slope, may inhibit the salamander's ability to move through talus. Only one specimen has been located at a site where the substrate consisted of dry mineral soil with little organic material, and no adjacent exposed talus slopes (Aubrey et al. 1987).

LIMITING FACTORS

This salamander is sedentary, and its dependance on a cool, moist environment may hinder dispersal to some degree. Colonization of suitable, unoccupied habitat may be difficult if it is a significant distance from where Larch Mountain salamander populations currently occur (Dumas 1956). The Larch Mountain salamander exists in isolated pockets, and evidence suggests there is probably little to no gene flow between populations. Its habitat requirements make it poorly equipped to adapt to the rapidly changing environmental conditions that often result from human land-use activities (Wash. Dept. Wildl. 1993).

Larch Mountain salamanders depend on the availability of undisturbed, shaded talus slopes with stable, moist microclimates. Human activities affecting these salamanders are related to forest practices, residential development, talus removal, and commercial and recreational activities (Herrington and Larsen 1985). Though it is unknown to what degree salamander populations are impacted by specimen collection, it can be surmised that locating specimens by disturbing or destroying habitat features may have some negative effect.

Few talus fields within this salamander's range remain undisturbed. Herrington (1988) surveyed 183 talus slopes in Washington and Oregon and found that almost 60% had been altered by talus removal and/or deforestation. Talus slopes are often used as a source for road building material, which can be problematic because removing material causes the talus field to shift to the base of the slope. Erosion and siltation of the talus often follow, which inhibits the salamander's movements between the rocks (Harrington and Larsen 1985). Removing the forest overstory that helps maintain a stable microclimate can also make talus uninhabitable. Herrington and Larsen (1985) studied a site where half a talus field was clearcut, while the other half retained a mature forest canopy. Larch Mountain salamanders did not inhabit the clearcut portion, but maintained stable numbers in the forested area.

Larch Mountain salamander populations found in caves may consist of very few individuals isolated from adjacent populations for a long period, and may be particularly vulnerable to habitat disturbance (Aubrey et al. 1987).

MANAGEMENT RECOMMENDATIONS

Talus slopes are the primary habitat of the Larch Mountain salamander and are also occasionally used by Dunn's and Van Dyke's salamanders. Logging and development should be avoided on talus slopes occupied by Larch Mountain salamanders (Bury et al. 1980).
When timber harvest or any other land use activity occurs near Larch Mountain salamander populations, a border of trees should be retained along the periphery of the talus fields. Leaving an uncut zone helps maintain populations of these salamanders in logged areas. Herrington and Larsen (1985) recommend a buffer of 30-50 m (98-164 ft). Where logging occurs near talus slopes, retain as much shade and downed slash as possible to help keep the ground cool and moist (Bury et al. 1980).

In areas where this salamander occurs, timber harvest and other land uses should be conducted so that important habitat features are retained. Building and development should be designed and carried out in a way that avoids disturbing talus. Logs should not be dragged across talus, and heavy machinery should be kept off talus (Herrington and Larsen 1985). Logs should be fully suspended when yarding timber over talus. Isolated patches of trees growing within talus slopes should be left undisturbed (Herrington and Larsen 1985). Gravel required for road construction and maintenance or other uses should be acquired from sources other than the talus supporting populations of Larch Mountain salamanders. Unsurveyed talus slopes within the known range of the Larch Mountain salamander that appear to contain suitable habitat should be protected until it is shown that they are unoccupied by this species.

Where Larch Mountain salamanders occur on steep, forested slopes, downed woody debris of all size and decay classes should be retained. The Washington Department of Fish and Wildlife (WDFW) suggests employing no harvest or partial harvest zones on forested slopes where Larch Mountain salamanders occur. These zones should be designed with the help of WDFW or other professional biologists.

Human access to caves where Larch Mountain salamanders occur should be restricted. Aubrey et al. (1987) suggest it is likely that the population found in the lava tube consists of few individuals, which make them especially vulnerable to extirpation. Individuals working in forested areas of the central and southern portions of Washington's Cascade range should learn to identify Larch Mountain salamanders and their habitats so that additional populations can be located and protected (Aubrey et al. 1987). Within the known range of the Larch Mountain salamander, planned timber harvest units and associated drainages should be surveyed for Larch Mountain salamanders. Surveys should include downed woody debris on steep slopes, debris piles beneath standing snags, rock outcrops, and areas containing gravel or talus that is upslope or adjacent to streams. Surveys should also include talus that is not near any immediate source of water.

Before undertaking any intensive survey efforts, particularly those employing traps or that involve the removal of substrate or handling specimens, WDFW should be contacted to determine whether a permit is necessary. When searching for amphibians, disturbed rocks and woody debris should be replaced in their original positions, and logs taken apart should be pieced together (Corkran and Thoms 1996). Destructive collecting methods, such as tearing apart logs or removing moss from rocks or talus, should be avoided (Bury et al. 1980, Larsen and Schaub 1982).

RESEARCH NEEDS

The effectiveness of current survey techniques used to locate Larch Mountain salamanders needs to be assessed.

More specific information is needed on Larch Mountain salamander habitat in forested areas where talus is absent.

Better characterization of areas where Larch Mountain salamanders do not occur is needed.

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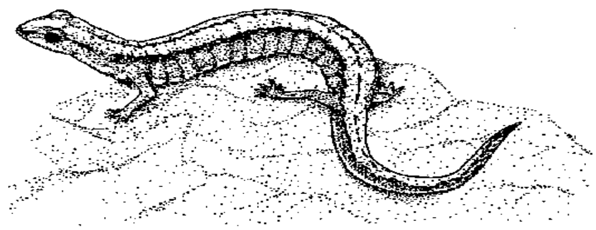
KEY POINTS



Larch Mountain Salamander
Plethodon larselli

Habitat Requirements

- Larch Mountain salamanders require moist, shady talus with cool temperatures and high humidity. They are most often found on slopes greater than 30°. They have been found within the top 30 cm (12 in) of talus where substrate temperatures ranged between 5 C and 14.5 C (41-58°F) and moisture values averaged between 35% and 64%.

- This salamander has also been found under woody debris on steep, forested slopes.

- Substrates inhabited by Larch Mountain salamanders usually contain large quantities of organic debris and very little mineral soil (<10%).

- Talus slopes inhabited by Larch Mountain salamanders usually have a dense overstory consisting of Douglas-fir, big-leaf maple and occasionally Oregon ash. These salamanders are most frequently found in upland habitats from 50 - 1,250 m (165 - 4,100 ft), and are not considered riparian associates.

Management Recommendations

- Individuals working in forested areas of the central and southern portions of Washington's Cascade range should learn to identify Larch Mountain salamanders and their habitats so that additional populations can be located and protected.

- Within the known range of the Larch Mountain salamander, planned timber harvest units and associated drainages should be surveyed for Larch Mountain salamanders. Surveys should include downed woody debris on steep slopes, debris piles beneath standing snags, rock outcrops, and areas containing gravel or talus that is upslope or adjacent to streams. Surveys should also include talus that is not near any immediate source of water.

- Before undertaking any intensive survey efforts, particularly those employing traps or that involve the removal of substrate or handling specimens, WDFW should be contacted to determine whether a permit is necessary.

- When searching for amphibians, disturbed rocks and woody debris should be replaced in their original positions. Destructive collecting methods, such as tearing apart logs or removing moss from rocks or talus, should be avoided.

- Timber harvest plans should minimize impacts to salamander habitats by addressing shade retention over talus slopes, retaining downed woody debris of all size and decay classes, and avoiding the disturbance of important rocky habitat areas, such as moss- and duff-covered talus slopes.

- A border of trees should be retained along the periphery of talus fields occupied by this salamander. A sufficient overstory is needed to ensure the talus slopes remain cool and moist. Herrington and Larsen (1985) recommend retaining a 27.4-45.7 m (90-150 ft) buffer.

- Logs should not be dragged across talus slopes.

- Road construction, gravel extraction, and other development, should not occur in talus occupied by Larch Mountain salamanders. Talus should be kept clear of heavy machinery.

- Human access to caves occupied by Larch Mountain salamanders should be restricted.

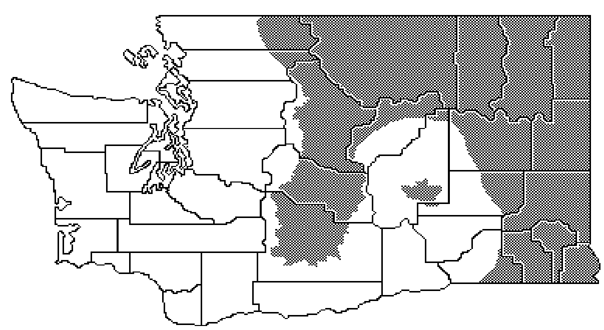
Columbia Spotted Frog
Rana luteiventris

Prepared by Noelle Nordstrom and Ruth Milner

GENERAL RANGE AND WASHINGTON DISTRIBUTION

The range of the Columbia spotted frog extends from the extreme southwestern Yukon, through the Alaska panhandle and most of British Columbia. It extends southeast, through eastern Washington, Idaho, western Montana, eastern Oregon, and northwestern Wyoming. Disjunct populations occur in southeastern Oregon, southwestern Idaho, the Bighorn Mountains of Wyoming, portions of Nevada, Utah's Wasatch Mountains, and the western desert of Utah (Corkran and Thoms 1996, Green et al. 1996, 1997)

In Washington, the Columbia spotted frog is found in parts of the Cascade mountains, and throughout areas of eastern Washington (Nussbaum et al. 1983, Leonard et al. 1993, Dvornich et al. 1996).



General range of the Columbia spotted frog, *Rana luteiventris*, in Washington. Map derived from the literature and GAP Analysis of Washington (Unpubl. 4th draft edition).

STATUS

The Columbia spotted frog is a State Candidate species.

RATIONALE

The Columbia spotted frog is vulnerable to habitat fragmentation, long-term overgrazing, and alterations to aquatic systems, such as diversions for irrigation and development around springs. Introduced bullfrogs and game fish may also facilitate the decline of this frog to an unknown extent (Munger 1997). Though the Columbia spotted frog still occurs throughout its range in Washington, preemptive measures are needed to preserve its distribution.

HABITAT REQUIREMENTS

Columbia spotted frogs are highly aquatic, inhabiting marshes and marshy edges of ponds, streams, and lakes. In dry habitats, these frogs also use deep pools within the main portions of watercourses (Munger 1997). These frogs are most often found in association with wetland plant communities consisting primarily of non-woody plants, such as sedges, rushes, and grasses (Leonard et al. 1993). They usually occur in slow moving waters with abundant emergent vegetation and a thick layer of dead and decaying vegetation on the bottom. The frogs take refuge in this layer when disturbed. Thick algal growth in overflow pools and backwaters of eastern Oregon creeks are used in the same way (Nussbaum et al. 1983). In Idaho, Munger et al. (1997) found that sites with these frogs had abundant submerged vegetation and algae, and low amounts of sagebrush and willow. Lakes with Columbia spotted frogs had muddy substrates, grassy banks, and logs along the margins.

Specific habitat attributes that are important to Columbia spotted frogs have not been precisely identified. However, sites suitable for oviposition, tadpole rearing, and refuges for postmetamorphic frogs such as hibernating adults, probably have certain aspects that make them good habitat (Nussbaum et al. 1983, Hayes and Jennings 1986). Columbia spotted frogs are active in lowland habitats from February through October and hibernate in muddy bottoms near their breeding sites in winter (Licht 1969, 1974; Svihla 1935). They are known to use cut banks, beaver dams, and pond bottoms as hibernacula (Munger 1997).

Courtship and breeding takes place in warm, shallow margins of ponds or rivers or in temporary pools. Breeding occurs between February and March at lower elevations in eastern Washington but may occur as late as May or June at higher elevations (Leonard et al. 1993, 1996, K. McAllister, pers. comm.) In May of two successive years, Leonard et al. (1996) found Columbia spotted frogs in the Cascade Mountains in Chelan County, breeding while snow still covered the ground and only a small portion of the pond was free of ice and snow. The water temperature where the eggs were found was 7.5 C (45° F). These observations suggest that Columbia spotted frogs overwinter in breeding ponds in the Cascade Mountains, allowing breeding to commence as soon as a small portion of water is free from snow and ice.

Female Columbia spotted frogs tend to deposit their eggs on or immediately next to other egg masses (McAllister et al. 1993). Consequently, as many as 50 masses may occur in an area as small as 75 cm (30 in) across. The rounded masses are not attached to vegetation, but rest on the bottom in shallow water (Nussbaum et al. 1983). Eggs are laid in water that is usually less than 30 cm (12 in) deep and are usually half-exposed to direct air. Thermal tolerance of embryos ranges between 7-28 C (44.6-82.4°F) (Licht 1971). Columbia spotted frogs use the same locations for egg-laying in successive years (Nussbaum 1983, Leonard et al. 1993), which may indicate the presence of unique characteristics at egg-laying sites (Licht 1969).

Columbia spotted frogs are opportunistic feeders and may forage to some extent under water (Nussbaum et al. 1983). Adults feed primarily on invertebrates, generally within one-half meter of shore on dry days. During and after rain, they may move away from permanent water to feed in wet vegetation or ephemeral puddles (Licht 1986). Larval frogs feed on aquatic algae and vascular plants, and scavenged plant and animal materials (Morris and Tanner 1969).

LIMITING FACTORS

Both mass mortality and localized reductions of ranid frog populations have been associated with natural factors such as predation, winterkill, and disease (Blaustein et al. 1994). Human impacts include altering habitat, introducing non-native fishes and other aquatic vertebrates, and introducing toxic chemicals into aquatic systems (Moyle 1973, Nussbaum et al. 1983, Hayes and Jennings 1986, Bradford 1991, McAllister and Leonard 1991, Leonard et al. 1993, McAllister et al. 1993, Brana et al. 1996, Corkran and Thoms 1996). A combination of factors may have a cumulative impact on Columbia spotted frogs, as Fellers and Drost (1992) found for the Cascades frog (*Rana cascadae*) in California. They concluded that common management practices, such as fire suppression and fish stocking, can have significant negative impacts on amphibians, especially when combined with normal environmental fluctuations (Fellers and Drost 1993).

Habitat Alterations

Currently, Columbia spotted frogs are most likely to be affected by altered habitats due to land conversion or changes in grazing practices. Human induced habitat alterations (changes to vegetation or topography) can reduce features Columbia spotted frogs need for various life stages and activities, such as consistent water temperatures, stable water levels, and cover. Activities that increase water level fluctuations are particularly detrimental, since egg masses of the Columbia spotted frog are most often laid in the shallow margins of water bodies, where they are particularly susceptible to freezing or desiccation (McAllister and Leonard 1997).

Grazing can either harm or benefit Columbia spotted frog habitat, depending on the condition of the vegetative community. In highly disturbed wetland areas, grazing may be beneficial by maintaining an open vegetation structure Columbia spotted frogs need for breeding. However, springs that serve as overwintering habitat may be negatively affected by cattle if they receive heavy use (McAllister and Leonard 1997).

Many of Washington's wetlands have been drained, filled, or otherwise altered (Corkran and Thoms 1996, McAllister and Leonard 1997). Associated hydrologic and plant community changes as well as polluted run-off jeopardize this frog. The increase of impervious surfaces, such as asphalt, roof-tops, and compacted soil over former wetlands and uplands increase run-off and exacerbate water level fluctuations (Wash. Dept. Ecol. 1992), which is detrimental to Columbia spotted frogs. Rapidly dropping water levels can strand egg masses, subjecting them to freezing or desiccation. Many amphibians are affected by this phenomenon, and it may be the single most harmful factor for amphibian populations in urbanizing areas (Richter and Azous 1995, McAllister and Leonard 1997).

Pollutants

Runoff from urban and agricultural areas often carry a variety of pollutants, depending on the activities in the vicinity. Road runoff contains petroleum products, lead, and cadmium, while residential and agricultural areas contribute fertilizers, pesticides, and animal waste (Wash. Dept. Ecol. 1992). Field observations suggesting toxicant-induced mortalities among North American frogs are limited, though pollutants probably have some impact. Larval stages seem to be more sensitive than embryonic or post-metamorphic stages. Hyperactivity and prolonged development are sublethal responses that can increase tadpoles' vulnerability to predation (Hays and Jennings 1986, Drost and Fellers 1996). Columbia spotted frog populations in eastern Washington are probably exposed to an assortment of agricultural chemicals. Marco (1997) found that Oregon spotted frog tadpoles are very sensitive to chemical fertilizers, and hypothesizes that nitrogen-based fertilizers may have contributed to this species' decline. Chemical fertilizers may have an impact on the Columbia spotted frog as well.

Introduced species

Bullfrogs (*Rana catesbeiana*) and several nonnative fishes have been implicated in the decline of ranid frogs across western North America, as both predators and competitors (Cory 1963; Hays and Jennings 1986; Bradford 1989, 1991; Bradford et al.1993; Fellers and Drost 1993; Hopey and Petranka 1994; Brana et al. 1996; Corkran and Thoms 1996; Drost and Fellers 1996; Fisher and Shaffer 1996; Hecnar and M'Closkey 1997; Monello et al. 1997). In a study of several amphibian species native to California's Great Central Valley, Fisher and Shaffer (1996) found that although native frogs and introduced species sometimes co-occurred, most ponds with native amphibians lacked introduced fish and bullfrogs. In Idaho, Munger et al. (1997) and Pilliod (1997) found that introduced trout did not significantly affect whether Columbia spotted frogs and other amphibians were present in lakes. Trout had a substantial negative effect, however, on the numbers of Columbia spotted frogs and other amphibians which occupied only very small and protected portions of the lakes. Large numbers of amphibians were only found in fishless lakes. Pilliod (1997) found that adult Columbia spotted frogs are less likely to be preyed upon by trout than frog larvae or sub-adult frogs. Introduced predators can indirect impact Columbia spotted frogs by fragmenting habitat or disrupting frog movement patterns between bodies of water. Frog populations may include several lakes within an area, some which are prime breeding habitat and others to which adults disperse. There may be relatively few suitable breeding or overwintering sites in an area, which could make these frogs vulnerable on a landscape scale if nonnative species were introduced into key breeding or wintering sites. The spatial configuration of stocked and fishless lakes in an area may determine whether a population of Columbia spotted frogs is able to persist (Pilliod 1997).

Unfortunately it is difficult to pinpoint to what degree each nonnative species has an impact, because more than one of these potential predators often occur simultaneously or in conjunction with other problems, such as altered habitats (Hays and Jennings 1986, Fisher and Shaffer 1996). Introduced species often thrive in modified habitats, confounding the impacts of predation, competition, and habitat degradation. Frequent observations of native amphibians successfully breeding at sites free of nonnative fish or bullfrogs, and the consistent absence or reduction of native amphibians where introduced species occur, support the hypothesis that nonnative species are important elements in the decline of ranid frogs, including the Columbia spotted frog (Fisher and Shaffer 1996). Many ponds and lakes within the range of the Columbia spotted frog in Washington contain bullfrogs and/or nonnative fish. Nonnative and transplanted fish have been released in Washington since the late 1800s (Wash. Dept. Fish and Wildl. 1996) and may affect the distribution of the Columbia spotted frog.

Other Factors

Several additional factors may contribute to the decline of the Columbia spotted frog and other ranids in Washington, but information is limited. To date there is no definitive word on how vulnerable Columbia spotted frogs or other frogs are to ultraviolet radiation. Though disease has been implicated in some large die-offs, there is no evidence that links viruses, bacteria or parasites to general amphibian decline (Hays and Jennings 1986). The fungus *Saprolegnia* is known to destroy the embryos of developing Oregon spotted frog eggs, but it has not been observed in epidemic proportions (McAllister and Leonard 1997). Field mortality of frogs due to acid rain has not been shown in western North America as it has in Sweden and other parts of Europe. Acid rain could potentially cause developmental anomalies, reduced sperm motility, or decreased growth rates (Hays and Jennings 1986).

MANAGEMENT RECOMMENDATIONS

Several factors have been implicated as negatively impacting Columbia spotted frogs, but there is very little information on which are the most significant. Some of these known or suspected factors can be addressed with specific actions (protecting native wetland vegetation, avoiding the introduction of nonnative species, controlling runoff, using alternatives to pesticides when possible). Though it may eventually be found that global problems such as acid rain or increased ultraviolet radiation are of far greater consequence, they are beyond the scope of these management recommendations.

Stable water levels and natural flow rates of lakes and streams where Columbia spotted frogs occur should be maintained. Riparian areas and wetlands supporting these frogs should not be flooded, drained, dredged, or otherwise altered. Land use activities planned for upland areas adjacent to Columbia spotted frog sites should be assessed for potential impacts to local hydrology.

Adequate cover should be maintained in wetlands used by Columbia spotted frogs. Vegetation along stream banks or pond edges should be retained. Vegetative cover provides refuge from predators and helps maintain stable water temperatures. Removing vegetative cover may raise water temperatures, enhancing conditions for competing bullfrogs.

Native fish and amphibian populations should be maintained and promoted. The introduction of nonnative amphibians, reptiles, and fish into sites supporting Columbia spotted frogs should be avoided where maintaining healthy populations of these frogs is a priority. Several studies have indicated that bullfrogs may prey on all life stages of spotted frogs and compete for resources as well (Moyle 1973, Fisher and Shaffer 1996). Introduced sunfish, such as warmouth (*Lepomis gulosus*), largemouth bass (*Micropterus salmoides*), and pumpkinseed (*Pomoxis gibbosus*), may prey upon frog tadpoles and eggs (Hayes and Jennings 1986).

Stocking game fish in waters supporting Columbia spotted frogs should be done only after assessing the potential impact on the viability of the frog's population. Munger et al. (1997) recommends only stocking lakes already containing fish. Lakes containing Columbia spotted frogs that are naturally fishless should remain so, particularly if they are important breeding or wintering sites (Pilliod 1997).

Algae, which is eaten by tadpoles, should not be removed or treated in wetlands where Columbia spotted frogs occur.

Muddy substrates, which may be used as hibernation sites, should not be altered.

Stormwater runoff from urban, agricultural or residential areas should not be diverted into spotted frog habitats. Runoff often contains pollutants that may affect frogs. Refer to the Department of Ecology's stormwater management manual (Wash. Dept. Ecol. 1992) which details methods for controlling stormwater.

Caution should be used when applying fertilizers containing nitrates and nitrites near waters containing the Columbia spotted frog. In lab experiments, Oregon spotted frogs suffered behavioral changes and eventual death when exposed to these compounds (Marco 1997). It is likely that Columbia spotted frogs would react similarly.

Pesticides and herbicides should be avoided in or adjacent to water bodies used by Columbia spotted frogs. If pesticide or herbicide use is being considered for areas where Columbia spotted frogs exist, refer to Appendix A, which contains contacts useful when assessing pesticides and herbicides.

Before undertaking any intensive survey efforts, particularly those employing traps or that involve the removal of substrate or handling specimens, WDFW should be contacted to determine whether a permit is necessary.

RESEARCH NEEDS

Factors thought to facilitate the decline of ranid frogs (introduced fish, bullfrogs, habitat alterations) need to be tested individually to determine their significance.

Long-term demographic studies are needed to differentiate short-term population fluctuations from longer-term declines of the Columbia spotted frog.

Conditions favoring bullfrog survival should be investigated. Most forms of human caused environmental changes may give bullfrogs the selective advantage over native frogs (Hays and Jennings 1986).

Means to safely and effectively remove or exclude introduced amphibian and fish species should be developed for use in areas where nonnative species are known to have a negative impact.

The Columbia spotted frog and the Oregon spotted frog were recently considered one species, the spotted frog. It needs to be determined whether what is now considered the Columbia spotted frog is really more than one species.

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KEY POINTS

Columbia Spotted Frog
Rana luteiventris

Habitat Requirements

- Columbia spotted frogs inhabit marshes, and the marshy edges of ponds, streams and lakes. In dry habitats, these frogs also use deep pools within the main portions of watercourses.

- These frogs are most often found in association with wetland plant communities consisting primarily of non-woody plants, such as sedges, rushes and grasses

- These frogs breed in the warm, shallow margins of marshes, ponds or rivers, or in temporary pools. The same breeding site may be used in successive years.

- Eggs are laid in water that is less than 30 cm (12 in) deep, and are usually half exposed to air.

- Embryo mortality occurs if water temperature falls below 7 C (45°F) or rises above 28 C (82°F).

- Columbia spotted frogs hibernate in muddy bottoms near breeding sites during winter.

Management Recommendations

- Stable water levels and natural flow rates of lakes and streams where Columbia spotted frogs occur should be maintained. Riparian areas and wetlands supporting these frogs should not be flooded, drained, dredged, or otherwise altered. Land use activities planned for upland areas adjacent to Columbia spotted frog sites should be assessed for potential impacts to local hydrology.

- Stable water temperatures should be maintained. Discharges of heated water or stormwater runoff into wetlands can cause water temperature fluctuations, and should be avoided where Columbia spotted frogs occur. Water temperatures should remain between 7 C (45°F) and 28 C (82°F) during the breeding period. Embryos may fail to develop if water temperatures are lower than 7 C (44.6°F)

- Adequate cover should be maintained in wetlands used by Columbia spotted frogs. Vegetation along stream banks or pond edges should be retained. Vegetative cover provides refuge from predators and helps maintain stable water temperatures.

- Native fish and amphibian populations should be maintained and promoted. The introduction of introduced amphibians, reptiles, and fish into sites supporting Columbia spotted frogs should be avoided where maintaining healthy populations of these frogs is a priority. Bullfrogs may prey on all life stages of spotted frogs and compete for resources as well. Introduced sunfish, such as warmouth (*Lepomis gulosus*), largemouth bass (*Micropterus salmoides*), and pumpkinseed (*Pomoxis gibbosus*), may prey upon frog tadpoles and eggs.

- Stocking game fish in waters supporting Columbia spotted frogs should be done only after assessing the potential impact on the viability of the frog population. Munger et al. (1997) recommends only stocking lakes already containing fish. Lakes containing Columbia spotted frogs that are naturally fishless should remain so, particularly if they are important breeding or wintering sites.

- Algae, which is eaten by tadpoles, should not be removed or treated in wetlands where Columbia spotted frogs occur.

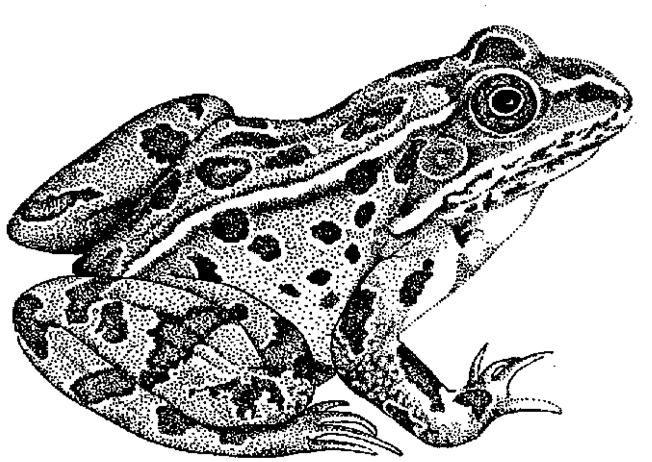
- Muddy substrates, which may be used as hibernation sites, should not be altered.

- Stormwater runoff from urban, agricultural, or residential areas should not be diverted into spotted frog habitats. Runoff often contains pollutants that may affect frogs. Refer to the Department of Ecology's stormwater management manual (Wash. Dept. Ecol. 1992) which details methods for controlling stormwater.

- Caution should be used when applying fertilizers containing nitrates and nitrites near waters containing the Columbia spotted frog. In lab experiments, Oregon spotted frogs suffered behavioral changes and eventual death when exposed to these compounds. It is likely that Columbia spotted frogs would react similarly.

- Pesticides and herbicides should be avoided in or adjacent to water bodies used by Columbia spotted frogs. If pesticide or herbicide use is being considered for areas where Columbia spotted frogs exist, refer to Appendix A, which contains contacts useful when assessing pesticides and herbicides.

- Before undertaking any intensive survey efforts, particularly those employing traps or that involve the removal of substrate or handling specimens, WDFW should be contacted to determine whether a permit is necessary.

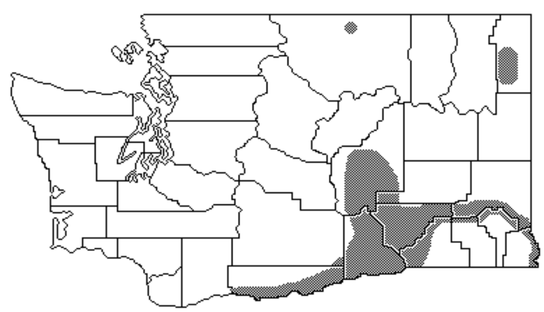


Northern Leopard Frog
Rana pipiens

Prepared by Noelle Nordstrom

GENERAL RANGE AND WASHINGTON DISTRIBUTION

The range of the northern leopard frog extends from the northeastern United States, through the Great Lakes, Midwest, and Great Plains regions. The western portion of its range includes eastern Washington the southwestern United States. In Canada it occurs throughout most of the southern provinces, including southeastern British Columbia (Stebbins 1951, Leonard et al. 1993).



Range of the northern leopard frog, *Rana pipiens*, in Washington. Map derived from the literature.

In Washington, this frog is found east of the Cascade Mountains, throughout the northeast and northcentral portions of the state. It has been documented in the Potholes Reservoir in Grant County, and along the Columbia and Snake Rivers in Walla Walla, Benton, Klickitat, and Whitman counties. These frogs have also been known to occur in Pend Oreille, Stevens, and Okanogan counties (Slater 1964, Leonard et al. 1993, Leonard and McAllister 1996).

STATUS

The northern leopard frog is a State Candidate species.

RATIONALE

In the last 20 years, the northern leopard frog has declined in numbers throughout North America, and this trend is apparent within Washington and Canada as well (Corn and Fogelman 1984, Roberts 1986, Clarkson and Rorabaugh 1989, Orchard 1992, Leonard and McAllister 1996). Preliminary surveys suggest that this frog may be absent from up to 90% of its historic range in Washington (Andelman and McAllister 1994). The definite causes for this decline are unknown, though habitat loss, pesticide use, and nonnative predators contribute to the problem (Hays and Jennings 1986, Andelman and McAllister 1994, Leonard and McAllister 1996). It is also possible that populations are eliminated by diseases caused by environmental stressors (Corkran and Thoms 1996).

HABITAT REQUIREMENTS

The northern leopard frog inhabits marshes, wet meadows, riparian areas, and moist, open woods, at elevations ranging from 82 m (270 ft) to 415 m (1,363 ft). Stebbins (1951) found this frog under a variety of environmental conditions. Prey items include insects and spiders, leeches, fish, other amphibians, small snakes, and birds (Leonard et al. 1993). This frog breeds in spring, in marshes and ponds or along lake margins where there is dense aquatic vegetation. It avoids bodies of water with no vegetation, preferring cattail or sedge marshes and weedy ponds. Northern leopard frogs will use both temporary and permanent bodies of water for breeding (Nussbaum et al. 1983, Corkran and Thoms 1996).

In Nevada, Panik and Barrett (1994) found northern leopard frogs at only one site on the lower stretch of the Truckee River, though this species had been reported at other locations along the river in the past. The lower portion of this river has a slow to moderate flow, with some pond-like stretches. The frogs were also found 80 m (262 ft) east of where they occurred in the river, in a mud-bottomed pond about 100 m (328 ft) wide and 14 cm (13.6 in) deep. The vegetation bordering the river and adjacent pond consisted of grasses, rushes, sedges, and clover. Panik and Barrett (1994) hypothesized that the frogs were moving to the pond to breed and then returning to the river.

Breeding usually begins in March or April. Northern leopard frogs will travel some distance to reach suitable breeding sites, and may be seen on roads during warm rainy nights in spring (Nussbaum et al. 1983). In Wyoming, breeding activities begin when the water temperature reaches 10 C (50°F). Eggs are usually attached to submerged vegetation, near the surface of water that is at least 0.5 m (1.6 ft) deep. There may be two or three dozen egg masses in a limited area. Eggs develop at temperatures between 6 and 27 C (43-80°F.). The time needed for eggs to hatch decreases as water temperatures increase. Northern leopard frogs reach sexual maturity two or three years after hatching (Stebbins 1951, Nussbaum et al.1983, Corkran and Thoms 1996).

In the summer this frog often strays far from water (Leonard et al. 1993). It inhabits moist meadows, hay fields and grassy woodlands, and requires high ground cover for concealment (Nussbaum et al. 1983). During the winter, northern leopard frogs hibernate under rocks or other objects within aquatic habitats (Stebbins 1951, Nussbaum et al. 1983).

LIMITING FACTORS

The definite causes of the northern leopard frog's decline are unknown, though habitat loss, water contaminants, disease promoted by environmental stress, and introduced predators are believed to contribute to the problem (Hays and Jennings 1986, Koonz 1992, Orchard 1992, Andelman and McAllister 1994, Corkran and Thoms 1996, Leonard and McAllister 1996). Natural predators include garter snakes, racoons, and herons (Leonard et al. 1993).

The historic range of the northern leopard frog includes an increasing amount of agricultural, residential, and urban lands, all of which potentially contribute to heavy metals, fertilizers, and pesticides entering aquatic systems. Land conversion can also alter the hydrology of an area, making it more prone to rapid water-level fluctuations. Both the deterioration of water quality in general, and water level fluctuations during the frogs' embryonic and larval periods may play a part in the decline of the northern leopard frog (Leonard and McAllister 1996). Since this is a highly aquatic frog species, it may be particularly sensitive to changes in water quality (Orchard 1992).

In the mid-1970s, Canada's northern leopard frog populations experienced a massive die-off. The frogs showed signs of kidney failure, but no single disease or parasite was identified as the cause. Frogs are especially vulnerable to air and water pollution because they breathe through their skin. This die-off may have resulted from deteriorating environmental conditions (Koonz 1992). Crawshaw (1992) states that disease in amphibian populations rarely cause massive die offs. Disease generally contributes to a gradual population decline, as a result of immune suppression, shorter adult life-spans, and increased egg and tadpole mortality.

Throughout western North America, declines in the northern leopard frog and other frog species often coincide with the introduction of the bullfrog, *Rana catesbeiana* (Moyle 1973, Hammerson 1982, Hays and Jennings 1986, Leonard and McAllister 1996).
Leonard et al. (1993) and Leonard and McAllister (1996) list predation by bullfrogs as the main reason for the northern leopard frog's disappearance from Washington's Columbia National Wildlife Refuge, where it was once common. Bullfrogs prey on other frogs and compete for food and space (Hays and Jennings 1986). Bullfrogs favor habitats with sandy or gravelly substrate, warm water, and rooted aquatic vegetation. They are most abundant in areas heavily altered by human activity, such as small impoundments, cattle-trampled banks, and road or construction sites where erosion has increased sediment loads to nearby bodies of water (Moyle 1973). Panik and

Barrett (1994) found that the northern leopard frog is in decline on Nevada's Truckee River and hypothesize that the success of the bullfrog may be responsible. The bullfrog may also play a part in the decline of leopard frogs in Colorado (Hammerson 1982). Similarly, the bullfrog's presence combined with human-caused habitat alterations are the suspected reasons for the disappearance of red-legged frogs (*Rana aurora*) and yellow-legged (*Rana boylii*) frog populations in portions of California (Moyle 1973).

Introduced fish have also been implicated in the decline of several ranid frog species across western North America (Cory 1963, Moyle 1973, Hays and Jennings 1986, Bradford 1989, 1991, Bradford et al.1993, Brana et al. 1996, Corkran and Thoms 1996, Hecnar and M'Closkey 1997) and may contribute to the northern leopard frog's decline. Though there have been no studies on the impact of introduced fish on Washington populations of northern leopard frogs specifically, several introduced fish species thrive in the warmwater habitats of eastern Washington and are likely to prey on the embryonic and larval stages of the northern leopard frog. Introduced fish also have the potential to carry pathogens, such as the fungus *Saprolegnia* (Blaustein et al. 1994). Nonnative fish inhabiting areas currently or historically occupied by this frog include the largemouth bass (*Micropterus salmoides*), black crappie (*Perca flavescens*), carp (*Cyprinus carpio*), and the brown bullhead (*Ictalurus nebulosus*). Carp can also alter frog habitat by destroying emergent vegetation, increasing turbidity, and reducing quantities of algae and invertebrates (Hays and Jennings 1986, Corkran and Thoms 1996, Leonard and McAllister 1996).

Unfortunately it is difficult to pinpoint to what degree each introduced species has an impact, because more than one of these potential predators often occurs simultaneously or in conjunction with other problems, such as altered habitats (Hays and Jennings 1986, Fisher and Shaffer 1996). Introduced species often thrive in modified habitats, confounding the impacts of predation, competition, and habitat degradation. Frequent observations of native amphibians successfully breeding at sites free of introduced fish or bullfrogs, and the consistent absence or reduction of native amphibians where introduced species occur, support the hypothesis that introduced species are elements in the decline of ranid frogs (Fisher and Shaffer 1996). Many ponds and lakes within the range of the northern leopard frog in Washington contain bullfrogs and/or nonnative fish. Nonnative and transplanted fish have been released in Washington since the late 1800s (Wash. Dept. Fish and Wildl. 1996) and may affect the distribution of the northern leopard frog.

Other Factors

Several additional factors may contribute to the decline of the northern leopard frog and other ranids in Washington, but information is limited. To date there is no definitive word on how vulnerable northern leopard frogs or other frogs are to ultraviolet radiation. Though disease has been implicated in some large die-offs (Blaustein et al. 1994), there is no evidence that links viruses, fungi, bacteria, or parasites to general, long-term amphibian decline (Hays and Jennings 1986). Field mortality of frogs due to acid rain has not been shown in Western North America as it has in Sweden and other parts of Europe. Acid rain could potentially cause developmental anomalies, reduced sperm motility, or decreased growth rates (Hays and Jennings 1986).

MANAGEMENT RECOMMENDATIONS

Populations of the northern leopard frog should be monitored for changes in numbers and evidence of disease. Currently or formerly occupied habitat, as well as areas of suitable habitat where northern leopard frogs have not been documented, should be surveyed regularly (Crawshaw 1992, Leonard and McAllister 1996). Before undertaking any intensive survey efforts, particularly those employing traps or that involve the removal of substrate or handling specimens, WDFW should be contacted to determine whether a permit is necessary.

Riparian areas and wetlands supporting northern leopard frogs should not be flooded, drained, dredged, or otherwise altered. Avoid activities that alter the water table or groundwater in ways that cause water-level fluctuations. Land use activities planned for areas adjacent to northern leopard frog sites should be assessed for potential impacts to local hydrology.

To maintain adequate cover for these frogs, wetland vegetation should not be removed from stream banks or pond edges, and nonnative plants should be controlled (Leonard and McAllister 1996). Vegetative cover provides refuge from predators and helps maintain stable water temperatures. In addition to degrading northern leopard frog habitat, removing vegetation may raise water temperatures and increase sedimentation, enhancing conditions for competing bullfrogs (Hayes and Jennings 1986).

Native fish and amphibian populations should be maintained and promoted. The introduction of nonnative amphibians, reptiles, and fish into sites supporting northern leopard frogs should be avoided where maintaining healthy populations of the northern leopard frog is a priority. Introduced fish may prey upon frog tadpoles and eggs. Carp also disturb vegetation and benthic sediment (Hayes and Jennings 1986). Studies have indicated that bullfrogs may prey on all life stages of ranid frogs and compete for resources as well (Moyle 1973, Fisher and Shaffer 1996).

Stocking game fish in waters supporting northern leopard frogs should be done only after assessing the potential impact on the viability of the frog population. Munger et al. (1997) recommends only stocking lakes already containing fish. Lakes containing northern leopard frogs that are naturally fishless should remain so (Pilliod 1997), particularly if they are important breeding or wintering sites.

Algae, which is eaten by tadpoles, should not be removed or treated in wetlands where northern leopard frogs occur.

Known hibernation sites should not be altered.

Stormwater runoff from urban, agricultural or residential areas should not be diverted into northern leopard frog habitats. Runoff often contains pollutants that may affect frogs. Please refer to the Department of Ecology’s stormwater management manual (Wash. Dept. Ecol. 1992) which details methods for controlling stormwater.

Pesticides and herbicides should be avoided in, or adjacent to, water bodies used by northern leopard frogs. If pesticide or herbicide use is being considered for areas where these frogs exist, refer to Appendix A, which contains contacts useful when assessing pesticides and herbicides.

RESEARCH NEEDS

Factors thought to facilitate the decline of ranid frogs (introduced fish, bullfrogs, habitat alterations) need to be tested individually to determine their significance in Washington.

Long-term demographic studies are needed to differentiate short-term population fluctuations from longer-term declines of the northern leopard frog.

Conditions favoring bullfrog survival should be investigated. Many forms of human caused environmental changes may give bullfrogs the selective advantage over native frogs (Hays and Jennings 1986).

Means to safely and effectively remove or exclude introduced amphibian and fish species should be developed for use in areas where native amphibians are a priority and where introduced species are known to have a negative impact.

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KEY POINTS

Northern Leopard Frog
Rana pipiens

Habitat Requirements

- The northern leopard frog inhabits marshes, wet meadows, riparian areas, and moist, open woods, at elevations ranging from 82 m (270 ft) to 415 m (1,363 ft).
- This frog breeds in marshes, ponds and along vegetated lake margins. It avoids bodies of water with no vegetation.
- Northern leopard frogs often use moist meadows, hay fields and grassy woodlands, where they require high ground cover for concealment.
- In winter, northern leopard frogs hibernate under rocks or other objects within aquatic habitats.

Management Recommendations

- Known populations of the northern leopard frog should be monitored for changes in numbers and evidence of disease. Currently or formerly occupied habitat, as well as areas of suitable habitat where northern leopard frogs have not been documented, should be surveyed regularly. Before undertaking any intensive survey efforts, particularly those employing traps or that involve the removal of substrate or handling specimens, WDFW should be contacted to determine whether a permit is necessary.
- Riparian areas and wetlands that support the northern leopard frog should not be flooded, drained, dredged, or otherwise altered. Activities that alter the water table or groundwater in ways that cause water-level fluctuations should be avoided.
- Land use activities planned for upland areas adjacent to northern leopard frog sites should be assessed for potential impacts to local hydrology.
- To maintain adequate cover for these frogs, wetland vegetation should not be removed from stream banks or pond edges, and nonnative plants should be controlled. Vegetative cover provides refuge from predators, and helps maintain stable water temperatures.

- Native fish and amphibian populations should be maintained and promoted. The introduction of nonnative amphibians, reptiles, and fish into sites supporting northern leopard frogs should be avoided where the maintainance of healthy northern leopard frog populations is a priority.

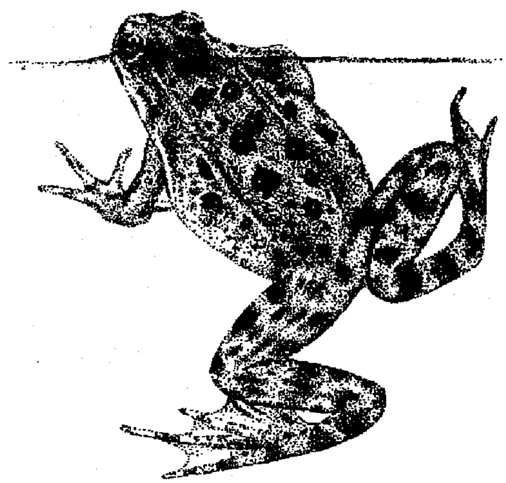
- Stocking game fish in waters supporting these frogs should be done only after assessing the potential impact on the viability of northern leopard frog populations. Munger et al. (1997) recommends only stocking lakes already containing fish. Lakes containing northern leopard frogs that are naturally fishless should remain so, particularly if they are important breeding or wintering sites.

- Algae, which is eaten by tadpoles, should not be removed or treated in wetlands where northern leopard frogs occur.

- Known hibernation sites should not be altered.

- Stormwater runoff from urban, agricultural or residential areas should not be diverted into spotted frog habitats. Runoff often contains pollutants that may harm frogs. Please refer to the Department of Ecology's stormwater management manual (Wash. Dept. Ecol. 1992) which details methods for controlling stormwater.

- Pesticides and herbicides should be avoided in or adjacent to water bodies used by northern leopard frogs. If pesticide or herbicide use is being considered for areas where these frogs exist, refer to Appendix A, which contains contacts useful when assessing pesticides and herbicides.

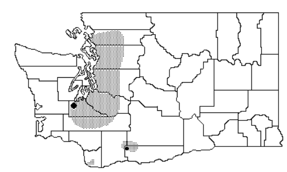


Oregon Spotted Frog
Rana pretiosa

Prepared by Noelle Nordstrom and Ruth Milner

GENERAL RANGE AND WASHINGTON DISTRIBUTION

The Oregon spotted frog is endemic to the Pacific Northwest. Historically its range extended from northeast California (Stebbins 1985), through the Puget Trough/Willamette Valley regions of Oregon and Washington, to the lower Fraser River Valley in British Columbia (McAllister 1995; McAllister and Leonard 1997; Green et al. 1996, 1997).



Historic Washington range of the Oregon spotted frog, *Rana pretiosa*. Black dots represent known remaining locations. Map derived from the literature and GAP Analysis of Washington (Unpubl. 4th draft edition).

In Washington, this frog once occurred throughout the Puget Trough lowlands, from the Canadian boarder to Vancouver, Washington, and east into the southern Washington Cascades. Currently, there are only three locations in Washington where these frogs are known to still exist; Dempsey Creek in Thurston County, and Trout and Conboy Lakes in Klickitat County (Dvornich et al. 1996). Other lowland western Washington populations are believed to be extirpated (McAllister et al. 1993).

STATUS

The Oregon spotted frog is a State Endangered species.

RATIONALE

In Washington, the Oregon spotted frog has experienced a dramatic decline in numbers (McAllister et al. 1993). The three remaining sites known to support Oregon spotted frogs are isolated, and particularly vulnerable to both natural and human events that could cause their extirpation.

HABITAT REQUIREMENTS

Oregon spotted frogs are highly aquatic, inhabiting marshes and marshy edges of ponds, streams, and lakes. Spotted frogs usually occur in shallow, slow moving waters with abundant emergent vegetation and a thick layer of dead and decaying vegetation on the bottom. The frogs take refuge in this layer when disturbed (Nussbaum et al. 1983, Corkran and Thoms 1996). Evidence from western Oregon suggests that postmetamorphic spotted frogs choose water between 20 and 35 C (68-95°F) during late spring and summer, and sites containing frogs all had a marsh or a bog (Licht 1974, Hayes 1994).

Oregon spotted frogs are active in lowland habitats from February through October, and hibernate in muddy bottoms near their breeding sites in winter (Licht 1969, 1974; Svihla 1935). It is possible that overwintering sites are also used for breeding (Hays 1994). Courtship and breeding occurs between February and March at lower elevations in western Washington (Leonard et al. 1993, 1996; K. McAllister pers. comm.) and takes place in warm, shallow margins of ponds or rivers or in temporary pools formed by rain or snowmelt (McAllister and Leonard 1997). The same breeding sites may be used over successive years (Nussbaum et al. 1983, Licht 1969). McAllister and Leonard (1997) found adults active at Dempsey Creek egg-laying sites when water temperatures were between -0.5 and 13 C (31-55°F). In Thurston County, egg laying begins in late February and is completed by mid-March. Locations in Klickitat County, which are at higher elevations, breeding commences in mid to late March. Hatching can occur as soon as 14 days after eggs are laid, though 18-30 days are more usual (McAllister and Leonard 1997).

Spotted frogs tend to lay their eggs in exposed shallows, usually less than 30 cm (12 in) deep. These waters warm quickly, which speeds development and hatching of the eggs (McAllister and Leonard 1997). Licht (1971) found Oregon spotted frog egg masses in water with an average daytime temperature of about 20 C (68°F), which would put the rate of development at near maximum (McAllister and Leonard 1997). Female spotted frogs tend to deposit their eggs on or immediately next to other spotted frog egg masses (McAllister et al. 1993, Corkran and Thoms 1996). The rounded masses, usually half-exposed to direct air, are not attached to vegetation, but rest on the bottom in shallow water (Nussbaum et al. 1983). Thermal tolerance of embryos ranges between 7-28 C (45-82°F) (Licht 1971).

Oregon spotted frogs are opportunistic feeders, and may forage to some extent under water (Nussbaum et al. 1983). Adult spotted frogs feed primarily on invertebrates, generally within one-half meter of shore on dry days. During and after rain, they may move away from permanent water to feed in wet vegetation or ephemeral puddles (Licht 1986). Larval frogs feed on aquatic algae and vascular plants, and scavenged plant and animal materials (Morris and Tanner 1969).

LIMITING FACTORS

It is difficult to pinpoint a single reason for the decline of the Oregon spotted frog in Washington. Both mass mortality and localized reductions of ranid frog populations have been associated with natural factors such as predation, winterkill, and disease (Blaustein et al. 1994). Human impacts include altering habitat, introducing nonnative fishes and other aquatic vertebrates, and introducing toxic chemicals into aquatic systems (Moyle 1973, Nussbaum et al. 1983, Hayes and Jennings 1986, Bradford 1991, McAllister and Leonard 1991, Leonard et al. 1993, McAllister et al. 1993, Brana et al. 1996, Corkran and Thoms 1996). A combination of factors may have a cumulative impact on populations of spotted frogs, as Fellers and Drost (1992) found for the Cascades frog (*Rana cascadae*) in California. They concluded that common management practices such as fire suppression and fish stocking can have significant negative impacts on amphibians, especially when combined with normal environmental fluctuations (Fellers and Drost 1993).

Habitat Alterations

Currently, Oregon spotted frogs are most likely to be affected by altered habitats due to residential development or changes in grazing practices. Human-induced habitat alterations (changes to vegetation or topography) can reduce features Oregon spotted frogs need for various life stages and activities, such as consistent water temperatures, stable water levels, and cover. Activities that increase water level fluctuations are particularly detrimental, since egg masses of the Oregon spotted frog are most often laid in the shallow margins of water bodies where they are particularly susceptible to freezing or desiccation (McAllister and Leonard 1997).

Grazing can either harm or benefit Oregon spotted frog habitat, depending on the condition of the vegetative community. In highly disturbed wetland areas, grazing may be beneficial by maintaining an open vegetation structure Oregon spotted frogs need for breeding. However, springs that serve as overwintering habitat may be negatively affected by cattle if they receive heavy use (McAllister and Leonard 1997).

Many of Washington’s wetlands have been drained, filled, or otherwise altered, and continued development in the vicinity of current spotted frog habitat is expected (Corkran and Thoms 1996, McAllister and Leonard 1997). Small wetlands are particularly vulnerable because they are more difficult to maintain as functional communities and are less resistant to changes in hydrology and water quality than larger wetlands (Richter and Azous 1995). Changes in hydrology and plant communities resulting from development, as well as polluted run-off jeopardize the Oregon spotted frog. Richter and Azous (1995) found that wetlands in watersheds with over 40% of the land urbanized were significantly more likely to have low amphibian richness than wetlands with less urbanized watersheds. The increase of impervious surfaces, such as asphalt, roof-tops, and compacted soil over former wetlands and uplands increase run-off and exacerbate water level fluctuations (Wash. Dept. Ecol. 1992), which is detrimental to Oregon spotted frogs. Rapidly dropping water levels can strand egg masses, subjecting them to freezing or desiccation. Many amphibians are affected by this phenomenon, and it may be the single most harmful factor for amphibian populations in urbanizing areas (Richter and Azous 1995, McAllister and Leonard 1997).

Runoff from urban areas also carry a variety of pollutants, depending on the activities conducted in the area. Road runoff contains petroleum products, lead and cadmium, while residential and agricultural areas contribute fertilizers, pesticides, and animal waste (Wash. Dept. Ecol. 1992).

Introduced species

Bullfrogs *(Rana catesbeiana*) and several nonnative fishes have been implicated in the decline of ranid frogs across western North America, as both predators and competitors (Cory 1963; Bacon 1966; Hays and Jennings 1986; Bradford 1989, 1991; Bradford et al.1993; Fellers and Drost 1993; Hopey and Petranka 1994; Brana et al. 1996; Corkran and Thoms 1996; Drost and Fellers 1996; Fisher and Shaffer 1996; Hecnar and M'Closkey 1997). In a study of several amphibian species native to California's Great Central Valley, Fisher and Shaffer (1996) found that although native frogs and introduced species sometimes co-occurred, most ponds with native amphibians lacked nonnative fish and bullfrogs. Unfortunately, it is difficult to pinpoint to what degree each species has an impact because more than one of these potential predators often occurs simultaneously or in conjunction with other problems, such as altered habitats (Hays and Jennings 1986, Fisher and Shaffer 1996). Nonnative species often thrive in modified habitats, confounding the impacts of predation, competition, and habitat degradation. However, frequent observations of native amphibians successfully breeding at sites free of nonnative fish or bullfrogs, and the consistent absence or reduction of native amphibians where nonnatives occur, support the hypothesis that introduced species contribute to the decline of ranid frogs (Fisher and Shaffer 1996).

Currently, with the exception of bullfrogs which are present at Conboy Lake, introduced fish or frogs are not known to occur with Oregon spotted frogs in Washington (McAllister and Leonard 1997). Engler (1997) found that one third of the prey items found in bullfrogs from Conboy lake were frogs, including the Oregon spotted frog. Most ponds and lakes within the historic range of the Oregon spotted frog in Washington do contain bullfrogs and/or nonnative fish, particularly largemouth bass (*Micropterus salmoides*), black crappie (*Pomoxis nigromaculatus*), yellow perch (*Perca flavescens*), pumpkinseed (*Pomoxis gibbosus*), bluegill (*Lepomis macrochirus*), brown bullhead (*Ameiurus nebulosus*), warmouth (*Lepomis gulosus*), and rainbow trout (*Oncorhynchus mykiss*) (McAllister and Leonard 1997). Nonnative and transplanted fish have been released in Washington since the late 1800s (Wash. Dept. Fish and Wildl. 1996) and may have played a part in the disappearance of the Oregon spotted frog. Although Richter and Azous (1995) found that in King County, Washington, amphibian richness in general was unrelated to the presence of predatory fish (*Oncorhynchus* spp.) or bullfrogs. In the future, it is likely that introduced species will spread into areas where spotted frogs now occur (McAllister and Leonard 1997).

Other Factors

Several other factors have been suggested as contributing to the decline of the Oregon spotted frog and other ranids in Washington, but information is limited. So far there is no definitive word on the vulnerability of Oregon spotted frogs or other frogs to ultraviolet radiation. Though disease has been implicated in some large die-offs, no current evidence exists that links viruses, bacteria, or parasites to general amphibian decline (Hays and Jennings 1986). The fungus *Saprolegnia* is known to destroy the embryos of developing Oregon spotted frog eggs, but it is unusual and has not been observed in epidemic proportions (McAllister and Leonard 1997). Field observations suggesting toxicant-induced mortalities among North American frogs are limited, though pollutants probably have some impact. Larval stages seem more sensitive than embryonic or post-metamorphic stages. Hyperactivity and prolonged development are sublethal responses that can increase tadpole vulnerability to predation (Hays and Jennings 1986, Drost and Fellers 1996). Marco (1997) found that Oregon spotted frog tadpoles are very sensitive to chemical fertilizers, and he hypothesizes that nitrogen-based fertilizers may have contributed to this species' decline. Field mortality of frogs due to acid rain has not been shown in Western North America as it has in Sweden and other parts of Europe. Acid rain could potentially interfere with ion regulatory capabilities or cause developmental anomalies, reduced sperm motility, or decreased growth rates (Hays and Jennings 1986).

MANAGEMENT RECOMMENDATIONS

Several factors have been implicated in the decline of Oregon spotted frogs, but there is very little information on which are the most significant. Some of these known or suspected factors can be addressed with specific actions (protecting native wetland vegetation, avoiding the introduction of nonnative species, controlling runoff, using alternatives to pesticides when possible). Though it may eventually be found that global problems such as acid rain or increased ultraviolet radiation are of far greater consequence, they are beyond the scope of these management recommendations.

Stable water levels and natural flow rates of lakes and streams where spotted frogs occur should be maintained. Riparian areas and wetlands that support Oregon spotted frogs should not be flooded, drained, dredged, or otherwise altered. Land use activities planned for upland areas adjacent to Oregon spotted frog sites should be assessed for potential impacts to local hydrology.

Adequate cover should be maintained in wetlands used by Oregon spotted frogs. Vegetation along stream banks or pond edges should be retained. Vegetative cover provides refuge from predators, and helps maintain stable water temperatures. Removing vegetative cover may raise water temperatures, enhancing conditions for competing bullfrogs.

Native fish and amphibian populations should be maintained and promoted. The introduction of nonnative amphibians, reptiles, and fish into sites supporting spotted frogs should be avoided. Several studies have indicated that bullfrogs may prey on all life stages of spotted frogs and compete for resources as well (Moyle 1973, Fisher and Shaffer 1996). Introduced fish, such as members of the sunfish family (warmouth, largemouth bass, pumpkinseed), may prey upon frog tadpoles and eggs (Hayes and Jennings 1986).

Game fish should not be introduced to the three locations where Oregon spotted frogs remain. Fish introductions planned for bodies of water within the Oregon spotted frog's historic range should be coordinated with any efforts to reestablish this frog where it once occurred.

Algae, which is eaten by tadpoles, should not be removed or treated in wetlands where spotted frogs occur.

Muddy substrates, which may be used as hibernation sites, should not be altered.

Stormwater runoff from urban developments should not be diverted into spotted frog habitats. Urban runoff often contains heavy metals and other pollutants that may affect frogs. Please refer to the Department of Ecology's stormwater management manual (Wash. Dept. Ecol. 1992) which details methods for controlling stormwater.

Pesticides and herbicides should be avoided in or adjacent to water bodies used by Oregon spotted frogs. If pesticide or herbicide use is being considered for areas where Oregon spotted frogs exist, refer to Appendix A, which contains contacts useful when assessing pesticides and herbicides.

Areas of good Oregon spotted frog habitat within its historic range should be surveyed periodically, so any undiscovered populations can be located and protected. Before undertaking any intensive survey efforts, particularly those employing traps or that involve the removal of substrate or handling specimens, WDFW should be contacted to determine whether a permit is necessary.

RESEARCH NEEDS

Factors thought to facilitate the decline of ranid frogs (introduced fish, bullfrogs, habitat alterations) need to be tested individually to determine their significance.

Long-term demographic studies are needed to differentiate short-term population fluctuations from longer-term declines.

Conditions favoring bullfrog survival should be investigated. Most forms of human caused environmental changes may give bullfrogs the selective advantage over native frogs (Hays and Jennings 1986).

Means to safely and effectively remove introduced amphibian and fish species should be developed for use in areas where nonnative species are known to have a negative impact.

The possibility of re-introducing the Oregon spotted frog into portions of its historic range should be considered.

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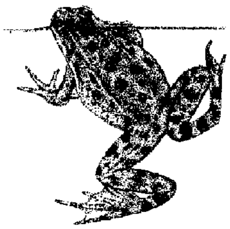
KEY POINTS



Oregon Spotted Frog
Rana pretiosa

Habitat Requirements

- Oregon spotted frogs inhabit marshes and the marshy edges of ponds, streams, and lakes.
- These frogs breed in the warm, shallow margins of marshes, ponds, or rivers, or in temporary pools. The same breeding site may be used in successive years.
- Eggs are laid in water that is less than 30 cm (12 in) deep, and are usually half exposed to air.
- Embryo mortality occurs if water temperature falls below 7 C (45°F) or rises above 28 C (82°F).
- Spotted frogs hibernate in muddy bottoms near breeding sites during winter.

Management Recommendations

- Avoid altering wetlands (e.g., flooding, draining, filling, dredging) used by Oregon spotted frogs.
- Avoid altering water levels or stream flows during the breeding period (March through August).
- Avoid causing water temperature to fall below 7 C (45°F) or rise above 28 C (82°F) during the breeding period.
- Avoid discharges of heated water or stormwater runoff into wetlands used by Oregon spotted frogs.
- Avoid removal of riparian vegetation, or removal or chemical treatment of aquatic algae in wetlands inhabited by Oregon spotted frogs.
- Avoid introducing nonnative fish or bullfrogs into wetlands used by Oregon spotted frogs. Gamefish introductions planned for waters within the historical range of this frog should be coordinated with any efforts to reestablish the Oregon spotted frog where it once occurred.

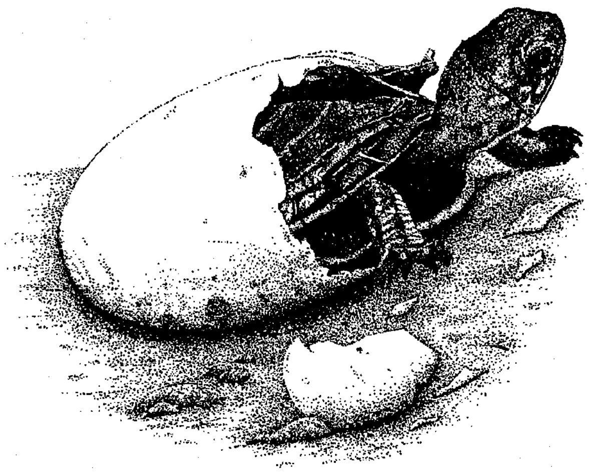
- Algae, which is eaten by tadpoles, should not be removed or treated in wetlands where Oregon spotted frogs occur.

- Muddy substrates, which may be used as hibernation sites, should not be altered.

- Avoid applying pesticides and herbicides in or adjacent to wetlands used by Oregon spotted frogs. If pesticide or herbicide use is being considered for areas where Oregon spotted frogs exist, refer to Appendix A which contains contacts useful when assessing pesticides and herbicides.

- Stormwater runoff from urban developments should not be diverted into spotted frog habitats. Urban runoff waters often contain heavy metals and other pollutants that may affect frogs. Refer to the Washington Department of Ecology's Stormwater management manual for the Puget Sound Basin (Wash. Dept. Ecol., 1992) for specific methods for controlling stormwater runoff.

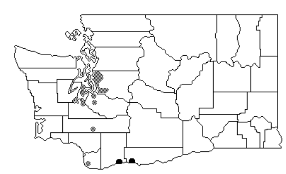
- Before undertaking any intensive survey efforts, particularly those employing traps or that involve the removal of substrate or handling specimens, WDFW should be contacted to determine whether a permit is necessary.



Western Pond Turtle
Clemmys marmorata

Prepared by Noelle Nordstrom and Ruth Milner

GENERAL RANGE AND WASHINGTON DISTRIBUTION



Historic range of the western pond turtle, *Clemmys marmorata*. Black dots represent locations known to remain. Map derived from WDFW data files.

The range of the western pond turtle follows the Pacific coast of North America, from the Puget Sound region in Washington to northwestern Baja California. Most populations are found west of the Cascade Mountain Range (Wash. Dept. Wildl.1993).

In recent years, these turtles have become virtually absent in the Puget Sound region (Wash. Dept. Wildl. 1993, Storm and Leonard 1995). Populations in Washington are confirmed only in Klickitat and Skamania counties. Individual turtle sightings have recently been confirmed in Pierce and King counties, which are part of the turtle's historic range. Historic records also exist for Clark and Thurston counties (McAllister 1995).

STATUS

The western pond turtle is a State Listed Endangered species.

RATIONALE

Populations of western pond turtles are declining in Washington. They are in jeopardy of extirpation due to their limited distribution, low numbers, and isolated populations. This species is vulnerable to extirpation in Washington by both natural and human-caused events (Wash. Dept. Wildl. 1993).

HABITAT REQUIREMENTS

Aquatic Habitats

Western pond turtles have been found in marshes, ponds, sloughs, and small lakes in Washington (Slater 1939), from sea level to approximately 763 m (2,500 ft) (Wash. Dept. Wildl. 1993). They have also been found in altered habitats such as gravel pits, reservoirs, stock ponds, and sewage treatment plants. They use both permanent and intermittent bodies of water, and have been found using a variety of substrates, including rock, gravel, sand, mud, decaying vegetation and various combinations of these (Wash. Dept. Wildl. 1993). These turtles have also been found in association with varying amounts of vegetation, from rocky streams with little emergent vegetation, to slow-moving waters with abundant emergent or submerged vegetation. Western pond turtles use sites with protected shallow areas that provide resting and feeding cover for juveniles. Submerged vegetation, rocks and logs, undercut banks, and mud are also important refugia for western pond turtles (Holland 1994, Storm and Leonard 1995). Adults require emergent logs or boulders, or floating vegetation for basking during sunny hours. Dense, woody vegetation that shades potential basking sites along watercourses may render an area unsuitable for western pond turtles (Wash. Dept. Wildl. 1993).

In a study of western pond turtle populations in Skamania County, Scott (1995) found these turtles more often in small or ephemeral ponds, than in larger ponds. Competition from painted turtles (*Chrysemys picta*), which were more frequent in the larger ponds, may have been a factor.

Water temperatures in which active western pond turtles have been observed range from 3 C (37°F) to 38 C (100°F), though they generally avoid water more than 35 C (95°F) (Wash. Dept. Wildl. 1993).

Terrestrial Habitats

Western pond turtles use open, upland habitats primarily for nesting, though dispersal and overwintering also occur on land (Holland 1994, Scott 1995). This species is extremely shy and easily disturbed. Vegetation that provides cover but that is not too dense for them to move through, is needed to provide refuge for turtles in upland areas.

Nesting - Female turtles leave the water to nest, sometime between late May and July. Females usually dig nests and deposit their eggs in compact, dry soil on upland sites (Storer 1930, Stebbins 1954, Nussbaum et al. 1983, Holland 1994, Storm and Leonard 1995). In Washington, nest sites have been found in hardpan soil with a significant clay or silt component. Most nests have been found in open areas with good sun exposure, on south or southwest-facing slopes that are sparsely covered with grasses and forbs (Holland 1994). The distance from water at which nesting occurs ranges from 3 m to 800 m (10 - 2,625 ft), though most nests are within 90 m (295 ft) of water (Holland 1994, Storm and Leonard 1995). Nests are flask or pear-shaped, and are carefully camouflaged with soil and vegetation by the female. In the northern portion of this turtle's range, hatchlings overwinter in the nest and emerge in the spring.

Dispersal - Western pond turtles move overland for several different reasons. Turtles may have a home range that includes separate bodies of water, such as a series of ponds. Environmental stress such as a drought, high water temperatures, or high water events that flush turtles from beneath river banks, also instigate overland movements.

Overwintering

Western pond turtles are mostly inactive during the winter in Washington, though they will periodically change locations or bask on sunny days. These turtles overwinter in both aquatic and terrestrial habitats. Terrestrial overwintering sites usually have a thick layer of duff into which the turtle will burrow, and have been found up to 500 m (1,640 ft) away from watercourses. In aquatic habitats, these turtles will winter under banks or in mud. Communal overwintering sites sometimes occur, with several turtles concentrated in a small area (< 1 m), such as the muddy bottom of a shallow pond. Movement to overwintering sites occurs between September and November, and emergence from these locations occurs between March and June (Holland 1994).

Diet

Western pond turtles are opportunistic feeders and eat a variety of food items, including carrion, aquatic invertebrates, insects, and worms. Plant material is not a primary food source, though it is occasionally consumed. Food sources probably vary from area to area, depending on local conditions (Bury 1986, Holland 1994).

LIMITING FACTORS

Western pond turtles are limited by the availability of shallow bodies of water with sufficient basking surfaces and vegetative cover. A variety of human activities can negatively affect this species. Predation, competition, and diseases from introduced species may also impact western pond turtles in Washington.

Though these turtles can live more than 30 years, they are slow growing and are not sexually mature until they are 8-12 years old (Nussbaum et al. 1983, Storm and Leonard 1995). They also suffer a high sub-adult mortality rate (Wash. Dept. Wildl. 1993). Holland (1994) suggests that survival of western pond turtles during the first three years of life is only between 10-15%. The combination low reproductive rate, high juvenile mortality and low recruitment makes this turtle very sensitive to disturbance. The long life spans of these turtles means that they may persist in an area for years after the population is no longer reproductively viable, making it difficult to tell when detrimental changes have occurred in their environment (Wash. Dept. Wildl. 1993).

Introduced Species

Nonnative reptile, amphibian, and fish species have the potential to elevate predation pressure on western pond turtles, compete with them for prey, and even alter habitat. Predation on young turtles by introduced bullfrogs (*Rana catesbeiana*) and possibly introduced fish such as the largemouth bass (*Micropterus salmoides*) (Holland and Bury 1997), may affect the western pond turtle in Washington. Numbers of bullfrogs in an area can be large enough to prevent significant recruitment within a population of western pond turtles (Holland 1994). Sunfish can compete with the turtles for prey, and carp alter habitat by feeding on submerged vegetation and disturbing benthic sediment (Wash. Dept. Wildl. 1993). Competition with introduced turtles such as the painted turtle, which is native to eastern Washington, and the red-eared slider, a turtle commonly sold in pet stores, may also be a factor. Introduced turtles compete with western pond turtles for resources, and they can also be a source of disease (Holland 1994, Storm and Leonard 1995). Western pond turtles have evolved in isolation from other turtle species, which may make them particularly vulnerable to pathogens carried by introduced species (Wash. Dept. Wildl. 1993).

Human Activities

Human activities affect this turtle on several different levels. Historically, western pond turtles have been used as a food source, though this probably occurs on a much smaller scale today, if at all. These turtles are also occasionally kept as pets, accidentally caught by fishers, shot, or otherwise harassed. Being run over by automobiles is probably the main form of direct, human caused mortality for turtles (Holland 1994).

Habitat alteration is probably the most significant problem faced by the western pond turtle. Many of Washington’s wetlands have been lost to reclamation, water diversion for irrigation, and development. Livestock grazing or trampling emergent vegetation can alter aquatic and riparian habitats, possibly making them less suitable for young turtles. Dams and reservoirs have also adversely impacted western pond turtles by altering the water flows in drainages, and by eliminating and fragmenting habitats (Wash. Dept. Wildl. 1993).

Upland activities such as timber harvest, slash burning, road building, and recreation within 500 m (0.3 mi) can harm these turtles, since they move overland to disperse, lay eggs, and overwinter. There may by little or no “safe” period for disturbances in upland areas used by western pond turtles. Egg-laying begins in May, and incubation extends into November. Hatchlings commonly overwinter in their nest, and many adults also winter in upland habitats. Overwintering adults have been known to remain in terrestrial habitats from 8 to 10 months (Holland 1994).

Pesticides such as rotenone (a fish poison) may directly poison turtles, or indirectly harm them by affecting food sources. Chemical spills in areas used by western pond turtles can also cause mortality (Holland 1994).

MANAGEMENT RECOMMENDATIONS

The western pond turtle should be considered when managing any watercourse within 1 km (0.5 mi) of a site known to contain this species (K. McAllister, pers. comm.). Efforts to manage for western pond turtles only in small portions of a watercourse or in discreet ponds may not help this species over time, since individual turtles range overland between aquatic sites (Holland 1994).

A no-disturbance buffer between 400-500 m (1,300 - 1,600 ft) should be employed around all bodies of water inhabited by western pond turtles (Holland 1994).

Emergent logs or stumps should be left in the water. Logs should be provided if basking sites are limited or unavailable. Western pond turtles bask out of water several hours each day (Bury and Wolfheim 1973).

Alterations to wetlands used by western pond turtles, such as draining or filling, should be avoided. These activities can eliminate protected shallow areas or cause vegetation to become so dense that the turtles cannot maneuver through them.

The construction of barriers such as bulkheads, roads, ditches, or chain link fences should be avoided within a radius of at least 400 m (1,300 ft) around bodies of water occupied by pond turtles. Adult turtles may travel several hundred meters to get to nesting sites (Storer 1930), or move between ponds. In Washington, nests have been found up to 800 m (2,625 ft) away from water, though most nests are within 90 m (295 ft) (Holland 1994, Storm and Leonard 1995).

Sunny embankments and other open sites used for nesting should be protected from vehicles, and trampling by people and livestock (Holland 1994).

Introduced fish or amphibian species should not be introduced into waters containing western pond turtles or in waters within close vicinity of these sites (Holland 1994). Bullfrogs, bass, and carp are not native to Washington and may prey on young turtles. Introduced carp may also damage the vegetative component of the turtle's habitat (Wash. Dept. Wildl. 1993). Game fish introductions within 5 km (3 mi) of western pond turtle sites should be carefully evaluated for potential impacts to this rare reptile. The release of pet turtles or other nonnative turtles into the wild should be avoided. Introduced turtles compete with western pond turtles for resources, and have the potential to spread disease and parasites (Holland 1994). Proposed releases of introduced species into habitats near sites known to support western pond turtles should be accompanied by research demonstrating compatibility.

Herbicides should not be applied where western pond turtles occur, if such action will destroy all available cover in all or part of a wetland. Removal of vegetative cover is likely to be detrimental to western pond turtles, except in situations where vegetation has become very dense as a result of succession or human-caused disturbance. Applications of pesticides and other chemicals that could eliminate food sources or have a toxic effect on turtles should also be avoided near sites occupied by western pond turtles. If pesticide or herbicide use is planned for areas in or near western pond turtle sites, refer to Appendix A, which lists contacts useful when assessing chemical treatments and their alternatives.

Activities such as timber harvest, road building, burning and recreational activities should not occur within 400 m (1,300 ft) of waters inhabited by these turtles. Western pond turtles have been known to winter in upland areas up to and occasionally beyond this distance from water (Holland 1994).

Succession of plant communities should be considered when managing areas used by these turtles. It is possible that plant community succession may need to be controlled in some situations. Most western pond turtle sites in Skamania County were found where early successional communities had been created by silvicultural or agricultural practices (Scott 1995).

Monitoring sites with western pond turtle populations and surveying suitable, unoccupied habitats, should continue (Scott 1995). Before undertaking any intensive survey efforts, particularly those employing traps or that involve the removal of substrate or handling specimens, WDFW should be contacted to determine whether a permit is necessary.

RESEARCH NEEDS

The genetic variability, life-history, and ecology of western pond turtle populations across their entire range needs to be examined. Factors influencing reproduction and nesting success need further study, as does effective protection of wild populations, ways to enhance survival of young turtles in the wild, and effective monitoring of disturbed and undisturbed habitats. The effectiveness of manipulative techniques, such as captive breeding or head start programs, and habitat creation/alteration also needs further study (Holland and Bury 1997).

In addition, introduced species thought to impact the western pond turtle should be studied individually to determine their significance. Means to safely and effectively remove or exclude introduced amphibian, reptile, and fish species should be developed for use in areas where they are known to have a negative impact.

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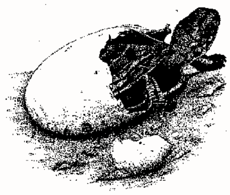
KEY POINTS



Western Pond Turtle
Clemmys marmorata

Habitat Requirements

- Western pond turtles inhabit ponds, small lakes, and other wetlands with abundant aquatic vegetation and protected shallow areas.

- These turtles require logs, banks, or floating vegetation for basking.

- Eggs are laid on the banks of bodies of water, or in open areas in adjacent uplands.

- Western pond turtles hibernate during winter in the muddy or sandy bottoms of lakes, or in duff on land.

Management Recommendations

- The western pond turtle should be considered when managing any watercourse within 1 km (0.5 mi) of a site known to contain this species. Efforts to manage for western pond turtles only in small portions of a watercourse or in discreet ponds, may not help this species over time, since individual turtles range overland between aquatic sites.

- A no disturbance buffer between 400-500 m (1,300 - 1,600 ft) should be employed around all bodies of water inhabited by western pond turtles. The construction of barriers such as bulkheads, roads, ditches, or chain link fences should be avoided within this distance, as should activities such as timber harvest, road building, burning, and recreation.

- Emergent logs and stumps should not be removed from waters where western pond turtles occur. Consider providing logs and other basking surfaces if basking sites are lacking or limited.

- Alterations to wetlands used by western pond turtles, such as draining, dredging, or filling should be avoided.

- The elimination of protected shallow areas in wetlands should be avoided.

- Disturbances that could cause vegetation in and around wetlands to become extremely dense, possibly inhibiting the turtles' movements, should be avoided.

- Banks, sunny slopes, and other open sites on adjacent uplands should be protected from excessive trampling by livestock, people, and vehicles.

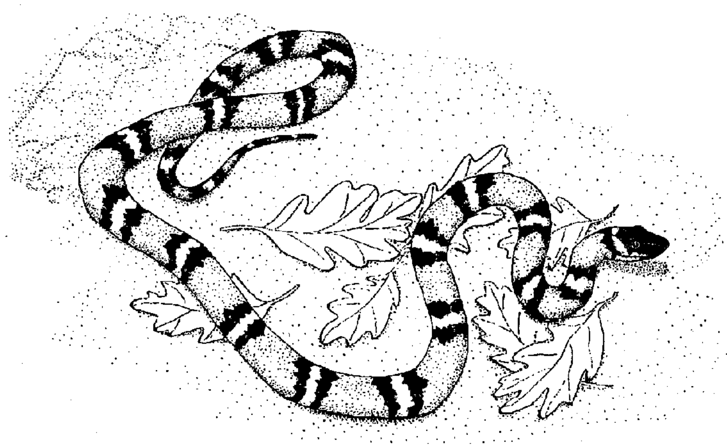
- The introduction of bullfrogs, nonnative fish, and introduced turtles into ponds used by western pond turtles should be avoided. Proposed releases of introduced species into habitats near sites known to support western pond turtles should be accompanied by research demonstrating compatibility.

- Herbicides should not be applied if such action will destroy all available cover in all or part of a wetland. Applications of herbicides, pesticides and other chemicals that could eliminate food sources or have a toxic effect on turtles should also be avoided near sites occupied by western pond turtles. If pesticide or herbicide use is planned for areas near where this species occurs, review Appendix A (page A-1), which lists contacts useful when assessing pesticides and their alternatives.

- If plant community succession is impacting areas used by these turtles, means of controlling succession should be considered.

- Monitoring sites with western pond turtle populations as well as suitable, unoccupied sites within the historic range of this species should continue.

- Before undertaking any intensive survey efforts, particularly those employing traps or that involve the removal of substrate or handling specimens, WDFW should be contacted to determine whether a permit is necessary.

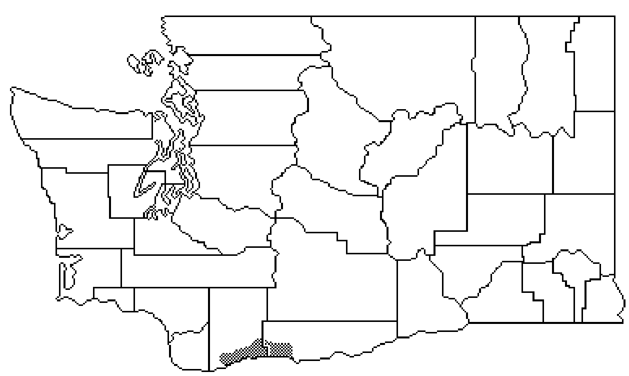


California mountain kingsnake
Lampropeltis zonata

Prepared by Noelle Nordstrom and Karen Riener

GENERAL RANGE AND WASHINGTON DISTRIBUTION

The range of the California mountain kingsnake extends from northern Baja California, northward through California and Oregon. An isolated population occurs in southcentral Washington (Wright and Wright 1957, Stebbins 1985). The eastern edge of this snake's range is bordered by the west slope of the Sierra Nevada mountains, from Kern County, California to southwestern Oregon. The California mountain kingsnake occurs no further west than the eastern slope of the Coast Range, from north of San Francisco Bay to southwestern Oregon (Zweifel 1975).



Known distribution of the California mountain kingsnake, *Lampropeltis zonata*, in Washington. Map derived from the literature.

In Washington, the California mountain kingsnake is known to occur along the Columbia River Gorge in Klickitat and Skamania counties (Stebbins 1985, Storm et al. 1995). This area, disjunct from the southern portions of the species' range by more than 200 miles, represents the northernmost occurrence of this snake. Additionally, there are unconfirmed observations from Yakima County and the Blue Mountains of southeastern Washington (Storm et al. 1995).

STATUS

The California mountain kingsnake is a State Candidate species.

RATIONALE

Numbers of California mountain kingsnakes in Washington appear to be low, and they are known to occur in only a very small area of Washington (Stebbins 1985, Storm et al. 1995).
This snake species is vulnerable to land use activities that alter its habitat.

HABITAT REQUIREMENTS

Little is known about the habitat requirements of this species. California mountain kingsnakes are generally found below 91 m (300 ft) in Washington but have been found up to 914 m (3,000 ft) in Oregon (Storm et al. 1995). This snake is most often found in forested canyons containing well illuminated, rocky streams, and abundant woody debris (Wright and Wright 1957, Knight 1979). This species has also been found in mountain forests and in dry farming habitats (Wright and Wright 1957) but is usually near streams, ponds, and creeks (Howe 1986). In Washington, the California mountain kingsnake seems to prefer moist habitats within Oregon white oak (*Quercus garryana*) woodlands and ponderosa pine (*Pinus ponderosa*) forests, where they can be found under rocks and rotting logs (Knight 1979, Storm et al. 1995).

The California mountain kingsnake's diet consists primarily of lizards and lizard eggs, bird eggs, nestling birds, small rodents, and frogs. Prey are killed by constriction (Wright and Wright 1957, Zweifel 1975, Stebbins 1985, Howe 1986, Storm et al. 1995).

LIMITING FACTORS

Factors limiting the distribution of this species are unknown. Since Washington populations of this snake are known to occur in oak woodlands and pine forests only, the presence of these forest types may be necessary to support the California mountain kingsnake in this state.

MANAGEMENT RECOMMENDATIONS

Because so little is known about California mountain kingsnake ecology, recommending specific land management strategies is difficult. At the very least, dead and down woody material and organic surface debris should be left for cover, as should talus and other rocky areas. Adjacent open areas may be equally important for thermoregulation and digestion.

Oak and pine forested riparian corridors containing surface water should be left undisturbed as habitat for the California mountain kingsnake. Tree and shrub-covered streamsides provide an important moist microclimate.

Within its known range, surveys for the California mountain kingsnake should be conducted prior to land-use activities that may alter its habitat.

Before undertaking any intensive survey efforts, particularly those employing traps or that involve the removal of substrate or handling specimens, WDFW should be contacted to determine whether a permit is necessary.

RESEARCH NEEDS

Further field studies are needed to assess the population status of the California mountain kingsnake in Washington, as well as which habitat features are important to this snake.

Details regarding the selection of hibernacula, prey requirements, breeding, and home ranges need further study.

It needs to be determined to what degree specimen collection impacts the California mountain kingsnake.

Washington's California mountain kingsnakes are isolated from the rest of this species' range by over 200 miles. How has this isolation affected the snakes genetically and demographically?

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KEY POINTS

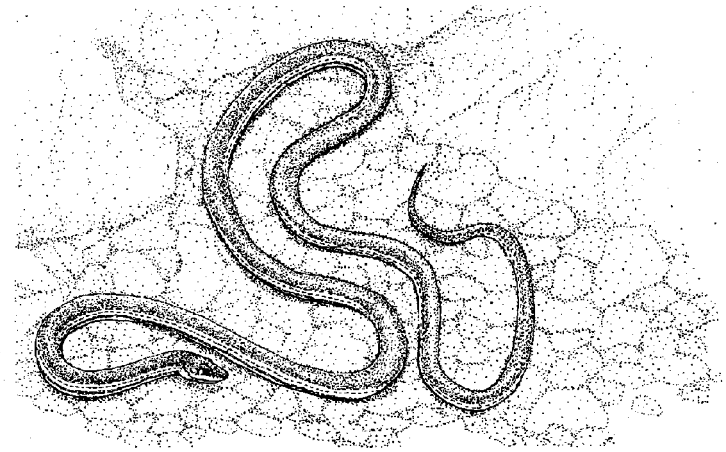
California mountain kingsnake
Lampropeltis zonata

Habitat Requirements

- California mountain kingsnakes are found in oak and pine wooded canyons where there is surface water, and abundant dead and down woody debris.
- This snake uses woody debris and rocks for cover.
- The California mountain kingsnake's prey base consists of lizards and lizard eggs, bird eggs, nestling birds, small rodents, and frogs.

Management Recommendations

- Oak and pine forested riparian corridors containing surface water should be left undisturbed as habitat for the California mountain kingsnake. Tree and shrub-covered streamsides provide an important moist microclimate.
- Tracts of native woodland habitats that are large enough to support a prey base for this snake should be retained.
- Dead and down woody material and organic surface debris, as well as talus and other rocky areas, should be retained for cover.
- Within its known range, surveys for the California mountain kingsnake should be conducted prior to land-use activities that may alter its habitat.
- Before undertaking any intensive survey efforts, particularly those employing traps or that involve the removal of substrate or handling specimens, WDFW should be contacted to determine whether a permit is necessary.

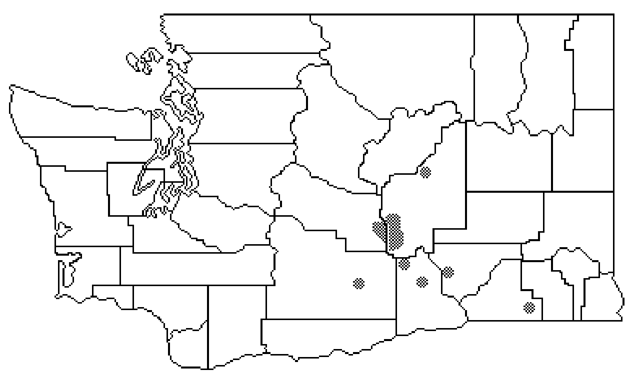


Striped Whipsnake
Masticophis taeniatus

Prepared by Noelle Nordstrom and Morie Whalen

GENERAL RANGE AND WASHINGTON DISTRIBUTION

The range of the striped whipsnake extends from northeastern Mexico and southwestern Texas, northwest through southern New Mexico and into the Great Basin. From there it stretches north through central Oregon and into southcentral Washington (Shaw and Campbell 1974, Behler and King 1979, Stebbins 1985).



Known distribution of the striped whipsnake, *Masticophis taeniatus*, in Washington. Distribution map derived from WDFW data files.

In Washington, this snake occurs in the Columbia Basin, along the Columbia River border of Walla Walla, Benton, Franklin, Kittitas, and Grant counties. One occurrence has been documented along the Yakima River in Yakima County (Svihla 1955, Slater 1963, Nussbaum et al. 1983, Folliard and Larsen 1990).

STATUS

The striped whipsnake is a State Candidate species.

RATIONALE

The striped whipsnake is rare in Washington (Svihla 1955, Slater 1963, Nussbaum et al. 1983, Folliard and Larsen 1990, Storm and Leonard 1995). There is little historic information available on its numbers and distribution, and sightings are few. This snake was probably never abundant in Washington, which is the northernmost extent of its range (Slater 1941, Svihla 1955).

Striped whipsnakes are in jeopardy due to diminishing habitat and low population numbers. These snakes also form vulnerable aggregations during the winter when they hibernate communally. Striped whipsnakes inhabit the shrub-steppe ecosystems of eastern Washington, much of which has been converted to agricultural lands. Only 40% of eastern Washington's original shrub-steppe remains, much of which is fragmented (Dobler et al.1996).

HABITAT REQUIREMENTS

In Washington, striped whipsnakes inhabit relatively undisturbed native grasslands, sagebrush flats, and dry, rocky canyons with elevations up to 605 m (1,985 ft) (Storm and Leonard 1995). They require shrubs for cover, and rock crevices or rodent burrows for egg-laying and hibernation. The striped whipsnake's diet consists primarily of lizards, snakes, and small mammals. They also reportedly feed on young birds and insects (Shaw and Campbell 1974, Parker and Brown 1980, Nussbaum et al. 1983).

Striped whipsnakes use the branches of bushes and small trees for hunting, basking, and cover (Shaw and Campbell 1974, Nussbaum et al. 1983). Dense, shrubby vegetation provides a safe route to rock outcrops and rodent burrows (St. John 1980). The shrub spiny hopsage (*Grayia spinosa*) has been found to provide good habitat for reptiles in shrub-steppe ecosystems (Folliard and Larsen 1990), and its presence may indicate an area's suitability for striped whipsnakes. Spiny hopsage is a dense shrub with a sound root system. It occurs in place of sagebrush on dry, rocky sites and in areas where soil salinity levels are high (Daubenmire 1942, Hayes and Garrison 1960, Daubenmire 1970, Lyons 1977, Franklin and Dyrness 1988). Parker and Brown (1972) found striped whipsnakes using rodent burrow systems for egg-laying. Since rodent burrows are important habitat for these snakes, the presence of spiny hopsage may be a useful visual clue to how suitable an area is for them.

Striped whipsnakes hibernate communally in winter, and have strong den-site fidelity (L. Hallock, pers. comm.). Rodent burrows, rocky crevices, and masses of rocks in dry washes are used as hibernaculum (Wright and Wright 1957; Parker and Brown 1972, 1980; St. John 1980; Nussbaum et al. 1983). Other species known to hibernate with striped whipsnakes include the gopher snake

(*Pituophis catenifer*), racer (*Coluber constrictor*), and western rattlesnake (*Crotalus viridis*) (Wright and Wright 1957, St. John 1980, Nussbaum et al. 1983). In the fall, striped whipsnakes congregate at hibernacula during ecdysis (skin-shedding) (Parker and Brown 1980).

In spring, areas surrounding hibernacula are used for mating before snakes disperse. Parker and Brown (1980) found that striped whipsnakes remained near their den from 2-7 weeks after emerging from the hibernaculum. Females moved to new locations within 200 m (656 ft) of the den and remained at these locations until mating, while the males actively searched for the females. Migration occurred after mating. Although sample sizes were small, the average distance for females was 1,455 m (4,772 ft), and was 992 m (3,254 ft) for males. Radio telemetry studies have not yielded enough data to discern average home ranges of striped whipsnakes, though they have been observed occupying the same area each year (Parker and Brown 1972, 1980).

LIMITING FACTORS

Activities that alter native grasslands, sagebrush, and dry, rocky canyons inhabited by striped whipsnakes, are detrimental to this species. Cultivation and irrigation are the two activities most likely to alter habitat within this snake's range.

The use of communal hibernacula may expose large numbers of whipsnakes to predation, disease, or destructive environmental conditions. Indiscriminate pest control of other snake species (e.g., injecting gasoline into dens to flush out rattlesnakes for extermination) may cause unintentional loss of striped whipsnake populations (K. McAllister, pers. comm.).

MANAGEMENT RECOMMENDATIONS

Areas of shrub-steppe habitat that support rodent burrow systems should be conserved. Rodent burrows in sagebrush, near talus slopes, rocky canyons and ravines, and dry, rocky streambeds are known to provide optimal habitats.

Disturbances to known hibernacula should be avoided.

Indiscriminate snake control methods that target communal hibernacula in shrub-steppe habitats should be avoided.

Before undertaking any intensive survey efforts, particularly those employing traps or that involve the removal of substrate or handling specimens, WDFW should be contacted to determine whether a permit is necessary.

RESEARCH NEEDS

Information is lacking on many aspects of striped whipsnake ecology in Washington. This species' distribution, specific habitat requirements, rate of den colonization, dispersal patterns and home range sizes, require further study. Studies on inter- and intra-specific relationships would also yield valuable information.

Stimuli that trigger autumn migration to hibernacula should be investigated, as should methods used for orientation by these snakes (Parker and Brown, 1980).

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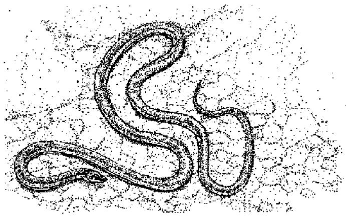
KEY POINTS



Striped Whipsnake
Masticophis taeniatus

Habitat Requirements

- Striped whipsnakes use shrub-steppe habitats near talus slopes, and ravines and canyons that are dry and rocky.
- Striped whipsnake dens and hibernacula are often used communally, and include rodent burrows, rock crevices, and rock piles.
- Sagebrush or hopsage bushes are used by striped whipsnakes as travel corridors between den sites and as important cover and feeding sites.

Management Recommendations

- Shrub-steppe habitats near talus slopes or dry, rocky canyons and ravines should be conserved.
- Known hibernaculum should be protected from human disturbance.
- Indiscriminate pest control methods of other snake species, especially methods that target communal hibernacula in shrub-steppe habitats, should be avoided.
- Before undertaking any intensive survey efforts, particularly those employing traps or that involve the removal of substrate or handling specimens, WDFW should be contacted to determine whether a permit is necessary.

APPENDIX A: CONTACTS USEFUL WHEN EVALUATING PESTICIDES AND THEIR ALTERNATIVES

GOVERNMENT ORGANIZATIONS

United States Environmental Protection Agency

Region 10 Public Affairs Office, Seattle 1-800-424-4372
Provides information, brochures, and technical help on pesticide application.

Washington State Department of Agriculture

Pesticide Management
General Information .... (360) 902-2010
Assistant Director .... (360) 902-2011

Compliance
Enforces state and federal pesticide laws; investigates complaints of pesticide misuse.
Manager .... (360) 902-2036
Olympia Compliance .... (360) 902-2040
Mount Vernon Compliance .... (360) 428-1091
Spokane Compliance .... (509) 625-5229
Wenatchee Compliance .... (509) 664-3171
Yakima Compliance .... (509) 575-2746

Registration
Registers pesticides sold and used in Washington.
Manager .... (360) 902-2026
Pesticide Registration - Olympia .... (360) 902-2030
Pesticide Registration - Yakima .... (509) 575-2595

Program Development and licensing
Licenses pesticide application equipment and pesticide dealers; commercial, public, and private pesticide applications; and operators and consultants. Conducts waste pesticide disposal program; responsible for public outreach and education.
Manager .... (360) 902-2051
Pesticide Licensing and Recertification .... (360) 902-2020
Waste Pesticide Collection .... (360) 902-2050
Farmworker Ed. and Pest. Licensing - Yakima .... (509) 575-2746

Washington Department of Ecology

Regional Contacts
Provides information and permits on applying pesticides directly or indirectly to open bodies of water.
Eastern Region, Spokane .... (509) 456-2873
Central Region, Yakima .... (509) 457-7207
Northwest Region, Bellevue .... (206) 649-7070
Southwest Region, Olympia .... (360) 407-6292

Washington Department of Fish and Wildlife

Regional Contacts

A regional program manager will direct your questions to a biologist. The department can provide information on what priority habitats and species are known to be in your area, and the life requisites of priority species.

Region 1, Spokane	(509) 456-4082
Region 2, Ephrata	(509) 754-4624
Region 3, Yakima	(509) 575-2740
Region 4, Mill Creek	(206) 775-1311
Region 5, Vancouver	(360) 696-6211
Region 6, Montesano	(360) 249-6523

Habitat Research and Information Services . . . . . (360) 902-2543

Mapped information and management recommendations for Washington's priority habitats and species can be obtained by calling

Washington Poison Control Center . . . . . (800) 732-6985

Provides information on who to contact in case of exposure to, or spill of pesticides and other toxic substances

WASHINGTON STATE UNIVERSITY COOPERATIVE EXTENSION SERVICE COUNTY AGENTS

County	Address	City	Phone #
Adams	210 W. Broadway	Ritzville 99169	(509) 659-0090 Ext. 214
Asotin	125 Second St.	Asotin 99402-0009	(509) 243-2018
Benton	1121 Dudly Ave.	Prosser 99350	(509) 786-5609
Benton	5600-E W Canal Pl.	Kennewick 99336	(509) 735-3551
Chelan	400 Washington St.	Wenatchee 98801	(509) 664-5540
Clallam	223 East 4th St.	Port Angeles 98362	(360) 417-2279
Clark	11104 NE 149th St.	Bush Prairie 98606	(360) 254-8436
Columbia	202 S. 2nd St.	Dayton 99328	(509) 382-4741
Cowlitz	207 4th Ave N	Kelso 98626	(360) 577-3014
Douglas	PO Box 550	Waterville 98858	(509) 745-8531
Ferry	350 E. Delaware	Republic 99166	(509) 775-5235
Franklin	Courthouse	Pasco 99301	(509) 545-3511
Garfield	PO Box 190	Pomeroy 99347	(509) 843-3701
Grant	1st and C St.	Ephrata 98823	(509) 754-2011 Ext. 412
Grays Harbor	100 Broadway W.	Montesano 98563	(360) 249-4332
Island	501 N Center	Coupeville 98239	(360) 679-7327
Jefferson	201 W. Patison	Port Hadlock 98339	(360) 379-5610
King	612 Smith Tower	Seattle 98104	(206) 296-3900
Kitsap	614 Division	Port Orchard 98366	(360) 876-7157
Kittitas	Courthouse - Rm 217	Ellensburg 98926	(509) 962-7507
Klickitat	228 W Main, Rm 210	Goldendale 98620	(509) 773-5817

County	Address	City	Phone #
Lewis	360 NW North St.	Chehalis 98532	(360) 740-1212
Lincoln	P.O. Box 399	Davenport 99122	(509) 725-4171
Mason	11840 Hwy 101 N	Shelton 98584	(360) 427-9670 Ext. 395
Okanogan	P.O. Box 391	Okanogan 98840	(509) 422-7245
Okanogan	Lake Roosevelt, 708 Crest Drive	Coulee Dam 99116	(509) 633-9196
Pacific	P.O. Box 88	South Bend 98586	(360) 875-9331
Pend Oreille	418 South Scott	Newport 99156	(509) 447-2401
Pierce	3049 S 36th,Ste. 300	Tacoma 98409	(260) 591-7180
San Juan	315 Court St.	Friday Harbor 98250	(360) 378-4414
Skagit	220 E College Way, Suite 180	Mount Vernon 98273	(360) 428-4270
Skamania	P.O. Box 790	Stevenson 98628	(509) 427-9427
Snohomish	600 128th St. NE	Everett 98208	(206) 338-2400
Spokane	222 N Havana	Spokane 99202	(509) 533-2048
Stevens	230 Williams Lake Rd	Colville 99114	(509) 684-2588
Thurston	921 Lake Ridge Dr. SW, Rm. 216	Olympia 98501	(360) 786-5445
Wahkiakum	68 Main St.	Cathlamet 98612	(360) 795-3278
Walla Walla	317 W. Rose St.	Walla Walla 99362	(509) 527-3260
Whatcom	11 N Forest St., Suite 201	Bellingham 98225	(360) 676-6736
Whitman	310 N Main, Rm. 209	Colfax 99111	(509)397-6290
Yakima	128 N 2nd St., Rm. 233	Yakima 98901	(509) 575-4218

NON-GOVERNMENT ORGANIZATIONS

Agricultural Support Groups

Tilth Producers . . . . (800) 731-1143
Chapter of Washington Tilth
P.O. Box 85056
Seattle, WA 98145-1056
Provides a directory of organic growers, food and farm suppliers, and resources, called the Washington Tilth Directory. Can help place farmers wishing to reduce pesticide use in touch with those who have already done so.

Northwest Coalition for Alternatives to Pesticides . . . . (541) 344-5044
P.O. Box 1393
Eugene, OR 97440
Provides information on a network of farmers practicing sustainable agriculture.

Palouse-Clearwater Environmental Institute . . . . (208) 882-1444
P.O. Box 8596
4th, Suite 1
Moscow, ID 83843
Coordinates farm/consumer improvement clubs in eastern Washington and is the western coordinator of the Campaign for Sustainable Agriculture.

Alternative Energy Resources Organization . . . . (406) 443-7272
25 S. Ewing Suite 214
Helena, MT 59601
Coordinates a network of farm improvement clubs and produces a list of organic growers in Montana. Has information on growing grains in the Palouse region.

Financial Support for Farmers Shifting to Sustainable Agriculture

Cascadia Revolving Loan Fund . . . . (206) 447-9226
157 Yesler Way, Suite 414
Seattle, WA 98104
A non-profit organization that lends money to small businesses.

Sustainable Agriculture Research and Education
Western Region SARE/ACE Program
ASTE Bldg. UMC 2310, Utah State University,
Logan, UT 84322-2310
A federal grant program for farmer-directed, on-farm research. The grants are called Farmer/Rancher Research Grants.

The Organic Farming Research Foundation . . . . (408) 426-6606
P.O. Box 440
Santa Cruz, CA 98061
Provides funding for organic farming methodology research.

Insectaries

Northwest Biocontrol Insectary/Quarantine Insectary . . . . (509) 335-5815
Terry Miller
Can provide limited technical advice on using beneficial insects as biological control agents.

Integrated Pest Management and Non-Chemical Alternatives

Bio-Integral Resource Center . . . . (510) 524-2567
P.O. Box 7414
Berkeley, CA 94707
Publishes "Common Sense Pest Control Quarterly", and "The IPM Practitioner Monitoring the Field of Pest Management."

Integrated Fertility Management . . . . (800) 332-3179
333 Ohme Gardens Rd.
Wenatchee, WA 98801
Provides information on organic farming, biological pest control, and soil amendments. Also provides a network with which growers can contact each other.

Northwest Coalition for Alternatives to Pesticides . . . . (541) 344-5044
Provides information regarding integrated pest management, a list of private consultants, as well as other sources and contacts.

Washington Toxics Coalition . . . . (206) 632-1545
Has an information file on many topics involving chemical pesticides, including effects on the environment and on human health, as well as alternatives to household and garden chemicals.

National Organizations

Appropriate Technology Transfer for Rural Areas . . . . (800) 346-9140
P.O. Box 3657
Fayetteville, AK 72702
Information service on sustainable agriculture and crop production.

Chemical Referral Center . . . . (800) 262-8200
(Non-emergency phone number)
Sponsored by the Chemical Manufacturers Association. Will refer the caller to the manufacturer of the chemical in question, and provide telephone numbers of other hotlines.

National Agricultural Library . . . . (301) 504-6559
Alternative Farming Systems Information Center
10301 Baltimore Blvd.
Beltsville, MD 20705-2351
Provides bibliographies on topics such as cover crops, living mulches, compost, etc. Will do individual searches on national agricultural databases for free. Provides specific, technical information.

National Pesticide Telecommunication Network . . . . (800) 858-PEST (7378)
(Oregon State University)
Provides 24-hour information on pesticide products, poisoning, cleanup and disposal, enforcement contacts, certification and training programs, and pesticide laws.

Safety, Storage, Handling, and Disposal

Washington Toxics Coalition . . . . (206) 632-1545
Has an information file on many topics involving chemical pesticides, including effects on the environment and on human health.

Local Solid Waste/Recycling Centers
Your county or municipal solid waste center may be of assistance when disposing of pesticides and herbicides.

INDEX TO SPECIES BY STANDARD NAME