Survey Protocols for

AMPHIBIANS

Under the Survey & Manage Provision of the Northwest Forest Plan

Version 3.0

October 1999

As the Nation's principal conservation agency, the Department of the Interior has responsibility for most of our nationally owned public lands and natural resources. This includes fostering the wisest use of our land and water resources, protecting our fish and wildlife, preserving the environmental and cultural values of our national parks and historical places, and providing for the enjoyment of life through outdoor recreation. The Department assesses our energy and mineral resources and works to assure that their development is in the best interest of all our people. The Department also has a major responsibility for American Indian reservation communities and for people who live in Island Territories under U.S. administration.

BLM/OR/WA/PT-00/033+1792

United States Department of Agriculture	**Forest Service R-5/6**	**Bureau of Land Management**	**United States Department of Interior OR/WA/CA**

Reply Refer To: 1920/2600 (FS)/ 1736-PFP(BLM) (931)P **Date:** October 18, 1999

EMS TRANSMISSION 10/19/99

FS-Memorandum **BLM-Instruction Memorandum No. OR-2000-004**
Expires: 09/30/2001

To: USDI Bureau of Land Management District Managers (Coos Bay, Eugene, Lakeview, Medford, Roseburg, Salem) and Field Managers (Arcata, Klamath Falls, Redding, and Ukiah) and USDA Forest Service Forest Supervisors Within the Area of the Northwest Forest Plan

Subject: Survey and Manage Survey Protocols - **Amphibians v. 3.0**

The ***Standards and Guidelines for Management of Habitat for Late-Successional and Old-Growth Forest Related Species within the Range of the Northern Spotted Owl*** include the requirement to conduct surveys for particular amphibians prior to all ground-disturbing activities that will be implemented in FY 1997 or later (page C-5, Component 2). Surveys are required within the known or suspected range and within the habitat types or vegetative communities associated with the amphibian species identified within Component 2.

Enclosed are the standard protocols (Version 3.0) for conducting surveys for amphibians. This version and transmittal letter replace the March 12, 1996 draft protocol that was transmitted by a cover letter dated March 18, 1996, memoranda dated October 2, 1997, June 29, 1998 (BLM Information Bulletin No. OR-98-246), and June 29, 1998 (R-6, File Code 2670) concerning amphibian survey protocol adjustments.

This memorandum transmits 5 amphibian protocols to field officials for immediate implementation. Survey methods and survey conditions in the 1996 draft protocol are more comprehensive than those in version 3.0. Therefore, surveys initiated following the draft protocol meet the requirements of the present Version 3.0 protocol.

The protocols are designed so that there is a high probability of finding populations of these species, if present. Please follow the standard protocols as closely as possible.

Although the protocols may be revised in the future, projects surveyed according to these protocols will be considered as meeting the requirements of Component 2.

Please address any questions to Cheryl McCaffrey (BLM), Sarah Madsen (FS R-6), or Paula Crumpton (FS R-5). They can be reached at:

Cheryl - 503-952-6050; E-mail: cmccaffr@or.blm.gov
Sarah - 503-808-2673; E-mail: smadsen/r6pnw@fs.fed.us
Paula - 530-242-2242; E-mail: pcrumpton/r5_shastatrinity@fs.fed.us

Signed By
Al Wright
ALFRED W. WRIGHT
Acting State Director, CA
USDI Bureau of Land Management

Signed By
Bradley E. Powell
BRADLEY E. POWELL
Acting Regional Forester, Region 5
USDA Forest Service

Signed By
William L. Bradley (for)
ELAINE Y. ZIELINSKI
State Director, OR/WA
USDI Bureau of Land Management

Signed By
Robert J. Devlin (for)
NANCY GRAYBEAL
Acting Regional Forester, Region 6
USDA Forest Service

Authenticated by
Mary O'Leary
Management Assistant

Enclosure (under separate cover)

Distribution:

<table>
<tr><th colspan="2">BLM</th><th colspan="2">Forest Service</th></tr>
<tr><td>District Managers Oregon</td><td>Field Managers</td><td>Forest Supervisors Region 6</td><td>Forest Supervisors Region 5</td></tr>
<tr><td>Coos Bay
Eugene
Lakeview
Medford
Roseburg
Salem</td><td>Arcata
Klamath Falls
Redding
Ukiah</td><td rowspan="2">Deschutes
Gifford Pinchot
Mt. Baker-Snoqualmie
Mt. Hood
Okanogan
Olympic
Rogue River
Siskiyou
Siuslaw
Umpqua
Wenatchee
Willamette
Winema</td><td>Klamath
Lassen
Mendocino
Modoc
Shasta Trinity
Six Rivers</td></tr>
<tr><td colspan="2"><u>BLM Distribution</u>:
WO-230 (Room 204LS)-1
CA-330 (P.Roush)-1
CA-930-1
OR-912 (A.Agnew)-1
OR-931 (C.McCaffrey)-1
OR-934 (P. Teensma)</td><td><u>FS Distribution</u>:
R5:
Shasta Trinity, Paula Crumpton
Orleans RD, John Larson
R6:
NR, Sarah Madsen
R6-SP - 1</td></tr>
<tr><td colspan="2"><u>REO Distribution</u>:
Belisle -1
Mohoric -1
Sims -1
Watson -1</td><td><u>Research Units</u>:
PNW - 1
PSW - 1</td><td></td></tr>
</table>

SURVEY PROTOCOLS FOR AMPHIBIANS

UNDER THE SURVEY AND MANAGE PROVISION

OF THE NORTHWEST FOREST PLAN

Version 3.0

OCTOBER 1999

Deanna H. Olson, Editor and Subgroup Lead

Survey and Manage Amphibian Subgroup
Chapter Authors

David R. Clayton
Charles M. Crisafulli
Lawrence L.C. Jones
Peter C. Lewendal
Richard S. Nauman
Lisa M. Ollivier
Deanna H. Olson
Hartwell H. Welsh, Jr.

Additional Appendix Contributor

John S. Applegarth

Version 3.0

ABSTRACT

Survey protocols were developed for Component/Strategy 2 amphibian species under the Survey and Manage provision of the federal Northwest Forest Plan. The goal of these protocols is to screen proposed project areas on federal lands for the presence of five endemic plethodontid salamander species: Shasta salamander (*Hydromantes shastae*), Siskiyou Mountains salamander (*Plethodon stormi*), Del Norte salamander (*P. elongatus*), Larch Mountain salamander (*P. larselli*), and Cascade Range populations of the Van Dyke's salamander (*P. vandykei*). This document is written to provide guidance to federal field crews implementing federally mandated surveys. Extensive reconnaissance level survey approaches that focus on species detection are presented. These protocols have undergone more than two years of field testing, and several rounds of peer, field-user, and manager reviews. Chapter I provides an overview of the species, survey methods, and identifies key changes from the draft protocols released by the Regional Ecosystem Office (Portland, OR) in 1996 (Olson et al. 1996). The similarities and differences in survey approaches among species are explained, and common elements of protocols are specified. Our recommended flexible and fixed survey elements are identified to aid subsequent management decisions regarding protocol implementation and the maintenance of regional data standards. Chapter II summarizes the procedures used to compile known site data, and provides our current known site data summaries and dot-maps of known site distributions. Each subsequent section (Chapters III-VII) focuses on the survey protocol for a single species, and each is written such that it may be read separately; field biologists or resource managers may need to apply only a single protocol. Hence, cross-referencing of information among protocols is minimized and some information is repeated among chapters. A separate document addresses the management requirements and recommendations for these species and provides a more thorough review of the known elements of the species' biology relevant for effective management (Olson 1999).

Version 3.0

Version 3.0

TABLE OF CONTENTS

Version 3.0

Chapter I

Standardized Survey Protocols for Amphibians under the Survey and Manage and Protection Buffer Provisions

Version 3.0

October 1999

Deanna H. Olson

AUTHOR

DEANNA H. OLSON is a research ecologist, USDA Forest Service, Pacific Northwest Research Station, 3200 SW Jefferson Way, Corvallis, OR 97331

ABSTRACT

This introductory chapter summarizes the need to develop standardized survey methods as a component of protective measures for five salamander species under the Northwest Forest Plan. Protocols in this volume are revised from those released in 1996. Main revisions are identified for all species in this chapter and reflect the tremendous efforts of field units across the region to implement surveys and provide their feedback to protocol authors. An overview of methods for terrestrial salamander sampling is provided, with corresponding rationale for the approaches opted herein. Streamlined survey methods are provided to meet the objectives of detecting target species presence at a site proposed for management, while minimizing surveyor time and effort in order to maximize area surveyed. Our protocols are not recommended for other objectives, such as complete species inventories, habitat assessments, or population monitoring. Due to differences in habitats and habits of the five salamanders, survey protocols vary with species. The similarities and differences in survey approaches among species are explained, and common elements of protocols are specified. These revised protocols identify procedures that are expected to vary with site conditions and case-by-case discretionary management decisions. In order to standardize surveys across the region, and maintain a comparable risk of Type II error (i.e., not finding an animal when it is present), certain survey elements are recommended to be fixed. These include the environmental “windows” of suitable survey conditions (e.g., temperature and moisture regimes), definition of “likely habitat,” and surveyor effort expended per project area. Our flexible and fixed survey elements are specified to aid subsequent management decisions regarding protocol implementation and the maintenance of regional data standards.

Version 3.0

TABLE OF CONTENTS

INTRODUCTION

The Northwest Forest Plan (Record of Decision [ROD], USDA and USDI 1994) includes numerous species protection mechanisms for organisms associated with old-growth forest conditions within the Plan's geographic coverage, federally administered lands within the range of the northern spotted owl *(Strix occidentalis*). These protective mechanisms include regionally designated reserved lands, habitat-based and species-specific provisions designated at intermediate spatial scales (e.g., habitats identified during Watershed Analysis or for Resource Management Plans), and habitat and species-specific mitigations that require site-scale implementation. The Survey & Manage and Protection Buffer provisions of the Plan are implemented when likely habitats for species are identified at the finer spatial scales, as project areas are considered for management. Together, these two provisions address species that were considered to be at risk of extinction if only the larger scale protection measures of the Plan were applied. The species-specific and site-specific approaches reflect our joint knowledge and uncertainty with regard to the rarity, uniqueness and long-term viability of these species.

Survey & Manage and Protection Buffer Amphibian Species

The Survey & Manage and Protection Buffer provisions include protection measures for five endemic terrestrial salamanders on federal lands. These two provisions were thought to significantly reduce their risk of extirpation (Forest Ecosystem Management Assessment Team [FEMAT] 1993; Species Analysis Team [FSEIS] 1994). These species are the Siskiyou Mountains salamander (*Plethodon stormi*, PLST), Del Norte salamander (*P. elongatus*, PLEL), Shasta salamander (*Hydromantes shastae*, HYSH), Larch Mountain salamander (*P. larselli*, PLLA) and Cascade Range populations of the Van Dyke's salamander (*P. vandykei*, PLVA). On federal lands, species-specific mitigations for these salamanders were developed in 1994 (Species Analysis Team 1994) primarily from: 1) literature, data, and expert-knowledge compiled during amphibian species status assessments conducted by species-expert panels (SAT Report, Thomas et al. 1993; FEMAT 1993); and 2) the subsequent Additional Species Analysis which followed the selection of the preferred management alternative, Option 9 (FEMAT 1993), and directives to develop provisions to increase the likelihood of species persistence on federal lands (Species Analysis Team 1994).

Protection Buffer--The Protection Buffer standards and guidelines include measures for four of the five amphibian species: PLEL, PLST, PLLA (ROD 1994, page C-28), and HYSH (ROD 1994, page C-20). These provisions have their roots in the previous Scientific Analysis Team report (Thomas et al. 1993, pp. 294-296). The provision includes protective measures for occupied sites and the delineation of protected buffer areas (one site-potential tree height or 100 horizontal feet, whichever is greater) around known sites (e.g., to maintain cool, moist microclimates of occupied habitats, Siskiyou Mountains salamander, p.295; larger distances upslope from sites on steep slopes presumably as unstable slope mitigation, Larch Mountain salamander, p.194; Thomas et al. 1993). Relative to this current document on survey protocols, Protection Buffer guidelines for each of the four amphibian species explicitly specifies the use of a "standardized survey protocol" to identify and delineate occupied locations for protection (ROD 1994, Thomas et al. 1993).

Survey & Manage Component/Strategy 1--The Survey and Manage provision has distinct Components/Strategies. Two of the five terrestrial salamanders (Shasta and Siskiyou Mountains salamanders) are listed under Component/Strategy 1, "*Manage known sites*," the category intended to receive the highest priority upon release of the Northwest Forest Plan in 1994. This category provides protection to all known locations of these rare species.

Survey & Manage Component/Strategy 2--All five terrestrial salamanders are listed under Component/Strategy 2, "*Survey prior to ground-disturbing activities*" (Table C-3, page C-59, ROD 1994). The standards and guidelines for this category state:

> "Within the known or suspected ranges and within the habitat types or vegetation communities associated with the species, surveys for Del Norte, Larch mountain, Shasta, Siskiyou Mountains, and Van Dyke's salamanders <and red tree voles and lynx> must precede the design of all ground-disturbing activities that will be implemented in 1997 or later."
>
> "For most species, this survey would start at the watershed analysis level with identification of likely species locations based on habitat. Those likely locations would then be thoroughly searched prior to implementation of activities."

Site management of newly discovered sites is referenced as part of Component/Strategy 2:

> "Management standards will be developed to manage habitat for the species on sites where they are located."
>
> "Survey protocols and proposed site management should be incorporated into interagency conservation strategies developed as part of ongoing planning efforts coordinated by the Regional Ecosystem Office."

Thus, Component/Strategy 2 involves the implementation of both a standardized survey protocol at likely species locations and the development of management standards for occupied habitats. This document provides guidance for implementation of regional survey efforts.

Survey and Manage Amphibian Subgroup--To develop Survey and Manage procedures from current knowledge of these species, the Survey and Manage Amphibian Subgroup was formed under the organizational structure of the Regional Ecosystem Office (Portland, OR). The subgroup has consisted of amphibian species-experts in the Pacific Northwest federal workforce, a combination of resource specialists and researchers. The subgroup was assigned several tasks related to implementation of Component/Strategy 2. In 1994 and 1995, the Amphibian Subgroup began:

- compiling historical species locality data and creating a known site database
- developing and testing survey protocols
- developing and testing management guidelines
- developing and offering training and consultation sessions to field units

Two of these tasks are summarized in this document, the known site data compilation and database (Chapter II) and the species-specific survey protocols (Chapter III-VII).

Research scientists are authors of every protocol chapter of this document. Although the role of researchers in science/policy decisions and management support continues to be defined, researchers are commonly restricted from making management decisions (Mills et al. 1998). Specifically, although scientists conduct research, synthesize knowledge, develop methods, and analyze data, they generally are not involved in policy development or implementation of management guidelines. Researchers provide essential roles in providing science information for management decisions, and may “add to a decision process by pointing out consequences of different choices,” but they do not determine which choice is best or make the decision (Mills et al. 1998). As such, because these amphibian survey protocols are written by researchers, they represent research scientist recommendations for regional application. Implementation of these procedures rest with decisions communicated by executives and managers at the Regional Ecosystem Office and federal agency headquarters, and the subsequent management decisions conducted by field units.

State Regulations

In addition to the federal designation of these salamanders as Component/Strategy 1 and 2 species under the Survey and Manage provision, and Protection Buffer species designations, all five of these amphibian species are categorized as State and Federal concern-species in the States of the Pacific Northwest (Table I.1 and II.2). The States of California, Oregon, and Washington have developed additional regulations for the capture, handling, and collection of these animals. These regulations vary from acquiring a State permit for handling and collecting, to the development of a Memorandum of Understanding with the State. State laws reflect the status of these rare salamanders, and these regulations need to be addressed if federal surveys and land management activities are planned.

Table I.1: State and Natural Heritage status of salamanders covered under the Survey and Manage provision. CA=California, OR=Oregon, WA=Washington.

Species	State			The Nature Conservancy		
	CA	OR	WA	CA	OR	WA
Shasta salamander	T	-	-	G1/2 S1/2	-	-
Siskiyou Mtns salamander	T	V	-	G2 S1/2	G2 S2	-
Del Norte salamander	SC	V	-	G3 S3	G3 S2	-
Van Dyke's salamander	-	-	C	-	-	G3 S2
Larch Mtn salamander	-	V	S	-	G2 S2	G2 S2

- indicates species not present in that State, T=threatened, SC=species of special concern, V=vulnerable, S=sensitive, C=candidate, G=global ranking, S= State status, 1=critically imperilled, 2=imperiled, ½=within imperilled range, 3=either very rare and local throughout its range or found locally in a restricted range.

Table I.2: Federal agency status of salamanders covered under the Survey and Manage provision. USFS=USDA Forest Service, R5=Region 5, R6=Region 6, BLM=USDI Bureau of Land Management, USFWS=USDI Fish and Wildlife Service, CA=California, OR/WA=Oregon and Washington.

Species	USFS		BLM		USFWS
	R5	R6	CA	OR/WA	
Shasta salamander	NS	-	NS	-	SC
Siskiyou Mtns salamander	NS	S	NS	S	SC
Del Norte salamander	NS	S	NS	S	SC
Van Dyke's salamander	-	NS	-	T	NS
Larch Mtn salamander	-	S	-	S	SC

- indicates species not present in that State, NS=no status, S=Sensitive, T=Tracking, SC=Species of Concern

PROTOCOL DEVELOPMENT

Adaptive management is the foundation of the Northwest Forest Plan, and thus the Survey and Manage standards and guidelines are not static. Survey and Manage procedures are anticipated to change over time in response to testing of current procedures, increased species information, the further development of policies under the Plan, and the refinement of regional interagency species management.

Survey procedures were developed by the Amphibian Subgroup from their knowledge regarding these species and their habitats, survey technique effectiveness, and survey feasibility on federal lands. An ecologically effective methodology was the top priority, however, sideboards of the economic and logistic feasibility of regional application was considered. The first draft of survey protocols was released by the USDA Forest Service and the USDI Bureau of Land Management, through the Regional Ecosystem Office, for implementation by field units in 1996 (Olson et al. 1996). Since then, these protocols have undergone extensive field testing, and reviews by field-users, resource specialists, managers and planners, agency executives and solicitors. This multi-chaptered document represents the consolidated revision of the 1996 amphibian protocols. Main revisions from the 1996 version are itemized below. These include primarily refinement of procedures in response to new information, and surveyor feedback concerning the need for greater clarification and various implementation problems. Future methods may change with additional species information or if protocol objectives change, for example, as multitaxa surveys develop (e.g., ground-dwelling fungi, lichens, bryophytes, mollusks and amphibians).

Main Revisions and Clarified Procedures

Chapters III-VII should be referenced for rationale and details concerning these revisions.

Applicable to All 5 Salamander Species:

- Flexible and fixed survey elements are clarified
- Survey triggers are defined and are discretionary
- Adjacent area survey distances are more discretionary, rather than 180 m
- Photographic plates of animals are included to aid species identification
- Photographic plates of habitats are included to aid habitat identification
- Summary of known site record compilation is included (Chapter II)
- Maps of known site locations, with various GIS overlays, are included
- Revised Survey Zones
- Revised Data Forms

Shasta Salamander:

- Slope habitat description is broadened, due to new information
- Spring is identified as best season for surveys
- Broader air relative humidity window for surveys in slope habitats
- 3 site visits (instead of 4), one should occur in spring
- 10+ day survey interval (instead of 21 days),
- Enabling completion of surveys within a single spring season
- Reduced search effort on slope habitats

Siskiyou Mountains Salamander:

- Range has expanded in response to federal surveys effort detecting new sites
- More complete habitat description is provided
- Expanded survey seasons, including winter and late spring if conditions warrant
- No surveys may occur if there has been freezing within previous 48 hours (rather than the night prior to survey), with a high elevation exception in California
- Minimum soil temperature for surveys was lowered to 3.5ºC, from 4.5ºC
- Air relative humidity for surveys was changed to $\geq$ 65%, from a minimum of 45%
- At least 1 of 3 site visits must be conducted in the spring
- 10+ day survey interval (instead of 21 days), enabling completion of surveys within a single spring season
- Search route is discretionary

Del Norte Salamander:

- Range has expanded in response to federal survey effort detecting new sites
- More complete habitat description provided
- Expanded seasons, including winter and late spring if conditions warrant
- No surveys should occur if there has been freezing within previous 48 hours (rather than the night prior to survey), with a high elevation exception in California
- Air relative humidity for surveys remains at a minimum of 45%
- Minimum air temperature for surveys was lowered to 4.5ºC, from 9ºC, allowing an expanded survey window of environmental conditions
- At least 1 of 3 site visits must be conducted in the spring
- 10+ day survey interval (instead of 21 days), enabling completion of surveys within a single spring season
- Search route is discretionary

<u>Van Dyke's Salamander:</u>

- Expanded species description is provided to avoid misidentification
- Expanded habitat description is given for clarification
- Spatial extent of survey coverage is changed
- Streamside survey is simplified
- Figures of survey methods are provided
- For activities crossing streams (e.g., road), surveys are hierarchical
- No surveys should occur if there has been freezing within previous 72 hours, or if snow is present
- Air relative humidity is removed as a condition for survey
- Expanded site delineation guidelines are provided

<u>Larch Mountain Salamander:</u>

- Expanded species description is provided to avoid misidentification
- Expanded habitat description is provided for clarification
- Spatial extent of survey coverage is suggested to be 40-100% of project area with likely habitat, depending on size of project
- No surveys should occur if there has been freezing within previous 72 hours (no freezing provision previously)
- Description of substrate moisture conditions is provided
- All 3 site visits may occur in the Fall or the Spring (i.e., Spring surveys are not required)

Protocol Standardization

The intent of survey "protocols" is the standardized application of survey methods for these species. Standardization is essential for broadly implemented inventory and monitoring objectives (Heyer et al. 1994, Olson et al. 1997). Without minimum survey or data standards, and quality assurance and control, data become unuseful for compilation and pattern analyses. Heyer et al. (1994) state "The importance of standardization cannot be overemphasized, because studies using different techniques are often simply not comparable, even at the simplest levels." Although we have refined the amphibian protocols, we have been extremely careful not to change critical elements that are important for the maintenance of survey standards. The most changed protocols, for Shasta and Van Dyke's salamanders, are those for which survey efforts generally have not been conducted since the implementation of the Northwest Forest Plan.

Survey protocol standardization is particularly important relative to the risk of "Type II error," not finding the target species when it is in fact present at a site (i.e., not detecting the truth in H_A when it is correct, Snedecor and Cochran 1980). A concern when protocols are changed, is a change in the level of this risk. If methods with differing risks of species-detection are used, their resulting data are not comparable and problems arise during data compilation. The Survey and

Manage Amphibian Subgroup has grappled with recommending and maintaining a level of such survey risk for these rare species, especially as that risk was necessarily balanced with the feasibility of conducting extensive regional surveys. At a qualitative level, we feel that this level of risk of Type II error has not changed significantly in this new version of the protocols. Surveyor effort is not changed, and survey conditions have been refined only to further optimize sampling during windows of salamander activity. As variation in application of the survey protocols are considered, qualitative assessments of changes to the level of risk of Type II error are strongly recommended and should be documented. To date, a quantitative risk assessment of our sampling procedures has not been attempted. This is a research objective, which should be addressed if further streamlining of survey effort is proposed.

Flexible and Fixed Survey Elements–Field-user review of the first draft of these protocols (Olson et al. 1996) included the need for case-by-case discretionary decisions regarding certain aspects of our procedures. We felt that latitude in application of some procedures was warranted and would not affect the risk of Type II error, as explained above. For other procedures, however, flexibility would compromise this risk, and standardization was needed. Our revised protocols specifies these flexible and fixed survey elements.

> First, we have explicitly identified flexible elements in these revised protocols. Several procedures may be determined on a case-by-case basis. We have added this feature to the protocols to acknowledge that circumstances vary across the forested landscape, and with individual projects. Field unit discretion is expected relative to these elements. In particular, we feel that “survey triggers” and “adjacent area surveys” often should be considered on a case-by-case basis. We have provided examples of each and our recommended approaches relative to them. Flexibility is most relevant for projects that do not pose serious risks to the persistence of these animals in likely habitats, for projects with impacts varying with site-specific conditions (e.g., spatial extent of adjacent area concerns), and for survey elements that do not compromise the application of regionally standardized survey efforts. Field units implementing surveys also should be discretionary regarding safety issues as required by site conditions. Safety of surveyors should not be compromised to complete surveys. As such case-by-case decisions are made by managers and field crews, we recommend full documentation of the rationale supporting such a decision.
>
> Additionally, “optional” and “supplemental” survey elements are included in these revised protocols. These protocols are streamlined to focus on the detection of species presence in a standardized and repeatable fashion. However, we recognize the dire need to fill knowledge gaps about these species and their role in the forested ecosystem. Consequently, we have outlined data elements that may be collected at the discretion of field units that would help our knowledge base, and potentially feedback-into revised management procedures. Optional survey elements include collecting additional habitat

information to characterize sites, and continuing to survey beyond first-detection so that a more accurate relative abundance estimate can be made and occupied habitat can be delineated. Additionally, alternative survey methods such as opportunistic searches or surveys during suboptimal conditions may be used to more quickly scan for animals. These are not our recommended approaches, and would not suffice under our protocols to be considered a “site visit” if animals were not detected, but if animals were found, presence may be established readily by such optional searches.

In contrast to flexible and optional survey elements, certain elements of these survey procedures are fixed such that administrative units should not alter them. These fixed elements directly correspond to risk of Type II errors and the probability of not finding animals when they are present. These elements specifically include the “windows” of suitable environmental conditions for surveys (such as seasons, temperatures, moisture/humidity levels), the definition of likely habitat (i.e., habitats in which surveys are triggered), and the level of survey effort (e.g., number of person-hours spent searching per area). As these elements are varied, the foundation for a “protocol” is compromised. In addition to an increased risk of Type II error, consequences of varying these elements include constraints on data compilation among project surveys or administrative units. Subsequent analyses to refine procedures, or assess species occurrences and habitat associations may not be possible if these data standards vary. With additional information to support their alteration, a revision can be proposed at the regional level for adoption by all field units. Until this process is further defined, proposed revisions should be elevated through the agency representatives for Survey and Manage, the Regional Ecosystem Office, and the Survey and Manage Amphibian Subgroup.

SALAMANDER ECOLOGY: BRIEF OVERVIEW

These salamanders share phylogenetic history and many ecological characteristics. They are members of the family plethodontidae, the lungless salamanders. The five Survey and Manage salamanders do not have an aquatic life history stage, and generally spend their entire lives in terrestrial environments. The southern two species in the genus *Plethodon*, the Siskiyou Mountains and Del Norte salamanders, are close relatives (the Elongatus Group, Nussbaum et al. 1983). Likewise, the northern two *Plethodon* species, the Larch Mountain and Van Dyke’s salamanders have been thought to be similar (the Vandykei Group, Nussbaum et al. 1994). Several aspects of their ecology cluster into north and south patterns. The closest relatives of *Hydromantes shastae*, the Shasta salamander, occur in the Sierra Nevada Range in California, and in Italy.

They are relatively rare, endemic species. Each has a restricted geographic distribution, falling entirely within a small portion of the range of the Northwest Forest Plan and having a large part of their distribution on federally-administered lands (estimated range 59-93%; Chapter II, Table II.4). These species are considered vulnerable to disturbance, and have been loosely described as close associates of old-growth forest conditions (FEMAT 1993; Blaustein et al. 1995; Olson 1999). More precisely, these species occur in the western forested landscape and appear to have tight associations with specific habitat conditions that have been affected by past common forest management activities (see Olson 1999).

They are generally terrestrial species, typically occurring in forested uplands. The exception is that Van Dyke's salamander also is found in association with small streams and seeps, and some lake shores (C. Crisafulli, pers. obs.; Chapter VI). These five species are ground-dwelling, thought to be associated with interior forest microhabitat and microclimate conditions (Olson 1999). They occur in the surface and sub-surface layers of substrate, litter, and debris. Four of the salamander species are found in association with rocky substrates: Del Norte, Siskiyou Mountains, Larch Mountain, and Shasta salamanders (FEMAT 1993; Standards and Guidelines, USDA and USDI 1994; Species Analysis Team 1994, Final SEIS). However, there are exceptions to their main habitat associations. For example, both Larch Mountain and Van Dyke's salamanders can be found upland forest, in areas without talus (Chapters VI and VII). While Shasta salamanders are primarily associated with limestone outcrops, they have been found in a volcanic outcrop as well as in forest habitats around outcrops, under woody material, to distances 100-200 m from outcrops (Chapter III). Site conditions sufficient for these terrestrial salamanders may vary geographically, with both coastal-to-inland and latitudinal gradients in microclimate conditions (e.g., Del Norte salamander, Chapter V), and as surrogate site conditions may develop from trade-offs of different forest structure elements, including canopy, down wood, rock substrates, and subsurface moisture sources (e.g., Larch Mountain salamander, Chapter VII).

Surface activity of these five species is associated with environmental conditions, both microclimatic and edaphic. Their seasons of surface-activity generally correspond to the Fall-through-Spring rainy periods when temperatures are neither too cold nor too warm. The temperature and moisture windows of survey conditions (Table I.3) reflect our knowledge of the behaviors and tolerance levels of these species and their relatives (e.g., Feder and Lynch 1982; Ray 1958; Spotila 1972; Taub 1961). When the animals are not active, they are thought to retreat subsurface. Soil, substrate, and cover conditions appear to play a role in their surface activity patterns, as has been observed for other salamander taxa (e.g., Keen 1984). Their vertical migration patterns are not well understood. Under some conditions, they may have diel surface migrations (e.g., Siskiyou Mountains and Del Norte salamanders [PLST and PLEL] at high elevations in California after “light” freezes, when temperatures dip slightly below freezing overnight and warm-up during the day), while under other conditions, they may remain deep within subsurface retreats for extended periods (e.g., dry summer months; after “hard” freezes for PLST and PLEL at high elevations in California). Surface activity patterns of the northern two *Plethodon* species (Vandykei Group) and the southern two *Plethodon* species (Elongatus Group) appear to differ, probably due to both differing environments and the species' behavioral ecology.

The management standards for these salamanders (Olson 1999) and the chapters therein, present a more comprehensive review of our knowledge of these species.

SURVEY APPROACHES

Surveys are designed as extensively applied screens to detect species presence in habitat areas potentially affected by proposed activities. With ecological effectiveness as our first priority, we have balanced survey feasibility, elements of amphibian ecology, and surveyor detectability to produce a procedure that optimizes the probability of detecting species presence. We chose methods that were effective but relatively inexpensive to implement because economic costs ware important issue for rare species management on public lands. For cost-effectiveness, with species detection as the survey goal, collection of habitat, relative abundance, and assemblage composition data were trimmed from the protocol. Although costs were considered during protocol development, it should be recognized that our protocols are not based on available budgets or expected funding allocations. These protocols may not be optimum for other species or appropriate for alternative survey objectives. For example, this protocol is not designed for population monitoring, habitat assessment, or addressing population size or demographics. Once presence is established at a site, the species-specific management recommendations guide decisions of how to proceed with site management and protection.

Survey Methods

Historically, surveys for terrestrial salamanders in the Pacific Northwest have been conducted by hand-searching through surface debris, including litter, substrate, and woody material, or by the installation of pit-fall traps and cover boards (e.g., Corn and Bury 1990; papers in: Ruggiero et al. 1991, Szaro et al. 1988). For extensively-conducted searches of rare terrestrial salamanders, two standardized types of "visual encounter surveys" that account for sampling effort are commonly used: a time-constrained search, and an area-constrained search (e.g., Corn and Bury 1990,Crump and Scott 1994, Heyer et al. 1994). Time and area searches have undergone extensive field-testing (e.g. papers in Ruggiero et al. 1991, Szaro et al. 1988) and have been successful in determining presence/absence. Among amphibian sampling techniques, these visual encounter survey methods involve the lowest relative time investment, financial cost, and personnel requirements (Heyer et al. 1994).

Area-constrained searches include many transect or quadrat sampling techniques. In particular, transects are useful for sampling across different microhabitats or gradients (e.g., Crump and Scott 1994, Jaeger 1994). For example, forest habitats may have gradients with stream proximity, percent slope, substrate composition, or aspect. When a target species or habitat is patchily distributed across a landscape, linear transects can effectively locate patches. Area-constrained searches also are useful when a discrete homogeneous habitat can be completely surveyed, suitable habitat for searching is sufficiently patchy as to result in frequent starting and stopping of the clock during timed searches, or if density or relative abundance estimates (no. captures per square meter) are needed. Time spent searching often is recorded for a second estimate of capture rate (no. captures per person-hour of search effort).

Time-constrained searches are particularly useful for inventories, especially when animals occur in definable habitat features (Crump and Scott 1994). This method is effective for discrete habitat patches. A survey effort in terms of time per area is easily applied. The biases of this method, including unequal search effort among microhabitat types or searchers and skewed relative abundance estimates, may be a minor issue for inventories geared toward assessing the presence of rare salamanders. Biases can be controlled by field training, oversight of field-searchers by a crew leader, and moving rules (not spending overlong at any one microsite). Timed searches often estimate area covered, again for a second estimate of capture rate.

For Survey and Manage salamanders, methods were developed by integrating knowledge of the life history and general ecology of these species, from ongoing and published studies of these animals, and the anticipated economic and logistical constraints. We compiled literature and field notes on survey capture rates (number of salamanders per person-hour, or per area sampled) and knowledge of surveys during which animals were not found yet the surveys were conducted during apparently optimum environmental conditions at known sites of populations. Common findings for all of these species were the potential for very low capture rates and knowledge of visits to known sites under apparently optimum environmental conditions when no animals could be found. As a result, common elements of surveys developed for these species include a conservative level of effort considered necessary to detect populations that may be patchily-distributed in space and whose surface-activity may be patchily distributed in time (i.e., within a season). Reconnaissance-level surveys that extensively cover habitats and multiple site visits were thought to be essential features of the methods. Detectability was balanced with survey feasibility, including cost, time and effort.

Table I.3: Environmental "windows" for field sampling for Survey and Manage amphibians (Shasta salamander = HYSH, Siskiyou Mountains salamander = PLST, Del Norte salamander = PLEL, Larch Mountain salamander = PLLA, and Cascade Range populations of the Van Dyke's salamander = PLVA). Chapters III-VII explain these guidelines.

Species	Sampling Season[1]	Air & Soil Temperature	Relative Humidity and Moisture
HYSH	Spring is best. Late Fall to Spring	Air $\geq$4ºC	Rock outcrops: Air minimum 90% Wet weather regime Slope habitat: Air minimum 65%
PLST	Spring is best. Late Fall to late Spring	Air 4-20ºC Soil 3.5-18ºC No night freezing previous 48 hrs, high elevation exceptions in California	Air minimum 65% Soil minimum 10% or moist below first layer of rock
PLEL	Spring is best. Late Fall to late Spring	Air 4.5-25ºC Soil 4.5-20ºC No night freezing previous 48 hrs, high elevation exceptions in California	Air minimum 45% Soil minimum 10% or moist below first layer of rock
PLVA	Fall and/or Spring	Soil 4-14ºC No night freezing previous 72 hrs	Soil or substrate moist or wet to 15 cm
PLLA	Fall and/or Spring	Soil 4-14ºC No night freezing previous 72 hrs	Soil or substrate moist or wet to 15 cm

[1] General seasons are provided, however, site conditions drive survey windows**.**

Table I.4: Comparison of protocols for Survey and Manage amphibians (Shasta salamander = HYSH, Siskiyou Mountains salamander = PLST, Del Norte salamander = PLEL, Larch Mountain salamander = PLLA, and Cascade Range populations of the Van Dyke's salamander = PLVA). Chapters III-VII explain habitat associations and survey procedures.

Species	Habitat	Method	Effort	Site Visits[1]	Time Intervals
HYSH	Rock Outcrops, primarily limestone	Timed Search	8hr/10ac of habitat	3 visits	10+ days
	Slope Habitat around rock outcrops	Timed Search	4hr/10ac of habitat See Chapter III	3 visits	
PLST	Surface Rock	Timed Search	4hr/10ac of habitat See Chapter IV	3 visits	10+ days
PLEL	Surface Rock	Timed Search	4hr/10ac of habitat See Chapter V	3 visits	10+ days
PLVA	Seeps, Some Streams, and Caves	Area Searches	See Chapter VI	3 visits	4+ days
	Forested Slopes	Belt Transects	See PLLA	3 visits	
	Streams and Lakes	Belt Transects	≥50% area searched See Chapter VI	3 visits	
PLLA	Forest, Talus, and Caves	Belt Transects	10-15m wide belts at 15-25m intervals, ≥40% area searched See Chapter VII	3 visits	4+ days

[1] See survey seasons for site visits, Table I.3.

The protocols vary with species and habitat (Tables I.3 and I.4). A time/area-constrained search is outlined for the three southern species, transect sampling for Larch Mountain, and a combination of both methods is presented for Van Dyke's salamanders. These differences in survey methods have resulted from the habitats in which these animals live and our knowledge of their spatial distributions.

Timed area-searches were chosen for the three southern species with known microhabitat affinities, for which suitable habitat patches are often discrete and more easily identified. Although these need to be “thoroughly searched” (ROD 1994) for species-detection, we did not feel that 100% of the substrate needed to be turned over. Our recommendations for surveyor hours per acre were developed from qualitatively balancing our compiled ranges of capture rates at occupied sites (i.e., estimates of time it could take to find an animal at an occupied site) with estimates of areas surveyable in a work day. From our collective experience, we estimated that two persons could extensively survey 40 acres of likely habitat in a single work day, each covering about 20 acres in 8 search hours, or 4 person-hours per 10 acres of habitat (Table I.2). If such a parcel were occupied by the target species, detection should occur within that timeframe, unless the population is extremely patchy, has low abundance, or animals are not surface active. Multiple site visits are recommended to hedge those circumstances. We felt that an effort of 20 habitat-acres searched per person per day would allow a reconnaissance-level survey effort with a moderate-to-low risk of Type II error. This level of effort would allow discrete project areas to be screened for animals readily by field crews. Search effort was doubled for Shasta salamanders in rock outcrop habitat (8 person-hours per 10 acres), in comparison to Shasta salamanders in forest habitat surrounding outcrops and for the Del Norte and Siskiyou Mountains salamanders (4 person-hours per 10 acres of habitat), because Shasta salamanders in outcrops were thought to be more difficult to detect when present. Within outcrops, they may be very patchily-distributed or have low abundance during the time-windows of surface activity. In forest surrounding outcrops, Shasta salamanders appear to be associated with downed wood, and a more extensively-applied search effort focussing on such cover items seemed warranted.

Transects were chosen for the two northern species (Larch Mountain salamander and Van Dyke’s salamander) that are found in forest macrohabitats that can be very extensive in size, yet within these macrohabitats, the animals can be very localized in their distribution. These animals are not as predictably found in discrete microhabitat types, as are the southern three species. More refined microhabitat affinities for these northern species have not been determined at present. Linear transects that extensively cross likely habitat areas may detect patches with the target species readily. Because of the patchiness of these two species and the great spatial extent of some proposed projects, guidelines for spatial coverage of transect surveys were developed.

> Multiple parallel transects are described for Larch Mountain salamanders ("belt-transects,” Crump and Scott 1994) and field-tests have demonstrated their effectiveness for inventories. This method is extensive and yields approximately 1 to 7

acres of habitat surveyed per person-hour (average value, 3.2 acres/person-hour; C. Crisafulli, pers. comm.), a comparable search effort to the southern species. For projects with small spatial extent, all likely habitat is recommended to be surveyed. For extensive projects, a minimum of 40-50% of the habitat is recommended to be surveyed.

As applied to streamside areas for Van Dyke's salamander surveys, transects provide a reconnaissance-level survey that may detect localized populations of this species. As for the Larch Mountain salamander, for projects with small spatial extent, all likely habitat (streamside, seeps, other) is recommended to be surveyed. For extensive projects such as long stream reaches, a minimum of 50% of the habitat is recommended to be surveyed. Timing complete area searches and transect surveys is recommended.

Our recommended levels of survey effort (i.e., 4-8 person hrs per 10 acres, area searches covering a specified percentage of likely habitat) provide a context for regional standardization. Effort can be repeated across administrative units such that there is a comparable risk of error among surveys, and survey results can be compiled and analyzed later. Risk assessments can be conducted if methods are standardly applied. Altered survey effort changes risk of Type II error. If surveys are later repeated or compiled for regional monitoring projects, survey variance complicates the process. We strongly recommend that survey documentation include descriptions of survey approaches and effort levels.

We caution against determination of population demography or assemblage parameters with our protocols. Calculations of species relative abundance estimates and assemblage compositions, in particular, could be skewed because our protocol allows surveys to stop at first-detection of the target species. Again, these protocols are specifically designed for detecting the presence of the target species.

Random Sampling--Although randomized sampling designs are important in many field studies, including amphibian inventory and monitoring (e.g., Heyer et al. 1994, Fellers 1997), we have not emphasized random sampling in our protocols because it is not effective for our objectives. Site selection is not random because surveys are conducted in response to land management activities. Within sites, our objective is to detect the presence of a single species that is thought to be rare, while minimizing surveyor time and effort. We have streamlined surveys for easy implementation, and random sampling can add procedures to the survey design (initial microhabitat characterization followed by randomization among microhabitat parameters before surveys begin, see Fellers 1997). Complete sampling is encouraged. When complete sampling is not possible, extensive reconnaissance surveys covering the entire project area at a standardized effort level is opted (Chapters VI and VII). This is a type of “representative sampling” (e.g., Fellers 1997).

Survey Errors

Reducing survey errors, particularly designating "absence" (no detection) to a site in which Survey and Manage salamanders are actually present (risk of a Type II error), was addressed in several ways.

Microclimate Conditions--First, restrictive microclimate conditions are to be met before surveys are conducted (Table I.3). Surface activities of these animals have shown associations with season, and more specifically, limited temperature and moisture regimes. These microclimate constraints are built into the protocols, with variation among species reflecting our knowledge of the different species' ecology. New information since 1996 has enabled some microclimate constraints to be revised. For example, in 1998 and 1999, federal field survey crews documented consistent surface-activity of Siskiyou Mountains salamanders and Del Norte salamanders at high elevations after freezing nights in California (i.e., during recent mollusk surveys). This has resulted in a relaxation of the overnight freezing constraint in this area. Additional geographic variation in activity patterns of these species may be anticipated across species' ranges or among habitat types. Chapters III-VII explain the temperature and moisture conditions for surveys, and the species-specific rationale from which those constraints developed.

Three Site Visits--Second, multiple site visits are needed to designate no detection. Three visits to a site was considered sufficient (Table I.4), given these visits were conducted during appropriate site-conditions (Table I.3) and separated by the recommended time-intervals. Three visits resulted from a conservative approach, and the knowledge that species experts have not always been able to find these animals at known localities during optimum conditions. The time intervals between visits were designed to allow for the further development of suitable site conditions (i.e. moisture, temperature) and to conservatively account for undefined circumstances of species' activity patterns. For example, moisture conditions may become more suitable as the Fall season progresses because the first rains may not penetrate the substrate. In the Spring, both moisture and temperature regimes may become more suitable as the season progresses. The time interval between site-visits was perceived to be longer in the southern portion of the Northwest Forest Plan, than in the northern section (Table I.4). Frequency of major storm events figured into this difference, as well as the relative contribution of snow-melt to substrate moisture regimes, the activity seasons of the salamanders, and the occurrences of known site visits during apparently optimum conditions when animals were not detected. In the south, minimum site-conditions may be met early in a season, but the animals might not be surface-active at that time. An interval of at least 10 days between surveys may allow for additional development of site conditions to trigger salamander activity. Figure I.1 illustrates the variation possible in plethodontid salamander surface activity, and frequency of storm events in northern California (H. Welsh and G. Hodgson, unpublished data from pitfall trapping, Mattole River drainage, CA). Although ensatina (*E. eschscholtzii*) was active in the Fall-through-Winter, surface activity was neither consistent through this time period nor entirely predictable from rain events.

Reference Sites--Reference sites are known species' locations that can be easily surveyed to determine whether or not the animals are surface-active. This knowledge is useful for decisions regarding survey timing, and to reduce the risk of Type II error (not finding the target species when it is in fact present at a site). The most appropriate reference sites to consider using are those in close proximity and with comparable site conditions to the new areas needing survey. In favor of reference sites, they can easily save surveyor time and effort. Detecting the presence of these inconspicuous animals at accessible reference sites harboring known Survey and Manage amphibian populations may be conducted prior to conducting surveys of new potential sites. If habitat conditions are comparable between locations, detection at a reference site suggests that salamanders would be surface-active in the potential site, if they occur there. In Chapters IV and V, Reference Sites are recommended prior to surveys of high elevation sites of the Siskiyou Mountain and Del Norte salamanders after freezing nights. Regionally, plethodontids generally are not known to be active following freezes, but surveys are showing an exception for these two species in a portion of their ranges. Reference Sites can validate this and support surveys during expanded environmental conditions. However, use of Reference Sites may overly-disturb a few easily-accessible known sites. Consequently, use of Reference Sites is not broadly recommended.

Voucher specimens--Voucher specimens traditionally provide quality assurance, document site locations and species identification, and once deposited in an institution, allow future data needs to be accessible by the larger scientific research community. However, voucher collection is no longer a standard procedure of herpetofaunal surveys because some populations may have very low abundances, and there is a concern that collecting vouchers may exacerbate declining populations (see Fellers 1997). Some functions of vouchered specimens have been addressed by other measures within the Survey and Manage procedures. For example: 1) surveyor training and experience should greatly reduce or eliminate identification errors; 2) taxa expert consultation is advised to confirm species identification, especially for range extensions or the rarest of species; and 3) federal surveys demand very high precision of site locality information, which should be easily accessible (along with companion data elements) through either individual administrative units or the regional federal database. Because the focus of our efforts is to identify and manage sites, as a further measure to streamline and reduce survey efforts, collection and deposition of preserved specimens has not become a required survey procedure in all protocols. If needed, researchers may contact administrative units or the federal database to request information from data forms. In some cases, researchers knowledgeable of extensive federal survey efforts have pursued partnerships with field units for collections of specimens or tissues (e.g., salamander tail tips for genetic analysis). At this time, photographic voucher specimens are suggested if the equipment is available; key characteristics need to be identifiable in photographs (see Chapters III-VII and accompanying photographic plates). To document range extensions in the literature (i.e., *Herpetological Review*), disposition of voucher specimens in a museum is needed. This does not need to be conducted by field crews, however. If necessary, a species expert can conduct a follow-up visit to the site to obtain a voucher.

.

Surveyor Training

To conduct surveys for these amphibians, knowledge is needed of the target species and its habitats, and other salamander species that may be found during sampling. These Component/Strategy 2 animals are generally inconspicuous. Individuals and populations can be patchily distributed, burrowed deep below the surface, active during a limited window of time of suitable microclimate conditions, and nocturnal. Knowledge of appropriate survey methods, microhabitat associations, and microclimate constraints for surface activity are needed to reliably find these organisms. The protocols are intended to be fairly simply implemented, however, attention to the details of the methods is crucial for reliable and standardized sampling. Training and experience reduce errors in field sampling for amphibians. Field crews need to have the skills listed below. These are covered in 2-day training sessions: one day of in-house lecture and species identification, and one day of field instruction. After training, when uncertainties arise as to habitat and species identification, experienced surveyors and taxa-experts should be questioned. If collecting permits allow, live animals may be transported to species-experts for confirmation of identity.

Training Requirements

Two-day training session

- **One day of lecture and species identification**
- **One day of field instruction**

Surveyor skills include

- **Ability to identify all salamander species encountered**
- **Ability to identify target species' likely habitat**
- **Knowledge of species' microhabitat associations**
- **Knowledge of species' microclimate associations**
- **Knowledge of species' surface activity patterns**
- **Knowledge of survey protocol and its implementation**
- **Knowledge of documentation procedures, dataforms and discretionary decisions**

TRIGGERS

Survey triggers identify when sampling is needed for these species. Triggers are land management activities or proposed projects that result in surveys because they may adversely affect these animals or their occupied habitats.

Trigger Criteria--Surveys for a Component/Strategy 2 amphibian species are **triggered** when:

1. **a proposed project occurs within the range of the Northwest Forest Plan, and**
2. **it occurs within the likely range of the species (its Survey Zone), and**
3. **habitat for the species is found within or adjacent to a proposed project site, and**
4. **the project may affect the animals directly or indirectly by degrading habitat.**

Ground-disturbing activities, in addition to some other types of forest management practices and land uses, could affect these animals because they occur in the surface layer of forests. Disturbance of surface microhabitats are general concerns. Surface microhabitat conditions important for these plethodontid salamanders include the three-dimensional physical structure of the substrate and surface cover features, and microclimate (e.g., temperature/moisture regime). Concerns for management include maintenance of the integrity of substrate interstices, surface debris (e.g., downed woody material), and cool, moist surface climate regimes. Management activities that degrade these habitat elements are survey triggers.

Some activities that alter habitat may appear superficially to benefit salamanders, but may in fact degrade habitat and pose risk to populations. For example, manual release of hardwoods, relocation of rock and downed wood, culvert removal, and stream channel restructuring are common fish habitat restoration projects along streams. However, these activities could cause microhabitat and microclimate shifts, which could negatively affect habitats of streambank salamanders such as the Van Dyke's salamander. Populations of this species may occur along relatively short sections of stream reaches, such that a small scale project might pose risks to critical elements of their habitats. Once surveys were conducted and animals detected, it might be possible to re-evaluate project implementation to mitigate risks (Olson 1999).

Activities without ground-disturbance may affect microhabitats, microclimates, and the animals. For example, chemical applications may affect animals directly or by creating inhospitable habitats. Indirect effects of some chemical applications (e.g., pesticides, fertilizers) may affect amphibians through their prey-base.

Trigger Decision Process--Land management activities should be evaluated on a case-by-case basis whether or not they qualify as survey triggers. The decision process to determine whether a proposed project triggers a survey involves evaluation of the four criteria above. Relative to the last criterion, surveys are triggered when the project is expected to affect suitable habitat conditions for the target species and/or the animals themselves. Site managers are expected to have the greatest discretion with regard to this final criterion. When evaluating the fourth criterion, managers also need to consider the site conditions, and methods and timing of project implementation (see below).

Distinction between Decisions to Survey and "Management Recommendations"–Decisions to survey and decisions regarding whether management practices may occur at occupied sites should be independent, however they are conceptually linked. They should be recognized as separate steps in project implementation, occurring as sequential decisions and potentially having different consequences. Our fourth criterion for survey triggers may result in a conservative decision to survey because of potential effects to habitats or animals. Once the target species is detected at a site, the management decision of how to proceed <u>then</u> needs to be addressed. Management Recommendations (Olson 1999) for each species provides guidance for known site management decisions, and may involve an evaluation of the significance of an effect on habitat, populations or individuals. A decision to survey does not necessarily indicate that the proposed management activity will be prohibited if the project area is occupied by the target species. However, a decision **<u>not</u>** to survey implies that the proposed management activity does not affect these salamanders or their habitats, and it may proceed at the project area. Documentation of the both survey decision and the management decision are recommended. The examples below are specific to decisions regarding whether or not to survey, yet they provide insight into our management recommendations for these species.

Land management activities that are survey triggers generally include:

A. Proposed timber management activities.
B. Trail or road construction and reconstruction.
C. Recreational development, such as campground expansion or creation.
D. Mining activities, including most rock removal proposals.
E. Residential and commercial development.
F. Chemical applications (herbicides, pesticides, fertilizers).

This list is not exhaustive. Common triggers within the range of each species are identified within Chapters III-VII. Although our focus is on land management activities, other activities such as research should be screened similarly to determine whether surveys are necessary prior to their implementation.

Activities that are <u>not</u> Triggers--Surveys are **<u>not</u>** warranted for activities that are judged to be benign relative to their effects on these salamanders, and in particular, on their habitats. This includes activities that have negligible affects on: 1) the integrity of surface/subsurface interstices; 2) surface cover features that may be important refugia for these salamanders; and 3) the microclimate regime in suitable habitat. A <u>change</u> in habitat is not necessarily an adverse effect on habitat, and this distinction should be evaluated. Direct and indirect effects on the animals and their habitats should be considered. Thus, not all ground disturbing activities may trigger surveys in potential habitat.

Examples of activities that are likely **not** to trigger surveys include:

G. Routine road or facilities maintenance.
H. Hazard tree removal or clearing blow-down from roads.
I. Replanting after timber harvest.
J. Removal of special forest products.
K. Control of weed infestations by hand.
L. Precommercial thinning of young plantations.

Triggers May Vary among Species or Site Conditions–Due to differences in habitat, life history, vulnerability to disturbances, triggers may vary among species. Also, because activities and projects vary on a case-by-case basis, some specific activities in the general areas above, A-F, may not require surveys due to the circumstances of the site or project. For example, if a particular activity will not degrade habitat conditions and is timed such that it occurs when animals are deep within substrates (e.g., seasonally restricted to dry, summer months), it is not expected to affect the animals themselves, it may not require a survey. If there were a risk to affecting animals directly because they are surface-active, a seasonal restriction of the activity during the dry summer when animals are inactive subsurface might be proposed. With such a restriction, if the animals are not affected, the survey may not be triggered.

For example, road decommissioning is a survey trigger for Van Dyke's salamanders when stream culvert removal is involved. Streamside areas are likely habitat for this species, and the activity could affect suitable habitat and directly affect localized populations of this species. In contrast, road decommissioning and culvert removal may not trigger a survey for the Del Norte salamander because they are not thought to use the compacted substrates of roads as habitat, and are not associated with streams. Disturbance to roadside or culvert areas that are likely habitats for Del Norte salamanders should be considered, however, and may require survey. A case is known where the culvert itself was inhabited by Del Norte salamanders. Again, does the disturbance change habitat? Does it result in a degradation of habitat conditions? Does it affect the animals? If a seasonal restriction were applied, would this alleviate the concern to animals? Is the net result of the activity an improvement of overall habitat conditions, rather than habitat degradation?

Another example is that use of existing rock quarry sites is identified as an activity that may not trigger a survey for the Siskiyou Mountains salamander. In this case, there are known Siskiyou Mountains populations persisting at rock quarries. Although the quarry rock removal changes habitat, it does not appear to always degrade habitat conditions for the animals if rock remains at the site and surrounding area, and the quarry is not expanded. In this scenario, the population may persist due to more stable conditions in the surrounding area, however this has not been studied. A seasonal restriction of activities is recommended to avoid surface-active animals. In contrast, rock removal from existing quarries would be a trigger for surveys in likely habitat of the Shasta salamander. For this species, we have no indication that the species can persist with this activity.

Prescribed fire may or may not trigger surveys, depending upon the circumstances of the project, site, and species. Chapters III-VII discuss species-specific fire effects to consider in more detail.

Triggers of Adjacent Area Surveys--A land management activity may trigger a survey in the proposed project area itself, and/or in an area immediately abutting the project ("adjacent area"). Adjacent area surveys are needed if potential habitat is identified next to projects and the proposed project could result in degradation of the microhabitat and microclimate conditions for salamanders in those adjacent areas. For example, if a proposed project is thought to alter hydrological regimes (e.g., surface/subsurface flow), substrate integrity (e.g., landslide potential), microhabitats (e.g., downed wood recruitment), and microclimates (e.g., edge effects on temperature and moisture; see Chen et al. 1995, Brosofske et al. 1997, Dong et al. 1998), in likely salamander habitat in adjacent areas, surveys may be triggered in those areas of potential influence. Effects on adjacent area habitats, and whether or not they represent triggers, should be considered on a case-by-case basis. Distance of surveys into adjacent areas are likewise discretionary, and should match the distance of influence from the project. Guidance for adjacent area survey distances is provided in individual species' protocols, Chapters III-VII.

Examples of projects that generally trigger adjacent area surveys are:

M. Regeneration timber harvest and some forest density management projects.
[Main concerns to adjacent area habitats include microclimate edge effects, substrate integrity, and downed wood recruitment.]

N. Road construction.
[Main concerns to adjacent area habitats may include microclimate edge effects, substrate integrity, and altered hydrological regimes.]

O. Campground construction.
[Some concerns to adjacent area habitats include reduction of surface cover from firewood collection and increased disturbance to habitat due to dispersed recreation activities (may be dampened if seasonally restricted during the summer).]

Examples of projects that are **not** likely to trigger adjacent area surveys are:

P. Trail construction.
[Adjacent area surveys may not be triggered if there are negligible effects on substrate integrity and impacts of adjacent areas by trail users (dispersed camping, firewood collection).]

Q. Instream habitat restoration.
[Adjacent area surveys may not be needed if there are no expected effects to animals or their habitats. For example, adjacent area effects on Van Dyke's salamander habitat may differ longitudinally and latitudinally to streams. Adjacent area surveys may be needed only at the project area with very localized impacts, or only up- and/or down-stream, but not away from streams.]

R. Forest density management.
[Depending on the activity and site, adjacent area effects on habitat may be negligible. Concerns are those in M, above.]

DOCUMENTATION OF SURVEY DECISIONS

Due to the discretionary nature of several survey elements (triggers, adjacent area distances), supporting rationale for case-by-case decisions is recommended to accompany activity proposals. In particular, if variance in survey procedures is implemented, the rationale should be documented and a qualitative assessment of the change in Type II error conducted. Relative to triggers, such rationale should include statements regarding the 4 criteria, listed above. For the fourth criterion, statements should be included regarding the anticipated impacts of the project on: 1) the animals themselves; and 2) habitat conditions (e.g., structure, microclimate). The record of the adjacent area decision rationale should be distinct from the project area trigger decision rationale. Likewise, decisions to survey should be documented separately from decisions on how to manage sites.

Recommendations for Documentation

Rationale for trigger decisions should be documented.
Rationale for trigger decisions should be separate from management recommendations.
Rationale for adjacent area survey decisions should be documented separately.
Rationale for any variance to protocol should be documented, with a qualitative assessment of changes to risk of Type II error.

ACKNOWLEDGMENTS

Our revised protocols benefitted from the input of numerous federal agency executives, managers, resource specialists, and species experts. We attempted to provide consensus documents, and to gain agreement on most issues. I thank Sheila Martinson for coordinating the final 1999 review of our protocol, and I thank the following persons for their significant efforts as Review Panel members: Paul Jeske, Sarah Madsen,, Karen Raftery, Ray Scharpf, Roger Schnoes, Lee Webb, and Quentin Youngblood. I thank Ward Hoffman and Stacy Lemieux for their efforts in coordinating the survey protocol reviews from non-agency scientists, field specialists, and managers in 1997. Comments were received from numerous persons across the region, and they were all greatly appreciated. I especially thank Char Corkran, David Vesely, and Kelly McAllister for providing their peer reviews. The following persons provided essential support and advise during the various phases of protocol development: Barb Behan, Robin Bown, Paula Crumpton, Randy Hickenbottom, Cheryl McCaffrey, Tom Mills, Randy Molina, Judy Nelson, Deanna Stouder, and Jay Watson**.** Bruce Bury and John Applegarth have provided valuable expert opinion since 1994. For Version 3.0, Rebecca Thompson and Kathryn Ronnenberg helped with figures, and Garth Hodgson provided unpublished data for Figure I.1. The Survey and Manage Amphibian Subgroup has worked together over several years to produce these protocols; all chapters in this document are a reflection of joint efforts by this taxa-team.

REFERENCES

Blaustein, Andrew R.; Beatty, Joseph J.; Olson, Deanna H.; Storm, Robert M. 1995. The biology of amphibians and reptiles in old-growth forests in the Pacific Northwest. Portland OR: USDA Forest Service Gen. Tech. Rep. PNW-GTR-337. 98 p.

Brosofske, K.D.; Chen, J.; Naiman, R.J. and Franklin, J.F. 1997 Effects of harvesting on microclimatic gradients from small streams to uplands in western Washington. Ecological Applications 7:1108-1200.

Chen, J.; Franklin, J.F.; Spies, T.A. 1995. Growing season microclimate gradients from clearcut edges into old-growth Douglas-fir forests. Ecological Applications 5: 74-86.

Corn, Paul Stephen; Bury, R. Bruce. 1990. Sampling methods for terrestrial amphibians and reptiles. Gen. Tech. Rep. PNW-GTR-256. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station. 34 p.

Crump, Martha L.; Scott, Norman J. 1994. Visual encounter surveys. In: Heyer, W. Ronald; Donnelly, Maureen A.; McDiarmid, R.W.[et al.], eds. *Measuring and monitoring biological diversity: standard methods for amphibians*. Washington, DC: Smithsonian Institution Press: 84-92.

Dong, J.; Chen, J.; Brosofske, K.D.; Naiman, R.J. 1998. Modelling air temperature gradients across managed small streams in western Washington. J. Environmental Management 33: 309-321.

Feder, Martin E.; Lynch, James F. 1982. Effects of latitude, season, elevation, and microhabitat on field body temperatures of neotropical and temperate zone salamanders. Ecology 63:1657-1664.

Fellers, Gary M. 1997. Design of amphibian surveys. Chapter 2 *In:* Olson, Deanna H., Leonard, William P., and Bury, R. Bruce 1997. Sampling amphibians in lentic habitats. Northwest Fauna 4: 23-34.

FEMAT 1993. [see Forest Ecosystem Management and Assessment Team 1993]

Forest Ecosystem Management and Assessment Team. 1993. [FEMAT 1993] Report of the Forest Ecosystem Management and Assessment Team. Washington DC: US Government Printing Office. Irregular Pagination.

Heyer, W.R.; Donnelly, M.A.; McDiarmid, R.W.; Hayek, L.C.; Foster, M.S. (eds.). 1994. *Measuring and monitoring biological diversity: Standard methods for amphibians.* Washington DC: Smithsonian Institution Press. 364 pp.

Jaeger, R.G. 1994. Transect sampling. *In:* Heyer, W.R., Donnelly, M.A., McDiarmid, R.W., Hayek, L.C. and Foster, M.S., eds. 1994. *Measuring and monitoring biological diversity: Standard methods for amphibians.* Washington DC: Smithsonian Institution Press: 103-107.

Keen, W. Hubert. 1984. Influence of moisture on the activity of a plethodontid salamander. Copeia 1984:684-688.

Mills, Thomas J.; Everest, Fred H.; Janik, Phil; Pendleton, Beth; Shaw, Charles G.; and Swanston, Doublas N. 1998. Science-Management Collaboration; Lessons from the revision of the Tongass National Forest Plan. Western Journal of Applied Forestry 13:90-96.

Nussbaum, Ronald A.; Brodie, Edmund D., Jr.; Storm, Robert M. 1983. *Amphibians and reptiles of the Pacific Northwest*. University of Idaho Press, Moscow, Idaho. 332 p.

Olson, D.H. (ed.) 1999 (in review). Management Recommendations for Component/Strategy 1 Amphibian Species. Special Interagency Publication.

Olson, D.H. (ed.); Applegarth J.; Bury, R.B.; Clayton D.; Crisafulli, C.; Jones, L.L.C.; Ollivier, L.; Welsh, H.H., Jr. 1996. Survey protocols for Component/Strategy 2 amphibians. Portland OR: Special Interagency Publication, Regional Ecosystem Office, Survey and Manage species. 73 p.

Olson, Deanna H.; Leonard, William P.; Bury, R. Bruce. 1997. Sampling amphibians in lentic habitats. Northwest Fauna 4, 134 p.

Ray, Carleton. 1958. Vital limits and rates of desiccation in salamanders. Ecology 39:75-83.

ROD 1994. [see USDA and USDI 1994]

Ruggiero, L.F.; Aubrey, K.B.; Carey, A.B.; Huff, M.H. (eds.) 1991. Wildlife and vegetation of unmanaged Douglas-fir forests. Portland OR: USDA Forest Service General Technical Report PNW-GTR-285. 533 p.

Snedecor, George W.; Cochran, William G. 1980. *Statistical methods*. Seventh edition. The Iowa State University Press, Ames, Iowa. 507 p.

Species Analysis Team. 1994. [FSEIS 1994] Final supplemental environmental impact statement on management of habitat for late-successional and old-growth forest related species within the range of the northern spotted owl: Appendix J2–Results of additional species analysis [place of publication unknown]: USDA Forest Service; USDI Bureau of Land Management. 476 p.

Spotila, James R. 1972. Role of temperature and water in the ecology of lungless salamanders. Ecol. Monogr. 42:95-125.

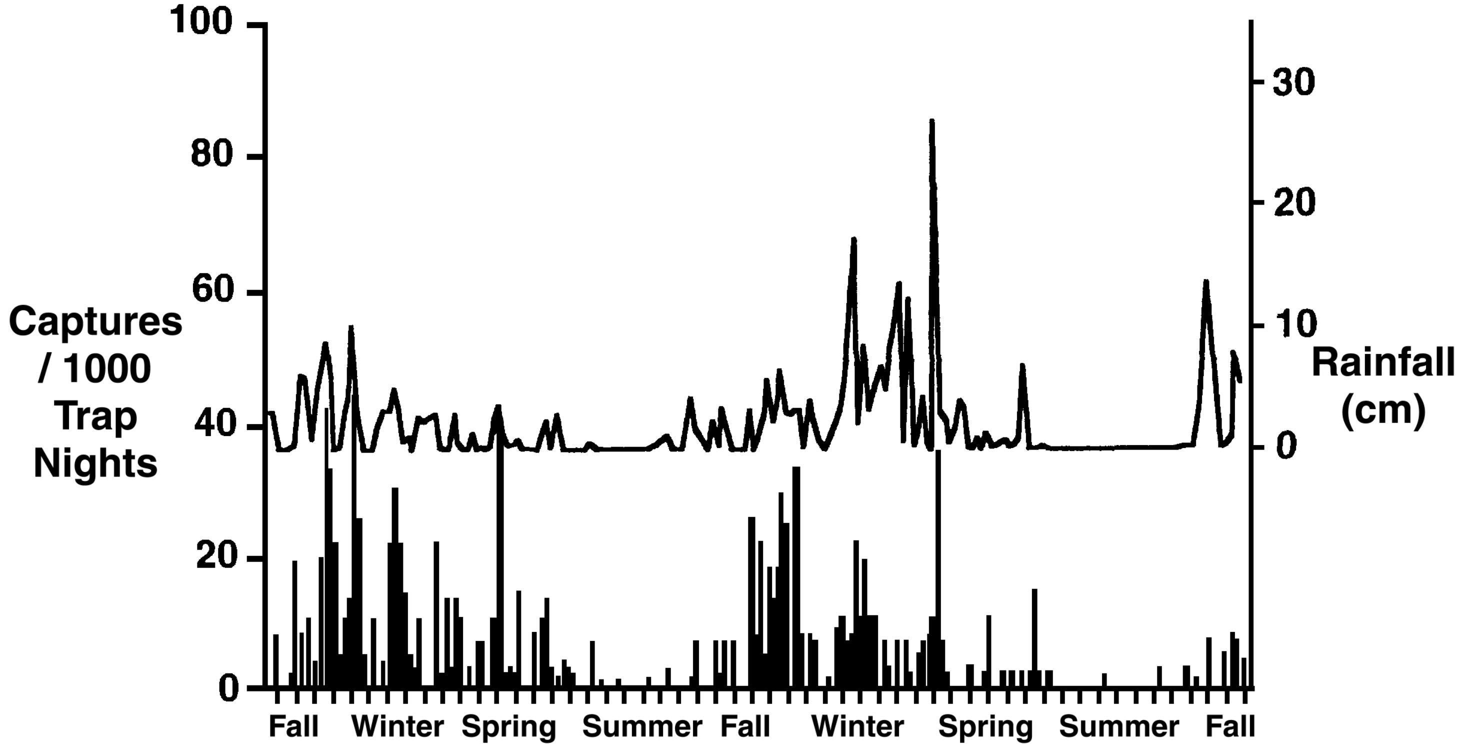
Szaro, R.C.; Severson, K.E.; Patton, D.R. (eds.). 1988. Management of amphibians, reptiles, and small mammals in North America. Gen. Tech. Rep RM-166. Ft. Collins, CO: USDA Forest Service, Rocky Mountain Forest and Range Experiment Station. 458 p.

Taub, Frieda B. 1961. The distribution of the red-backed salamander, *Plethodon c. cinereus*, within the soil. Ecology 42:681-698.

Thomas, Jack Ward; Raphael, Martin G.; Anthony, Robert B.; Forsman, Eric D. [et al.]. 1993. Viability assessments and management considerations for species associated with late-successional and old-growth forests of the Pacific Northwest. The Report of the Scientific Analysis Team [SAT Report]. USDA Forest Service, Region 10 printing office. 530 p.

U.S. Department of Agriculture, Forest Service; U.S. Department of the Interior, Bureau of Land Management. 1994. [ROD 1994] Record of Decision: for amendments to Forest Service and Bureau of Land Management planning documents within the range of the northern spotted owl. [place of publication unknown]. 74 p. [plus Attachment A: Standards and Guidelines: for management of habitat for late-successional and old-growth forest related species within the range of the northern spotted owl].

Figure I.1 Ensatina salamander captures per 1000 trap nights are reported against rainfall amounts to illustrate salamander surface movement and size and frequency of rainfall events. Salamander data are pitfall captures from an array in the Mattole River Watershed (H. Welsh and G. Hodgson, unpublished data). Rainfall data were collected in a rain gauge located near the array.



Chapter II

Survey and Manage Salamander Known Sites

Version 3.0

OCTOBER 1999

Richard S. Nauman and Deanna H. Olson

AUTHORS

RICHARD S. NAUMAN is a fisheries biologist and DEANNA H. OLSON is a research ecologist, USDA Forest Service, Pacific Northwest Research Station, 3200 SW Jefferson Way, Corvallis, OR 97331

ABSTRACT

Implementation of the Survey and Manage and Protection Buffer provisions of the Northwest Forest Plan requires identification of known sites of the five salamander species protected under these provisions. These species are the Shasta salamander (*Hydromantes shastae*), Del Norte salamander (*Plethodon elongatus),* Siskiyou Mountains salamander (*P. stormi*), Van Dyke's salamander (Cascade Range populations only, *P. vandykei*); and Larch Mountain salamander (*P. larselli*). Compilation of known sites (i.e., distinct localities) has been ongoing since 1994. In this chapter, we summarize our procedures to compile historical known site records and provide recent survey results. We analyze species distribution patterns with landscape coverages such as land ownership and federal land allocation. Localities of known sites, especially the distribution of recent detections, are important for implementation of the survey protocols, Chapters III-VII, and understanding their revisions from the 1996 draft protocols. The number of unique sites for the five amphibian species currently ranges from 28 to 882. However, we caution that these "sites" do not necessarily represent different populations. The number and distribution of sites by three time periods (pre-1980, 1980-1993, post-1993) displays the historic development of our knowledge. Tremendous federal survey efforts are evident from the wealth of data generated over the last four years. Such efforts have resulted in remarkable range expansions for several species and new understandings of their basic ecology. These compiled data are now feeding-back into the adaptive management of these species, such as revisions of their Survey Zones (e.g., Chapters IV and V) and new species status assessments, and are generating of a new pulse of research on habitat requirements and phylogenetic associations.

Version 3.0

TABLE OF CONTENTS

INTRODUCTION

Identification of unique localities of rare species is needed for implementation of the federal Protection Buffer and Survey & Manage provisions of the Northwest Forest Plan (USDA and USDI 1994). These two provisions address management standards and guidelines for localities on federal lands of five amphibian species: Shasta salamander, *Hydromantes shastae* (HYSH); Del Norte salamander, *Plethodon elongatus* (PLEL); Siskiyou Mountains salamander, *P. stormi* (PLST); Van Dyke's salamander (Cascade Range populations only), *P. vandykei* (PLVA); and Larch Mountain salamander, *P. larselli* (PLLA). Once known sites are identified, federal management standards and guidelines can be implemented: 1) our current knowledge of species distribution patterns affect survey decisions; 2) species management on federal lands for these rare salamanders currently requires a site-by-site approach, thus locality precision is needed; and 3) number of known sites and their distribution on federal lands are evaluation criteria for the adaptive management of these rare species under the Northwest Forest Plan. In this chapter we summarize data compilation procedures and database formation for Survey and Manage salamanders. A data retrieval effort has been made to identify known sites detected from mandated federal surveys through 1998. Unique localities for each species are mapped, with federal land allocation and ownership, survey zone and time period of first detection (< 1980, 1980-1993, >1993). Emerging distribution patterns illustrate our increasing knowledge of the ranges of these animals, and have resulted in revisions to survey protocols (Chapters III-VII) and management recommendations (Olson 1999).

"Known Site" Definition

Two usages of the term "known site" have been recognized as the Survey and Manage provision has been implemented for amphibians. These differ by the spatial scale at which species-localities are addressed, and the context for which the locality information is being used. At the broad spatial scale, for purposes of providing regional "dot" maps and landscape scale analyses of distribution patterns, such as those in this Chapter, a site is an observational record (e.g., a single museum record) which has sufficient locality information to differentiate it from other records. In this context, a site is a point locality although it may represent a population of large or small areal extent. Decision criteria used in this Chapter to recognize sites are further described in Methods, below.

In the species survey protocols (Chapters III-IV), and most project level planning, a known site is described as the two-dimensional area inhabited by an animal or population. This area can be delineated by the polygon created by individual captures, or by habitat (see Chapters III-VII, site delineation). In most cases, when these animals have been detected, a point locality or a generic locality description has been recorded, but not the site-area dimensions. During surveys that detect these salamanders, we recommend that both the first capture location be identified using a Global Positioning System for use in the regional database, and the area of the site be estimated from habitat or capture information (see "site delineation" at end of survey protocols, Chapters III-VII).

Representing known sites with a single point is problematic. A point locality could indicate an individual animal, a cluster of captures, or a population. Herein, we distinguish "records" (any observation of an animal), from "sites" (a discernable geographic location where animals have been found one or more times) and "populations" (interbreeding groups which have some level of isolation from surrounding groups and are typically the focus of conservation efforts). In our known site data compilation, we attempted to retrieve all documented records of these rare salamanders and consolidate these into site-localities. Often many records exist for a precise site-locality, especially those which have been known for a long period of time. One or more sites may represent a population, but we have not attempted this next level of consolidation because we generally lack the habitat or capture data to estimate population extent. The distinction between known sites as point localities and populations will be important to recognize during implementation and adaptive management of Survey and Manage procedures.

METHODS

Data Compilation

Historical known sites for these five salamander species were compiled in 1994-1998 during two data retrieval efforts. Records were sought from museums, published locations, Natural Heritage databases, federal and state agencies, industrial and private landowners, and individuals (Appendix II.1). Because the Van Dyke's salamander is only protected by the Survey and Manage provision in the Washington Cascade Range, only sites for this region were compiled. An initial compilation of records was begun in 1994. These records were compiled in the USDA Forest Service and USDI Bureau of Land Management "Known Sites Database" (J.S. Applegarth, pers. commun.). In 1996, a second effort was begun focusing on adding the results of post-1994 federal surveys to the original database and consolidating records in order to estimate the number of unique known sites.

Considerable effort was made to consolidate records to create a unique sites database. Often, National Forests, Natural Heritage Programs, State agencies and others had compiled the same museum records independently. When these files were combined into the Known Sites Database, a single museum specimen resulted in multiple records. Also, animals from a single site and collected on a single field trip were sometimes deposited in more than one museum. These were retrieved separately during our data compilation process and resulted in multiple records for a site. Duplication of site-localities also resulted from repeated visits to the same site over time.

Due to non-disclosure requirements of three institutions which would be violated by the federal Freedom of Information Act, data from collections in three museums (Carnegie Museum of

Natural History, University of California Berkeley Museum of Vertebrate Zoology and the California Academy of Sciences) are currently not included in our database, maps, and analysis. Approximately 230 sites, primarily those of the Del Norte salamander, are not included in our records. We were able to compile many of these museum records by direct contact with researchers, published locations and duplicate records in other museums (most museum records are from repeated visits to a limited number of sites and animals often are deposited in more than one institution). We have reviewed the missing data and feel that no significant sites have been omitted and that the known range of all five species are accurately described. We are currently attempting to resolve the situation and hope to include these data in the future.

Determination of Point Localities

The following procedures were used to evaluate records for our database. First, records with insufficient information to map with any confidence were dropped. These were typically older records and are possible represented by more recent records in the same area. These records, such as “Tacoma,” “Tilton River,” and “Limestone area north of Redding” are not included in our unique sites database. None of the deleted records are from areas without more precise records and their inclusion would not cause increases in the known range or substantially change the outcome of our analysis. Second, many records which could be mapped only with low precision were lumped into one site when it appeared that they likely represented the same location. An example of this are records for “Low Pass Creek Cave,” “Slopes below Low Pass Creek Cave,” and “Low Pass Creek Meadows, edge of Flat Creek Road.” Often a record with low precision was combined with a record of high precision when the data available for the low precision record was insufficient to differentiate it from the high precision record. For example, a record with limited information (i.e., legal description only) and a record with the same information plus additional site information (legal description, plus a good written description and/or Global Positioning Systems coordinates and/or other data) were lumped as one site when the data available did not indicate that they were different sites. Finally, for records with high precision, we have combined those <100 m apart into a single site.

Site Verification

Exceptional or unusual sites (i.e.: range extensions or unexpected habitats) were included only if a voucher (specimen or photograph) was available or if a species expert identified the animal. Vouchers have been collected at the more anomalous localities (e.g., new northern records of Larch Mountain salamander and southern range extensions for the Del Norte and Siskiyou Mountains salamanders). The majority of pre 1980 sites are represented my museum specimens.

Known Site Maps

Maps of site locations were generated using a Geographic Information System (GIS). After the initial compilation of sites and the production of preliminary maps with State and County boundaries, mapped sites were reviewed by species experts and others familiar with the distribution of known populations (Dave Clayton, Oregon populations of Siskiyou Mountains salamander; Louise Trippe, southern Washington populations of Larch Mountains salamanders; Lisa Ollivier, Del Norte Salamander; John Gutterman, northern coastal populations of Del Norte salamander; Greg Schmidt and Helen Fitting, southern populations of Del Norte Salamander). Comparisons to published maps (McAllister 1995; Nussbaum et al. 1983) were made as an additional quality control step. Corrections to site locations were made as appropriate.

GIS Coverages–Known site locations were mapped with several geographic coverages, including federal land allocations and land ownerships (nonfederal, USDI Bureau of Land Management, USDI National Park Service, and USDA Forest Service). Under the Northwest Forest Plan, federal land allocations include Matrix, Adaptive Management Area (AMA), Late Successional Reserve (LSR), Congressionally Withdrawn, Administratively Withdrawn, and Managed LSR. Land allocations were obtained from the GIS files maintained by Aquatic-Land Interactions Research Program (USDA Forest Service, Pacific Northwest Research Station, Corvallis, OR), originally obtained from the Regional Ecosystem Office, Portland, Oregon. Federal ownership boundaries were retrieved from the Interior Columbia Basin Ecosystem Management Project web page (http://www.icbemp.gov/).

Survey Zone boundaries were mapped to identify potential species ranges. Survey Zones are geographic areas in which federal surveys are triggered if likely habitat is expected to be affected by proposed projects (see Chapters I, triggers; Chapters III-VII, Survey Zones). The Survey Zones reflect our uncertainty and lack of knowledge regarding the ranges of these species.

Time Periods–Known sites are coded on maps by three time periods: pre-1980, 1980-1993, and post-1993. The years 1980 and 1993 were chosen because they represent shifts in natural resource information and management for the region. Awareness of multiple resource management issues in forests accelerated in the 1980's (e.g., wildlife issues, Szaro et al. 1988, Ruggiero 1991). In particular, the period of 1980-1993 represents a period of increasing effort to understand forest salamander habitats in both the management and research communities (review in Blaustein et al. 1995). A pivotal change in western federal forest management occurred in 1993 with the implementation of the Northwest Forest Plan. A surge of federal survey efforts began for salamanders under the Survey and Manage provision in 1994, and particularly in 1996-to-present utilizing standardized survey protocols (Olson et al. 1996).

Data Summaries

Total numbers of known sites by species are presented. Tallies also are computed for the three time periods and land allocations. Known species ranges are calculated using peripheral sites and a minimum convex polygon methodology (Hooge and Eichenlaub, 1998). Range area is presented for three years (1980, 1993, 1998) and by land allocation. New species information (e.g., since 1993) is emphasized. In particular, range extensions and elevational extensions resulting from federal surveys are described.

RESULTS AND DISCUSSION

The updated distribution data for these species demonstrate their endemism. At this time, from 28 to 882 unique sites have been compiled per species (Table II.1). Sites that may have been subject to extirpation are included here, such that these totals represent the sum of all sites ever detected and not necessarily extant sites. For example, in a survey of historical sites of Van Dyke's salamander, Wilson (1993) was able to find confirm presence at only 2 of 10 sites searched in the Washington Cascades. Furthermore, the number of sites is likely larger than the number of populations, as discussed above. Overlapping and clusters of dots on our maps (Figures II.1-10) may reflect interconnected localities. Such patterning of clusters and isolates should be considered for both site management options and future development of species conservation strategies.

Summaries of known sites by time period (Table II.1) show our developing knowledge of the species' distributions. For some of these species, information has increased significantly in recent years (Table II.1; see post-1993 sites in Figures II.1-10). For example, widespread recent surveys for Del Norte salamanders triggered by management activities have resulted in the majority of the 266 new sites discovered since 1993. This contrasts the Shasta salamander and Van Dyke's salamander with only two and four new sites discovered since 1993. This is likely a result of both their rarity and a lack of recent survey efforts for these two species (i.e., surveys for Van Dyke's salamanders in Riparian Reserves).

Table II.1. Known sites by time period and total number of known sites for the five Survey and Manage salamander species.

	Species				
	HYSH	PLST	PLEL	PLLA	PLVA
Unknown	0	0	135	0	0
Pre 1980	26	34	86	18	9
1980-1993	7	13	395	54	15
Post 1993	2	116	266	27	4
Total	**35**	**163**	**882**	**99**	**28**

Our knowledge of three species' ranges has increased recently (Table II.2; see post-1993 sites in Figures II.1-10). Until recently, Larch Mountain salamanders were considered to be restricted to the Columbia River Gorge (Nussbaum et al., 1983). Since 1993 their known range has been extended >60 km to the north, with three sites in the Wenatchee National Forest and six sites in the Green River Drainage. Also, two sites occur >16 km south of the Columbia River Gorge in Oregon, and their elevational extent has increased to 1,219 m (4,000 ft). New Siskiyou Mountains salamander sites have been found along the periphery of its range, roughly doubling their known range. The Siskiyou Mountain salamander's known distribution recently has been extended 18 km to the south, 11 km east, and 16 km west, all significant increases given the small spatial extent of its range. While the eastern extent appears to be well-bounded by the Rogue River valley, the southern range expansion has been remarkable. An increase in the elevation of known sites of this species also has been documented (to 1,830 m [6,000 ft], D. Clayton, Chapter IV). The Del Norte salamander has had recent range extensions including 8 km to the north and 32 km to the east. Such range extensions for multiple species supports the need for broad survey efforts such as those recommended by the Survey Zones.

Table II.2. Known range (ha, minimum convex polygon of unique sites) for the five Survey and Manage salamanders in 1980, 1993, and 1998.

	Species				
	HYSH	PLST	PLEL	PLLA	PLVA
1980	46,019	48,133	1,482,040	167,281	154,039
1993	69,912	60,888	1,702,046	625,029	441,709
1998	77,324	136,595	1,904,225	1,180,101	462,425

Additional spatial patterns of current known sites are apparent in the maps showing federal land allocations and ownerships (Figures II.1-10; Tables II.3-II.4). Gaps in the Del Norte salamander range clearly coincide with unroaded wilderness areas, to which surveyor access and consequently survey effort has been limited. Gaps in the Larch Mountain salamander range likewise coincide with unroaded reserved lands, in addition to mountain peaks and the active volcanic zones of Mount Saint Helens and Mount Rainier. While the historic range of the Siskiyou Mountains salamander appears to coincide with the Applegate Adaptive Management Area, it is now known from multiple allocations and ownerships. For all species, with recent surveys mainly in areas proposed for management, "strings" of new sites are appearing in areas where projects have been proposed and surveys have been conducted (e.g., PLLA, on either side of Highway 90 in response to a proposed land exchange and other projects; PLEL, Salmon River, California; PLST, Scott River and Grider Ridge, California [Grider Ridge sites are potentially PLEL or PLEL-PLST intergrades, D. Wake, pers. commun.]).

Species Summaries

Shasta Salamander--The Shasta salamander is the rarest amphibian in the northwest. As currently known, its range is 77,324 ha of which approximately 9,500 ha are covered by the Shasta Reservoir. The species is known from 35 sites (Table II.1) which are believed to represent approximately 14 populations, ranging in size from < 0.4 ha to about 6,300 ha (Lewendal, 1995; Papenfuss and Carufel, 1977).

Survey efforts for this species have been limited because projects on federal lands have not been proposed in the recreation area around Shasta Lake. Only two new sites have been discovered since 1993 (Table II.1; Lewendal, 1995). The discovery of a site in the Dutch Creek drainage in 1983 represents a 14 km range extension (Figures II.1 and II.6). This site increased the known range by roughly 35%. Within the known range of Shasta salamanders, large gaps exist which may represent biological reality or sampling bias. While many visits have been made to several populations, little surveying in other areas has been done, especially areas outside of limestone outcrops. While current scientific opinion associates this species with limestone outcrops, recent observations of this species using oak woodland habitats and the discovery of a population on a volcanic outcrop opens the possibility of the species using a broader range of habitats than commonly believed (Chapter III).

Table II.3. Number of unique known sites of the five Survey and Manage salamanders by land allocation. Managed LSR is not included in this table because no sites are known from this allocation. The number of sites in Riparian Reserves is unknown.

	Species									
	HYSH		PLST		PLEL		PLLA		PLVA	
Land Allocation	Number	%	Number	%	Number	%	Number	%	Number	%
Nonfederal	12	34	12	7	193	22	41	41	8	30
Congressionally Withdrawn	0	0	0	0	34	4	6	6	6	21
Administratively Withdrawn	10	29	4	2	38	4	4	4	1	4
LSR	0	0	35	21	270	31	37	37	5	19
Matrix*	13	37	3	2	314	36	5	5	8	30
AMA*	0	0	109	67	33	4	6	6	0	0
Total	35		163		882		99		28	

Table II.4. Known species range (ha, minimum convex polygon) by land allocations (nonfederal and Northwest Forest Plan allocations). The species range in Riparian Reserves is unknown.

	Species									
	HYSH		PLST		PLEL		PLLA		PLVA	
Land Allocation	area	%	area	%	area	%	area	%	area	%
Nonfederal	23,003	30	21,690	16	574,408	30	372,890	32	236,351	51
Congressionally Withdrawn	0	0	5,685	4	393,482	21	265,179	22	80,810	17
Administratively Withdrawn	17,971	23	8,900	7	100,748	5	47,472	4	11,853	3
LSR	274	0.4	36,529	27	504,066	26	228,888	19	70,664	15
Matrix*	35,996	47	12,197	9	277,989	15	182,272	15	54,035	12
Managed LSR	80	0.1	0	0	0	0	7,408	0.6	0	0
AMA*	0	0	51,594	38	53,532	3	75,992	6	8,712	2
Total Range	77,324		136,595		1,904,225		1,180,101		462,425	

The number of Shasta salamander known sites is roughly equal for nonfederal lands (N=12), Administratively Withdrawn areas (N=10), and Matrix (N=13, Table II.3). No sites are known from Late Successional Reserve or Congressionally Withdrawn lands. The species' range follows a similar distribution with 30% falling on nonfederal lands, 23% on Administratively Withdrawn, and 47% on Matrix with small amounts (< 1%) on LSR and managed LSR (Table II.4).

Overall this species appears to be a rare endemic restricted to one county with a few isolated populations. The protected land allocations of the Northwest Forest Plan (i.e., LSR, Withdrawn lands) offer limited protection to this species, but the Protection Buffer and Survey and Manage Standards and Guidelines as well as California State regulations provide protection on federal and non-federal lands.

Siskiyou Mountains Salamander–While having 163 known sites (Table II.1), this species is restricted to roughly 137,000 ha (Table II.2) in Jackson and Josephine Counties in Southern Oregon and Siskiyou County in Northern California. Recent survey efforts have greatly increased the number of known sites (116 of 163 discovered since 1993; Table II.1). This animal is now known to an elevation of 1,830 m (6,000 ft). New sites are primarily the result of heavy survey efforts associated with ongoing research projects and management activities. Range extensions discovered between 1993 and 1998 have more than doubled the known range of his species (Table II.2). Of particular interest are the range extensions south of the Klamath River in the Scott River and Grider Creek drainages. A large number of Siskiyou Mountains salamander known sites fall within the Applegate AMA (N=67) and only a few are in LSR (N=27) and Withdrawn allocations (2 in Administratively Withdrawn areas) leaving the majority (77%) in unprotected allocations (Table II.3; Figure II.2).

While the northeastern portion of the species range is relatively well-defined by the Rogue Valley, and the eastern portion of the range by the contact zone with the Del Norte salamander, there are expected to be further southern range extensions. The Marble Mountains Wilderness lies south of the known range (see large withdrawn area south of range on Figure II.2). The closely related Del Norte salamander is known from the western edge of the wilderness and has been recently found south of the wilderness, including a site near Idlewild Campground near the southeastern corner of the wilderness. It is likely that one or both of these species inhabits the wilderness area and that the contact zone between the two species extends south from Grider Ridge into the wilderness. Future work in the wilderness may result in additional range extensions.

Del Norte Salamander--The Del Norte salamander is the most abundant (882 known sites; Table II.1) and widest ranging (1,904,225 ha; Table II.2) species of the five Survey and Manage salamanders. Recent range extensions to the east up the Salmon River Drainage (Figures II.3 and II.8) as well as other smaller extensions to the north, northeast and south have resulted in a near doubling of the known range since 1993. However, many known sites (58%; Table II.3) are in unprotected Matrix and nonfederal holdings. The known range is 30% non-federal (largely private) and 15% Matrix (Table II.4). Large blocks of Withdrawn lands (wilderness) lack known sites (Figure II.3), likely due to a lack of surveys in roadless areas. The southeastern extent of the range probably is in the Trinity Alps Wilderness and the contact zone with the Siskiyou Mountains salamander continues into the Marble Mountains Wilderness (see Siskiyou Mountains salamander discussion).

Van Dyke's Salamander--The Cascade Range portion of the Van Dyke's salamander is large (462,425 ha; Table II.2) relative to the small number of known sites (N=28; Table II.1). This species has the smallest number of known sites of the five Survey and Manage salamanders. This may result from the naturally patchy distribution coupled with the apparent lack of surveys in Riparian Reserves. Currently, the species is known from three main clusters of populations in the Washington Cascade Range (Figures II.4 and II.9): the Mt. St. Helens area, the area northwest of Morton, and Mt. Rainier. The gaps between these clusters may be filled by future surveys. The status of the Mt. Rainier cluster is uncertain. Wilson (1993) could not find animals at the type locality on the south side of Mt. Rainier National Park. The status of the Carbon River site on the north side of Mt. Rainier National Park is unknown. The third site in the Mt. Rainier area was last visited in 1991 and was occupied (Wilson, 1993). The cluster of sites near Morton is isolated by an approximately 15 mile wide band of private ownership.

Larch Mountain Salamander–Our knowledge of the distribution of Larch Mountain salamanders has greatly increased in the last 20 years, with over 80% of the known sites detected since 1980, and over 25% detected since 1993. Our knowledge of the species' range has grown tremendously, with the range almost doubling since 1993 (Table II.2). Their elevational extent is now known to be 1,219 m (4,000 ft). The Columbia River Gorge has been maintained as a distribution center for this animal, yet populations extending >60 km north of the Gorge, and >15 km south of Mount Hood significantly alters our "Gorge-centric" view of this species (Chapter VII). The patchy distribution of Larch Mountain salamander sites in forested habitats north and south of the Columbia River Gorge may result from a great deal of unsuitable habitat, a product of the legacy of past disturbances (catastrophic fire, volcanism) and elevational constraints of the Washington Cascade Range (C. Crisafulli, pers. Commun.). However, much of this landscape has not been surveyed for this species. While a moderate portion of the species range is protected (44% in LSR and Withdrawn allocations) these areas have had few or no surveys. While many sites are known outside of the Columbia River Gorge, the majority of known sites are in or near the Gorge. Ownership on the Oregon side of the Gorge is largely Forest Service in LSR allocation. On the Washington side of the Gorge Ownership is primarily private. Known sites are split between LSR (37% of known sites) and private lands (41% of known sites) with the remaining 22% of sites split between the other allocations.

Expansion of Knowledge

It is clear that the federal survey efforts for these salamanders have been tremendous and hugely successful. Although our current database and site maps do not include sites where surveys have been conducted but animals have <u>not</u> been found, the scope of recent search efforts across the region is well-documented from new localities. Federal survey efforts are reshaping our understanding of the regional amphibian fauna. There are invaluable rewards from the documented range expansions and new site localities of these endemic species. The data compiled here are generating hypotheses for future investigation. New studies have been proposed to refine habitat associations, investigate response to management activities, and examine phylogenetic relationships for several species. Simultaneously, feedback of these survey results to federal forest managers is testing and demonstrating the adaptive capacity of the Northwest Forest Plan. These site data may enable managers to reexamine approaches to species protection on federal lands. Development of conservation strategies and new options for species management are expected.

Database Management

Known site data should be maintained at the regional level. Until a routine mechanism for centralized database management and regularly-scheduled updates is in place, we are maintaining our unique sites database (USDA Forest Service, Pacific Northwest Research Station, Corvallis, OR) and will be conducting annual updates. We recommend that field units retain copies of their data from surveys.

Recommendations

While our data provide a summary of the current state of knowledge of the distribution of these species, we recommend that several new paths in data analysis be pursued in anticipation of future management needs. First, federal survey forms with no species detections exist in field units. Compilation of these localities would provide insight into the patchiness of these rare species, in addition to a means of addressing surveyor effort relative to new species localities. Second, basic habitat data has been collected during surveys. If this were compiled, it could lead to comparisons between known sites and no-detection sites and result in new hypotheses regarding habitat associations. Third, habitat at a larger spatial scale could be assessed. Some field units working with the southern species have created GIS coverages for rocky habitats in areas where surveys have been conducted. Compiling these data would provide insights into the proportion of the landscape that provides habitat. Fourth, because surveys are time constrained, an estimate of relative abundance can be made for new known sites. This could be used to begin to address the question "What is a site?" Finally, survey protocols could be refined if all data forms were compiled and analyzed. For example, an assessment could be conducted of multiple site visits, survey effort, and environmental conditions.

With the addition of a few survey parameters to federal survey efforts, valuable data would be collected that would greatly increase our knowledge of these species. Again, such information would feed directly into future management needs. Current protocols are streamlined to determine only if the target species is present at an area in which a project is proposed. Several additional data needs during protocol surveys are identified: relative abundance or density estimates of animals at sites, areal extent of known sites (requiring delineation of habitat and/or populations, see "Site Delineation" in Chapters III-VII), and additional habitat descriptors.

Additional surveys also are recommended. Surveys are needed in reserved lands in order to assess whether these species are protected there. Large blocks of land in the Pacific Northwest have not been explored for amphibians. In particular wilderness and other roadless areas have been poorly explored. Lack of access and difficulty in wilderness travel during appropriate salamander seasons (cool and wet) has limited surveys. Areas such as the Marble Mountains in California and the Goat Rocks in Washington provide opportunities for herpetological exploration. It is likely that such future work will reveal currently unrecognized cryptic biodiversity within this taxa.

ACKNOWLEDGMENTS

This project would not have been possible without the help of numerous persons and institutions nationwide who have provided site records. John Applegarth initiated the collection of known site records in 1994. He conducted a great deal of "detective work" to determine precise site localities. Kelly Christiansen, Zoe Rickenbach and Kathryn Ronnenberg provided valuable assistance with map creation and layout design. Members of the Survey and Manage Amphibian Subgroup have worked extremely hard to improve the accuracy and completeness of these data.

REFERENCES

Blaustein, Andrew R.; Beatty, Joseph J.; Olson, Deanna H.; Storm, Robert M. 1995. The biology of amphibians and reptiles in old-growth forests in the Pacific Northwest. Portland OR: USDA Forest Service Gen. Tech. Rep. PNW-GTR-337. 98 p.

Brodie, Edmund D., Jr. 1970. Western salamanders of the genus *Plethodon*: systematics and geographic variation. Herpetologica 26:468-516.

P. N. Hooge and W.M. Eichenlaub. 1998. Animal movement extension to arcview. ver. 1.1. Alaska Biological Science Center, U.S. Geological Survey, Anchorage, AK, USA. Available: http://www.absc.usgs.gov/glba/gistools.htm.

Lewendal, P. 1995. Habitat-use by the Shasta salamander *Hydromantes shastae*. Report to: California Department of Fish and Game, Redding, CA. 32 p.

McAllister, K.R. 1995. *Distribution of Amphibians and Reptiles in Washington State.* Northwest Fauna 3:81-112.

Nusbaum, R.A., E.D. Brodie Jr. and R.M. Storm 1983. *Amphibians and Reptiles of the Pacific Northwest*. University Press of Idaho, Moscow, Idaho. 332 p.

Olson, D.H. (ed.) 1999 (in review). Management Recommendations for Component/Strategy 1 Amphibian Species. Special Interagency Publication.

Olson, D.H. (ed.); Applegarth J.; Bury, R.B.; Clayton D.; Crisafulli, C.; Jones, L.L.C.; Ollivier, L.; Welsh, H.H., Jr. 1996. Survey protocols for Component/Strategy 2 amphibians. Portland OR: Special Interagency Publication, Regional Ecosystem Office, Survey and Manage species. 73 p.

Pappenfus, T.; Carufel, D. 1977. A survey of the habitat of the Shasta salamander *Hydromantes shastae*. An interim report. Unpublished report to the USDA Forest Service. 18pp.

Ruggiero, L.F.; Aubrey, K.B.; Carey, A.B.; Huff, M.H. (eds.) 1991. Wildlife and vegetation of unmanaged Douglas-fir forests. Portland OR: USDA Forest Service General Technical Report PNW-GTR-285. 533 p.

Szaro, R.C.; Severson, K.E.; Patton, D.R. (eds.). 1988. Management of amphibians, reptiles, and small mammals in North America. Gen. Tech. Rep RM-166. Ft. Collins, CO: USDA Forest Service, Rocky Mountain Forest and Range Experiment Station. 458 p. of Idaho Press. Moscow, Idaho. 332 pp.

U.S. Department of Agriculture, Forest Service; U.S. Department of the Interior, Bureau of Land Management. 1994. Record of Decision: for amendments to Forest Service and Bureau of Land Management planning documents within the range of the northern spotted owl. [place of publication unknown]. 74 p. [plus attachment A: Standards and Guidelines: for management of habitat for late-successional and old-growth forest related species within the range of the northern spotted owl]. (ROD 1994).

Wilson, A.G. Jr. 1993. Distribution of Van Dyke's salamander, *Plethodon vandykei* Van Denburgh. Unpublished report submitted to the Washington Department of Wildlife. 145 pp.

Figure II.1. Northwest Forest Plan land allocations and known sites of the Shasta salamander by time period. The heavy line represents the species survey zone. The survey zone was constructed using data available through 1998.

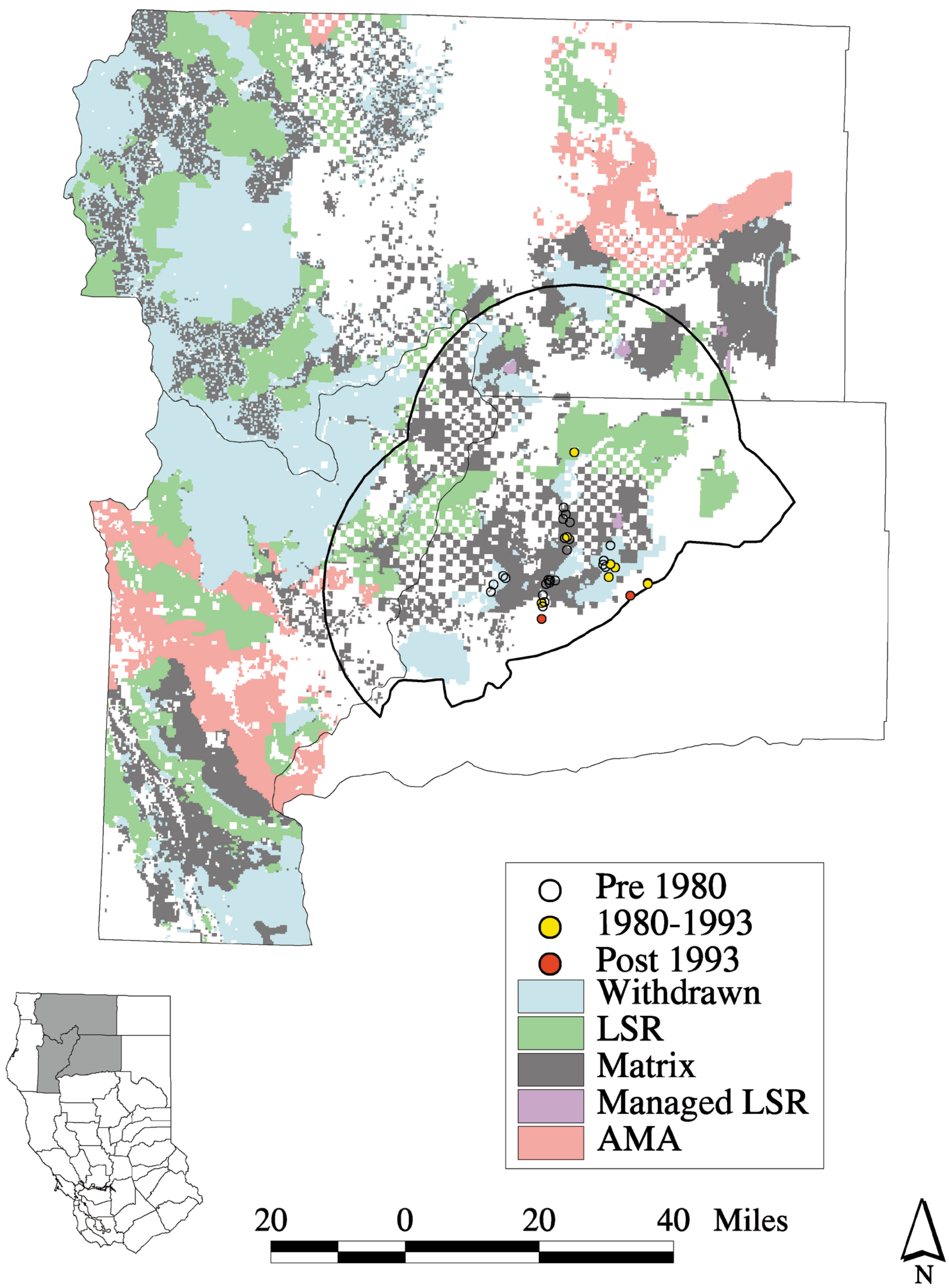


Figure II.2 Northwest Forest Plan land allocations and known sites of the Siskiyou Mountains salamander. The heavy line represents the species survey zone and the cross hatched area represents the combined Del Norte/Siskiyou Mountians salamander survey area.

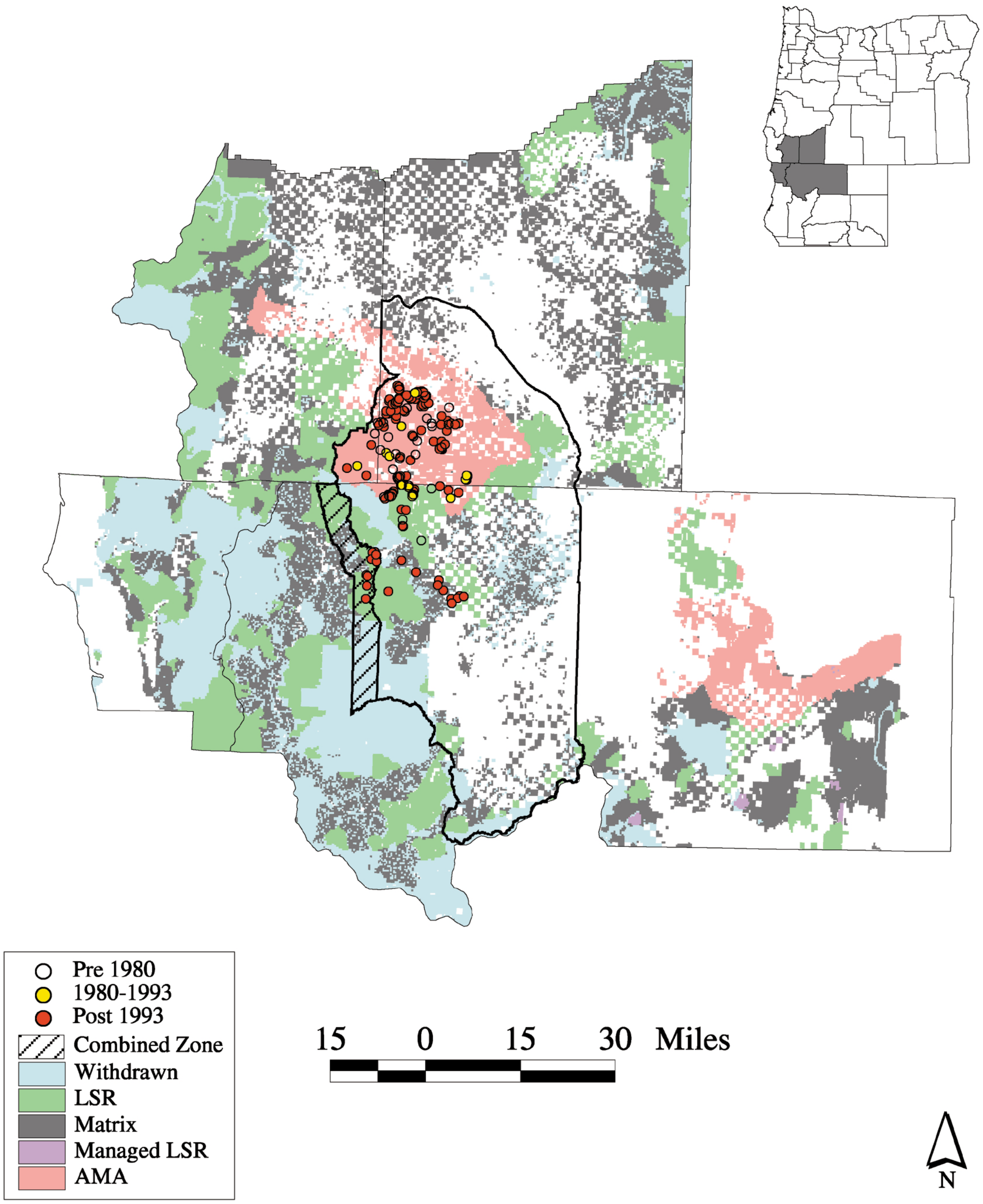


Figure II.3. Northwest Forest Plan land allocations and known sites of the Del Norte salamander by time period. The heavy line represents the species survey zone and the cross hatched area represents the combined Del Norte/Siskiyou Mountains salamander survey zone.

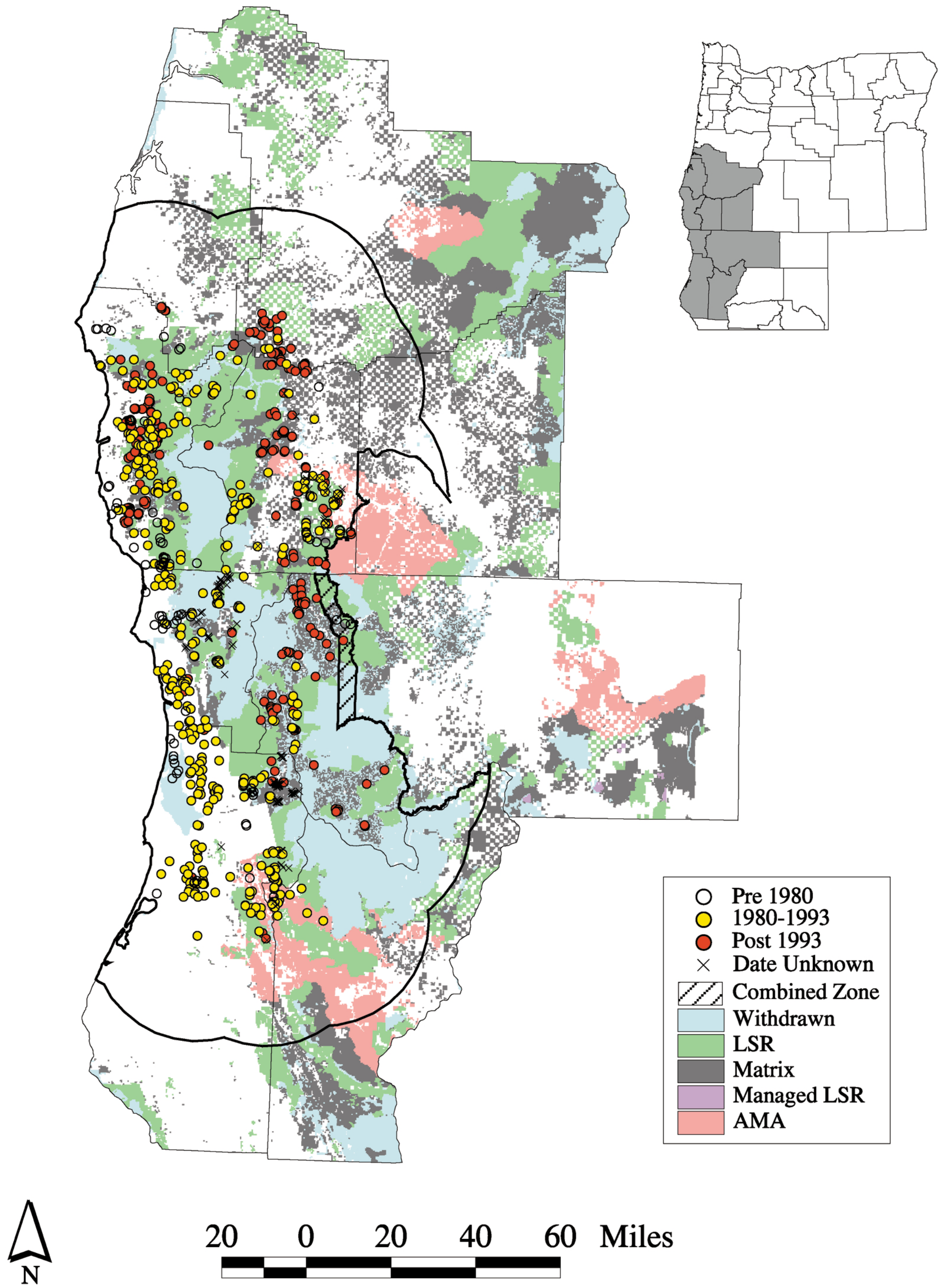


Figure II.4. Northwest Forest Plan land allocations and known sites of the Van Dyke's salamander by time period. The heavy line represents the species survey zone.

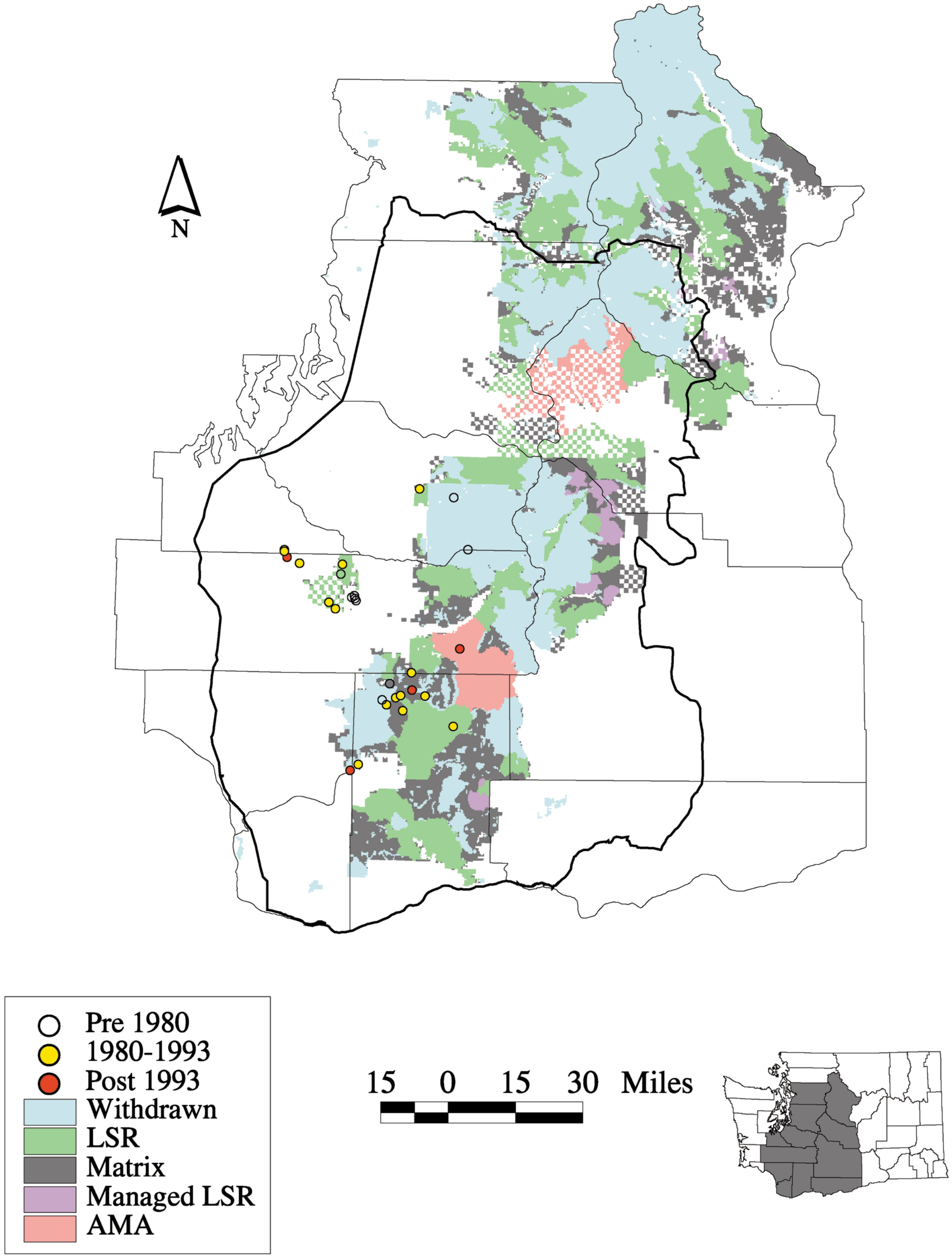


Figure II.5. Northwest Forest Plan land allocations and known sites of the Larch Mountain salamander. The heavy line represents the species survey zone.

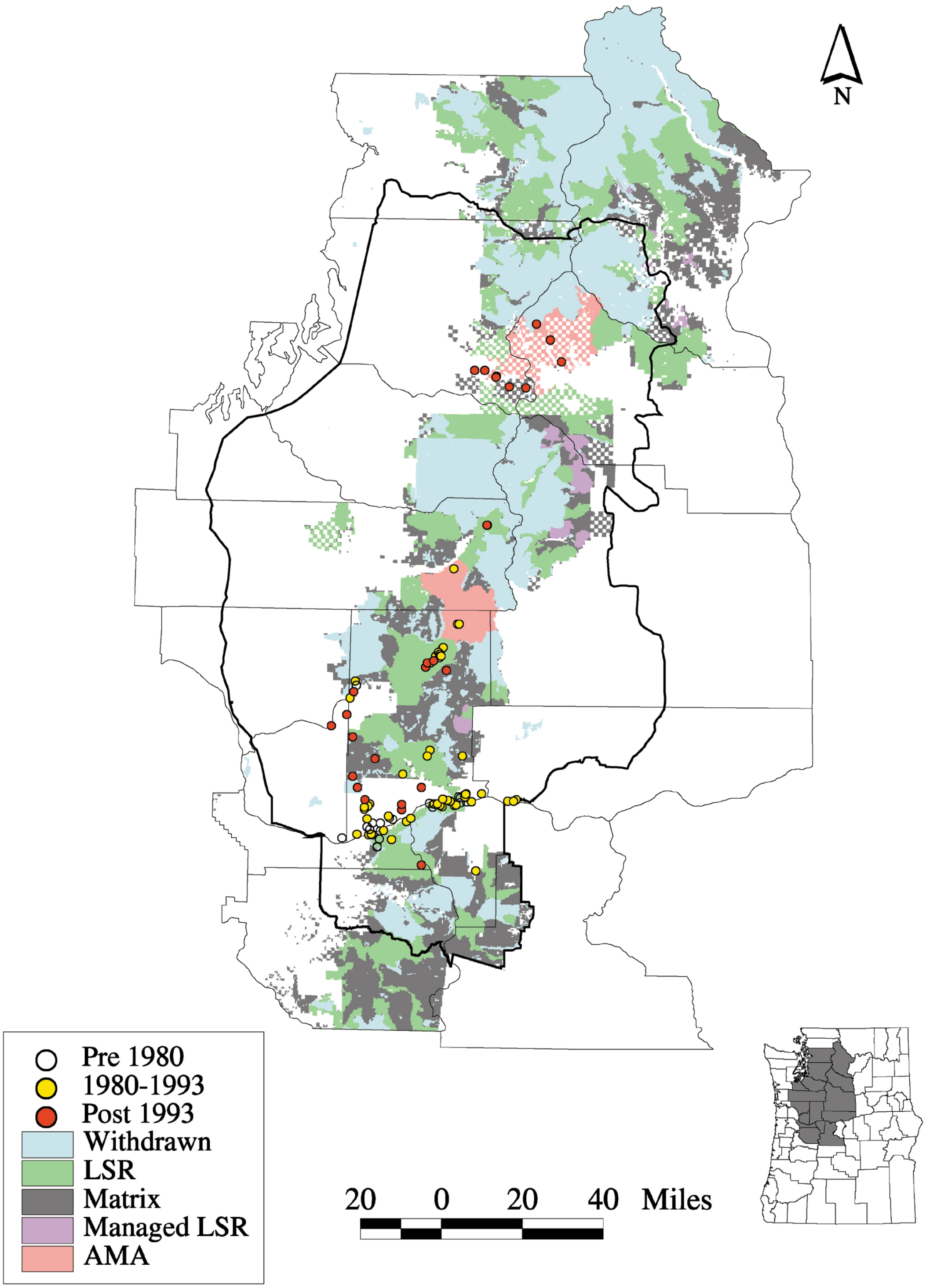


Figure II.6. Known sites of the Shasta salamander by time period and Federal land ownership. The heavy line represents the species survey zone. The survey zone was constructed with data available through 1998.

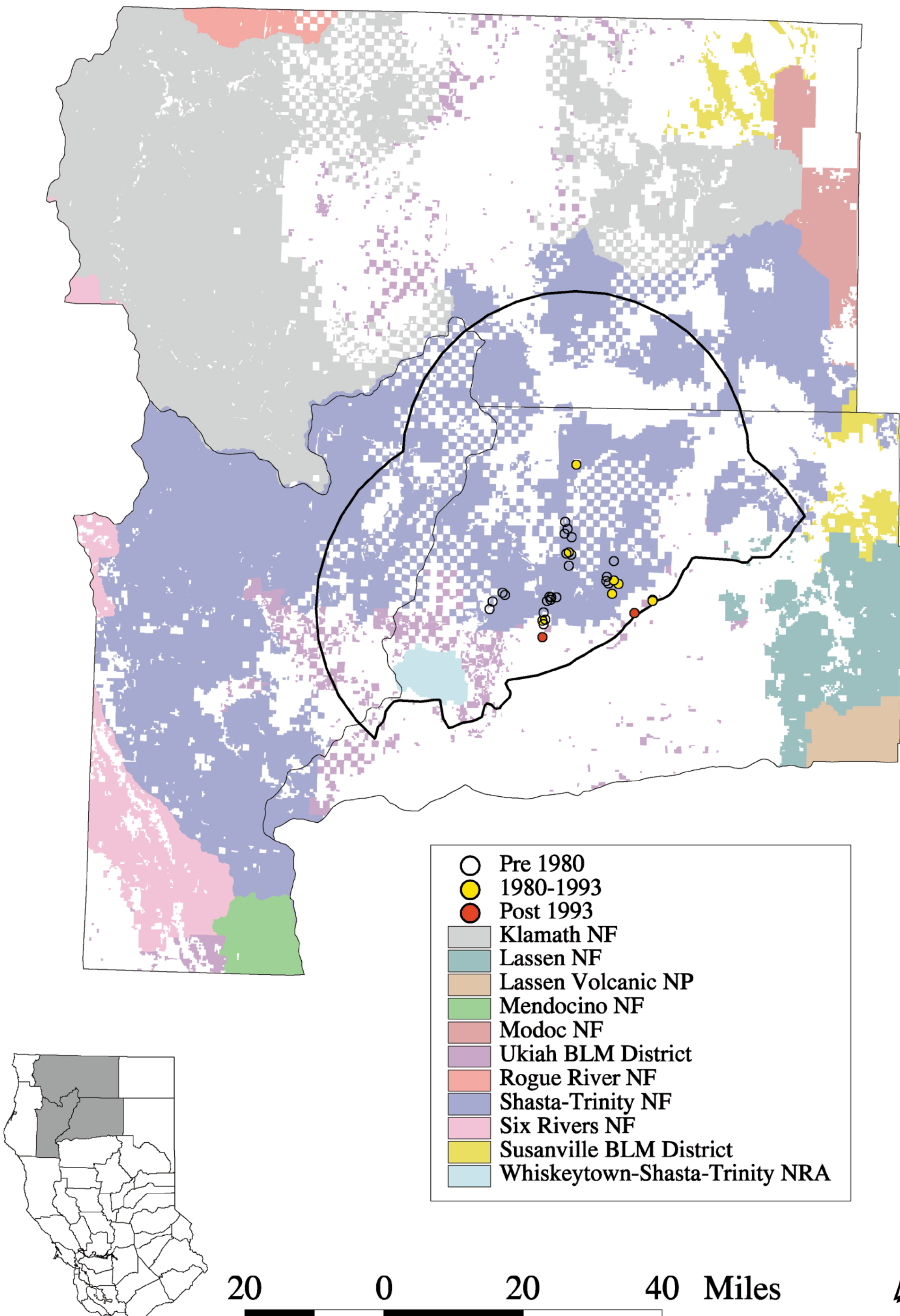


Figure II.7 Known sites of the Siskiyou Mountians salamander and Federal land ownership. The heavy line represents the species survey zone and the cross hatched area represents the combined Del Norte/Siskiyou Mountains salamander survey zone.

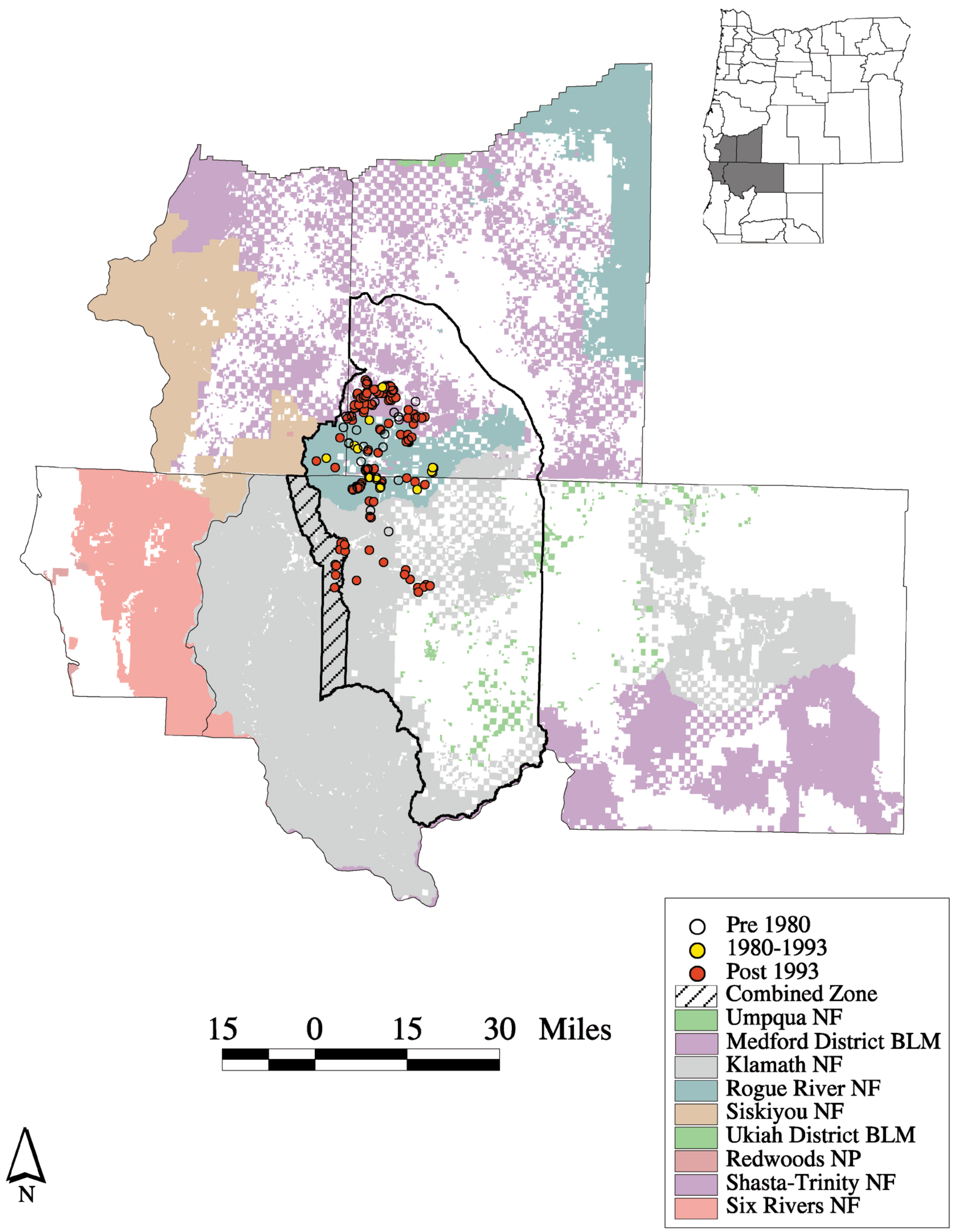


Figure II.8 Known sites of the Del Norte salamander and Federal land ownership. The heavy line represents the species survey zone and the cross hatched area represents the combined Del Norte/Siskiyou Mountains salamander survey zone.

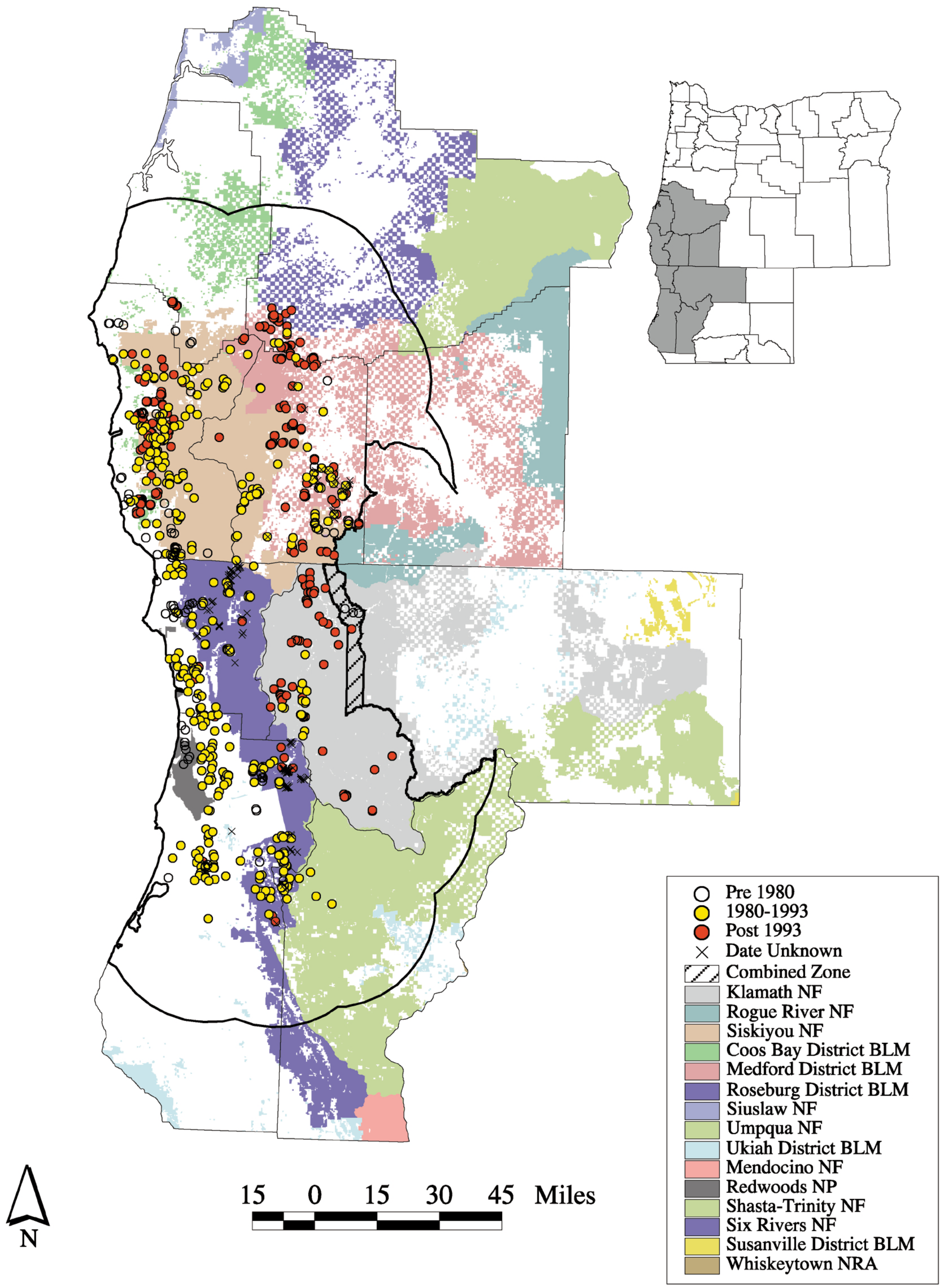


Figure II.9. Known sites of Van Dyke's salamander by time period and Federal land ownership. The heavy line represents the species survey zone.

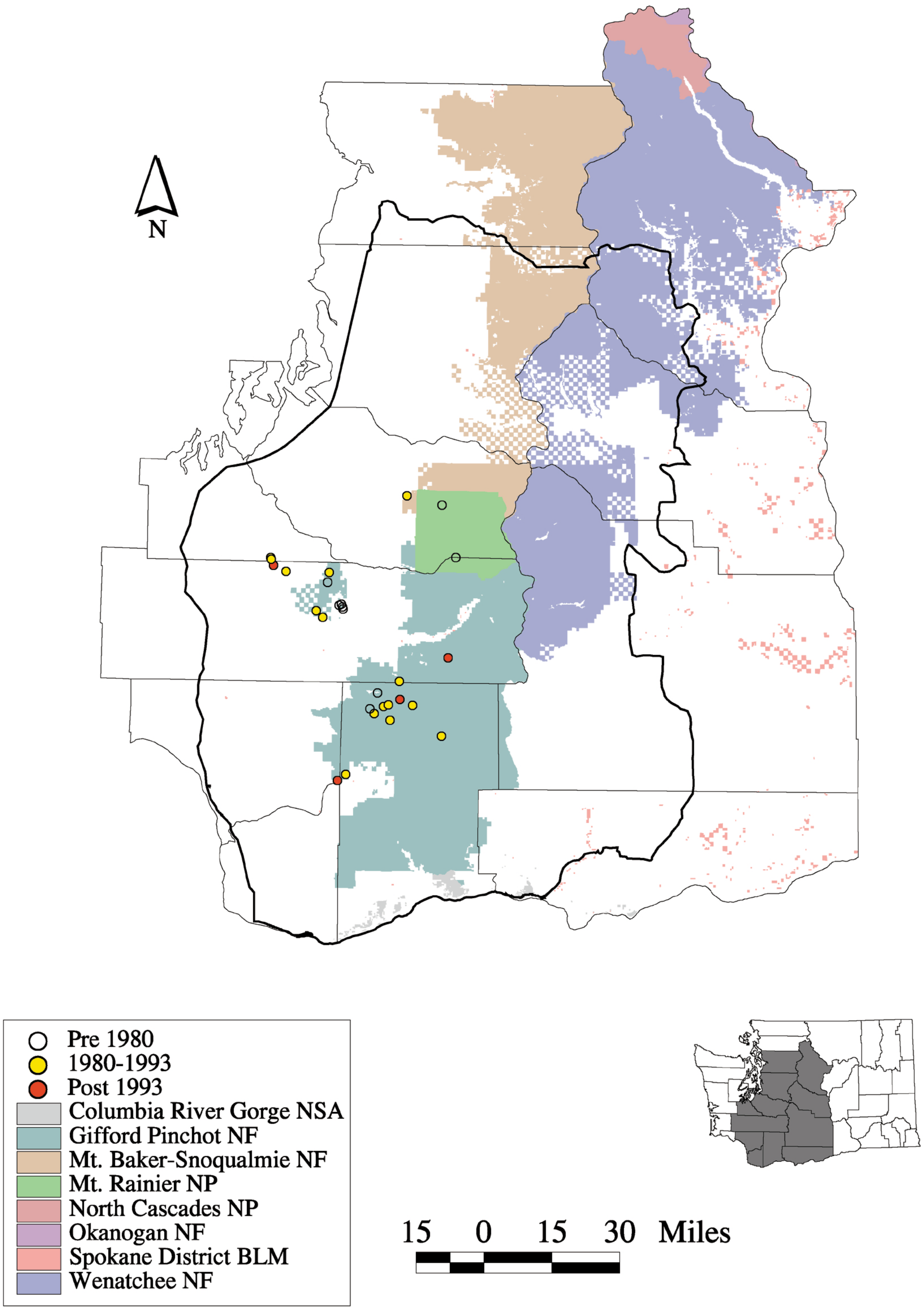
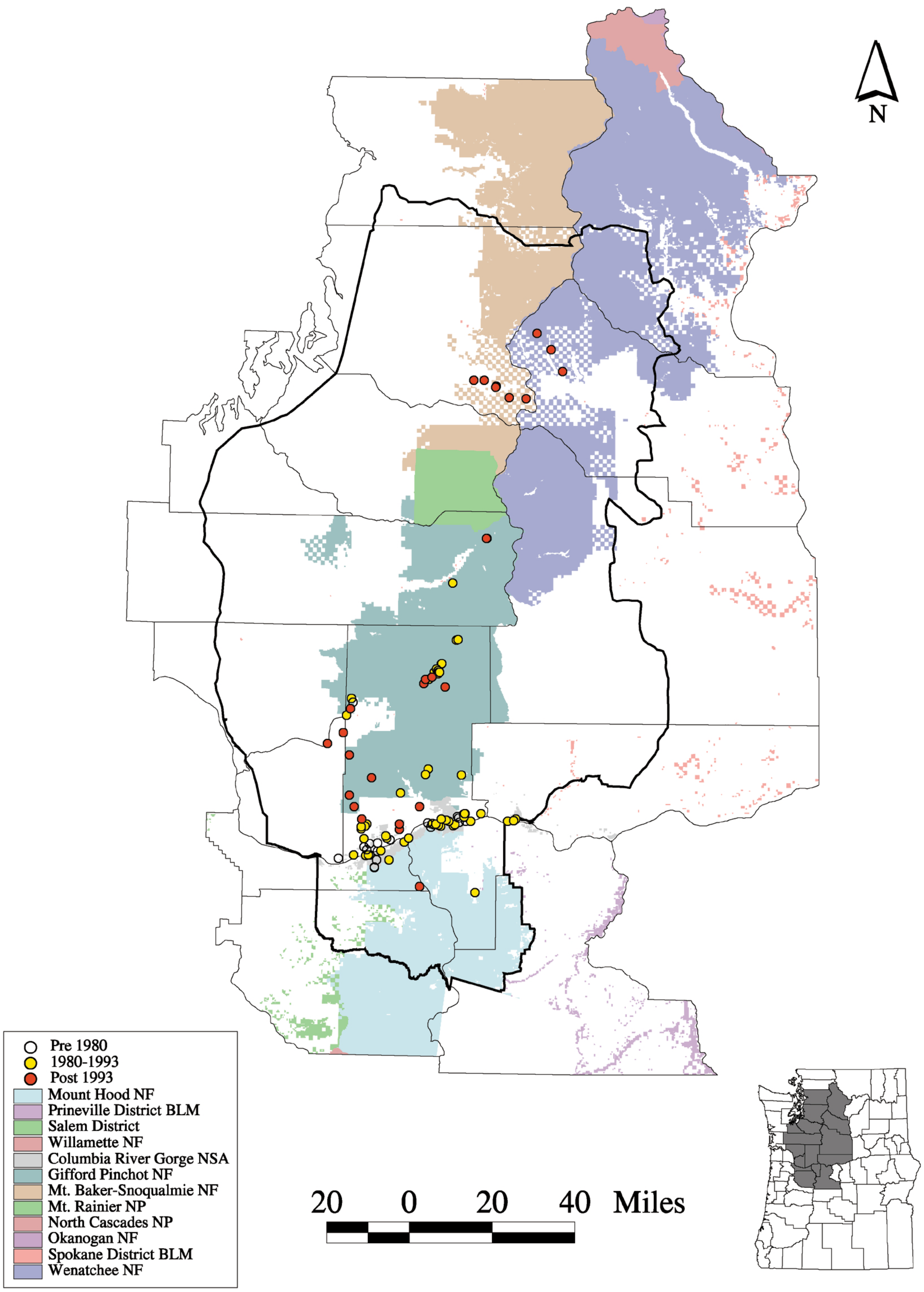


Figure II.10. Known sites of the Larch Mountain salamander and Federal land ownership. The heavy line represents the species survey zone.



Appendix II.1

SOURCES OF AMPHIBIAN KNOWN SITE DATA

Richard S. Nauman
(USDA Forest Service, Pacific Northwest Research Station, Corvallis, OR)
and
John S. Applegarth
(USDI Bureau of Land Management, Eugene District)

USDA Forest Service

Rogue River National Forest
Gifford-Pinchot National Forest
Klamath National Forest
Mt. Hood National Forest
Siskiyou National Forest
Shasta-Trinity National Forest
Six Rivers National Forest
Pacific Southwest Research Station, Redwood Sciences Laboratory

USDI Bureau of Land Management

Medford District
Coos Bay District
Arcata Field Office

Museums

American Museum of Natural History
Academy of Natural Sciences, Philadelphia
Central Washington University
Cornell University
Field Museum of Natural History, Chicago
Harvard University, Museum of Comparative Zoology
Humboldt State University
Idaho Museum of Natural History, Idaho State University, Pocatello
Louisiana State University (Baton Rouge) Museum of Natural Science
Los Angeles County Museum of Natural History
Milwaukee Public Museum

Museum of Southwestern Biology University of New Mexico
National Museum of Natural History
Portland State University
San Diego Society of Natural History
Texas Cooperative Wildlife Collection
Texas Natural Heritage Collection
University of Arizona
University of Colorado Museum of Natural History
University of Florida, Florida State Museum
University of Illinois Museum of Natural History
University of Kansas Natural History Museum
University of Michigan Museum of Zoology
University of Puget Sound Slater Museum of Natural History
University of Texas at Arlington
University of Washington Burke Museum
Washington State University Charles R Conner Museum

Individuals

J. Applegarth
Ted Brown
R.B. Bury
Dave Clayton
Char Corkran
James Kirk
Bill Leonard
Brad Norman
Lisa Ollivier
Marty Raphael
Karen Seaman

State Agencies and Natural Heritage Programs

California Department of Fish and Game
Oregon Department of Fish and Wildlife
Oregon Natural Heritage Program
Washington Department of Fish and Wildlife
Washington Natural Heritage Program

Private Industry and Consultants

Steve Bondi - EDAW Inc.
Lowell Diller - Simpson Timber
Mike Hall - Foster Wheeler Environmental
Peter Lewendal - Mason, Bruce & Girard, Inc. (Formerly of Shasta Land Management Consultants)
Henning Stabins - Plum Creek Timber

Chapter III

Survey Protocol for the Shasta Salamander (*Hydromantes shastae*)

Version 3.0

OCTOBER 1999

Deanna H. Olson and Peter C. Lewendal

AUTHORS

DEANNA H. OLSON is a research ecologist, USDA Forest Service, Pacific Northwest Research Station, 3200 SW Jefferson Way, Corvallis, OR 97331.

PETER C. LEWENDAL is a wildlife biologist, Mason, Bruce & Girard, Inc., P.O. Box 337, Junction City, CA 96408.

ABSTRACT

Surveys to detect the presence of the Shasta salamander are needed on federal lands when proposed management activities may affect Shasta salamander populations or their habitat. This protocol is recommended to standardize survey efforts for species-detection on federal lands. State regulations must be recognized; this is a California State Threatened species. Permits are required to survey for this species and it is illegal to "take" this animal without State permission, thus mortality from activities on federal lands should be avoided. Surveys are conducted only in potential habitat for this species, when such habitat occurs in or adjacent to proposed project areas that occur within 25 miles of a known site for the species. Habitat includes rock outcrops and their surrounding slopes. Surveys must occur from late Fall to Spring, under restricted environmental conditions (temperature $\geq$ 4°C; at rock outcrops: relative humidity $\geq$ 90%; at slope habitats surrounding outcrops: relative humidity $\geq$ 65%). At least one site visit must occur during the preferred spring survey season. Search effort differs between rock outcrops and surrounding slope habitats: a minimum of 8 person-hours per 10 acres should be used for rock outcrops, and at least 4 person-hours per 10 acres should be used for surrounding slopes. During a site visit, surveyors search for salamanders along predetermined paths which provide a complete coverage of the designated Survey Area (habitat potentially affected by proposed management). If Shasta salamanders are not found, then a total of three site visits with full-surveys of the area need to be conducted. Site visits must be at least 10 days apart. "Presence" is designated when at least one Shasta salamander is found.

TABLE OF CONTENTS

INTRODUCTION

Survey procedures for determining the presence of the Shasta salamander, *Hydromantes shastae* (HYSH), on federally owned and managed lands were developed in response to the Record of Decision for the Northwest Forest Plan (USDA and USDI 1994). This document provides the conceptual framework and steps to conduct surveys in areas where projects have been proposed that have the potential to affect HYSH populations and habitats.

Before initiating surveys, read this entire document and its companion (Chapter I), which addresses general information and survey guidelines common to all five Survey and Manage amphibian species. Knowledge of the basic biology and management guidelines for this species (Olson 1999) will facilitate an understanding for the survey procedures.

Main Revisions and Clarified Procedures

This protocol is revised from the 1996 draft protocol (Olson et al. 1996). The list below summarizes the main revisions and clarified procedures specific to Shasta salamander surveys. Revisions have resulted from new information, and extensive review comments provided by agency executives, managers, field specialists, species-experts, and non-agency scientists. Revisions are for clarification, to refine procedures for optimizing sampling, but do not significantly alter survey effort compared to the 1996 draft protocol.

- **Flexible and fixed survey elements are clarified**
- **Survey triggers are defined and are discretionary**
- **Adjacent area survey distances are more discretionary, rather than 180 m**
- **Photographic plates of animals are included to aid species identification**
- **Photographic plates of habitats are included to aid habitat identification**
- **Summary of known site record compilation is included (Chapter II)**
- **Map of known site locations (Figure III.1), with other coverages (Chapter II)**
- **Revised Survey Zone, from northern California to 25 mile radius from sites**
- **Revised Data Form**
- **Slope habitat description is broadened, due to new information**
- **Spring is identified as best season for surveys**
- **Broader air relative humidity window for surveys in slope habitats**
- **3 site visits (instead of 4), one should occur in spring**
- **10+ day survey interval (instead of 21 days),
enabling completion of surveys within a single spring season**
- **Reduced search effort on slope habitats**

Survey Requirements

USDA and USDI (1994: Table C-3, p. C-59 and C-20) states that HYSH is a Component 2 species under the Survey and Manage provision and is a Protection Buffer species. Component 2 direction is to “survey prior to activities and manage sites,” while Protection Buffer guidelines state "Additional surveys conducted using a standardized protocol must be undertaken to identify and delineate all occupied sites within the species' potential range." The guidelines of this chapter provide parameters and procedures for triggering and conducting a survey to meet the requirements for federal land management activities. Surveys are conducted to determine if the target species, the species for which surveys are being conducted (i.e., HYSH), is present at a site.

State Regulations--This is a California State Threatened species and is subject to regulations in the California Fish and Game Code (1986, Gould Publications, Inc., Longwood, Florida; current version includes 1995 legislative sections). It is prohibited to handle these organisms without a Memorandum of Understanding in place with the California Department of Fish & Game. Capture and handling are necessary to identify these salamanders, thus a Memorandum of Understanding must be obtained prior to survey. Such permission should be received prior to field reconnaissance of proposed project areas, in preparation for possible salamander observations or incidental disturbance. Taking, including collection of voucher specimens (live or preserved), is prohibited (Section 2080, California Fish and Game Code) unless a State letter of permission is granted. The State needs to be notified if any incidental mortality occurs, and the specimen should be preserved and routed as per their direction.

Surveyor training--Training of field personnel is necessary prior to conducting surveys for HYSH. Surveyors must be able to identify HYSH and sympatric salamander species, identify HYSH habitats, understand the known ecology and behavior of this animal, and fully understand survey procedures for standardized implementation under field conditions.

<u>Training Requirements</u>

Two-day training session

- **One day of lecture and species identification**
- **One day of field instruction**

Surveyor skills include

- **Ability to identify all salamander species encountered**
- **Ability to identify target species’ likely habitat**
- **Knowledge of species’ microhabitat associations**
- **Knowledge of species’ microclimate associations**
- **Knowledge of species’ surface activity patterns**
- **Knowledge of survey protocol and its implementation**
- **Knowledge of documentation procedures, dataforms and discretionary decisions**

Presence--"Presence" is determined when one or more HYSH are detected and positively identified. If HYSH is detected, searching may be terminated. Once presence is determined, it is then assumed that a population occurs at that site and contiguous suitable habitat (see below) may be managed to maintain HYSH at the site using the current management guidelines (Olson 1999).

Not detected--"Not-detected" may be designated if the target species is not observed after three site visits, during each of which full surveys are conducted. After the site has been surveyed three separate times with no detection of HYSH, the site does not need to be managed according to HYSH management guidelines. Avoid the term "absence" because it is an absolute that cannot be ascertained after three site visits.

GENERAL BIOLOGY AND ECOLOGY

Much of the natural history and ecology of this species is reviewed in Olson (1999). A general reference for identification is Stebbins (1985).

The Shasta salamander is a member of the lungless family Plethodontidae. They respire through their moist skin and have an entirely terrestrial life cycle.

HYSH is a web-toed salamander, genus *Hydromantes*. Members of this genus occur in association with rock outcrops in California and Europe. They are known to be adept climbers.

Although HYSH is not aquatic, they are sensitive to temperature/moisture regimes and occur in relatively cool, moist microhabitats. This species is generally found (i.e., is surface-active) under restricted microclimate conditions. They are active during the fall, winter and spring rains (Hansen and Papenfuss 1994). HYSH has been found when temperatures ranged 3.9-11.7ºC, average 8.5ºC (39-53ºF, average 47ºF) and relative humidity ranged 75-100%, average 89% (Lewendal 1995).

Species Identification

Identifying features of HYSH (Plates III.1-4) include their webbed toes, their slightly flattened body and head, and their blunt, cylindrical tail, extending one-third their total length (Gorman and Camp 1953). Their adpressed limbs overlap by 0.5-1.5 costal folds (Stebbins 1985), although juvenile limbs may overlap by 2.5-3 costal folds (Gorman and Camp 1953). Coloration is variable, although **they usually have some yellow on their tail**, white blotches on their chest and abdomen, and silvery flecks on the adult sides, lower limbs and feet (Gorman and Camp 1953, Lewendal 1995). Sizes from 23 to 92 mm (total length) are reported (Lewendal 1995, Papenfuss and Brouha 1979). Juvenile HYSH are potentially mistaken for black salamanders (*Aneides flavipunctatus*) and Ensatina (*Ensatina eschscholtzii*) (Peter Lewendal, pers. observ.). Species identification is a necessary element of Surveyor Training.

Range

This species is apparently unique to a small area north and east of Redding, California, however surveys have not been conducted in potential habitat in other areas of northern California. Known sites of HYSH are shown in Figure III.1, and occur within about a 27 km (17 mile) radius of O'Brien, California. Known sites are mapped with land allocations and ownerships in Chapter II (Figures II.1 and II.6). The Survey Zone is described below.

Habitat

Primary habitats for HYSH are twofold: limestone rock outcrops and slopes surrounding these outcrops. Populations are found in association with the cracks, crevices, caves, and rock faces within limestone rock outcrops. Non-limestone rock outcrops are <u>potential</u> HYSH habitat; one population is known from a volcanic rock outcrop (Papenfuss and Cross 1980). Examples of HYSH habitats are shown in Plates III.5-14. As can be seen from the photographs, overstory vegetation is not a necessary habitat feature at rock outcrops, and vegetation occurs variably among sites. Other outcrop habitat conditions have not been assessed for this animal, such as topographic, hydrological, or microclimate conditions. Existing populations occur in outcrop habitat areas from <0.4 ha (1 acre) to 6,300 ha (15,600 acres). Animals within outcrops are typically found at the surface during periods of high moisture (i.e., rain; see seasonal activity patterns, below), and apparently withdraw into subsurface refuges when surface moisture abates.

<u>Habitat</u>:

- **Rock outcrops**
  - **- Surveys are required in limestone outcrops**
  - **- Surveys are recommended in all rock outcrops**
- **Slopes adjacent to rock outcrops**
  - **- Surveys are required adjacent to limestone outcrops**
  - **- Surveys are recommended adjacent to all outcrops**

Areas surrounding outcrops, termed "slope habitats," are habitat for HYSH during their season of surface activity. In slope habitats, HYSH are found in association with the surface and subsurface refuges (i.e., rocks, downed wood, litter, substrata) that are typically used by many woodland salamanders (Lewendal 1995; review in Olson 1999). In particular, although they often are tied to rock outcrops, they do not appear to seek out only rocks in these peripheral areas. In contrast, HYSH often are found under small wood pieces (e.g., Plate III.12). These slope habitat areas are not characterized by specific habitat conditions, and may include a variety of physical characteristics (unspecified topography, hydrology, substrate, etc.) and vegetative cover types (oak, fir, pine, shrubs, herbs and grasses).

The distances from rock outcrops used as "slope habitat" by HYSH is not well-known. At this time, HYSH have been detected in the areas searched, which have extended 100-200 m from outcrops. For example, during recent sampling at a known site (during suboptimal outcrop survey conditions: clear day between storm systems), 29 of 30 HYSH found occurred in slope habitat, and 6 of these were located between 100 and 150 m from the outcrop (pers. observ.; P. Lewendal, pers. observ.). Unfortunately, only a few surveys in slope habitats have been conducted that have quantified distance from the outcrop for search effort and HYSH occurrences. Until this is investigated further, the boundaries of their population in slope habitat cannot be estimated based on distance. Research is needed to assess habitat use around outcrops.

Rock outcrops within 150 m of each other should be considered contiguous habitat. This distance stems from our current knowledge that HYSH can occupy slope areas to approximately this distance from outcrops; hence, neighboring outcrops separated by 150 m may have full overlap of their occupied slope habitats and thus together represent the habitat of a connected population. At this time, adjacent outcrops greater than 150 m apart may be considered non-contiguous, although their slope habitats may overlap.

SURVEY PARAMETERS AND RATIONALE

Triggers

Triggers are parameters that initiate the survey. These are generally project proposals that include ground disturbance or other activities that may negatively impact HYSH or their habitats. Triggers are cross-referenced to the management recommendations for this species (Olson 1999), such that if HYSH habitat protection is recommended in response to an activity, it may be considered a survey trigger.

Trigger Criteria--Surveys are triggered only when the proposed activity occurs:

1. **on federal lands covered by the Northwest Forest Plan, and**
2. **within the Survey Zone for HYSH, and**
3. **in an area in which there is suitable habitat for HYSH, and**
4. **the proposed project may affect animals directly or indirectly by altering habitat.**

For clarification: Known HYSH habitats where surveys are required are limestone outcrops and their adjacent slopes, while surveys are recommended in potential habitats, which include all other types of rock outcrops and their adjacent slopes.

As ground-disturbing activities occur on or in the substrate, they have the potential to severely affect this species. Adverse effects on the substrate microhabitat are the specific concerns. Surface microhabitat conditions important for this species include the physical structure and surface cover features, and the microclimate (e.g., temperature/moisture regime). Concerns for management include the maintenance of the integrity of substrate interstices and cool, moist surface regimes. Proposed management activities that may affect these habitat elements are survey triggers.

Activities with little or no ground-disturbance also may affect microhabitat for this species. For example, chemical applications may affect individual animals directly by creating inhospitable habitats. Some chemical applications (e.g., pesticides), also may affect amphibians indirectly by impacting their prey-base.

Trigger Decision Process— Land management activities should be evaluated on a case-by-case basis whether on not they represent obvious triggers. To make this management decision, the four above criteria should be evaluated. For the last criterion, “does the proposed project affect the habitat conditions for the species or the individual animals?” Site managers are expected to have the greatest discretion with regard to this final criterion. Site conditions or project implementation methods or timing can affect whether or not a particular activity is a trigger (see also Chapter I).

Activities that May Not Trigger Surveys--Surveys may not be triggered for activities that are determined to have low potential to effect this species or its habitat. This may include activities that do not affect substrate integrity, or the microclimatic regime within suitable habitat. In addition, if a particular activity does not affect microhabitat conditions and it is timed so that the activity occurs when the animals are not surface active (e.g., during dry, summer months), and thus not expected to affect the animals themselves, the activity may not trigger surveys. See also Chapter I for further discussion of triggers.

Specific examples of triggers and non-triggers:

A. Most proposed timber management activities, including thinning, regeneration harvest and salvage would trigger surveys. These types of activities involve reduction of canopy and high levels of disturbance to the substrate.

B. Road construction or reconstruction would trigger surveys. Routine road maintenance may not trigger surveys. Road construction and reconstruction can involve high levels of substrate disturbance and removal of overstory. Routine maintenance typically involves only those activities within the already disturbed road prism that is not likely to be habitat.

C. Recreational development, such as campground creation or expansion would trigger surveys. Routine facilities maintenance may not trigger surveys. Development or expansion of recreational sites can involve overstory reduction and substrate disturbance in likely habitat. Regularly disturbed sites may not provide likely habitat.

D. Mining activities would trigger surveys. These are direct impacts to HYSH habitats.

E. Chemical applications (e.g. pesticides, herbicides, fertilizers) within suitable habitats would trigger surveys.

F. Prescribed fire as necessary for the reduction of fuel loads and species-habitat improvement, and slash after felling operations, would not trigger surveys if burning were conducted when HYSH are not active at the surface (generally 1 June - 30 Sept.), and no net loss of canopy would occur. This species has evolved with fire and fire effects do not generally extend into the substrate. Consequently, if fire is introduced to a site when the animals are not active near the surface, direct effects to individuals may be reduced or avoided.

G. Road decommissioning would not trigger surveys because it is unlikely that the substrate affected within the road prism during decommissioning would be suitable habitat for the species.

H. Replanting and timber stand improvement (pre-commercial thinning) of plantations thirty years old or less would not trigger surveys. Plantations are disturbed sites that generally do not provide suitable habitat due to low canopy closure and disturbed substrate and likely have not been re-colonized by the species.

I. Hazard tree removal of single trees and clearing blow-down from roads would not trigger surveys. This type of activity has low potential to impact to HYSH habitat.

J. Seeding of native species of grasses or plants would not trigger surveys. This type of activity has low potential to disturb HYSH habitat.

K. Construction or reconstruction of fences would not trigger surveys unless the construction would lead to increased disturbance within HYSH occupied habitat, such as might occur with livestock collection devices.

L. Special Forest Products: Proposed removal of talus for flagstone or burl harvest would trigger surveys because of the potential for disturbance to HYSH substrate. Surveys would not be triggered for removal of forest products such as mushrooms, bear grass, fir boughs, and Christmas trees because of low levels of potential for disturbance to HYSH habitat.

M. Surveys would not be triggered for removal of small infestations of noxious weeds by hand pulling or digging because of the low potential for disturbance to HYSH habitat.

N. Areas proposed for concentrated wood cutting would trigger surveys due to the potential for canopy reduction, substrate disturbance, and impacts to microhabitat. Dispersed (single tree) wood cutting would not trigger surveys as this type of activity has a low potential to disturb substrate or reduce overall canopy within HYSH habitat.

Adjacent Area Surveys

Appropriate habitats within adjacent areas surrounding the proposed project area should be surveyed if the project may affect HYSH habitat in adjacent areas. Effects on microclimates (e.g., edge effects, Chen et al, 1995), microhabitats, and slope stability should be considered.

Surveys of areas adjacent to proposed site-disturbing activities should be considered on a case-by-case basis (see Table III.1, below). Depending on site conditions and potential effects to habitat and microclimate, there is discretion when determining the width of adjacent area required for survey. An adequate analysis should be conducted and documentation of the decision should be provided (see also Chapter I). Guidelines for adjacent area surveys are provided in Table III.1. The adjacent area guidelines are cross referenced to the management recommendations for the species so that the recommended surveys area for an activity matches to the corresponding management recommendations in the companion management document (Olson 1999). Although every attempt was made to address most potential activities, this should not be considered an all-inclusive list.

Justification for not surveying in adjacent areas may be considered under circumstances that are not expected to affect potential HYSH or their habitats adjacent to activities. In particular, not surveying within adjacent habitat might be considered when: 1) there is no adjacent area ground disturbance expected that would cause salamander mortality; and 2) proposed activities are not expected to alter adjacent area microclimate or microhabitat conditions. For example, although trail construction may be a trigger of surveys along the trail alignment, adjacent areas along trails would not require surveys if adjacent area microclimates remain unaffected (e.g., no timber felling resulting in dominant canopy cover reduction is involved) and if adjacent area microhabitat will remain intact (e.g., blasting is not conducted).

Table III.1: Suggested adjacent area survey distances for a range of management activities. Other proposed activities may use these as general guidelines for adjacent area decisions.

Management Activity	Disturbance Parameters	Recommended* Adjacent Area Survey
Trail Construction	Tread 60-120 cm (i.e., 24-48 in)	**0-150 m** Survey trail route only if adjacent area impacts are expected to be negligible, such as no significant canopy removal and no blasting involved. Survey up to 150 m if surface may be disturbed adjacent to trail, during or after construction (e.g., increased recreation, firewood collection).
Road Construction	Roadbed 3-7 m (10-20 ft) Secondary road	**10-30 m** A minimum of 10 m is suggested to address possible microclimate/microhabitat effects. Survey up to 30 m if surface may be disturbed adjacent to road during or after construction (e.g., increased recreation, firewood collection).
Timber Harvest	Thinning >60% retention	**0-60 m** Survey distance relates primarily to potential microclimate concerns. Wood recruitment to slope habitat may be an issue.
Timber Harvest	Thinning <60% retention	**0-120 m** Survey distance relates primarily to potential microclimate concerns. Wood recruitment to slope habitat is also an issue.
Timber Harvest	Regeneration 0-15% retention	**120-240 m** Survey distance relates primarily to potential microclimate concerns. Wood recruitment to slope habitat is also an issue.
Mining/Quarries	Expansion/new quarries	**60-150 m** Survey distance relates to combined microclimate/ microhabitat concerns.
Recreational Development	Expanded or new facilities	**0-150 m** Survey distance relates to combined microclimate/ microhabitat concerns.

*** These widths are intended only as general guidelines, site-specific analysis will determine actual adjacent area survey widths.**

Site Location

Survey Zone--The entire geographic area within which HYSH surveys under the Survey and Manage provision are needed is termed the Survey Zone. This Zone is larger than the current species range, extending 25 miles from existing known sites (within the range of the Northwest Forest Plan), because there is uncertainty regarding the distribution of this species. Few systematic surveys have been conducted with the objective of determining HYSH presence, and targeting HYSH habitats and optimal environmental conditions for HYSH surface activity. Land allocations and ownerships within the Survey Zone are shown in Chapter II (Figures II.1 and II.6).

Screening Project Areas for Habitat--As land management activities or projects are proposed within the Survey Zone, unless a project is exempt from survey, project activity areas need to be screened for suitable HYSH habitat. Screening for HYSH habitat involves reference to maps, existing Geographic Information System coverages, aerial photographs, and conducting field reconnaissance visits. HYSH habitats include both rock outcrops and their surrounding slopes (see above, review in Olson 1999). If HYSH habitat occurs within or adjacent to the proposed project area, and the proposed management activity is a potential "trigger" of surveys, it becomes the potential Survey Area for the project (Figure III.2).

Screening the proposed project area for known sites of HYSH may facilitate development of projects in areas that are not likely to be occupied by this species. It will be important to recognize that around rock outcrops, surrounding slopes may be habitat and occupied, and that outcrops within 150 m are recommended to be designated contiguous. All contiguous habitat to a known site should be considered occupied until site delineation surveys are completed. The distance of 150 m stems from the known occurrences of HYSH in slope habitat to this distance from outcrops; thus, outcrops spaced this far apart are likely to share slope habitats, and hence are likely to be "connected."

Survey Area--The Survey Area is HYSH habitat that may be affected adversely by a particular management activity. It is the area within which surveys need to be conducted before that activity is further developed and implemented. The Survey Area includes potential HYSH habitat <u>within</u> a project area, and may include HYSH habitats <u>adjacent</u> to the proposed activity (see adjacent areas, above; Figure III.2, Table III.1). Portions of the Survey Area that cannot be safely searched may be omitted.

Site Visits

Multiple site visits are necessary to designate the species "not detected" in the Survey Area under this survey protocol. Full searches of the Survey Area should be completed 3 times (i.e., 3 site visits). This was included in the HYSH protocol in response to known surveys at occupied sites in which HYSH was not detected, despite apparently suitable weather conditions. For this species in particular, surface activity is not very predictable.

If a Survey Area is not completely sampled in a day, that "site visit" may be continued on subsequent days. For example, if the Survey Area is 30 acres of rock outcrop habitat and 2 surveyors are conducting the search, then the 24 hrs (3 x 8 person-hrs per 10 acres) of a survey may be completed in >1 days, and these days need not be consecutive.

Intervals between site visits--Unless presence is established, surveys for separate site visits at a Project Area must be separated by at least 10 days. The 10 day interval may allow for site conditions to develop in response to weather regimes and may allow seasonal salamander activity to be triggered. This survey interval allows the 3 site visits to be completed within a single spring season.

Environmental Conditions

Environmental conditions must be evaluated before a survey can begin. HYSH appears to be surface-active especially during warm tropical weather systems (P. Lewendal, pers. observ.).

Seasons:
- **Winter through Spring, during wet conditions**
- **Spring is the optimal sampling period**
- **with no detections, 1 of the 3 site visits must occur in Spring**
- **all 3 site visits may occur in Spring**

The optimal sampling period is during wet, humid early spring. It is possible to conduct all 3 site visits in the spring season. However, HYSH appears to have an extended period of potential surface activity in comparison to many other lungless salamanders. It may be possible to encounter this species during the winter or spring seasons, if the environmental requirements are met. Surveys should not begin in the winter until ground-soaking rains have occurred. If HYSH is not detected during winter surveys, ONE SURVEY MUST BE SCHEDULED IN THE LATTER PART OF THE SPRING SURVEY SEASON, to attempt to match optimal activity conditions.

Temperature/Moisture--The following temperature-moisture conditions must be met for surveys to be conducted.

Relative humidity:
- **minimum of 90% for rock outcrop surveys**
- **minimum of 65% for slope habitat surveys**

Air temperature:
- **minimum of 4-5°C**

Outcrop surveys are conducted during wet conditions. Surface rocks seem to dry relatively quickly, and once the surface rocks dry, HYSH appear to retreat into the recesses of the cracks in the outcrop and are difficult to detect. For rock outcrop surveys, the air relative humidity at the site should be a minimum of 90%, when measured at chest height at the survey site, on the day of survey, before the survey begins. Two additional relative humidity measurements should be conducted during a survey day, mid-day and at the end of the survey day. A 90% minimum reading needs to be maintained mid-way through the survey on a day for surveys to continue.

Slope habitat surveys are not conducted only during wet conditions, but may occur between rainy periods. In slope habitats, surface cover items for HYSH appear to retain moisture between rains and HYSH can be found under such surface cover, perhaps because they do not have the deep recesses of rock crevices available for retreat. For slope habitat surveys, the air relative humidity may be lower, a minimum of 65%, when measured at chest height at the survey site, on the day of survey, before the survey begins. Two additional relative humidity measurements are needed during a survey day, mid-day and at the end of the survey day. A 65% minimum reading must be maintained mid-way through the survey on a day for slope surveys to continue. This relaxed relative humidity constraint will allow more opportunities for slope habitats to be surveyed, which also should correspond to the anticipated greater need to survey slope habitats.

The air temperature must be 4-5°C or greater (chest height measure) at the site during the survey of both outcrops and slope habitats. Air temperature should be taken and recorded before the survey begins, mid-day, and at the end of the day. If the temperature is noted to fall below the minimum at any time during the day, the survey should be stopped.

Reference Sites

Use of reference sites is not recommended for this species. HYSH is rare and known populations should not be disturbed.

Voucher Specimens

Voucher specimens are not required for this species, due to its status of concern. If necessary, species experts with the proper permits may return to the site to photograph or collect voucher specimens. This animal is not easily mis-identified, once its key characters have been assessed. Training of field personnel in species identification should eliminate misidentification. If there is doubt as to the identification of a captured salamander, local species-experts can be sought to verify the identity of the animal and to confirm a "known site."

Choice of Search Method

The survey method described here is a combined area- and time-constrained sampling technique (e.g., Corn and Bury 1990), also considered a type of Visual Encounter Survey (Crump and Scott 1994). It is a systematic searching for animals within a specified area. This method is well-suited for species detection, and is particularly effective for species occurring in definable habitat features (Crump and Scott 1994), such as the rock outcrops inhabited by HYSH. Also, this method can be used to detect animals that occur patchily within an apparently homogeneous area. Within rock outcrops inhabited by HYSH, gradients in habitat conditions may be unrecognized, thus suitable habitat conditions may appear homogeneous. When habitat patches are recognized, search effort can be adjusted to prioritize microhabitats to be sampled, while still providing complete coverage of a survey area. Species detectability is increased by increasing the area and time of surveys, and balancing extensive reconnaissance with more thorough searches of any high-priority patches (caves, collections of surface objects).

Search effort--Search effort is determined by person-hours expended and this should be standardized across sites by defining a search rate over the area sampled (no. person-hours per unit area). To obtain this formula for search effort, regional taxa experts compiled existing data on capture rates (no. animals per person hour, no. animals captured per area sampled) to assess the range of variation in relative abundances across occupied sites. In support of the need for more intensive survey efforts were the extremely low capture rates at some HYSH known sites with large populations, and the overall rarity of this species. Some populations are known from the capture of only a single individual. More intensive search efforts are applied specifically to rock outcrop habitats for HYSH which may be more difficult to search and within which animals may occur in patches that are not discernable from habitat features.

Two factors supported the need for a more extensive, reconnaissance-level survey: 1) HYSH occurrences may be associated with recognizable patches (e.g., surface cover objects); and 2) the survey objective is to detect HYSH presence, and detectability may increase by increasing the search area covered. These two criteria apply well to slope habitat areas, in particular. Thus, more extensive, reconnaissance-level surveys have been developed for slope habitat areas.

The search effort formalae for HYSH (below) are the result of opposing factors, a high likelihood of detectability was sought for minimal cost, time, and effort. Restricting surveys to seasons of known surface activity and under specific microclimate conditions also increases the likelihood of detectability.

Rock Outcrop Habitat: • **minimum of 8 person-hours per 10 acres**

Slope Habitat: • **minimum of 4 person-hours per 10 acres**

Thus, a 20-acre outcrop of limestone rock would result in a minimum survey of 16 person-hrs. Four surveyors could accomplish this in 4 person-hrs apiece. We recommend complete sampling of small outcrops.

The HYSH search effort is greater than that used for other Survey and Manage salamanders because it was apparent that HYSH capture rates at known sites (i.e., rock outcrops) under apparently optimal conditions were much lower. For this species, it appears that there is a greater chance of not detecting them when they are present at a site (Type II error). This resulted in a relatively greater survey time in rock outcrop habitats.

Bias--A bias of this technique is that search effort and species-detection may vary with surveyors, search pattern used, and site conditions. To increase the repeatability of surveys, surveyor training is required, environmental conditions for surveys are restricted, and survey parameters and site conditions are recorded. This method does not allow density estimates to be determined. If relative abundance is compared among sites, by calculating the number of captures per person-hour (capture rate), possible survey biases should be recognized.

Search pattern--The search pattern chosen for HYSH surveys may be a zig-zag, a spiral, or other design that extensively covers the entire habitat. The habitat must be "thoroughly searched" (USDA and USDI 1994, C-5). The search pattern should include any areas that appear to offer optimal refugia for HYSH, such as highly fractured rock, caves, or an abundance of surface objects. If these are considered the most likely localities for HYSH to be detected, searching may begin at these features. Again, the goal is to detect HYSH, thus prioritizing search sites may facilitate early detection and reduce surveyor time/effort.

Microhabitat prioritization–Searching may approximate a "bead-on-a-string" approach, where a greater search effort is devoted to complex microhabitats encountered along the search path, potential refuges such as surface objects or rock outcrop caves and crevices (beads), than more one-dimensional microhabitats such as bare rock or compacted soil (string). Thus, the two-dimensional linear rate of searching along the path is not necessarily constant, and will vary as three-dimensional habitats are encountered. Without *a priori* knowledge of HYSH distributions, the "string" areas also should be searched. If microhabitats are prioritized, they should be marked on a map for subsequent use in planning surveys. Priority areas may be included in the search pattern, or identified as first-search areas.

Moving Rules--Moving rules along the path facilitates coverage of the entire area in the time allotted and reduces the tendency to spend a great deal of time in one particular area. Moving rules for Survey Area subunits and specific microhabitats (i.e., "beads," above) are recommended.

For large Survey Areas, in particular, search effort can be determined for subunits of the entire Area, to ensure that sampling occurs extensively across the entire site. For example, the area that is needed to be covered hourly or in 2-4 hr time-blocks of sampling can be determined.

Moving rules for microhabitats should be used to avoid spending too much time in one particular area. For example, a maximum of 5-10 minutes is suggested to be spent at any specific spot. A larger feature, such as a larger cave system or highly fissured section, may seem to require more time, however, moving rules should be maintained to ensure the entire Survey Area is covered.

Daytime surveys--These animals are nocturnal during wet conditions, but also are found during daytime searches. Both day and night surveys may be conducted, although for safety reasons, only daytime surveys might be appropriate.

Safety Issues

Field units implementing surveys should be discretionary regarding safety issues as required by site conditions. Safety of surveyors should not be compromised to complete surveys. As such case-by-case decisions are made, managers, supervisors, and field crews should be in communication. We recommend full documentation of the rationale supporting such a decision.

Survey Ethics

All surveys should be conducted in a relatively non-destructive manner. Surface objects are lifted and replaced to their original position. Hill sides should be kept relatively intact whenever possible. Bark may be pulled off of logs, but it should be done carefully, so that it can be replaced. Logs that are moderately decayed into large chunks or splits may be separated, but again, the pieces should be replaced as best as possible. However, logs should not be completely destroyed. Moss mats should be replaced. The intent here is not to abstain from any alteration; that would be next to impossible and would make it difficult to detect salamanders. The intent is to be conscientious about minimizing disturbance to the habitat by using a light-handed approach.

SURVEY PROTOCOL

The survey procedures below are to be used as the standardized protocol to assess the presence of HYSH and satisfy the legal requirements of the Northwest Forest Plan. If HYSH is detected by the use of other survey methods, the designation of "presence" can be used to complete the HYSH survey requirements at the site, and additional surveys "to protocol" are not needed.

All surveying should be documented such that it is accountable and repeatable. To meet these goals, surveyors should be trained, and survey data should be collected to account for area, time, habitat searched, search pattern, and environmental factors. A data form and its explanation are provided in Appendix III.1.

Procedures

1. **Prior to conducting surveys**

   a. Obtain necessary permits and training.

   b. Conduct field reconnaissance.

   c. Delineate the Survey Area boundaries. The area should be photographed, if possible.

   d. Plan the search pattern to give an extensive reconnaissance-level approach to the entire area. It may be a zig zag, spiral, or another design that fits the Survey Area. Obvious caves, highly fissured areas, rubble or cliffs should be identified and incorporated into the search route or prioritized as first-search areas.

   e. Determine the number of surveyors, search route for each surveyor, moving rules, how timing will be kept, and other survey logistics.

2. **At the site on the survey day, prior to searching**

   a. Review survey procedures with the field crew.

   b. Fill out header information on the data form as per code sheet (Appendix III.1) at the site.

   c. Do the environmental conditions meet the acceptable criteria?

3. **Doing the search**

   a. Maintain timing for each surveyor, <u>tracking only search time</u>, and not movements between search areas or time handling animals.

   b. During daylight, salamanders are usually found underneath surface objects and in cracks and crevices in rock outcrops. Carefully lift and look under surface objects along the predetermined path of the search pattern. Carefully replace objects to their original position, and re-pack leaf litter and other debris around the object to minimize dessication of microhabitat.

Surface objects may be items on top of the substrate (e.g., a rock on soil) or may be interspersed (e.g., rockpile, talus). Objects to search include anywhere a salamander may seek moisture or refuge from daylight: rocks, cracks in rocks, talus, rockwall debris, logs, slabs, bark piles, bark on logs, anthropogenic structures, moss (particularly when it forms a mat), and litter.

The “surface” is generally considered to be within the upper 30 cm of the top of the substrate. The survey intent is to capture animals that are “surface active.” Deep excavation of rock outcrops, lifting heavy boulders, or digging deeper than about 30 cm is unnecessary.

A flashlight can facilitate surveys of dark fissures or caves.

Surveys should be conducted in a relatively non-destructive manner. Surface objects are lifted and replaced to their original position. Bark may be pulled off of logs, but it should be done carefully, so that it can be replaced. Logs that are moderately decayed into large chunks or splits may be separated, but again, the pieces should be replaced as best possible. However, logs should not be completely destroyed. The intent here is not to abstain from any habitat alteration; that would be next to impossible and would make it difficult to detect salamanders. The intent is to be conscientious about minimizing disturbance to the habitat by using a light-handed approach. If the ground-disturbing activity is destructive (e.g., clear-cut logging, clearing the land for a large development), then a more heavy-handed approach may be warranted, as intensive searching may increase the probability of detection. Potato rakes may be used, but only with extreme caution. Use of hand trowels is recommended.

c. Field crew leaders should spot check surveyors for comparable search effort, progress along the search path, and accurate species identification.

d. Collect mid-day environmental data.

4. Handling Captures

a. Search time does not include time handling animals that are captured. Once a capture is made, stop the clock.

b. Record all amphibian species captured, and their life stage (juvenile/subadult, adult). This may be important information if species identification is later questioned. Optional data include amphibian sizes (snout-vent length, total length) and microhabitat cover (e.g., on/under/in wood/rock/soil/vegetation/litter/other).

c. For HYSH captures, confirm species identification.

d. Mark the HYSH capture site on a map and/or a sketch of the site on the data form, add location description to dataform.

e. Mark HYSH location at the site. Marking should be done in a manner that will allow others to locate the exact site. For example, the site could be marked with bold flagging, and labeled with a paint marker stating “known site: HYSH.” A permanent marker also should be placed at the site. This might include an aluminum tree marking tag (placed low on the bole of a living tree) and/or rebar with bright orange safety paint on the end. The site may be located with a Global Positioning System (GPS) and differentially corrected for the best accuracy possible (sub-meter accuracy is preferred; known sites should be precisely located to effectively manage them).

f. Return captured animal to the site by first replacing cover object then placing salamander beside it (allowing the animal to take refuge on its own). Do not place the cover object on top of the salamander.

5. Completing the survey

a. Collect final data (see data form). Record information on time and area searched and sketch the area. Redraw search pattern if necessary, identifying encountered microhabitats that may be considered priority areas for HYSH, highlighting any areas with a detection. When detections are made, estimate area of contiguous habitat.

b. Records need to be kept on all surveys whether or not a detection is made. Surveyed sites should be well-documented and mapped. Data forms and other documentation (e.g., field notes, maps) are to be retained at the local level (e.g., Ranger District, for National Forest System).

c. Contact a species expert if a new known site is detected.

Site Delineation

Once HYSH is detected, the first detection location will become the "site" for the Known Site Database. However, management guidelines for HYSH are generally based on ameliorating potential effects to the population and its habitat within the Survey Area, rather than just the first detection location. If HYSH is detected within the Survey Area, land managers have 3 options on how to proceed with planned activities:

1. They may terminate the activity. The remaining site visits of the Protocol surveys and Site Delineation surveys would not need to be conducted if the project were no longer expected to occur.

2. They may opt to treat all suitable habitat within the Survey Area as occupied. The remaining Protocol surveys and Site Delineation surveys would not need to be conducted. However, the entire Survey Area should be managed according to the Management Recommendations (Olson 1999).

3. They may opt to proceed with the activity in unoccupied portions of the Survey Area, and manage according to the Management Recommendations only in areas known or believed to be occupied. If so, Site Delineation surveys must ensue.

Site Delineation Procedures--Before initiating the Site Delineation survey(s), we recommend that all three Protocol surveys be completed. This addresses the survey condition that for areas to be designated as HYSH "not detected," 3 site visits should be conducted. During these 3 Protocol surveys, every detection location is flagged. Data are recorded on all target species detections and all other species are tallied. After the third visit, the general distribution of the target species in the Survey Area hopefully will be revealed.

The Site Delineation survey is more intensive than a Protocol survey, because it is intended to establish the spatial extent of the population within the Survey Area. For our purposes, the "population" will be the area occupied by HYSH within the Survey Area.

The general technique for a Site Delineation survey is similar to a Protocol survey: it involves walking and turning over objects only during acceptable environmental conditions. However, as it is more intensive, there are some pertinent differences:

- Survey paths should not be > 5 m apart.

- Survey paths must cover the entire Survey Area for small-scale projects. For large-scale projects, surveys are oriented around all flagged detection locations. These become the focal points, with surveys radiating out to the perimeter of the Survey Area (if possible) or the apparent boundary of the population. The extent of the area searched on large projects is discretionary and the rationale for the area covered should be well documented by the lead biologist and land manager.

- Search paths may be in a zig-zag pattern, concentric rings, spiral, or parallel transects.

- It is apropos to spend more time to determine if the species is present at a particular area–hence, moving rules are not necessary. Search effort per unit area is usually greater with Site Delineation surveys.

- Because the area is known to harbor the target species and extensive searching will be undertaken, great care must be taken to ensure that habitat is not destroyed.

Whenever a new peripheral detection location is made, the area to be searched enlarges, but not beyond the Survey Area.

The perimeter of the population within the Survey Area needs to be well marked and should be accurately GPSed for management purposes.

Survey Season Review

Communication among all parties that have conducted surveys within a year is recommended. Sharing of new sites may affect decisions for sampling in the subsequent year.

It is recommended that HYSH survey and management procedures be reviewed at regular intervals. During reviews, field units should assess: 1) adherence to State and Federal standards and guidelines (e.g., renewal of permits, changes in survey protocols, training needs); 2) impacts to animals and habitats; and 3) new information available on this species and its management/protection. All field data should be retained at field units until requested for regional compilation.

OPTIONAL SAMPLING

Surveying Beyond First-Detection

From a biological standpoint, continuing surveys beyond first-detection is preferred because more information is collected that may be useful later. Continuing surveys can address whether a lone individual or a patch of animals has been detected.

There are several options for continuing surveys, some of these are described below.

One survey hour--Completing one additional survey hour after the target species has been found may be a minimal additional effort to assess whether a patch of animals has been detected.

Complete the survey day or site visit--Increasing the time and area covered during a survey will provide more information about the HYSH population. Completing the surveys planned for that day or site visit may provide critical information as to the relative importance of that habitat in relation to neighboring sites.

Supplemental Habitat Characterization

To streamline surveys, the survey protocol includes collection of few habitat data. To fill knowledge gaps concerning this species, additional habitat information is needed. A more detailed site characterization is strongly recommended, particularly macrohabitat elements such as forest stand structure and composition, and elements of geomorphology and site history, and microhabitat conditions (what animals are in/on/under, environmental conditions at capture localities).

Supplemental Searches

Supplemental searches should not be considered a site visit under our protocols, but might prove to be a quick and inexpensive way to detect a target species, should it occur at a site. Supplemental surveys are completely optional. Supplemental surveys may be used as proposed project areas are being prioritized and general field reconnaissance of habitats is being conducted. The following are suggestions for supplemental searches. An important note about supplemental searches is that they should be nondestructive, and specifically should not compromise the efforts of protocol searches.

Opportunistic searches--Quite simply, an opportunistic search is done anywhere, anytime, by any method. It usually translates into “just going out and looking.” However, it is recommended to document the time and/or area of effort (or preferably both).

Searching during marginal conditions--The need for good environmental conditions has been stressed for surveys, but it may be possible to find salamanders when conditions are marginal (however, fewer HYSH may be detected). Surveys under marginal conditions may be done to quickly scan a site in the hope of quick detection, for example if the crew finds less than adequate conditions upon arrival at a site.

Night searches--Searching for HYSH at night can be productive. It may be attempted if the conditions are right and the opportunity presents itself (e.g., en route to other night-time activities). This method may be most readily applied if the site is near a road, for logistical and safety reasons. Slowly search the site with a flashlight, looking for the salamanders on the surface, in cracks, or under surface objects. Search carefully, because only the head may be visible in dark recesses. Night searches need not be considered supplemental; if the necessary guidelines are followed, surveys using the recommended protocol may be conducted at night.

Off-season searches--Although the best time to survey is mid-November to mid-April, and spring is preferred, it may be possible to encounter HYSH outside of this time-window if conditions are conducive. Disruption of breeding animals, late summer to fall, should be avoided.

Random sampling regimes, plot sampling, subsampling, pitfall trapping and drift fences-- These are examples of additional survey approaches that may detect HYSH. Although these methods were perceived to be less effective for the goal of species detection, required here, they are often the method-of-choice for research and monitoring objectives.

DOCUMENTATION OF SURVEY DECISIONS

Due to the discretionary nature of several survey elements (triggers, adjacent area distances), supporting rationale for case-by-case decisions is recommended to accompany activity proposals. In particular, if variance in survey procedures is implemented, the rationale should be documented and a qualitative assessment of the change in Type II error conducted (i.e., risk of not detecting the target species when it is in fact present at a site). Relative to triggers, such rationale should include statements regarding the 4 trigger criteria, listed above. For the fourth criterion, statements should be included regarding the anticipated impacts of the project on: 1) the animals themselves; and 2) habitat conditions (e.g., structure, microclimate). The record of the adjacent area decision rationale should be distinct from the project area trigger decision rationale. Likewise, decisions to survey should be documented separately from decisions on how to manage sites.

Recommendations for Documentation

- **Rationale for trigger decisions should be documented.**
- **Rationale for trigger decisions should be separate from management recommendations.**
- **Rationale for adjacent area survey decisions should be documented separately.**
- **Rationale for any variance to protocol should be documented, with a qualitative assessment of changes to risk of Type II error.**

ACKNOWLEDGMENTS

We thank John Applegarth for the use of his photographs. The development of this protocol resulted from valuable reviews conducted by many persons, including: John Applegarth, Bruce Bury, Paula Crumpton, Randy Hickenbottom, Paul Jeske, Sarah Madsen, Sheila Martinson, Karen Raftery, Roger Schnoes, Lee Webb, Quentin Youngblood. Most importantly, all the coauthors of this volume have contributed to this Chapter, and we have been extremely fortunate to work with them.

REFERENCES

Corn, Paul Stephen; Bury, R. Bruce. 1990. Sampling methods for terrestrial amphibians and reptiles. Gen. Tech. Rep. PNW-GTR-256. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station. 34 p.

Crump, Martha L.; Scott, Norman J. 1994. Visual encounter surveys. In: Heyer, W. Ronald; Donnelly, Maureen A.; McDiarmid, Roy W.; Hayek, Lee-Ann C.; Foster Mercedes S., eds. *Measuring and monitoring biological diversity: standard methods for amphibians*. Washington, DC: Smithsonian Institution Press: 84-92.

Gorman, Joe; Camp, C.L. 1953. A new cave species of salamander of the genus *Hydromantes* from California, with notes on habits and habitat. COPEIA. 953: 39-43.

Hansen, R.W.; Papenfuss, T.J. 1994. Shasta salamander. pp256-257 in: Thelander, C.G.; Crabtree, M. (eds.), *Life on the edge: A guide to California's endangered natural resources: Volume 1 Wildlife.* BioSystems Books, Santa Cruz, CA, xvi + 550 p.

Lewendal, Peter. 1995. Habitat-use by the Shasta salamander *Hydromantes shastae*. Report to: California Department of Fish and Game, Redding, CA. 32 p.

Olson, D.H. (ed.) 1999 (in review). Management Recommendations for Component/Strategy 1 Amphibian Species. Special Interagency Publication.

Olson, D.H. (ed.); Applegarth J.; Bury, R.B.; Clayton D.; Crisafulli, C.; Jones, L.L.C.; Ollivier, L.; Welsh, H.H., Jr. 1996. Survey protocols for Component/Strategy 2 amphibians. Portland OR: Special Interagency Publication, Regional Ecosystem Office, Survey and Manage species. 73 p.

Papenfuss, Ted; Brouha, Paul. 1979. The status of the Shasta Salamander *(Hydromantes shastae*). In: Bogener, David J.; Brouha, Paul. Comprehensive species management plan: Shasta Salamander, *Hydromantes shastae*. Shasta-Trinity National Forest Contract Report: 10-36.

Papenfuss, Ted; Cross, David. 1980. The status of the Shasta salamander (*Hydromantes shastae*) in the mountain gate and cedar creek areas of Shasta County. BLM Contract Report.

Stebbins, Robert C. 1985. *Peterson Field Guides: Western amphibians and reptiles.* Boston, MA: Houghton Mifflin Co. 336 p.

U.S. Department of Agriculture, Forest Service; U.S. Department of the Interior, Bureau of Land Management. 1994. Record of Decision: for amendments to Forest Service and Bureau of Land Management planning documents within the range of the northern spotted owl. [place of publication unknown]. 74 p. [plus attachment A: Standards and Guidelines: for management of habitat for late-successional and old-growth forest related species within the range of the northern spotted owl]. (ROD 1994).

Figure II.1 Known distribution of the Shasta salamander. The heavy line represents the species survey zone. The survey zone was constructed with all data available through the end of 1998.

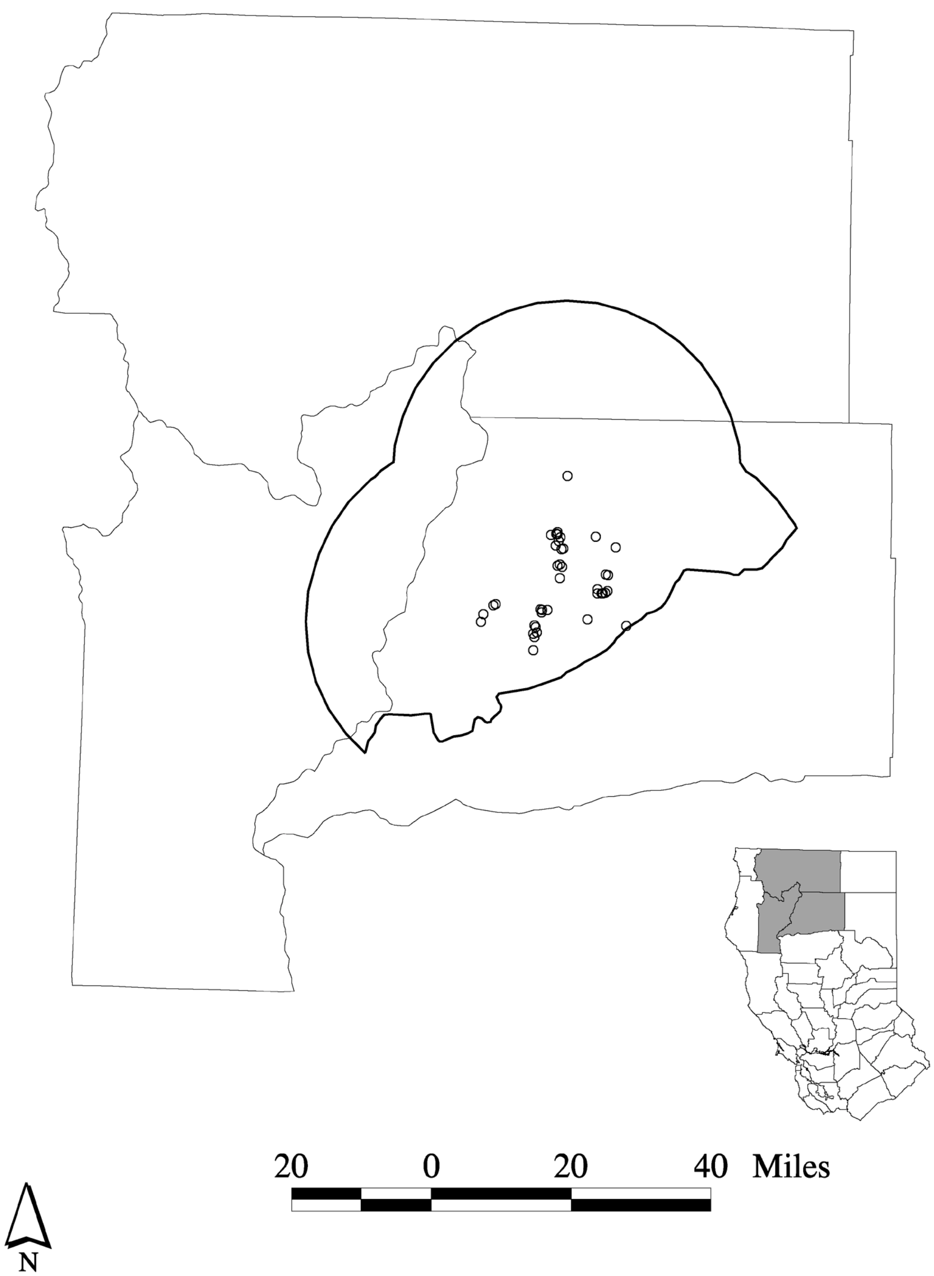


Figure III.2. Delineating the survey area. The adjacent area shown may vary in width (Table III.1).

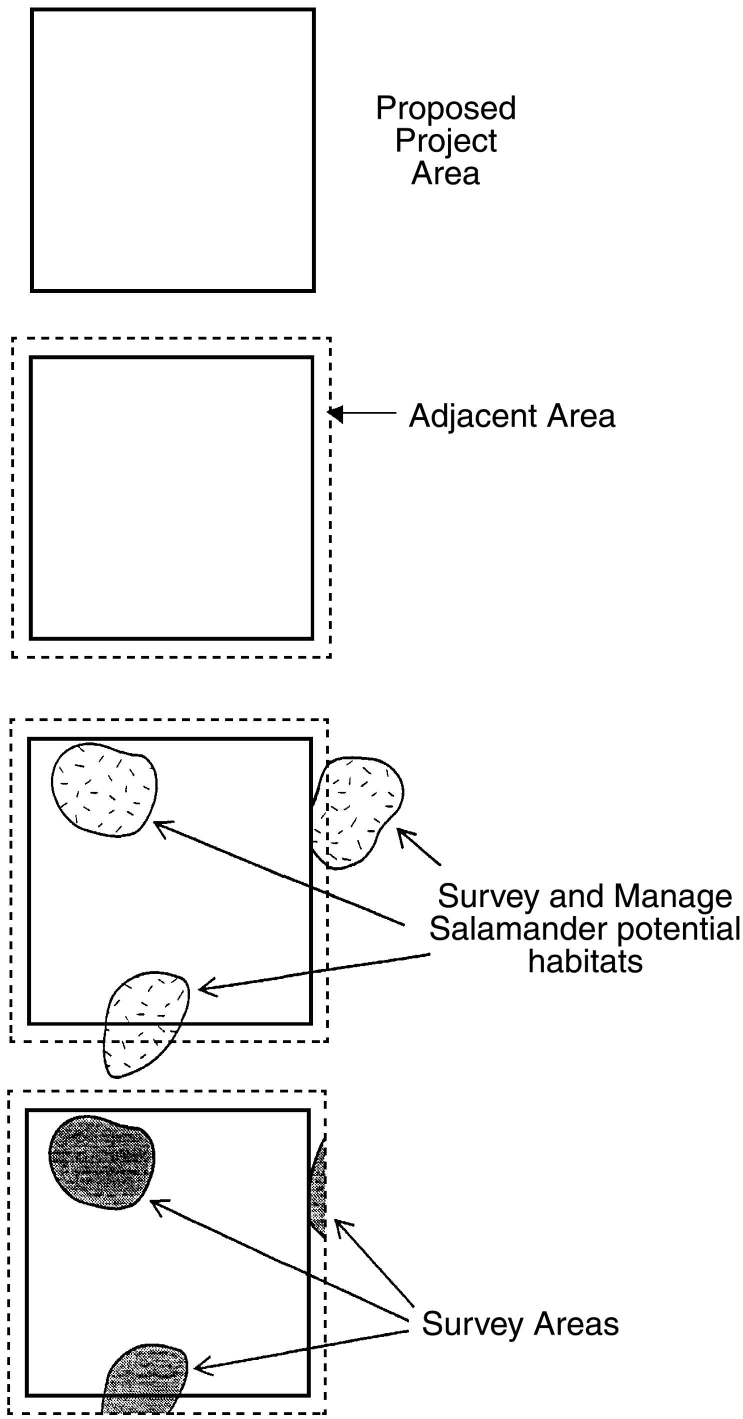


Plate III.1 Shasta salamander (*Hydromantes shastae*) (Photo by William P. Leonard).

Plate III.2 Shasta salamander (*Hydromantes shastae*) (Photo by William P. Leonard).

Plate III.3 Shasta salamander (*Hydromantes shastae*) (Photo by John S. Applegarth).

Plate III.4 Shasta salamander (*Hydromantes shastae*) (Photo by John S. Applegarth)).

Plate III.5 Typical Shasta salamander habitat in Shasta County, California: limestone rock outcrop and vegetated downslope area (Photo by Peter Lewendal).

Plate III.6 Typical Shasta salamander habitat in Shasta County, California: limestone rock outcrop and vegetated downslope area (Photo by Peter Lewendal).

Plate III.7 Known site of Shasta salamanders: limestone outcrop surrounded by oak-fir woodland (Photo by Peter Lewendal).

Plate III.8 Shasta salamanders use areas with moss-covered rock (Photo by Peter Lewendal).

Plate III.9 Shasta salamanders use rocky areas without moss and with grass (Photo by Peter Lewendal).

Plate III.10 Shasta salamanders use exposed rocky areas without moss or grass (Photo by Peter Lewendal).

Plate III.11 Exposed sites that are subject to hot-dry summer conditions can provide optimum habitat for Shasta salamanders: animals are found in abundance here during wet, cool periods. This south-west facing slope with loose rocks having numerous interstitial spaces is inhabited by a large Shasta salamander population (Photo by Peter Lewendal).

Plate III.12 Typical slope microhabitat for Shasta salamanders during the wet season, small wood pieces (Photo by Peter Lewendal).

Plate III.13 Road construction within potential Shasta salamander habitat, as is occurring here, now requires full survey for this species on federal lands. “Take” of these animals is illegal in California, thus surveys should be conducted prior to this type of ground disturbance in suitable habitat areas throughout their potential range (Photo by Peter Lewendal).

Plate III.14 Aerial view of potential Shasta salamander habitat, a rock outcrop and it’s surrounding slope (Photo by Peter Lewendal).


Plate III.1


Plate III.2


Plate III.3


Plate III.4


Plate III.5


Plate III.6

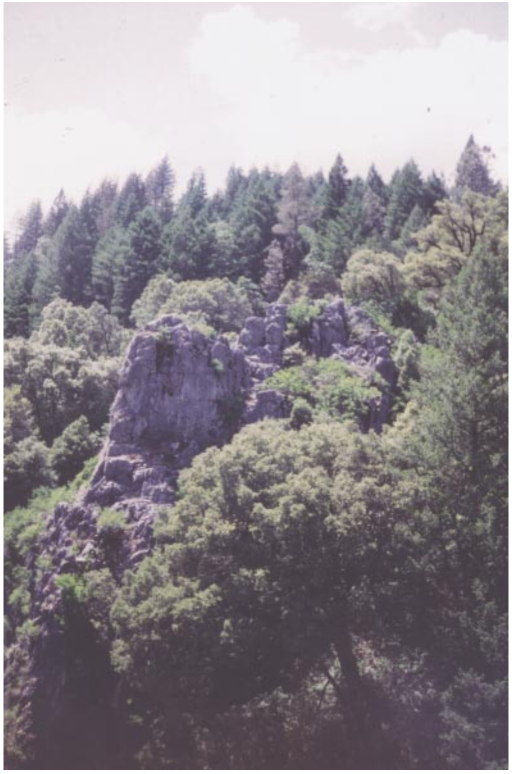


Plate III.7

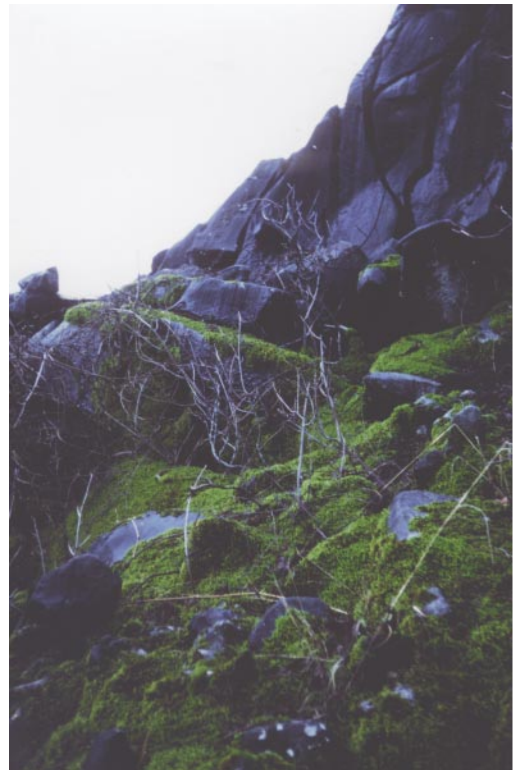


Plate III.8


Plate III.9


Plate III.10

Plate III.11

Plate III.12

Plate III.13

Plate III.14

Appendix III.1. Data form and codes/definitions for the Shasta Salamander.

CODES/DEFINITIONS

P___of___:	Page number of total pages for this particular site.
Date:	Day/Month/Year.
Site Visit No.:	With no HYSH detections, 3 site visits should be conducted. Is this visit number 1, 2 or 3?
Surveyor(s):	Names of observers included on data form, including middle initials.
Location (Legal):	Township, range, section, and quarter section (1/16th or better should also be recorded). Sites need to be relocated to within 100 m.
Latitude/Longitude:	Include to the greatest precision possible.
UTM N, E.	Universal Transverse Mercator coordinates, north and east, to nearest m or best measure possible.
Location description:	Very important. This is a written description of how you got the area and just where the species was detected. Use additional sheets if necessary.
Habitat Surveyed:	Rock outcrop and slope surveys should be recorded separately on different forms.
Site Description:	Written description of site, including size of rocks available, or other cover for HYSH, vegetation, etc.
Elevation:	Elevation in m from GPS or topographic map.
Aspect:	Azimuth reading to nearest degree along downhill slope.
Slope:	% gradient of downhill slope, or state range if slope varies.
Photograph taken:	Photograph of site

Site sketch: Include drawing of survey route and potential priority areas.

Weather: Predominate type since previous midnight: C = clear; O = overcast; F = fog; C = cloudy. Predominate precipitation since the previous midnight: F = Fog/mist; D = drizzle; L = light rain; M = moderate rain; H = heavy rain; S = snow, sleet, or hail.

Conditions: Collected three times during surveys.

Air Temp.: Air temperature in ^{o}C, measured at chest height.

Rel. Hum.: Air relative humidity, measured at chest height.

Species: Four-letter code (GEnus and SPecies names) of species sampled. All species of amphibians are recorded. All individuals are recorded. Use additional sheets of paper if necessary

Stage: H = hatchling (terrestrial species); J = juvenile (terrestrial species, includes subadults); A = adult (showing secondary sexual characters or of approximately reproducible size for terrestrial species; any fully metamorphosed aquatic species)

SVL: Optional data: Snout-vent length, in mm, to posterior margin of vent.
Total length, in mm, may also be recorded (TL).

Cover: Optional data: Cover object. Include what an animal is on, in, and under. Cover objects include wood, rocks, substrate, vegetation, litter, etc.

Approx. Area: The measurement or estimate of the area (length * mean width) that was searched.

Total Time Sampled: The net amount of time in minutes that was actually spent doing the survey.

Voucher: Indicate whether photographic or preserved voucher specimen was collected. Deposition includes where voucher is maintained and how it is catalogued.

Site Marker: Written descriptions of how the site was marked with particular reference to permanence of the markers.

First Capture Location: Precise location of detections is needed.

Estimated area of contiguous habitat: A Known Site is both the mapped point of detection and the area inhabited by the species. The areas of contiguous rock and slope habitats will enable site-areas to be estimated.

Taxa-expert contacted? : Few sites are known for this species. Species experts should be contacted to confirm detection and include site in the database.

Tally Sheet for Time and Area Searches: *Optional* form to track search effort**.**

Version 3.0

SHASTA SALAMANDER SURVEY DATAFORM **P___of ___**

Date (DMY) _____________ Site Visit No. (circle) 1 2 3
Surveyor(s)____

____

Location (Legal) T_____, R_____, ¼Sec _____ Latitude___________ Longitude____________
UTM N____________E ______________
Location Description (be precise)____

____

____

Map Attached (yes/no)
Habitat type surveyed (circle one, use one form per type): Rock outcrop or Slope

Site Description____

____

____

Elevation_____________(ft or m) Aspect_______________ Slope________________
Photograph taken/attached: yes/no Site sketch attached: yes/no (indicate search path)

Weather Description____

____

Search Method Used (circle one): HYSH Protocol or other (explain here)

____

Start Conditions	*Mid-day Conditions*	*End Conditions*
Time _____	Time _____	Time _____
Air Temp. _____°C	Air Temp. _____°C	Air Temp. _____°C
Rel. Hum. _____ %	Rel. Hum. _____ %	Rel. Hum. _____ %

Species Occurrences

		Optional				Optional	
Species	Stage	Size (SVL)	Cover	Species	Stage	Size (SVL)	Cover
_______	_____	_________	_____	_______	_____	_________	_____
_______	_____	_________	_____	_______	_____	_________	_____
_______	_____	_________	_____	_______	_____	_________	_____
_______	_____	_________	_____	_______	_____	_________	_____

Total Time (min.) Sampled =___________ Approx. Area = ________ acre or ha (circle one)

For New Detections:
Voucher Collected (yes/no). If yes, Photograph or Specimen (circle one) Deposition__________
Site Markers__________________________
First Capture Location (Legal) T_____, R_____, ¼Sec _____ Latitude_________ Longitude___________
UTM N____________E ______________
Estimated area of contiguous habitat: Rock____________ Slope_____________(units? ha/acre/m^2/other)
Taxa-expert contacted? Yes/No If yes, who/when?____

NOTES (page attached with additional field notes: Yes/No)

Optional Tally Sheet for Time and Area Searches

Start time ________	Start time ________	Start time ________	Start time ________
Stop time ________	Stop time ________	Stop time ________	Stop time ________
Total ________	Total ________	Total ________	Total ________
Start time ________	Start time ________	Start time ________	Start time ________
Stop time ________	Stop time ________	Stop time ________	Stop time ________
Total ________	Total ________	Total ________	Total ________
Start time ________	Start time ________	Start time ________	Start time ________
Stop time ________	Stop time ________	Stop time ________	Stop time ________
Total ________	Total ________	Total ________	Total ________
Start time ________	Start time ________	Start time ________	Start time ________
Stop time ________	Stop time ________	Stop time ________	Stop time ________
Total ________	Total ________	Total ________	Total ________
Start time ________	Start time ________	Start time ________	Start time ________
Stop time ________	Stop time ________	Stop time ________	Stop time ________
Total ________	Total ________	Total ________	Total ________
Start time ________	Start time ________	Start time ________	Start time ________
Stop time ________	Stop time ________	Stop time ________	Stop time ________
Total ________	Total ________	Total ________	Total ________
Start time ________	Start time ________	Start time ________	Start time ________
Stop time ________	Stop time ________	Stop time ________	Stop time ________
Total ________	Total ________	Total ________	Total ________
Start time ________	Start time ________	Start time ________	Start time ________
Stop time ________	Stop time ________	Stop time ________	Stop time ________
Total ________	Total ________	Total ________	Total ________

Running Tally of Search Area Covered (square meters):

Chapter IV

Survey Protocol for the Siskiyou Mountains Salamander (*Plethodon stormi*)

Version 3.0

OCTOBER 1999

David R. Clayton
Lisa M. Ollivier
Hartwell H. Welsh, Jr.

AUTHORS

DAVID R. CLAYTON is a wildlife biologist, USDA Forest Service, Rogue River National Forest, 6941 Upper Applegate Rd., Jacksonville OR. 97530

LISA M. OLLIVIER is a research wildlife biologist, USDA Forest Service, Pacific Southwest Research Station, 1700 Bayview Drive, Arcata, CA. 95521

HARTWELL H. WELSH, Jr. is a research wildlife biologist, USDA Forest Service, Pacific Southwest Research Station, 1700 Bayview Drive, Arcata, CA. 95521

ABSTRACT

Surveys to detect the presence of the Siskiyou Mountain salamander are needed on federal lands when proposed management activities may affect Siskiyou Mountain salamander populations or their habitat. This protocol is recommended to standardize survey efforts for species-detection on federal lands. State regulations must be recognized; this is a California State Threatened species, and it is protected in Oregon. State permits are required prior to surveys. Surveys need to be conducted on federal lands covered by the Northwest Forest Plan, and within the Survey Zone for the species, in an area in which there is suitable habitat for the species, and the proposed project may affect animals directly or indirectly by altering habitat. Surveys must occur from late fall to late spring under restricted environmental conditions (ambient temperature between 4-20 ^{o}C, soil temperature between 3.5-18 ^{o}C, relative humidity 65% or greater, no freezing 48 hours prior to survey [high elevation exceptions to the freezing constraints]). The preferred survey period is spring, at least one site visit must be conducted during the preferred spring survey season. The minimum search effort for any site is four person hours per ten acres of habitat. The search method involves expanding concentric circles or random searching of the suitable habitat in order to ensure complete coverage of that habitat. If Siskiyou Mountains salamanders are not found, a total of three complete surveys of the habitat need to be conducted. Site visits must be at least 10 days apart. Presence is confirmed when one or more Siskiyou Mountain salamanders are found.

Version 3.0

TABLE OF CONTENTS

INTRODUCTION

This survey protocol was developed in response to the Record of Decision for the Northwest Forest Plan (USDA and USDI 1994) to determine the presence of the Siskiyou Mountains salamander, *Plethodon stormi* (PLST), on federally owned and managed lands. It provides the conceptual framework and steps to conduct surveys in areas where proposed projects have the potential to affect PLST populations and habitat.

Before initiating surveys, read this entire document and its companion (Chapter I), which addresses general information and guidelines for the Survey and Manage amphibians. Knowledge of the basic biology and management guidelines for this species (Olson 1999) will facilitate an understanding of the survey procedures.

Main Revisions and Clarified Procedures

This protocol is revised from the 1996 draft protocol (Olson et al. 1996). The list below summarizes the main revisions and clarified procedures specific to Siskiyou Mountains salamander surveys. Revisions have resulted from new information, and extensive review comments provided by agency executives, managers, field specialists, species-experts, and non-agency scientists. Revisions are for clarification, to refine procedures for optimizing sampling, but do not significantly alter survey effort compared to the 1996 draft protocol.

- **Flexible and fixed survey elements are clarified**
- **Survey triggers are defined and are discretionary**
- **Adjacent area survey distances are more discretionary, rather than 180 m**
- **Photographic plates of animals are included to aid species identification**
- **Photographic plates of habitats are included to aid habitat identification**
- **Summary of known site record compilation is included (Chapter II)**
- **Maps of known site locations (Figure IV.1), with other coverages (Chapter II)**
- **Revised Survey Zone, narrowing the area for surveys**
- **Revised Data Forms**
- **Range has expanded in response to federal surveys effort detecting new sites**
- **More complete habitat description is provided**
- **Expanded survey seasons, including winter and late spring if conditions warrant**
- **No surveys may occur if there has been freezing within previous 48 hours (rather than the night prior to survey), with a high elevation exception in California**
- **Minimum soil temperature for surveys was lowered to 3.5ºC, from 4.5ºC**
- **Air relative humidity for surveys was changed to ≥ 65%, from 45%**
- **At least 1 of 3 site visits must be conducted in the spring**
- **10+ day survey interval (instead of 21 days)**
- **Search route is discretionary**

Survey Requirements

USDA and USDI (1994; Table C-3, p. C-59 and C-28) states that PLST is a Component 2 species under the Survey and Manage provisions and is a Protection Buffer species. Component 2 direction is to "survey prior to proposed activities and manage known sites," while Protection Buffer guidelines state "Additional surveys conducted using a standardized protocol must be undertaken to delineate range and identify subpopulations." The guidelines of this chapter present the parameters and procedures for triggering and conducting a survey to meet the requirements for federal land management activities. Surveys are conducted to determine if the species is present at the site.

State Regulations--The states of Oregon and California have requirements for both the handling and collecting of these animals. Capture and handling is necessary to identify these salamanders, thus the following regulations are to be followed. In Oregon, PLST is a State Sensitive species, listed in the Vulnerable category, and considered Protected wildlife (OAR 635-44-130). A permit from the Oregon Department of Fisheries and Wildlife is required to collect or take this species.

In California, PLST is a State Threatened species and it is prohibited to handle these organisms without a Memorandum of Understanding in place with the California Department of Fish & Game. The state needs to be notified if any incidental mortality occurs, and specimen needs to be preserved and routed as per their direction.

Surveyor Training-- Training of field personnel is necessary prior to conducting surveys for PLST (Chapter I). Surveyors must be able to identify PLST and any sympatric salamander species, identify PLST habitat, understand the known ecology and behavior of the animal, and fully understand the survey procedures for their standardized implementation under field conditions.

<u>Training Requirements</u>

Two-day training session

- **One day of lecture and species identification**
- **One day of field instruction**

Surveyor skills include

- **Ability to identify all salamander species encountered**
- **Ability to identify target species' likely habitat**
- **Knowledge of species' microhabitat associations**
- **Knowledge of species' microclimate associations**
- **Knowledge of species' surface activity patterns**
- **Knowledge of survey protocol and its implementation**
- **Knowledge of documentation procedures, dataforms and discretionary decisions**

Presence-- "Presence" is determined when one or more PLST are detected and positively identified. If PLST is detected, the surveyors may terminate the survey. Once presence is determined, it is assumed that a population occurs at the site and all contiguous habitat (see below) is managed to maintain PLST at the site according to current guidelines (Olson 1999).

Not Detected-- "Not detected" is designated if the target species is not observed after three site visits during each of which full surveys have been conducted. After the site has been surveyed three separate times with no detection of PLST, the requirements for Survey and Manage have been met and the site would not need to be managed according to PLST management recommendations. The term "absence" is to be avoided, because it is an absolute that can not be determined after only three site visits.

GENERAL BIOLOGY AND ECOLOGY

Much of the natural history and ecology of this species is reviewed in Olson (1999). A general reference for identification is Stebbins (1985).

The Siskiyou Mountains salamander was first collected in May 1963 and described as a species in 1965 (Highton and Brahme 1965). It is a member of the family Plethodontidae, the lungless salamanders. The members of the genus Plethodon respire primarily through their skin and are completely terrestrial.

Although not aquatic, PLST is very sensitive to temperature and moisture regimes and only occurs in relatively cool, moist microhabitats. This species will move up or down through the substrate as microhabitat conditions become favorable for them. The species is generally only surface active under very restricted microclimatic conditions. They are usually active only during the fall, winter and spring rains. PLST have been found when soil temperatures ranged from 3.5-18ºC (range 0.5-18^{0}C), and ambient temperatures were between 4-20ºC (range=1-24ºC), (Nussbaum 1973; D. Clayton pers. obs.). High relative humidity is also an important predictor of surface activity for this species. Ninety-one percent of all animals (N=620) found during surveys from 1992 to 1998 in the Applegate and Klamath River Valleys were found when the relative humidity was at or above 65% (range=31%-100%), (D.Clayton unpubl. data). In addition, capture rates were greatly influenced by relative humidity, above 65%RH the capture rate was 3.7 animals per hour and the capture rate below 65%RH was only 1.5 animals per hour. There also may be a time lag that will affect how fast the animals will respond to changes in microhabitat conditions. Harsh and unfavorable conditions such as hard freezing, inundation, or very dry conditions may cause them to not respond quickly to good surface conditions and it may take up to two or three days for them to become surface active (Taub 1961).

Species Identification

An adult <u>P</u>. <u>stormi</u> is distinguished by having a modal number of 17 costal grooves and 4 to 5.5 intercostal folds between adpressed limbs (Nussbaum et al. 1983). Siskiyou Mountains salamanders are slim and long-bodied (approximately 14-70 mm SVL), and are chocolate-brown to purplish-brown, dorsally, with varying amounts of light flecking on the head, sides, and limbs (Plate IV.1). Adults may have a faint lighter brown dorsal stripe, and the ventral color is grayish-purple. Juveniles tend to be black or very dark brown with flecking, often exhibit a light brown or tan dorsal stripe, and are gray ventrally (Plate IV.2). Surveyor training is needed to be able to identify this animal. In the contact zone with the Del Norte salamander (*Plethodon elongatus*, PLEL, see Survey Zone, below), PLST has been found with 5.5 costal folds between adpressed limbs and with copper dorsal stripes (D.Clayton, L. Ollivier, pers obs.).

Range

This species is known only from southwestern Oregon and northwestern California (Figure IV.1). It occurs in Siskiyou County, California, in Jackson and Josephine Counties, Oregon. The known range of the Siskiyou Mountains salamander has roughly doubled since 1993 and the onset of federal surveys under the Survey and Manage provision. This species is known to occur up to 1800 meters (6,000 feet) in elevation. Along its western edge, its range is contiguous with the that of the Del Norte Salamander (Figure IV.2).

Habitat

The Siskiyou Mountains salamander is considered a talus or rock substrate obligate, and has rarely been found far from talus deposits or fissured rock outcrops, (Plates IV.3-4), (Herrington 1988; Stebbins 1966; Nussbaum 1974). Suitable habitats for PLST are listed below.

<u>Habitat</u>: **Rock outcrops**
Forested rocky soils
Rock on rock substrates
Exposure, vegetation, slope, and aspect may vary

Nussbaum (1974) characterized optimum habitat for PLST as stabilized talus in old growth stands with high canopy closure and a northern aspect. Abundances are significantly higher in late-successional forest, capture rates can approach 30 individuals per hour. Canopy closure is typically high on occupied sites, the average canopy of 52 known sites in 1992 was 72% (range 2-100%)(D Clayton, pers. obs.). Catastrophic loss of canopy can extirpate the animals from a given site. An occupied site clearcut in 1990 was sampled in 1991 and 40 individuals were found, after one year only one individual was found and since 1993, no PLST have been found at the site (D. Clayton, pers. obs.). While some occupied sites may occur within relatively young forest, canopy closure are still high on these sites. Occupied sites on south and east facing slopes also typically have higher amounts of canopy closure than do north and west facing sites.

Nussbaum et al. (1983), reported that talus depths in occupied PLST habitat ranged from 0-45.7 cm deep with an average depth of 10-30cm. Generally, this species is found predominantly in forested situations with rocky substrates. Sites suitable for PLST include appropriate habitat in the form of surface and subsurface rock deep enough for the animals to retreat into as environmental conditions warrant. Sites occupied by PLST generally have layered rock substrate with at least some cobble-sized rock that serve as cover objects. Because of this species' physiological requirements (e.g., respiration through the skin), the species is typically found in rocky substrates that are deep enough to retreat into when conditions become too harsh for the animal at the surface. During wet weather, this species occasionally may be found under bark or logs in association with suitable rock substrates. Surveyor training is needed to be able to identify the full range of suitable habitats.

SURVEY PARAMETERS

Triggers

Triggers are the parameters that initiate the survey. These are generally project proposals that include ground disturbance or other activities that may negatively impact PLST or their habitats. Triggers are cross-referenced to the management recommendations for this species (Olson 1999), such that if PLST habitat protection is recommended in response to an activity, it may be considered a trigger.

Trigger Criteria--Surveys are triggered only when the proposed activity occurs:

1. **on federal lands covered by the Northwest Forest Plan, and**
2. **within the Survey Zone for PLST, and**
3. **in an area in which there is suitable habitat for PLST, and**
4. **the proposed project may affect animals directly or indirectly by altering habitat.**

As ground-disturbing activities occur on or in the substrate, they have the potential to severely affect this species. Adverse effects on the substrate microhabitat is the specific concern. Surface microhabitat conditions important for this species include the physical structure and surface cover features, and the microclimate (e.g., temperature/moisture regime). Concerns for management include the maintenance of the integrity of substrate interstices and cool, moist surface regimes. Proposed management activities that may affect these habitat elements are survey triggers.

Activities with little or no ground-disturbance may also affect microhabitat for this species. For example, chemical applications may affect individual animals directly by creating inhospitable habitats. Some chemical applications (e.g., pesticides), may also affect amphibians indirectly by impacting their prey-base.

Trigger Decision Process— Land management activities should be evaluated on a case-by-case basis whether on not they represent obvious triggers. To make this management decision, the four above criteria should be evaluated. For the last criterion, "does the proposed project adversely affect the habitat conditions for the species or the individual animals?" Site managers are expected to have the greatest discretion with regard to this final criterion. Site conditions or project implementation timing can affect whether or not a particular activity is a trigger (see also Chapter I).

Activities that May Not Trigger Surveys--Surveys may not be triggered for activities that are determined to have low potential to affect this species or its habitat. This may include activities that do not affect substrate integrity, or the microclimatic regime within suitable habitat. In addition, if a particular activity does not affect microhabitat conditions and it is timed so that the activity occurs when the animals are not surface active (e.g., during dry, summer months), and thus not expected to affect the animals themselves, the activity may not trigger surveys. See also Chapter 1 for further discussion of triggers.

Specific examples of triggers and non-triggers include:

A. Most proposed timber management activities, including thinning, regeneration harvest and salvage would trigger surveys. These types of activities involve reduction of canopy and high levels of disturbance to the substrate.

B. Road construction or reconstruction would trigger surveys. Routine road maintenance may not trigger surveys. Road construction and reconstruction can involve high levels of substrate disturbance and removal of overstory. Routine maintenance typically involves only those activities within the already disturbed road prism that is not likely to be habitat for PLST.

C. Recreational development, such as campground creation or expansion would trigger surveys. Routine maintenance may not trigger surveys. Development or expansion of recreational sites can involve overstory reduction and substrate disturbance, while maintenance only involves work in previously disturbed sites that may not be likely habitat.

D. Most mining activities, including new rock source development would trigger surveys. Rock removal at existing rock sources would not trigger surveys if no outward expansion of the site occurs and if activities are conducted when the animals are not active at the surface (generally 1 June - 30 Sept.). Existing quarries are highly disturbed sites and may be occupied only seasonally by the animals. The seasonal restriction reflects that time when the animals are unlikely to occupy the site and activities conducted at this time will avoid direct impacts to individual animals.

E. Chemical applications (e.g. pesticides, herbicides, fertilizers) within suitable habitats would trigger surveys. Surveys would not be triggered if applications are proposed within plantations less than thirty years old. Plantations are disturbed sites that generally do not provide suitable habitat due to low canopy closure and disturbed substrate and likely have not been re-colonized by the species.

F. Prescribed fire as necessary for the reduction of fuel loads and species-habitat improvement, and slash after felling operations, would not trigger surveys if burning is conducted when PLST are not active at the surface (generally 1 June - 30 Sept.), and no net loss of canopy would occur. This species has evolved with fire and fire effects do not generally extend into the substrate. Consequently, if fire is introduced to a site when the animals are not active near the surface, direct effects to individuals may be reduced or avoided.

G. Road decommissioning - Surveys of roads would not be triggered for road decommissioning as it is unlikely the substrate affected within the road prism during decommissioning would be suitable habitat for the species.

H. Replanting and timber stand improvement (pre-commercial thinning) of plantations thirty years old or less would not trigger surveys. Plantations are disturbed sites that generally do not provide suitable habitat due to low canopy closure and disturbed substrate and likely have not been re-colonized by the species.

I. Hazard tree removal of single trees and clearing blow-down from roads would not trigger surveys. This type of activity has low potential to impact to PLST habitat.

J. Seeding of native species of grasses or plants would not trigger surveys. This type of activity has low potential to disturb PLST habitat.

K. Construction or reconstruction of fences would not trigger surveys unless the construction would lead to increased disturbance within PLST occupied habitat, such as might occur with livestock collection devices.

L. Special Forest Products: Proposed removal of talus for flagstone or burl harvest would trigger surveys because of the potential for disturbance to PLST substrate. Surveys would not be triggered for removal of forest products such as mushrooms, bear grass, fir boughs, and Christmas trees because of low levels of potential for disturbance to PLST habitat.

M. Surveys would not be triggered for removal of small infestations of noxious weeds by hand pulling or digging because of the low potential for disturbance to PLST habitat.

N. Areas proposed for concentrated wood cutting would trigger surveys due to the potential for canopy reduction, substrate disturbance, and impacts to microhabitat. Dispersed (single tree) wood cutting would not trigger surveys as this type of activity has a low potential to disturb substrate or reduce overall canopy within PLST habitat.

Adjacent Area Surveys

Appropriate habitats within adjacent areas surrounding the proposed project area should be surveyed if the project may affect PLST habitat in adjacent areas. Effects on microclimates (e.g., edge effects, Chen et al, 1995), microhabitats, and slope stability should be considered.

Surveys of areas adjacent to proposed site-disturbing activities should be considered on a case-by-case basis (see Table IV.1, below). Depending on site conditions and potential effects to habitat and microclimate, there is discretion when determining the width of adjacent area required for survey. An adequate analysis should be conducted and documentation of the decision should be provided (see also Chapter I). Guidelines for adjacent area surveys are provided in Table IV.1. These guidelines are cross referenced to the management recommendations for the species (Olson 1999). Although every attempt was made to address most potential activities, this should not be considered an all-inclusive list.

Table IV.1: Adjacent Area Survey Width Recommendations.

Management Activity	Disturbance Parameters	Disturbance Intensity	Recommended* Adjacent Area for Survey
Trail construction	Tread 24-48 in. linear disturbance only	Low	0m, survey trail route only
Road	Roadbed 10-20 ft.	Moderate	10-30m on either side of center
Timber Harvest	Thinning,>60% retention	Moderate	0-60m, depending on site conditions
Timber Harvest	Thinning,<60% retention	Moderate-High	0-120m, depending on site conditions
Timber Harvest	Regeneration, 0-15% retention	High	120-240m, depending on site conditions
Mining/Quarries	Expansion/new quarries	High	60-80m, depending on site conditions
Recreational Development	Expanded or new facilities	Moderate	0-60m, depending on site conditions

* **These widths are intended only as general guidelines, site-specific analysis will determine actual adjacent area survey widths.**

Justification for not surveying in adjacent areas may be considered under circumstances that are not expected to affect potential PLST or their habitats adjacent to activities. In particular, not surveying within adjacent habitat might be considered when: 1) there is no adjacent area ground disturbance expected that would cause salamander mortality; and 2) proposed activities are not expected to alter adjacent area microclimate or microhabitat conditions. For example, although trail construction may be a trigger of surveys along the trail alignment, adjacent areas along trails would not require surveys if adjacent area microclimates remain unaffected (e.g., no timber felling resulting in dominant canopy cover reduction is involved) and if adjacent area microhabitat will remain intact (e.g., blasting is not conducted).

Site Location

Survey Zone--The entire geographic area where surveys are needed for PLST is termed the Survey Zone (Figure IV.1). The results of extensive federal surveys since 1993 have resulted in the following adjustments to Survey Zone boundaries. Further adjustments to this survey zone boundary may be made annually as new information on the actual range of the species becomes available.

> In Oregon: The Survey Zone extends north from the Oregon/California border at the Applegate/Illinois Valley Ranger District boundary, along the Applegate District boundary until it bisects the western boundary of the Thompson Creek watershed. The Zone continues north along the watershed boundary to the confluence of Thompson Creek and the Applegate River. It then continues northwest along the Applegate River to the Jackson/Josephine County line. It continues north along this county line to Interstate 5. The Survey Zone boundary described thus far is also the eastward Survey Zone boundary of the Del Norte salamander (PLEL, Chapter V). From Interstate 5 at the Jackson/Josephine County line, the PLST Survey Zone goes south along Interstate 5 to the Oregon/California border (see Figure IV.1).

> In California: The Survey Zone follows Interstate 5 south to the R7W/R6W boundary line. It continues south on this line to the Klamath/Shasta-Trinity National Forest Boundary. It continues southwest along the forest boundary to the Scott River/Salmon River District boundary. It then goes northwest along the Scott River/Salmon River boundary to the Humboldt/Mt. Diablo Meridian. The Zone goes north along this meridian to China Point. The line then crosses at the confluence of the Klamath River and Thompson Creek. It continues north along the western watershed boundary of Thompson Creek to the Oregon/California border.

In the Klamath River area of contact between the two species, PLST and PLEL, there will be a “shared” Survey Zone (Figure IV.2). Within this Zone, surveys should be conducted only until one of the species is detected. Whichever species is detected first will determine management for the Survey Area. For species determination, PLST has 4-5.5 costal folds between adpressed limbs, while PLEL has 6-8 costal folds between adpressed limbs.

> Shared survey zone: The shared zone extends south along the western watershed boundary of Thompson Creek from the Oregon/California border to the confluence of Thompson Creek and the Klamath River. It continues across the Klamath River at China Point to the Humboldt/Mt. Diablo Meridian. It continues south on the meridian to the Scott/Salmon River boundary at North Fork Camp. It follows northeast along this boundary to Anthony Milne Camp, goes due north along this line to the headwaters of Grider Creek at the Oak Knoll/Scott River District boundary. It extends north along Grider Creek to the confluence of Grider and the Klamath River. It follows northwest along the Klamath River to the Happy Camp/Oak Knoll District boundary. It goes northwest along this line to the Oregon/California border.

Survey Area--Within the boundaries of the Survey Zone, the Survey Area includes PLST habitats potentially affected by the proposed activity. Surveys may be triggered if appropriate habitat is found at or adjacent to a site proposed for ground disturbing activities and the proposed activity triggers a survey (Figure IV.3).

Habitat is described above. Generally, this species is found in forested situations with rocky substrates and is considered a rocky substrate obligate. The site to be sampled for PLST should include appropriate habitat in the form of surface and subsurface rock. Sites occupied by PLST generally have layered rock substrate with at least some cobble-sized rock that serve as cover objects. Discrete pockets of habitat that are greater than 75 m apart (edge-to-edge with no intervening habitat) should be considered separate and would require separate surveys. If sites are within 75 m of each other, they can be considered part of the same survey.

Survey Timing

Seasons--Surveys for animals must occur during the appropriate months: generally late fall through late spring. These times coincide with the fall and spring rainy seasons (see below). Spring usually offers a longer period of time with appropriate conditions for sampling. Areas of high elevation (generally above 5,000ft., 1450m), may not be free of snow until after the spring period and may be surveyed at a later time if environmental and substrate conditions are met.

Number of Site Visits-- Each site must be visited a total of three times over the course of the spring or fall rainy seasons (see environmental conditions below), unless presence is established. At least one sample period must be conducted during appropriate conditions in the spring.

Intervals Between Site Visits-- Site visits must be separated by at least 10 days. Preferably, sampling will occur at least every 10 days, although weather events may cause longer periods to pass between visits. With this interval, it may be possible to complete a survey effort within a single survey season. However, attention must be paid to environmental conditions that constrain surveys which are described below.

Survey Effort-- Search effort must be a minimum of four person-hours per ten acres of suitable PLST habitat. As an example, a twenty acre area of habitat would need a minimum of eight person-hours of survey time for one visit. A crew of four surveyors could complete this in two hours time.

Environmental Conditions

The activity patterns of PLST are highly dependent on local environmental factors such as relative humidity and temperature. These factors must be taken into careful consideration when determining when to survey for these animals. The following conditions must be met before surveys may proceed:

Air conditions--The air temperature and humidity must meet the following criteria. Relative humidity of the site must be a minimum of 65%. At potential sites to be surveyed for PLST, the air temperature must fall between 4-20^{0}C (D. Clayton, pers. obs.). In addition, freezing temperatures must not have occurred at the site within 48 hours prior to the site visit.

However, on federal lands in California, sites above 4,500 ft (1372 m) may be searched without the freezing provision. In this area only, it may lightly freeze the night prior to survey. This expanded window of environmental conditions pertains only to this area because normal protocol conditions could not be met at these sites and data have been compiled from this region showing that PLST have been somewhat surface-active after light freezes (approximately -2 ^{o}C) . If multiple site visits are necessary to these California high elevation sites, at least one site visit must occur with the low elevation freezing provision: no freezing at the site within 48 hours prior to the site visit. Use of Reference Sites is strongly recommended for these high elevation areas.

Soil conditions-- The soil temperature and humidity must meet the following constraints. The soil temperature, taken 10 cm below the surface, must fall between 3.5-18^{0}C. The substrate below the first layer of rock within the area being searched must be moist to the touch.

Reference Sites

These salamanders are highly sensitive to local climate shifts. Freezing temperatures at a site during the night prior to a survey may cause the salamanders to retreat down into the rock substrates, rendering them undetectable by the search technique. When possible, we recommend the use of reference sites to determine if these animals may be active on a given day near the site to be surveyed. A reference site may be a historic site or even a road cut with the appropriate microhabitat that supports a population. A reference site should be located in the same sub-drainage and at or near the elevation and aspect of the survey site to be informative about potential salamander activity on the survey site. If no individuals are found at the reference site, it is likely that environmental conditions are not suitable and salamander surveys will not be effective and should not be conducted.

Voucher Specimens

Voucher specimens are not needed for this species, due to its status of concern and the required training of field personnel in species identification. This animal is not easily misidentified, once its key characters have been assessed. If there is doubt as to the identification of a captured salamander, local species experts should be sought to verify the identity of the animal.

SURVEY PROTOCOL

General Guidelines

For all surveys conducted for PLST, certain guidelines will help the surveyor know where, when and how to survey:

a. Survey only during acceptable environmental conditions. The intent is to capture animals that are surface active, so searching deeper than the upper 10-30 cm is not necessary.

b. Portions of the Survey Area that cannot be safely searched may be omitted.

c. The search is time-constrained at 4 person-hours for every 10 acres of habitat. Search until the habitat patch has been fully searched, until time is up for that search, or until the first PLST is found.

d. All of the surveying is done in a walk and turn over [surface objects], hand-search manner. Salamanders, during daylight, are usually found underneath surface objects. Carefully look under surface objects while moving across the patch of habitat. Surface objects may be items on top (e.g., a rock on rock) or may be interspersed (e.g., talus, soil mixture). For this protocol, the surface is generally considered to be within the approximate upper 30 cm of the top of the substrate.

e. Do not spend too much time in any one place. A maximum of 10 minutes should be spent at any specific spot, whether captures are occurring or not. At the end of this brief time, stop your timer and move to another location a few paces away. Restart your timer and resume searching. It is important to move across the substrate

f. The walk and turn over method ensures that the observers will cover the area spatially, to maximize the likelihood of capturing the target species, which may be clustered in a small portion of the Survey Area.

Survey Ethics

All surveys should be conducted in a relatively non-destructive manner. Surface objects are lifted and replaced to their original position. Hill sides should be kept relatively intact whenever possible. Bark may be pulled off of logs, but it should be done carefully, so that it can be replaced. Logs that are moderately decayed into large chunks or splits may be separated, but again, the pieces should be replaced as best as possible. However, logs should not be completely destroyed. Moss mats should be replaced. The intent here is not to abstain from any alteration; that would be next to impossible and would make it difficult to detect salamanders. The intent is to be conscientious about minimizing disturbance to the habitat by using a light-handed approach.

Safety Issues

Field units implementing surveys should be discretionary regarding safety issues as required by site conditions. Safety of surveyors should not be compromised to complete surveys. As such case-by-case decisions are made, managers, supervisors, and field crews should be in communication. We recommend full documentation of the rationale supporting such a decision.

Prior To Sampling

Review Survey Area–A contour map covering the specific proposed project area (e.g., forest management activity, recreational development) is needed when conducting a survey. Features such as pockets of late-seral forest, cliffs, rocky substrates and areas of steep terrain (>40%) should be delineated within the project area boundary, as these areas are the most likely to support PLST populations. Soil type maps also may enable one to narrow the search area somewhat by keying in on specific soil types with high percentages of gravel and cobble.

Location of plot center–The time-constrained search may begin at the plot center (i.e., the approximate center of the largest area of suitable habitat within the Survey Area). To find this location, systematically walk the proposed project area to locate areas containing surface rock with suitable substrate. Place plot center in the center of the area with the greatest concentration of surface and subsurface of searchable size (easily turned by hand), remember to replace rocks and other cover objects in original position after searching to preserve habitat quality. Areas with cover primarily comprised of large boulders and large outcrops are not readily sampled by this search technique. There may be more than one patch of suitable substrate within and adjacent to a proposed activity area. All patches of suitable habitat should be surveyed for occupancy.

Data Form Completion (see Appendix IV.1)

a. Site Information, Location and Topography: **Mandatory**

- Project name, unit number and site number, directions to site.
- Record estimated habitat dimensions, area, and minimum search time.
- Record Township, Range, Section, quarter section, latitude and longitude.
- Locate site on a copy of a 7.5 min. topographic-map and attach to data form.
- Record elevation (m).
- Record ownership (Forest service (NF, RD), BLM district, RA), non-federal).
- Record slope and aspect.

b. Time and date: **Mandatory**

- At the time of site entry, record military time.
- Record date (Month, Day, Year)

c. Observer/s Name/s: **Mandatory**

d. Weather (record and measure at plot center prior to sampling): **Mandatory**

- Sky = Clear, Partly cloudy, Very cloudy
- Moisture = Dry, Foggy, Intermittent rain, Light rain, Heavy rain
- Wind = None, Light, Moderate, Strong
- Air temperature (^{0}C) - alcohol, mercury or digital thermometer
- Air relative humidity (%) - psychrometer

* Air temperature and relative humidity should be taken three times during the survey, at the beginning, middle, and at the end of the survey. If environmental conditions go outside of parameters for survey at any time during the survey, terminate the survey.

e. Soil temperature and moisture: **Mandatory**

Five measurements of these variables are needed to validate survey conditions at the beginning of the survey period. Compare the **average** of the five measurements to the environmental constraints listed previously. If soil/substrate conditions are not within the bounds previously outlined, surveys should not be conducted. The sites for the measures are located as follows:

Site 1. Locate center of plot to be surveyed. Measure soil temperature and moisture (also canopy closure, see below).

Sites 2-5. Stand at plot center. Measure 15 m in each of the 4 cardinal directions (N, S, E, W) to locate the other four sample points. Measure soil temperature and moisture (also canopy closure, see below).

Measures:
- Surface temperature (^{O}C) measured 10 cm below surface
- Soil dry by touch /moist by touch, for soil and litter below the duff layer.

f. Canopy closure: **Mandatory**

Record canopy closure (%) with densiometer at each soil survey station and average to determine overall canopy closure (see data form, Appendix IV.1).

g. Suitable habitat data fields: **Optional**

- Dominant rock size and shape
- Cover type, record % cover by each type using codes provided on form
- Composition of canopy by species group as percent and presence/absence
- Stand age class using codes provided on form

Time-Constrained Search

Begin searching by hand anywhere within the patch of habitat . Turn cover objects, carefully lift moss mats, and sift leaf litter as you systematically move around the area. Expand the search out in concentric circles or by using a search pattern that thoroughly covers all habitat within the plot. Please note: Potato rakes should not be needed or used. Searchers should move about the site, spending no more than 10 minutes searching a small area (whether captures are occurring or not). After 10 minutes of intensive searching in a small area, searchers should move a few paces and begin searching again. When moving to a new site or handling a capture (recording information) the timer stops. Time of search applies only to time spent actively searching for animals. Keep track of time each observer spends searching. At end of search, record actual search time in person-hours and acres searched.

If animals are captured record the following information:

b. Species - four-letter code (see code sheet) determined by identification keys provided during field training. Record all amphibian species captured.

b. Stage - juvenile, subadult, or adult

c. Capture location - for Survey and Manage species, mark and map site. Describe both cover and substrate of captures (what is the animal in, on, and under?). Cover objects and substrate types are provided on data form.

All captures are to be released as close to original capture location as possible. Replace cover object in original position, then place the animal next to the object, allowing animal to return underneath the object. While searching, attempt to return all rocks and other large cover objects back to original positions. Replace moss mats, where possible. When an individual PLST is found, searching can be stopped (record time), "presence" is designated, the entire habitat is designated occupied (see below), and the habitat becomes a known site and is entered into the known site database.

Site Delineation

Once PLST is detected, the first detection location will become the "site" for the Known Site Database (i.e., a point locality). To delineate a PLST site for known site management, all suitable rock substrate habitat, as determined by a qualified biologist, that is contiguous with an occupied site will be considered occupied. The full extent of this occupied suitable habitat should be identified and managed as described in the Management Recommendations (Olson 1999). If suitable habitat is separated by no more than 75 m, then it also may be considered occupied. If there is doubt as to the occupancy status of habitat near a known site, survey the areas using the same survey protocol. This may include all contiguous rocky habitats. The potential ecological value of contiguous, but possibly currently unoccupied habitat (in terms of desired future conditions, population dynamics, and connectivity), should be considered. Conservative measures are recommended when dealing with this type of rare endemic vertebrate species.

Survey Season Review

Annually, a joint meeting of all parties that have conducted surveys is recommended. Sharing of new sites may affect decisions for surveys and survey zone adjustments in subsequent years.
It is recommended that PLST survey and management procedures be reviewed at regular intervals. Field units should assess: 1) adherence to State and Federal standards and guidelines (e.g., renewal of permits, changes in survey protocols, training needs); 2) impacts to animals and habitats; and 3) new information available on this species and its management/protection. All field data should be retained at the field units.

OPTIONAL SAMPLING

Surveys Beyond First-Detection

From a biological standpoint, continuing surveys beyond first-detection is preferred because more information is collected that may be useful later. Continuing surveys can address whether a lone individual or a patch of animals has been detected, if a potential boundary of a population has been found or if specific conditions have triggered salamander surface activity. Such optional surveys will enable a more meaningful estimate of relative abundance to be made. However, it is realized that if a detection is all that is needed to establish a population, then the survey can be completed as soon as one verifiable specimen is obtained. There are several options for continuing surveys:

One survey hour -- Completing one additional survey hour after the target species has been detected may be a minimal additional effort to assess whether a population of animals has been detected.

Complete the survey day or site visit -- The more time and area covered during a survey will provide more information about the PLST population. Completing the surveys planned for that day or site visit may provide critical information as to the relative importance of that habitat in relation to neighboring sites.

Supplemental Habitat Characterization

To streamline surveys, the survey protocol includes collection of few habitat data. To fill knowledge gaps concerning identification of suitable habitat for this species, additional habitat information is needed. A more detailed site characterization is strongly recommended, particularly habitat elements such as forest stand structure and composition (e.g., canopy), and substrate conditions. These data fields are on the data form and it is encouraged that units fill out these fields.

Supplemental Searches

Supplemental searches might prove to be a quick and inexpensive way to detect a target species, if it occurs at a site. Supplemental surveys are completely optional, but are not recommended for use as a standardized protocol. Supplemental surveys may be used as proposed project areas are being prioritized and general field reconnaissance of habitats is being conducted. The following are suggestions for supplemental searches. An important note about supplemental searches is that they should be nondestructive, and specifically should not compromise the efforts of protocol-searches. These types of surveys would only count as an official site visit if animals are found and all data is collected to protocol.

Opportunistic searches -- An opportunistic search is done anywhere, anytime, by any method. It usually translates into "just going out and looking." However, it is recommended to document the time and/or area of effort (or preferably both). Use of a Reference Site is recommended under these conditions.

Off-season searches -- Although surveys may be conducted late fall to late spring, and spring is preferred, it may be possible to encounter PLST outside of this time-window if conditions are conducive.

Searching during marginal conditions -- The need for good environmental conditions has been stressed for surveys, but it is often possible to find salamanders when conditions are marginal (however, fewer PLST are expected to be detected). This type of survey may be done if the crew finds less than adequate conditions upon arrival at a site. Use of a Reference Site is recommended under these conditions.

DOCUMENTATION OF SURVEY DECISIONS

Due to the discretionary nature of several survey elements (triggers, adjacent area distances), supporting rationale for case-by-case decisions is recommended to accompany activity proposals. In particular, if variance in survey procedures is implemented, the rationale should be documented and a qualitative assessment of the change in Type II error conducted (i.e., risk of not detecting the target species when it is in fact present at a site). Relative to triggers, such rationale should include statements regarding the 4 trigger criteria, listed above. For the fourth criterion, statements should be included regarding the anticipated impacts of the project on: 1) the animals themselves; and 2) habitat conditions (e.g., structure, microclimate). The record of the adjacent area decision rationale should be distinct from the project area trigger decision rationale. Likewise, decisions to survey should be documented separately from decisions on how to manage sites.

Recommendations for Documentation

Rationale for trigger decisions should be documented.
Rationale for trigger decisions should be separate from management recommendations.
Rationale for adjacent area survey decisions should be documented separately.
Rationale for any variance to protocol should be documented, with a qualitative assessment of changes to risk of Type II error.

ACKNOWLEDGMENTS

I would like to thank all the members of the Amphibian Subgroup of the Survey and Manage Team, especially Deanna Olson for her support, editorial comments, and endless hard work on this project. Thanks also to Lisa Ollivier and Hart Welsh for editorial comments, study design, and massive amounts of data. Thanks to Rich Nauman for the known site database, distribution and range maps, and to Bill Leonard for the wonderful photographs of the species. Thanks to all of the various field crews who have worked with this species over the last several years.

REFERENCES

Chen, J.; Franklin, J.F.; Spies, T.A. 1995. Growing season microclimate gradients from clearcut edges into old-growth Douglas-fir forests. Ecological Applications 5: 74-86.

Herrington, R.E. 1988. Talus use by amphibians and reptiles in the Pacific Northwest. In: Szaro, R.C., Severson, K.E. and Patton, D.R., eds. 1988. Management of amphibians, reptiles, and small mammals in North America. Gen. Tech. Rep RM-166. Ft. Collins, CO: USDA Forest Service, Rocky Mountain Forest and Range Experiment Station: 216-221.

Highton, R.; Brahme, A. 1965. *Plethodon stormi* species. November. Amphibian: Urodela: Plethodontidae. Pilot Register of Zoology, Card No. 20.

Nussbaum, R.A. 1974. A report on the distributional ecology and life history of the Siskiyou Mountains salamander, *Plethodon stormi*, in relation to the potential impact of the proposed Applegate Reservoir on this species. Unpublished report submitted to the Army Corps of Engineers, Portland Division, Portland, Oregon. 70 p.

Nussbaum, R.A.; Brodie, E.D., Jr.; Storm, R.M. 1983. Amphibians and reptiles of the Pacific Northwest. Moscow, ID: University Press of Idaho. 332 p.

Olson, D.H. (ed.); Applegarth J.; Bury, R.B.; Clayton D.; Crisafulli, C.; Jones, L.L.C.; Ollivier, L.; Welsh, H.H., Jr. 1996. Survey protocols for Component/Strategy 2 amphibians. Portland OR: Special Interagency Publication, Regional Ecosystem Office, Survey and Manage species. 73 p.

Olson, D.H. (ed.) 1999 (in review). Management recommendations for Component/Strategy 1 amphibian species. Special Interagency Publication.

Stebbins, R.C. 1966. A field guide to western reptiles and amphibians. Boston, MA: Houghton Mifflin Co. 279 p.

Stebbins, R.C. 1985. Peterson field guides: Western amphibians and reptiles. Boston, MA: Houghton Mifflin Co. xiv + 336 p.

Taub, F.B. 1961. The distribution of the red-backed salamander, Plethodon c. cinereus, within the soil. Ecology 42(4): 681-698.

U.S. Department of Agriculture, Forest Service; U.S. Department of the Interior, Bureau of Land Management. 1994. Record of Decision: for amendments to Forest Service and Bureau of Land Management planning documents within the range of the northern spotted owl. [place of publication unknown]. 74 p. [plus attachment A: Standards and Guidelines: for management of habitat for late-successional and old-growth forest related species within the range of the northern spotted owl]. (ROD 1994).Chen, J.; Franklin, J.F.; Spies, T.A. 1995. Growing season microclimate gradients from clearcut edges into old-growth Douglas-fir forests. Ecological Applications 5: 74-86.

Figure IV.1 Known distribution of the Siskiyou Mountians salamander. The heavy line represents the species survey zone. The cross hatched area represents the combined Del Norte/Siskiyou Mountains salamander survey zone.

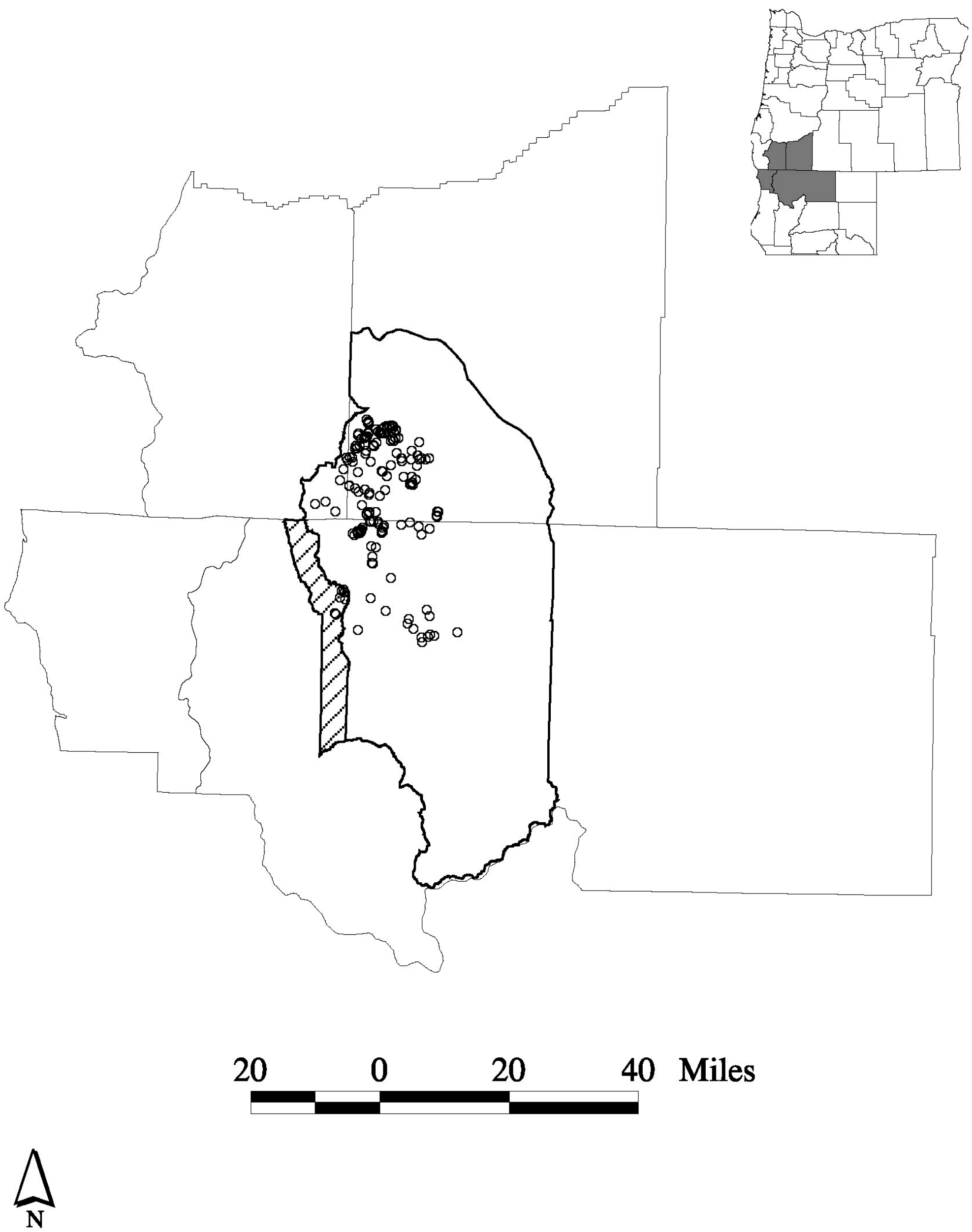


Figure IV.2. Known sites of Siskiyou Mountains and Del Norte salamanders with species survey zones (heavy line) and combined species survey zone (cross hatching).

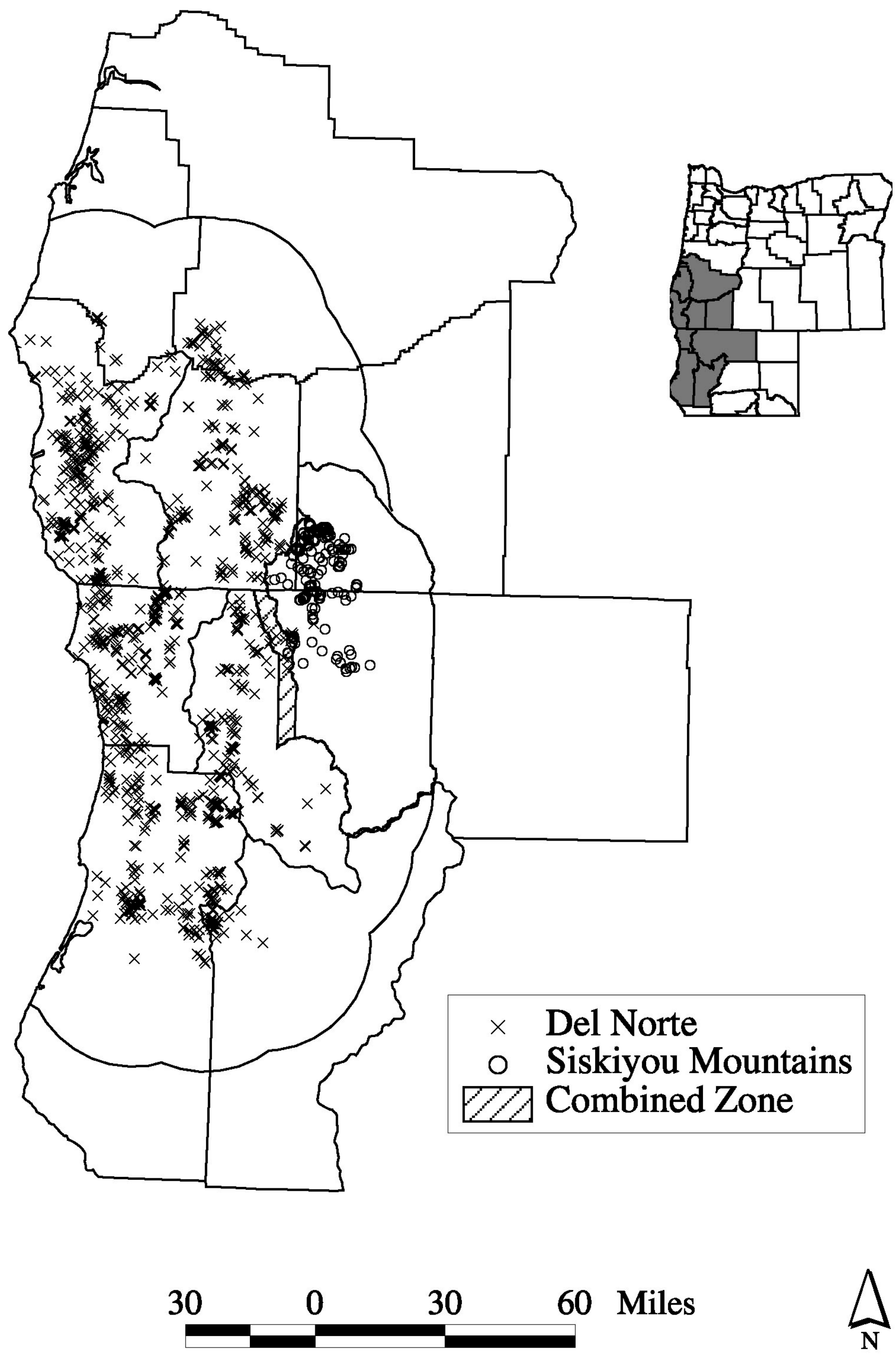


Figure IV.3. Delineating the survey area. The adjacent area shown may vary in width (Table IV.1).

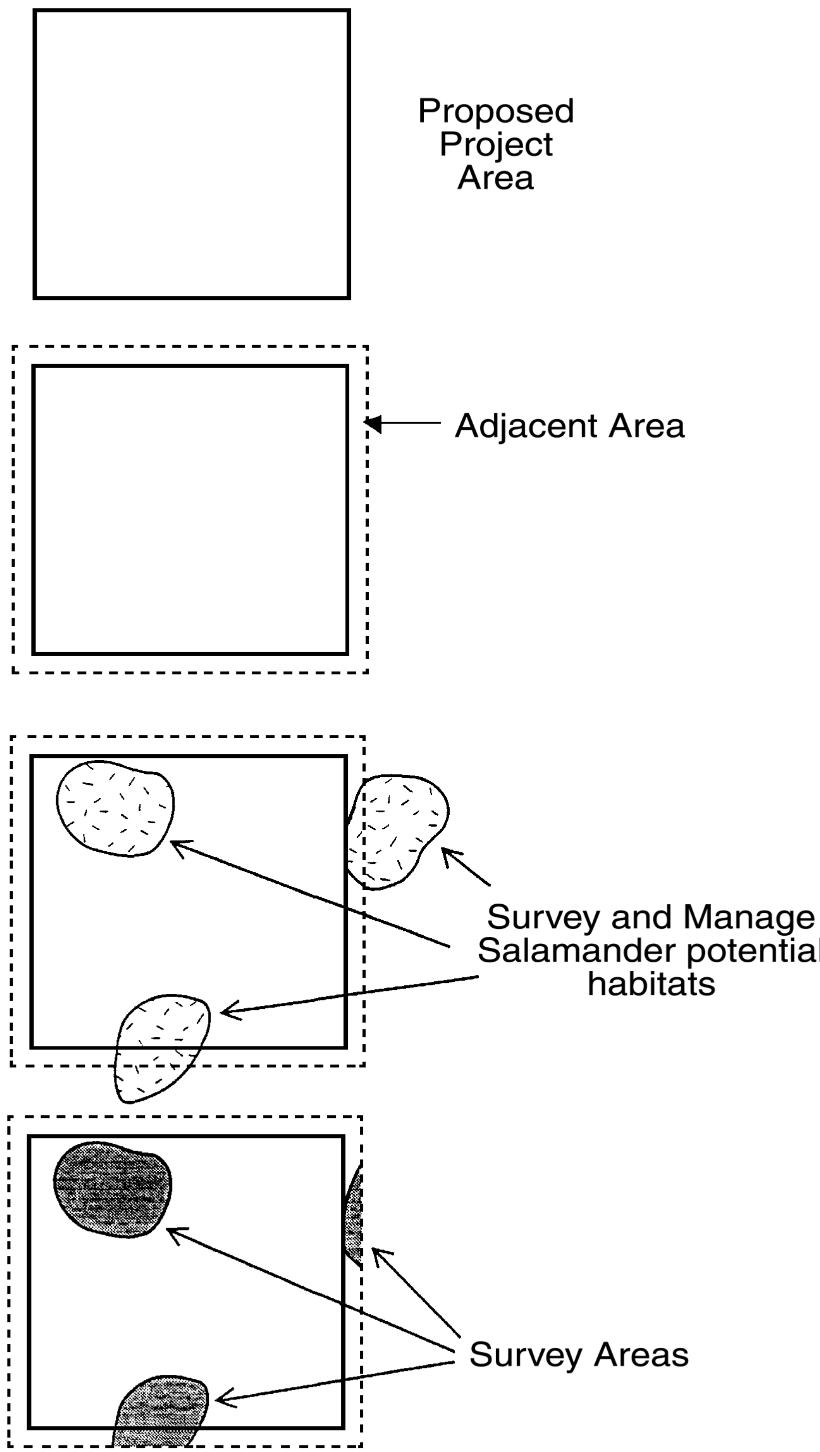


Plate IV.1 Adult Siskiyou Mountains salamander (*Plethodon stormi*) (Photo by William P. Leonard).

Plate IV.2 Juvenile Siskiyou Mountians salamander (Photo by William P. Leonard).

Plate IV.3 Siskiyou Mountains salamander habitat (Photo by Dave Clayton).

Plate IV.4 Siskiyou Mountains salamander microhabitat. Note layered rock, abundant interstitial spaces and salamander (indicated by arrow) (Photo by Dave Clayton)


Plate IV.1


Plate IV.2


Plate IV.3


Plate IV.4

Appendix IV.1: PLEL/PLST Data Forms and Instructions

PLEL / PLST SALAMANDER SURVEY FORM INSTRUCTIONS

SITE REFERENCE INFORMATION PAGE

Site Information (Mandatory)
Project Name. See list of projects for your area.
Unit Number. See project map.
Site Number. Record site number searched within the same project unit. Number the sites in chronological order.
Estimated Habitat Dimension. Record dimensions (approximate length times width, in feet or m) of habitat polygon.
Estimated Habitat Acreage. Use conversion from square feet to acres (or square meters to hectares) listed on survey form.
Minimum Search Time. Record calculated minimum search time based on estimated habitat acreage.

Location and Topography (Mandatory)
Forest. Record National Forest or BLM Resource Area name.
District. Record Ranger District or BLM District.
Legal. Township, Range, Section #, 1/4 section (NW, NE, SW, SE), 1/16 section (i.e. 1/4 section of the 1/4 section -- NW, NE, SW, SE). See quad map.
Quad #. see list of quad maps for your area.
Quad name. name of specific quad map.
Elevation. Record to the nearest meter, using an altimeter.
Aspect. Record aspect that the slope faces, using a compass (0-360 degrees).
Slope %. Record slope of the habitat patch, using a clinometer.
UTM_E. Will be added by office personnel.
UTM_N. Will be added by office personnel.
Location description. Directions to the site, describe how to get to the habitat polygon, using information such as mileage, road / spur names, topography (drainages, benches, saddles, etc.), specifying unmarked road forks, etc.

Suitable Habitat Substrate and Canopy (Canopy closure is Mandatory, other measures are Optional)
Dominant Rock Size. Circle one.
Rock Shape. Circle one. **Rubble** = round, **Slate** = flat and platy, **Mixed** = both rubble and slate.
Surface Water. Is water in the stand near search area? Circle all that apply. **Seep, Pond, Stream, None.**
Cover Type and Class. For each cover type listed, record the cover class using the codes listed on the data form.
Canopy. For each canopy element listed, circle yes or no for presence/absence and estimate % cover of habitat polygon.
Stand Age. Circle one. **Pre-canopy** = 0-30 yrs, **Young** = 31-99 yrs, **Mature** = 100-199 yrs, **Old-growth** = 200+ yrs.
Canopy closure. (Mandatory) Record canopy closure using a spherical densiometer (type B, concave not convex) at each soil station. Record amount of canopy closure (i.e. number of dots blocked out by vegetation) in each of the four cardinal directions (N, S, E, W), then average and multiply by 1.04. Then record average across all 5 sites to get average for habitat area.

Attach a Topographic Map (Mandatory)
Show the suitable habitat polygon, area surveyed.

Version 3.0

PLEL / PLST SALAMANDER SURVEY DATA FORM
SITE REFERENCE INFORMATION

SITE INFORMATION (Mandatory)

Project Name: ____

Unit Number: ______________________ Site Number: ________________

Estimated Habitat Dimension: _________ (ft or m) X _________ (ft or m) = _________ (ft^2 or m^2)

Estimated Habitat Acreage ______________ (ft^2) X 0.00002295 = _________ (acres)

or ______________ (m2) X 0.0001 = ____________ (hectares)

Minimum Search Time (person hours): ____________

LOCATION AND TOPOGRAPHY (Mandatory)

Forest: ________________________ District: ____________________

Legal:T__________ R__________ section ________ 1/4 sec________ 1/16 sec________

Quad #: ____________________ Quad Name: ______________________

Elevation: ________________ Aspect: ______________ Slope %: __________

UTM_E: ___________________ UTM_N: ________________________

Location Description:____

____

____

SUITABLE HABITAT – SUBSTRATE AND CANOPY (Optional, Except Canopy Closure)

Dominant Rock Size (circle one)

Gravel	(2-32mm)
Pebble	(33-63mm)
Cobble	(65-256mm)
Boulder	(>256mm)

Cover Type	Cover Class	Cover Codes
Surface Rock	________	0 = none
Moss	________	1 = 1-25%
DWD	________	2 = 26-50%
Litter	________	3 = 51-75%
Lichen	________	4 = 76-100%

Rock Shape (circle one)
Rubble / Slate / Mixed

Canopy (circle yes or no)			%
Conifer presence	yes	no	________
Hardwood presence	yes	no	________
Shrub presence	yes	no	________

Surface Water (circle all that apply)
Seep / Pond / Stream / None

Stand Age (circle one): Pre-canopy (0-30 yrs) Young (31-99) Mature (100-199) Old-growth (200+)

Canopy Closure % **(Mandatory)**

	1	2	3	4	5	
N	____	____	____	____	____	
S	____	____	____	____	____	
E	____	____	____	____	____	
W	____	____	____	____	____	Average Across
Average	____	____	____	____	____	Soil Stations
X 1.04	____	____	____	____	____	________

Attach a topo map that shows the suitable habitat polygon and TCS plot center.

PLEL / PLST SALAMANDER SURVEY DATA FORM INSTRUCTIONS

FIELD VISIT INFORMATION PAGE

Site Information (Mandatory)
Project Name. See list of projects for your area.
Unit Number. See project map.
Site Number. Record the site number searched within the same project unit. Number the sites in chronological order.
Visit Number. Record the visit number (1, 2, or 3) for the Project-Unit-Site listed above.
Date. Month, Day, Year
Start Time. Record the time when you arrive at plot center and begin to take habitat measurements. Use military 24-hour clock.
End Time. Record the time when you are done collecting habitat measurements or the search is complete, whichever is latest. Use military 24-hour clock.
Actual Search Time. Record total minutes searched.
Acres Searched. Record actual acreage of area searched.

Weather and Soil Conditions (Mandatory)
Microclimate in Protocol. Circle one (**Yes** or **No**)
Sky. Circle one (**Clear, Partly cloudy, Very cloudy**).
Moisture. Circle one (**Dry, Foggy, Intermittent rain, Light rain, Heavy rain**).
Wind. Circle one (**None, Light, Moderate, Strong**).
Air Temperature. Record air temperature in ºC, taken at beginning, middle and end of search.
Relative Humidity. Record air relative humidity % using a sling psychrometer before beginning search for animals, at the middle of the search and then when search is finished. Record both wet bulb and dry bulb temperatures, then convert to % using a table.
Froze last night. Circle one (**Yes, No** or **Unknown**).

Soil Stations (Mandatory)
Soil temperature. Record soil temperature (ºC) at 10cm below the surface at each soil station using a soil thermometer. Rrecord the average.
Soil moisture. Enter the correct code (**D** = dry by touch, **M** = moist by touch). Take this measurement under the first layer of cover.

Minutes Sampled (by Observer) (Mandatory)
Observer(s). First initial, Last name.
Start time. Record the start time for each person searching.
End time. Record the end time for each person searching.
 # Minutes. Record the length of search time for each person, in minutes.
Total Minutes Searched. Sum up the search times for all participants.

Detections (Mandatory)
Species. Record the 4-letter code for each species observed.
Stage. Record the life stage for each animal captured (**J** = juvenile, **S** = subadult, **A** = Adult).
Cover object. Record the code for the cover object each salamander was found under. (Cover types: **1** = Rock, **2** = Moss, **3** = Downed woody debris, **4** = Leaf litter, **5** = Lichen)
Substrate type. Record the code for what the salamander was found sitting on. (Substrate types: **1** = Rock, **2** = Moss, **3** = Downed woody debris, **4** = Leaf litter, **5** = Lichen, **6** = Soil).

Comments: (on back of form) Record any unusual and/or helpful information, such as a piece of equipment was not working, sudden unrecorded weather change, etc.

Attach a Topographic Map (Mandatory)
Show the suitable habitat polygon, area surveyed, location of captures of PLEL or PLST, occupied habitat.

Version 3.0

PLEL / PLST SALAMANDER SURVEY DATA FORM
FIELD VISIT INFORMATION

SITE INFORMATION (Mandatory)

Project Name: ____________________

Unit Number: __________ Site Number: __________ Visit Number: __________

Date: __________ Start Time: __________ End Time: __________

Actual Search Time (person hours): __________ Acres Searched: __________

WEATHER AND SOIL CONDITIONS (Mandatory)

Met protocol for microclimate constraints? Yes No

Sky (circle one)
Clear / Partly Cloudy / Very Cloudy

Wind (circle one)
None / Light / Moderate / Strong

	Air Temp (ºC)	Relative Humidity Wet bulb	Dry bulb	%
Start				
Middle				
End				

Moisture (circle one)
Dry / Foggy / Intermittent Rain / Light Rain / Heavy Rain

Froze last night? (circle one)
Yes No Unknown

Station Number

	1	2	3	4	5	Average
Soil temp. (ºC)						
Soil moisture (D or M)						

Observer(s) **(Mandatory)**	Start time	End time	No. minutes
		Total minutes:	

Stage	Cover / Substrate
J = juvenile	1 = rock
S = subadult	2 = moss
A = adult	3 = DWD
	4 = litter
	5 = lichen
	6 = soil

DETECTIONS (Mandatory)

Species	Stage	Cover Object	Substrate	Species	Stage	Cover Object	Substrate

Attach topo map that shows the suitable habitat, area surveyed, and location of occupied sites.

Chapter V

Survey Protocol for the Del Norte Salamander (*Plethodon elongatus*)

Version 3.0

OCTOBER 1999

Lisa M. Ollivier
Hartwell H. Welsh, Jr.

AUTHORS

LISA M. OLLIVIER is a research wildlife biologist, USDA Forest Service, Pacific Southwest Research Station, 1700 Bayview Drive, Arcata, CA. 95521.

HARTWELL H. WELSH, JR. is a research wildlife biologist, USDA Forest Service, Pacific Southwest Research Station, 1700 Bayview Drive, Arcata, CA. 95521.

ABSTRACT

Surveys to detect the presence of the Del Norte salamander are needed on federal lands when proposed management activities may affect Del Norte salamander populations or their habitat. This protocol is recommended to standardize survey efforts for species-detection on federal lands. State regulations must be recognized; this species is protected in California and Oregon. State permits are needed prior to survey for these animals in California and Oregon. Surveys are conducted only in potential habitat for the species when such habitat occurs in or adjacent to proposed project areas that occur within the Survey Zone for the species. Surveys must occur from late fall to late spring under restricted environmental conditions (ambient temperature between 4.5-25 ^{o}C, soil temperature between 4.5-20 ^{o}C, relative humidity 45% or greater, no freezing 48 hours prior to survey, with a high elevation exception in California). The preferred survey period is spring, at least one site visit must be conducted during the preferred spring survey season. The minimum search effort for any site is four person hours per ten acres of habitat. The search method involves systematic searching of the suitable habitat in order to ensure complete coverage of that habitat. If Del Norte salamanders are not found, a total of three complete surveys of the habitat are conducted. Site visits must be at least ten days apart. Presence is confirmed when one or more Del Norte salamanders are found.

Version 3.0

TABLE OF CONTENTS

INTRODUCTION

This survey protocol was developed in response to the Record of Decision for the Northwest Forest Plan (USDA and USDI 1994) for determining the presence of the Del Norte salamander, *Plethodon elongatus* (PLEL), on federally owned and managed lands. It provides the conceptual framework and steps to conduct surveys in areas where proposed projects have the potential to affect PLEL populations and habitat.

Before initiating surveys, read this entire document and its companion (Chapter I), which addresses general information and guidelines for the Survey and Manage amphibians. Knowledge of the basic biology and management guidelines for this species (Olson 1999) will facilitate an understanding of the survey procedures.

Main Revisions and Clarified Procedures

This protocol is revised from the 1996 draft protocol (Olson et al. 1996). The list below summarizes the main revisions and clarified procedures specific to Del Norte salamander surveys. Revisions have resulted from new information, and extensive review comments provided by agency executives, managers, field specialists, species-experts, and non-agency scientists. Revisions are for clarification, to refine procedures for optimizing sampling, but do not significantly alter survey effort compared to the 1996 draft protocol.

- **Flexible and fixed survey elements are clarified**
- **Survey triggers are defined and are discretionary**
- **Adjacent area survey distances are more discretionary, rather than 180 m**
- **Photographic plates of animals are included to aid species identification**
- **Photographic plates of habitats are included to aid habitat identification**
- **Summary of known site record compilation is included (Chapter II)**
- **Maps of known site locations (Figure V.1), with various coverages (Chapter II)**
- **Revised Survey Zones**
- **Revised Data Forms**
- **Range has expanded in response to federal survey effort detecting new sites**
- **More complete habitat description provided**
- **Expanded seasons, including winter and late spring if conditions warrant**
- **No surveys should occur if there has been freezing within previous 48 hours (rather than 24 hrs), with a high elevation exception in California**
- **Air relative humidity for surveys remains at a minimum of 45%**
- **Minimum air temperature for surveys was lowered to 4.5ºC, from 9ºC**
- **At least 1 of 3 site visits must be conducted in the spring**
- **10+ day survey interval (instead of 21 days)**
- **Search route is discretionary**

Survey Requirements

The USDA and USDI (1994; Table C-3, p. C-59, C-28) states that PLEL is a Component 2 species under the Survey and Manage provision, and is a Protection Buffer species. Component 2 direction is to "survey prior to proposed activities and manage known sites," while Protection Buffer guidelines state "Additional mitigation options in this upland matrix include identifying locations (talus areas inhabited by the species) by using a standardized survey protocol, then protecting the location from ground-disturbing activities." The guidelines of this chapter present the parameters and procedures for triggering and conducting a survey to meet the requirements for federal land management activities. Surveys are conducted to determine if the species is present at the site. If a detection of the target species occurs, the surveyors may terminate the search.

State Regulations--The states of Oregon and California have requirements for both the handling and collecting of these animals. Capture and handling is necessary to identify these salamanders, thus the following regulations are to be followed. In Oregon, PLEL is a State Sensitive species, listed in the Vulnerable category, and considered Protected wildlife (OAR 635-44-130). A permit from the Oregon Department of Fish and Wildlife is required to capture or take this species.

In California, PLEL is a Species of Special Concern and a scientific collecting permit from the California Department of Fish and Game (CDFG) with an additional letter of permission is required for handling this salamander. Scientific collecting permits and letters of permission should be applied for well in advance of the survey date to ensure they arrive before the onset of the field season. Surveyors will be required to summarize their captures by area at the end of the year, at which time they may apply for a new permit. One permit may sometimes cover multiple permittees, check with CDFG for permit details.

Surveyor Training–Training of field personnel is necessary prior to conducting surveys for PLEL (Chapter I). Surveyors must be able to identify PLEL and sympatric salamander species, identify PLEL habitats, understand the known ecology and behavior of this animal, and fully understand the survey procedures for standardized implementation under field conditions.

Training Requirements

Two-day training session

- **One day of lecture and species identification**
- **One day of field instruction**

Surveyor skills include

- **Ability to identify all salamander species encountered**
- **Ability to identify target species' likely habitat**
- **Knowledge of species' microhabitat associations**

- **Knowledge of species' microclimate associations**
- **Knowledge of species' surface activity patterns**
- **Knowledge of survey protocol and its implementation**
- **Knowledge of documentation procedures, dataforms and discretionary decisions**

Presence-- "Presence" is determined when one or more PLEL are detected and positively identified. If PLEL is detected, the surveyors may terminate the survey. Once presence is determined, it is assumed a population occurs at the site and all contiguous suitable habitat (see below) is managed to maintain PLEL at the site according to current guidelines (Olson 1999).

Not Detected– "Not detected" is designated if the target species is not observed after three site visits during each of which full surveys have been conducted. After the site has been surveyed three separate times with no detection of PLEL, the requirements for Survey and Manage have been met and the site would not need to be managed according to PLEL management recommendations (Olson 1999). The term "absence"is to be avoided, because it is an absolute that can not be determined after only three site visits.

GENERAL BIOLOGY AND ECOLOGY

Much of the natural history and ecology of this species is reviewed in Olson (1999). General references for identification and basic natural history include Stebbins (1985), Nussbaum et al. (1983), Leonard et al. (1993), and Corkran and Thoms (1996).

The Del Norte salamander is a patchily distributed and relatively uncommon species of terrestrial salamander endemic to northwestern California and southwestern Oregon (Leonard et al. 1993, Stebbins 1985). It was first collected in 1911 and described as a species in 1916 (Van Denburgh 1916). It is a member of the family Plethodontidae, the lungless salamanders. This genus of salamanders respire entirely through their skin and are completely terrestrial.

Although not aquatic, the Del Norte salamander is very sensitive to temperature and moisture extremes. They only occur in relatively cool, moist microhabitats. This species will move up and down through the substrate as the microclimate at the surface changes. For example the salamanders may move deep into the substrate in response to sustained freezing temperatures making detection at the surface impossible. The species is generally only surface active under very restricted microclimatic conditions. They are active only during fall, winter and spring rains. PLEL have been found when soil temperatures ranged from 2.5 - 25^o C (range sampled = 2.5-33^o C) and ambient temperatures ranged from 0.8 - 27^o C (range sampled = 0.8-31^o C; Welsh and Lind 1995; K. Raftery and K. Schmidt, pers. comm.). Ninety-six percent of all animals found during surveys from 1989 to 1998 in California were found when air temperature fell between 4.5^o C and 25^o C (n=913) and 98% of captures occurred when soil temperatures fell between

4.5º C and 20º C (n=918). High relative humidity is also an important predictor of surface activity for this species. Ninety-six percent of all animals (n=846) found during a sampling of PLEL sites in 1989 were found when the relative humidity was 45% or above (range sampled = 14-100%; Welsh and Lind 1995; K. Raftery and K. Schmidt, pers. comm.). There may be a time lag that will affect how fast the animals will respond to changes in microhabitat conditions at the surface. Sustained harsh and unfavorable conditions may cause them to fail to respond quickly to good surface conditions and it may take up to 2-3 days for them to become surface active.

Species Identification

An adult PLEL is distinguished by having a modal number of 18 costal grooves (range 17 - 20) and 6.5 - 7.5 intercostal folds between adpressed limbs (Nussbaum et al. 1983, Corkran and Thoms 1996). Del Norte salamanders are the longest-bodied of the western Plethodontids (approximately 12-77mm SVL). Adults have a dark background color of dark brown, gray or black (Plates V.1-2). Flecking may occur on the sides and occasionally on the dorsum. Adults may show a faint copper dorsal stripe. Juveniles have a distinct copper dorsal stripe, other coloration is similar to adults. In the "contact zone" with the Siskiyou Mountains salamander, *Plethodon stormi* (PLST, see Survey Zone, below), PLEL has been found with 6.0 intercostal folds between adpressed limbs (L. Ollivier, pers. obs.). Surveyor training is needed to be able to identify this animal.

Range

Currently this species is known in southwestern Oregon and northwestern California (Figure V.1). It occurs in Del Norte, Humboldt, Trinity, and Siskiyou counties in California and Coos, Curry, Douglas, and Josephine counties in Oregon. The known range of the Del Norte salamander has grown since 1993 and the onset of federal surveys under the Survey and Manage provision (see Chapter II, Figures II.3 and II.8). This species has been found from sea level to 1570 m in elevation.

Habitat

Welsh and Lind (1995) described the habitat of PLEL as older forests with a closed, multi-storied canopy (composed of both conifers and hardwoods), with a cool moist microclimate, and rocky substrates dominated by cobble-sized pieces.

Habitat:

- **Forested rocky soils (i.e. rock on rock)**
- **Rock outcrops**
- **When rock is not present, PLEL in coastal redwoods use down wood for cover and substrate**
- **Exposure, vegetation, slope, and aspect may vary**

Welsh and Lind (1995) characterized the optimum habitat for PLEL as older forests with a closed, multi-storied canopy (composed of both conifers and hardwoods) with rocky substrates dominated by cobble-sized pieces. Del Norte salamanders occur in surface and subsurface forest microhabitats. Abundances are significantly higher in late-successional forest, densities can approach 0.6 animals per square meter. Canopy closure is typically high on occupied sites, the average canopy of 30 known sites sampled in 1989 for this species was 72.5% (range 2-98%) (Welsh and Lind 1995).

In inland sites the Del Norte salamander is considered a surface rock obligate, and has rarely been found far from surface rock deposits or fissured rock outcrops (Plates V.3-6) (Welsh and Lind 1995, Nussbaum 1974). Nussbaum et al. (1983) reported that talus depths in occupied habitat of the Siskiyou Mountains salamander, a closely related species to PLEL, ranged from 0 - 45.7 cm deep. In the coastal redwoods this species has been found using downed woody material in areas where rock is sparse (L.Ollivier, pers. obs.). Sites occupied by PLEL generally have layered rock substrates with at least some cobble-sized rock that serve as cover objects. Because of this species' physiological requirements (e.g. respiration through the skin), the species is typically found in rocky substrates deep enough to retreat into environmental conditions warrant. During periods of surface activity this species may occasionally be found under bark or logs in association with surface rock. Surveyor training is needed to recognize the range of habitat conditions suitable for this species.

SURVEY PARAMETERS

Triggers

Survey triggers identify when surveying is needed for this species. Triggers are land management activities or proposed projects that result in surveys because they may adversely affect these animals or their habitats.

Trigger Criteria--Surveys for PLEL are triggered when the proposed activity:

1. **is within the range of the Northwest Forest Plan, and**
2. **is within the Survey Zone for the species, and**
3. **is in an area in which there is suitable habitat for the species, and**
4. **may affect animals directly or indirectly by degrading (altering) habitat.**

Ground-disturbing activities, in addition to some other types of forest management practices and land uses, could severely compromise these animals, which occur in the surface layer of forest substrates. Adverse effects on surface microhabitats are the specific concern. Surface microhabitat conditions important for these plethodontid salamanders include the three-dimensional physical structure of the substrate and surface cover features, and microclimate (e.g., temperature/moisture regime). Concerns for management include maintenance of the integrity of substrate interstices, and cool, moist surface regimes. Proposed management activities that degrade these habitat elements are triggers.

Activities with little or no ground-disturbance may affect microhabitats, microclimates, and the animals. For example, forest canopy removal by aerial techniques may affect forest floor microclimates. Chemical applications may affect animals directly by creating inhospitable habitats. Some chemical applications (e.g., pesticides) may affect amphibians indirectly by impacting their prey-base.

Trigger Decision Process – Land management activities should be evaluated on a case-by-case basis as to whether or not they represent triggers . The above four criteria should be evaluated to make this management decision. Site managers are expected to have the greatest discretion with regard to the last criterion, "does the proposed project adversely affect the habitat conditions for PLEL, or the animals themselves?" Site conditions or project implementation may affect whether a particular activity is a trigger.

Activities that May Not Trigger Surveys--Surveys may not be triggered for activities that are determined to have low potential to effect this species or it's habitat. This may include activities that do not adversely affect: 1) integrity of surface/subsurface interstices, 2) surface cover features that may be important refugia, and 3) the microclimatic regime in likely habitat. A change in habitat is not necessarily an adverse effect on habitat, and this distinction should be evaluated. Direct and indirect effects on the animals and their habitats should be considered. Thus, not all ground disturbing activities may trigger surveys in potential habitat. For example, if a particular activity does not affect microhabitat conditions and it is timed so that the activity occurs when the animals are not surface active (e.g., during dry, summer months), and thus not expected to affect the animals themselves, the activity may not trigger surveys.

Specific examples of triggers and non-triggers include:

A. Most proposed timber management activities, including thinning, regeneration harvest and salvage would trigger surveys. These activities will likely affect habitat through the reduction of canopy and high levels of substrate disturbance.

B. Road construction or reconstruction would trigger surveys, routine road maintenance would not trigger surveys. Road construction and reconstruction can involve high levels of substrate disturbance and removal of overstory. Routine maintenance typically involves only those activities within the already disturbed road prism.

C. Recreational development, such as campground creation or expansion would trigger surveys, routine maintenance would not trigger surveys. Development or expansion of recreational sites can involve overstory reduction and substrate disturbance, while maintenance only involves work in previously disturbed sites.

D. Most mining activities, including new rock source development would trigger surveys. Rock removal at existing rock sources would not trigger surveys if no outward expansion of the site occurs and if activities are conducted when the animals are not active at the surface (1 June - Sept. 30). Existing quarries are highly disturbed sites and are usually occupied seasonally by the animals. The seasonal restriction reflects that time when the animals are unlikely to occupy the site and activities conducted at this time will avoid direct impacts to individual animals.

E. Chemical applications (e.g., pesticides, herbicides, fertilizers) within suitable habitats would trigger surveys. Surveys would not be triggered if applications are proposed within plantations less than 30 years old. Plantations are disturbed sites that generally do not provide suitable habitat due to low canopy closure and disturbed substrate and likely have not been re-colonized by the species.

F. Prescribed fire as necessary for reduction of fuel loads and to remove slash after felling operations would not trigger surveys if burning was conducted with a cool under-burn, such that 50% of the duff layer, most large woody debris would be left intact, and there was no net loss of canopy. This species has evolved with fire and fire effects do not generally extend into the substrate. Some individuals active at the surface may be directly impacted, this is reduced by burning in late spring and summer. Creation of tractor lines is not proposed as a fire exemption.

G. Road decommissioning - Surveys of roads would not be triggered for road decommissioning as it is unlikely the substrate affected within the road prism during decommissioning would be suitable habitat for the species.

H. Replanting and timber stand improvement (pre-commercial thinning) of plantations less than 30 years old would not trigger surveys. Plantations are disturbed sites that generally do not provide suitable habitat due to low canopy closure and disturbed substrate and likely have not been re-colonized by the species.

I. Hazard tree removal of single trees and clearing blow-down from roads would not trigger surveys. This type of activity has low potential to impact PLEL habitat.

J. Seeding of native species of grasses or plants would not trigger surveys. This type of activity has low potential to disturb PLEL habitat.

K. Construction or reconstruction of fences would not trigger surveys unless the construction would lead to increased disturbance within PLEL occupied habitat, such as might occur with livestock collection devices.

L. Special forest products: proposed removal of talus for flagstone or burl harvest would trigger surveys because of the potential for disturbance to PLEL substrate. Surveys would not be triggered for removal of forest products such as mushrooms, bear grass, fir boughs, and Christmas trees because of the low potential for disturbance to PLEL habitat.

M. Surveys would not be triggered for removal of small infestations of noxious weeds by hand pulling or digging because of the low potential for disturbance to PLEL habitat.

N. Areas proposed for concentrated wood cutting would trigger surveys due to the potential for canopy reduction, substrate disturbance, and impacts to microhabitat. Dispersed (single tree) wood cutting would not trigger surveys as this type of activity has a low potential to disturb substrate or reduce overall canopy within PLEL habitat.

The above list of examples is not an exhaustive list. If a special case arises and the survey procedures do not appear applicable, full documentation should accompany management decisions.

Adjacent Area Surveys

Adjacent area surveys are needed if potential habitat is identified next to a project and the proposed project could result in degradation of the microhabitat and microclimate conditions for salamanders in those adjacent areas. Surveys of areas adjacent to proposed site-disturbing activities should be considered on a case-by-case basis. Depending on site conditions and potential effects to habitat and microclimate, there is discretion when determining the width of adjacent area to survey. Effects on microclimates (e.g., edge effects, Chen et al. 1995), microhabitats, and slope stability should be considered. Recommended distances for adjacent area surveys are provided in Table V.1. The adjacent area widths are cross-referenced to the management recommendations for the species so that the survey area matches to the corresponding management recommendations in the companion management document (Olson 1999). A qualitative analysis should be conducted and documentation of the decision should be provided (see also Chapter I).

Justification for not surveying in adjacent areas may be considered under circumstances that are not expected to affect potential PLEL or their habitats adjacent to activities. In particular, not surveying within adjacent habitat might be considered when: 1) there is no adjacent area ground disturbance expected that would cause salamander mortality; and 2) proposed activities are not expected to alter adjacent area microclimate or microhabitat conditions. For example, although trail construction may be a trigger of surveys along the trail alignment, adjacent areas along proposed trails would not require surveys if adjacent area microclimates remain unaffected (e.g., no timber felling resulting in dominant canopy cover reduction is involved) and if adjacent area microhabitat will remain intact (e.g., blasting is not conducted).

Table V.1: Adjacent Area Survey Width Recommendations (Chen et al. 1995).

Management Activity	Disturbance Parameters	Disturbance Intensity	Recommended Adjacent Area for Survey *
Trail construction	Tread 0.6-1.3m, linear disturbance only	Low	0m, survey trail route only
Road	Roadbed 2.5-5.2m	Moderate	10-30m on either side of road center line
Timber Harvest	Thinning >70% retention	Moderate	0-60m, depending on site conditions
Timber Harvest	Thinning <70% retention	Moderate-high	0-120m, depending on site conditions
Timber Harvest	Regeneration harvest, 0-15% retention	High	120-240m, depending on site conditions
Mining/Quarries	Expansion/new quarries	High	60-80m, depending on site conditions
Recreational Development	Expanded or new facilities	Moderate	0-60m, depending on site conditions

*** These widths are intended only as suggested guidelines and site-specific conditions will determine actual adjacent area survey widths.**

Examples of projects that trigger and do not trigger adjacent area surveys are:.

1. Regeneration timber harvest and most forest density management projects would trigger adjacent area surveys. These projects could degrade habitat in adjacent areas through microclimate edge effects and potential loss of substrate integrity.

2. Road construction and reconstruction may trigger adjacent area surveys. These projects may degrade habitat in adjacent areas through microclimate edge effects and substrate integrity effects.

3. Recreational development, such as campground development or expansion may trigger adjacent area surveys. These projects may degrade habitat in adjacent areas through reduction of surface cover from firewood collection, increased disturbance to habitat due to dispersed recreation activities, and microclimate edge effects if canopy if removed.

4. Trail construction would likely not trigger adjacent area surveys. If canopy is not to be removed for creation of the trail, microclimate would not be effected.

Site Location

Survey Zone**--**The entire geographic area where surveys are required for PLEL is termed the Survey Zone (Figure V.1). It includes the known range and a bordering area of 25 miles radius from the edge of the known range, except in the PLST/PLEL shared area in California and PLST/PLEL contact zone in Oregon (see below, Figures V.1 and V.2). This shared area arises as a result of extensive federal surveys since 1993. Further adjustments to the survey zone boundary may be made annually as new information on the actual range of the species becomes available. The edges of the range for PLEL have not been fully mapped and may change as surveys increase the number of known sites.

In California, in the Klamath River area of contact between the two species, PLST and PLEL, there will be a “shared” Survey Zone (Figure V.1 and V.2). Within this Zone, surveys are to be conducted only until one of the two species is detected. Whichever species is detected first will determine management guidelines. For species determination, PLST has 4-5.5 costal folds between adpressed limbs, while PLEL has 6-8 costal folds between adpressed limbs.

Shared survey zone: The shared zone extends south along the western watershed boundary of Thompson Creek from the Oregon/California border to the confluence of Thompson Creek and the Klamath River. It continues across the Klamath River at China Point to the Humboldt/Mt. Diablo Meridian. It continues south on the meridian to the Scott/Salmon River boundary at North Fork Camp. It follows northeast along this boundary to Anthony Milne Camp, goes due north along this line to the headwaters of Grider Creek at the Oak Knoll/Scott River District boundary. It extends north along Grider Creek to the confluence of Grider and the Klamath River. It follows northwest along the Klamath River to the Happy Camp/Oak Knoll District boundary. It goes northwest along this line to the Oregon/California border.

In Oregon, along the PLST/PLEL contact zone, the eastern PLEL Survey Zone boundary is also the westward Survey Zone boundary of PLST (Chapter IV). This portion of the Survey Zone extends north from the Oregon/California border at the Applegate/Illinois Valley Ranger District boundary, along the Applegate District boundary until it bisects the western boundary of the Thompson Creek watershed. The Zone continues north along the watershed boundary to the confluence of Thompson Creek and the Applegate River. It then continues northwest along the Applegate River to the Jackson/Josephine County line. It continues north along this county line to Interstate 5.

Survey Area--Within the Survey Zone boundaries, the Survey Area includes PLEL habitats potentially affected by the proposed activity. Surveys may be triggered if appropriate habitat is found at or adjacent to a site proposed for ground-disturbing activities and the proposed activity triggers a survey (Figure V.3).

Habitat is described above. Generally, this species is found in forested situations with rocky substrates and is considered a rocky substrate obligate. The site to be surveyed for PLEL should include appropriate habitat in the form of surface and subsurface rock. Sites occupied by PLEL generally have layered rock substrates with at least some cobble-sized rock that serve as cover objects. Discrete pockets of habitat that are greater than 75m apart (edge-to-edge with no intervening habitat) should be considered separate and would require separate surveys. If sites are within 75m of each other, they can be considered to be part of the same survey.

Survey Timing

Seasons--Surveying for animals must occur during the appropriate months: generally late fall through late spring. This time period includes the fall and spring rainy seasons (see below). Spring usually offers a longer period of time with appropriate conditions for surveying, this is the preferred survey season. Areas of high elevation (generally above 5,000 ft, 1524 m) may not be free of snow late spring and may be surveyed at a later time if environmental and substrate conditions are met.

Number of Site Visits– Each site must be visited a total of three times over the course of the spring or fall rainy seasons (see environmental conditions below) unless presence is established. At least one site visit must be conducted during appropriate microclimatic conditions in the spring.

Intervals Between Site Visits--Site visits must be separated by at least 10 days. Preferably, site visits will occur at least every 10 days, although weather events may cause longer periods to pass between site visits. With this interval, it is possible to complete a survey effort within a single survey season. However, attention must be paid to environmental conditions that constrain surveys which are described below.

Survey Effort–Search effort must to be a minimum of four person-hours per ten acres of suitable PLEL habitat. As an example, a twenty acre area of habitat would require a minimum of eight person-hours of survey time for one visit. A crew of four surveyors could complete this in two hours time.

Environmental Conditions

The activity patterns of PLEL are highly dependent on local environmental factors such as relative humidity and temperature. These factors must be taken into careful consideration in determining when to survey for these animals. The following conditions must be met before surveying may proceed:

Air Conditions-- The air temperature and relative humidity must meet the following criteria. Relative humidity must be a minimum of 45%. At potential sites surveyed for PLEL, the air temperature must fall between 4.5-25 ºC (L. Ollivier, pers. obs.). In addition, freezing temperatures cannot have occurred at the site within 48 hours prior to the site visit.

However, on federal lands in California, sites above 4,500 ft (1372 m) may be searched without the freezing provision. In this area only, it may lightly freeze the night prior to survey. This expanded window of environmental conditions pertains only to this area because normal protocol conditions could not be met at these sites and data have been compiled from this region showing that PLEL have been somewhat surface-active after light freezes (approximately -2 ºC on the night prior to survey). If multiple site visits are necessary to these California high elevation sites, at least one site visit must occur with the low elevation freezing provision: no freezing at the site within 48 hours prior to the site visit. Use of Reference Sites is strongly recommended for these high elevation areas.

Soil Conditions-- The soil temperature and moisture must meet the following constraints. The soil temperature, taken 10 cm below the surface, must fall between 4.5-20ºC. As a qualitative measure of soil moisture, soil below the first layer of rock within the area being searched must be moist to the touch. The substrate below the first layer of rock within the area to be searches must be moist to the touch.

Reference Sites

These salamanders are highly sensitive to local climate shifts. Freezing temperatures at a site during the night prior to a site visit may cause the salamanders to retreat down into the rock substrates, rendering them undetectable by the search technique. When possible, we recommend the use of reference sites to determine if these animals may be active on a given day near the site to be surveyed. A reference site may be a historic site or even a road cut with the appropriate microhabitat that supports a population. A reference site should be located in the same subdrainage and at or near the elevation of the survey site to be informative about potential salamander activity on the survey site. If no individuals are found at the reference site, it is likely that environmental conditions are not suitable and salamander surveys will not be effective and should not be conducted.

Voucher Specimens

Voucher specimens are not needed for this species, due to its status of concern and the required training of field personnel in species identification. This animal is not easily misidentified, once its key characters have been assessed. If there is doubt as to the identification of a captured salamander, local species-experts can be sought to verify the identity of the animal.

SURVEY PROTOCOL

General Guidelines

For all surveys conducted for PLEL, certain guidelines will help the surveyor know where, when, and how to survey:

a. Survey only during acceptable environmental conditions. The intent is to capture animals that are surface active, so searching deeper than the upper 10-30 cm is not necessary.

b. Portions of the Survey Area that cannot be safely searched may be omitted.

c. The search protocol is time-constrained at 4 person-hours for every 10 acres of habitat. Search until the habitat patch has been fully searched, until time is up for that search, or until the first PLEL capture.

d. All of the surveying is done in a walk and turn [surface objects], hand-search manner. Salamanders, during daylight, are usually found underneath surface objects. Carefully look under surface objects while moving across the patch of habitat. Surface objects may be items on top of the rock substrate (e.g., rock on rock or downed woody debris on rock) or may be interspersed (e.g., rock mixed with soil or leaf litter). For this protocol the “surface” is generally considered to be within the upper 30 cm of the top of the substrate. Search under moss mats and leaf litter often found covering rock substrates in addition to the first layer of rock.

e. Do not spend too much time in any one place. A maximum of 10 minutes should be spent at any specific spot, whether captures are occurring or not. At the end of this brief time, stop your timer and move to another location a few paces away. Restart your timer and resume searching. It is important to move across the substrate.

f. The walk and turn method ensures that the observers will cover the area spatially, to maximize the likelihood of capturing the target species, which may be clustered in a small portion of the Survey Area.

Survey Ethics

All surveys should be conducted in a relatively non-destructive manner. Surface objects are lifted and replaced to their original position. Hill sides should be kept relatively intact, whenever possible. Bark may be pulled off of logs, but it should be done carefully, so that it can be replaced. Logs that are moderately decayed into large chunks or splits may be separated, but again, the pieces should be replaced as best as possible. However, logs should not be completely destroyed. The intent here is not to abstain from any alteration; that would be next to impossible and would make it difficult to detect salamanders. The intent is to be conscientious about minimizing disturbance to the habitat by using a light-handed approach.

Safety Issues

Field units implementing surveys should be discretionary regarding safety issues as required by site conditions. Safety of surveyors should not be compromised to complete surveys. As such case-by-case decisions are made, managers, supervisors, and field crews should be in communication. We recommend full documentation of the rationale supporting such a decision.

Prior To Sampling

Review Survey Area--A contour map covering the specific proposed project area (e.g., forest management activity, recreational development) is needed when conducting a survey. Features such as pockets of late-seral forest, cliffs, talus, rocky substrates, and areas of steep terrain (>40%) should be delineated within the project area boundary, as these areas are the most likely to support PLEL populations. Soil type maps may also enable one to narrow the search area somewhat by keying in on specific soil types with high percentages of gravel and cobble substrates.

Location of Plot Center--The time-constrained search may begin at the plot center (i.e., the approximate center of the largest area of suitable habitat within the Survey Area). To find this location, systematically walk the proposed activity area to locate areas containing surface rock. Place plot center in the center of the area with the greatest concentration of surface and subsurface rock of searchable size (easily turned by hand), remember to replace rocks and other cover objects in original position after searching, to preserve habitat quality. Areas primarily comprised of large boulders and large outcrops are not readily sampled by this search technique. There may be more than one patch of suitable substrate within and adjacent to a proposed activity area. All of these patches of suitable habitat should be surveyed for occupancy.

Data Form Completion (see Appendix V.1)

a. Site Information, Location and Topography: Mandatory.

- Project name, unit number and site number, directions to site.
- Record estimated habitat dimensions, area, and minimum search time.
- Record Township, Range, Section, quarter section, latitude and longitude.
- Locate site on a copy of a 7.5 min. topographic-map and attach to data form.
- Record elevation (m).
- Record ownership (Forest service (NF, RD), BLM district, RA), non-federal).
- Record slope and aspect.

b. Time and Date: Mandatory.

- At the time of site entry, record military time.
- Record date (Month, Day, Year)

c. Observer/s name/s: Mandatory.

d. Weather (record and measure at plot center prior to searching): Mandatory.

- Sky = **C**lear, **P**artly cloudy, **V**ery cloudy
- Moisture = **D**ry, **F**oggy, **I**ntermittent rain, **L**ight rain, **H**eavy rain
- Wind = **N**one, **L**ight, **M**oderate, **S**trong
- Air temperature (ºC) - alcohol, mercury, or digital thermometer
- Air relative humidity (%) - psychrometer

* Air temperature and relative humidity should be taken three times during the survey, at the beginning, middle, and at the end of the survey. If environmental conditions go outside of parameters for survey at any time during the survey, terminate the survey.

e. Soil Temperature and Moisture: Mandatory

Five measurements of these variables are needed to validate survey conditions at the beginning of the survey period. Compare the **average** of the five measurements to the environmental constraints listed above. If soil and substrate conditions are not within the bounds previously outlined, surveys should not be conducted. The sites for the measures are located as follows:

Site 1. Locate center of plot to be surveyed. Measure soil temperature and humidity (also canopy closure, see below).

Sites 2-5. Stand at plot center. Measure 15 m in each of the 4 cardinal directions (N, S, E, W) to locate the other four sample points. Measure soil temperature and relative humidity (also canopy closure, see below).

Measures:
- Surface temperature (^{O}C) measured 10 cm below surface.
- Soil moisture: dry by touch or moist by touch for soil and litter below the duff layer.

f. Canopy Closure: Mandatory.

Record canopy closure (%) with densiometer at each soil survey station, and average to determine overall canopy closure (see data form, Appendix V.1).

g. Suitable habitat data fields: Optional

- Dominant rock size and shape
- Cover type, record % cover by each type using codes provided on form
- Composition of canopy by species group as percent and presence/absence
- Stand age class using codes provided on form

Time-Constrained Search (TCS)

Begin searching by hand anywhere in the patch of habitat. Turn all cover objects, carefully lift moss mats, and sift leaf litter as you systematically move around the area. Expand searching across the patch of habitat using a search pattern that thoroughly covers all of the suitable habitat in the patch. One possible pattern is to search in concentric circles from the plot center (Welsh 1987). Please note: Potato rakes should not be needed or used. Searchers should move about the site, spending no more than 10 minutes searching a small area (whether captures are occurring or not). After 10 minutes of intensive searching in a small area, searchers should move a few paces away along their designated search path, and begin searching again. **When moving to a new site or handling a capture (recording information) the timer stops**. Time of search applies only to time spent actively searching for animals. Keep track of the time each observer spends searching.

If animals are captured record the following information:

- **a. Species** - four-letter code (see code sheet) determined by identification keys provided during field training. Record **all** amphibian species captured.
- **b. Stage** - juvenile/subadult or adult.
- **c. Capture location** - for Survey and Manage species, mark and map the site. Describe both cover and substrate of captures (what is the animal in, on, and under?). Cover objects and substrate types are provided on data form.

All captures are to be released as close to the original capture location as possible. While searching, attempt to return rocks and other large cover objects back to original positions. Replace moss mats, where possible. When an individual PLEL is found, searching can be stopped (record time), "presence" is designated, the entire habitat patch is designated occupied (see below), and the habitat becomes a known site and is entered into the known site database.

Site Delineation

Once PLEL is detected, the first detection location will become the “site” for the Known Site Database (i.e. point locality). To delineate a PLEL site for known site management, all suitable surface rock habitat, as determined by a qualified biologist, that is contiguous with an occupied site should be considered occupied. The full extent of the occupied suitable habitat should be identified and managed as described in the Management Recommendations (Olson 1999). If patches of suitable habitat are separated by no more than 75 meters, then the additional patches should also be considered occupied. If there is doubt as to the occupancy status of suitable habitat near a known site, survey the site using this same survey protocol. This may include contiguous rocky habitats. Unoccupied habitats may be identified by additional surveys to further delineate sites. The potential ecological value of contiguous but possibly currently unoccupied habitat (in regard to desired future conditions, population dynamics, and connectivity) should be considered. Conservative measures are recommended when dealing with this type of rare endemic vertebrate species.

Survey Season Review

Annually, a joint meeting of all parties that have conducted surveys is recommended. Sharing of new sites may affect decisions for sampling and survey zone adjustments in subsequent years. It is recommended that PLEL survey and management procedures be reviewed at regular intervals. During reviews, field units should assess: 1) adherence to State and Federal standards and guidelines (e.g., renewal of permits, changes in survey protocols, training needs); 2) impacts to animals and habitats; and 3) new information available on this species and its management/protection. All field data should be retained at the field units.

OPTIONAL SAMPLING

Surveys Beyond First-Detection

From a biological standpoint, continuing surveys beyond first-detection is preferred because more information is collected that may be useful later. Continuing surveys can address whether a lone individual or a population of animals has been detected, if a potential boundary of a population has been found or if specific conditions have triggered salamander surface activity. Such optional surveys will enable a more meaningful estimate of relative abundance to be made. However, it is realized that if a detection is all that is needed to establish a population, then the survey can be completed as soon as one verifiable specimen is obtained. There are several options for continuing surveys:

One Survey Hour-- Completing one additional survey hour after the target species has been detected may be a minimal additional effort to assess whether a population of animals has been detected.

Complete the Survey Day or Site Visit-- The more time and area covered during a survey will provide more information about the PLEL population. Completing the surveys planned for that day or site visit may provide critical information as to the relative importance of that habitat in relation to neighboring sites.

Supplemental Habitat Characterization

To streamline surveys, the survey protocol includes collection of few habitat data. To fill knowledge gaps concerning identification of suitable habitat for this species, additional habitat information is needed. A more detailed site characterization is strongly recommended, particularly macrohabitat elements such as forest stand structure and composition (e.g., canopy), and substrate conditions. These data fields are on the data form and it is encouraged that units fill out these fields.

Supplemental Searches

Supplemental searches might prove to be a quick and inexpensive way to detect a target species, if it occurs at a site. Supplemental searches are completely optional, but are not recommended for use as a standardized protocol. Supplemental surveys may be used as proposed project areas are being prioritized and general field reconnaissance of habitats is being conducted. The following are suggestions for supplemental searches. An important note about supplemental searches is that they should be nondestructive, and specifically should not compromise the efforts of protocol searches. These types of surveys would only count as an official site visit if animals are found and all data are collected to protocol.

Opportunistic Searches-- An opportunistic search is done anywhere, anytime, by any method. It usually translates into “just going out and looking.” However, it is recommended to document the time and/or area of effort (or preferably both). Use of a reference site is recommended under these conditions.

Off-season searches--Although the best time to survey is late fall to late spring, and spring is preferred, it may be possible to encounter PLEL outside of this time-window if conditions are conducive.

Searching During Marginal Conditions-- The need for good environmental conditions has been stressed for protocol surveys, but it is possible to find the target species when conditions are marginal (however, fewer PLEL are expected to be detected). This type of survey may be done if the crew finds less than adequate conditions upon arrival at a site. Use of a reference site is recommended under these conditions.

DOCUMENTATION OF SURVEY DECISIONS

Due to the discretionary nature of several survey elements (triggers, adjacent area distances), supporting rationale for case-by-case decisions is recommended to accompany activity proposals. In particular, if variance in survey procedures is implemented, the rationale should be documented and a qualitative assessment of the change in Type II error conducted (i.e., risk of not detecting the target species when it is in fact present at a site). Relative to triggers, such rationale should include statements regarding the 4 trigger criteria, listed above. For the fourth criterion, statements should be included regarding the anticipated impacts of the project on: 1) the animals themselves; and 2) habitat conditions (e.g., structure, microclimate). The record of the adjacent area decision rationale should be distinct from the project area trigger decision rationale. Likewise, decisions to survey should be documented separately from decisions on how to manage sites.

Recommendations for Documentation

- **Rationale for trigger decisions should be documented.**
- **Rationale for trigger decisions should be separate from management recommendations.**
- **Rationale for adjacent area survey decisions should be documented separately.**
- **Rationale for any variance to protocol should be documented, with a qualitative assessment of changes to risk of Type II error.**

ACKNOWLEDGMENTS

I would like to thank all the members of the Amphibian Subgroup of the Survey and Manage Team, especially Deanna Olson for her support, editorial comments, and endless hard work on this project. Thanks to Rich Nauman for the known site database, distribution and range maps, and to Bill Leonard for the wonderful photographs of the species. Thanks to all of the various field crews who have worked with this species over the last several years.

REFERENCES

Chen, J.; Franklin, J.F.; Spies, T.A. 1995. Growing season microclimate gradients from clearcut edges into old-growth Douglas-fir forests. Ecological Applications 5: 74-86.

Corkran, C.C.; Thoms, C. 1996. *Amphibians of Oregon, Washington, and British Columbia: a field identification manual.* Redmond WA: Lone Pine Publishing. 175 p.

Leonard, W.P.; Brown, H.A.; Jones, L.L.C.; McAllister, K.R.; Storm, R.M. 1993. *Amphibians of Washington and Oregon.* Seattle WA: Seattle Audubon Society. 168 p.

Nussbaum, R.A. 1974. A report on the distributional ecology and life history of the Siskiyou Mountains salamander, *Plethodon stormi*, in relation to the potential impact of the proposed Applegate Reservoir on this species. Unpublished Report to the Army Corps of Engineers, Portland Division, Portland, Oregon. 70 p.

Nussbaum, R.A.; Brodie, E.D., Jr.; Storm, R.M. 1983. *Amphibians and reptiles of the Pacific Northwest*. Moscow, ID: University Press of Idaho. 332 p.

Olson, Deanna H. (ed.) 1999 (in review). Management recommendations for Component/Strategy 1 amphibian species. Portland, OR: Special Interagency Publication, Regional Ecosystem Office.

Olson, D.H. (ed.); Applegarth J.; Bury, R.B.; Clayton D.; Crisafulli, C.; Jones, L.L.C.; Ollivier, L.; Welsh, H.H., Jr. 1996. Survey protocols for Component/Strategy 2 amphibians. Portland OR: Special Interagency Publication, Regional Ecosystem Office, Survey and Manage species. 73 p.

Stebbins, Robert C. 1985. *Peterson field guides: Western amphibians and reptiles.* Boston, MA: Houghton Mifflin Co. xiv + 336 p.

U.S. Dept. Agriculture, Forest Service; U.S. Dept. Interior, Bureau of Land Management. 1994. Record of Decision: for amendments to Forest Service and Bureau of Land Management planning documents within the range of the northern spotted owl. [place of publication unknown]. 74 p. [plus attachment A: Standards and Guidelines: for management of habitat for late-successional and old-growth forest related species within the range of the northern spotted owl].

Van Denburgh, John. 1916. Four species of salamanders new to the State of California, with a description of Plethodon elongatus, a new species, and notes on other salamanders. Proceed. Calif. Acad. Sci. [4th series] VI(7):215-221.

Welsh, Hartwell H., Jr.; Lind, A,H, 1995. Habitat correlates of the Del Norte salamander, *Plethodon elongatus* (Caudata: Plethodontidae), in northwestern California. J. Herpetology. 29(2): 198-210.

Figure V.1 Known distribution of the Del Norte salamander. The heavy line represents the combined Del Norte/Siskiyou Mountains salamander survey zone. The survey zone was created using data available through 1998.

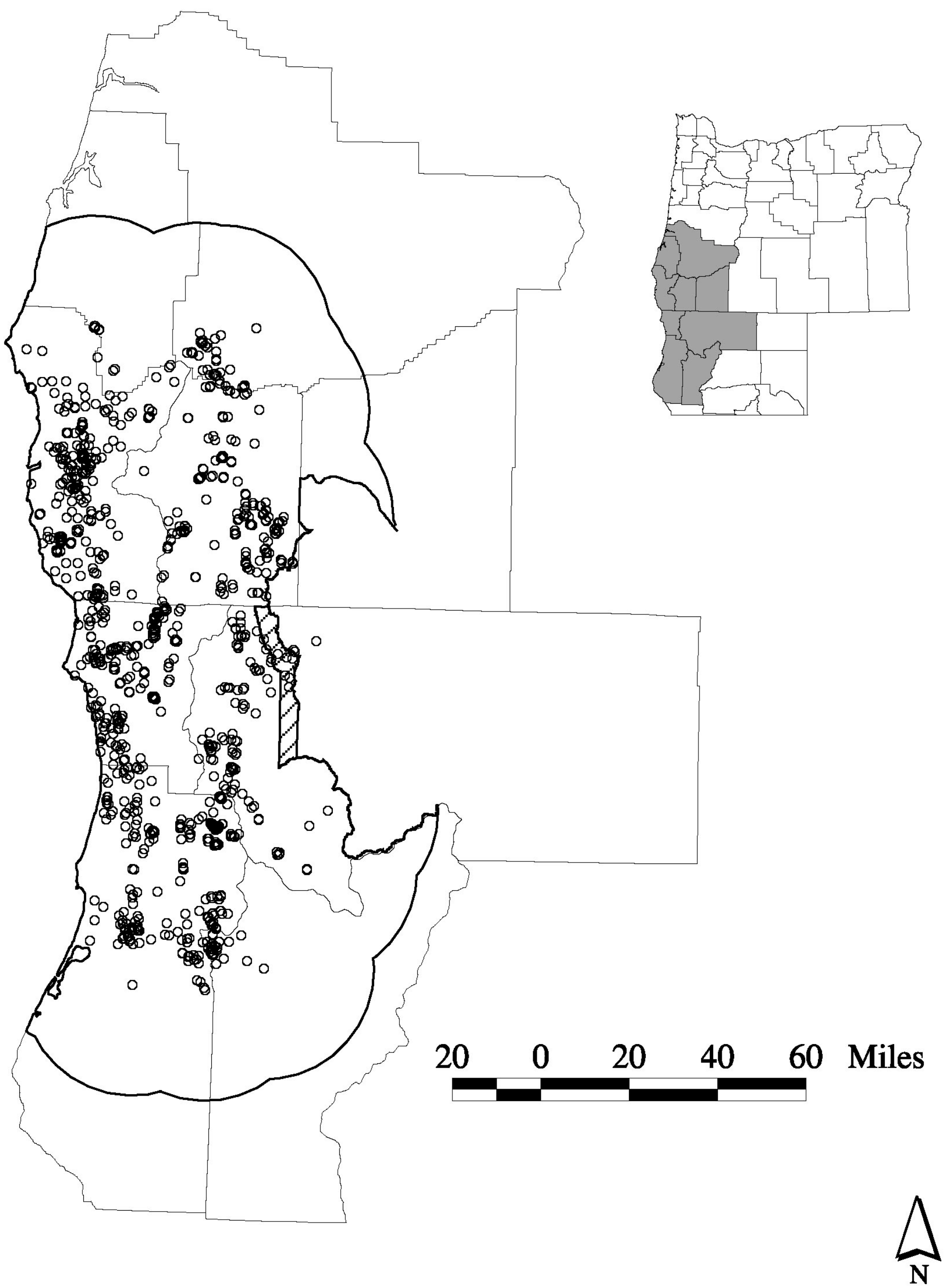


Figure V.2. Known sites of Siskiyou Mountains and Del Norte salamanders with species survey zones (heavy line) and combined species survey zone (cross hatching).

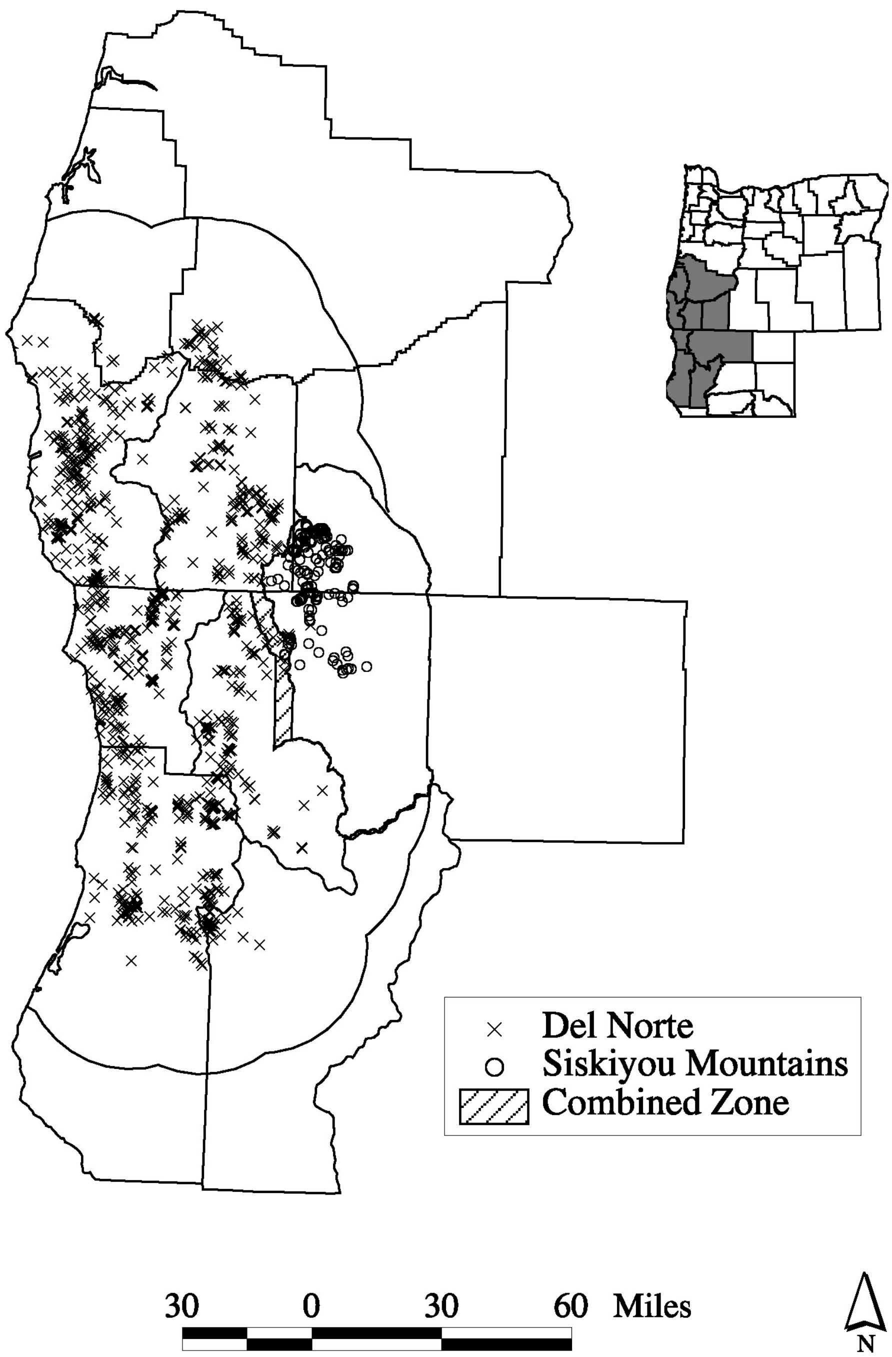


Figure V.3. Delineating the survey area. the adjacent area shown may vary in width (Table V.1).

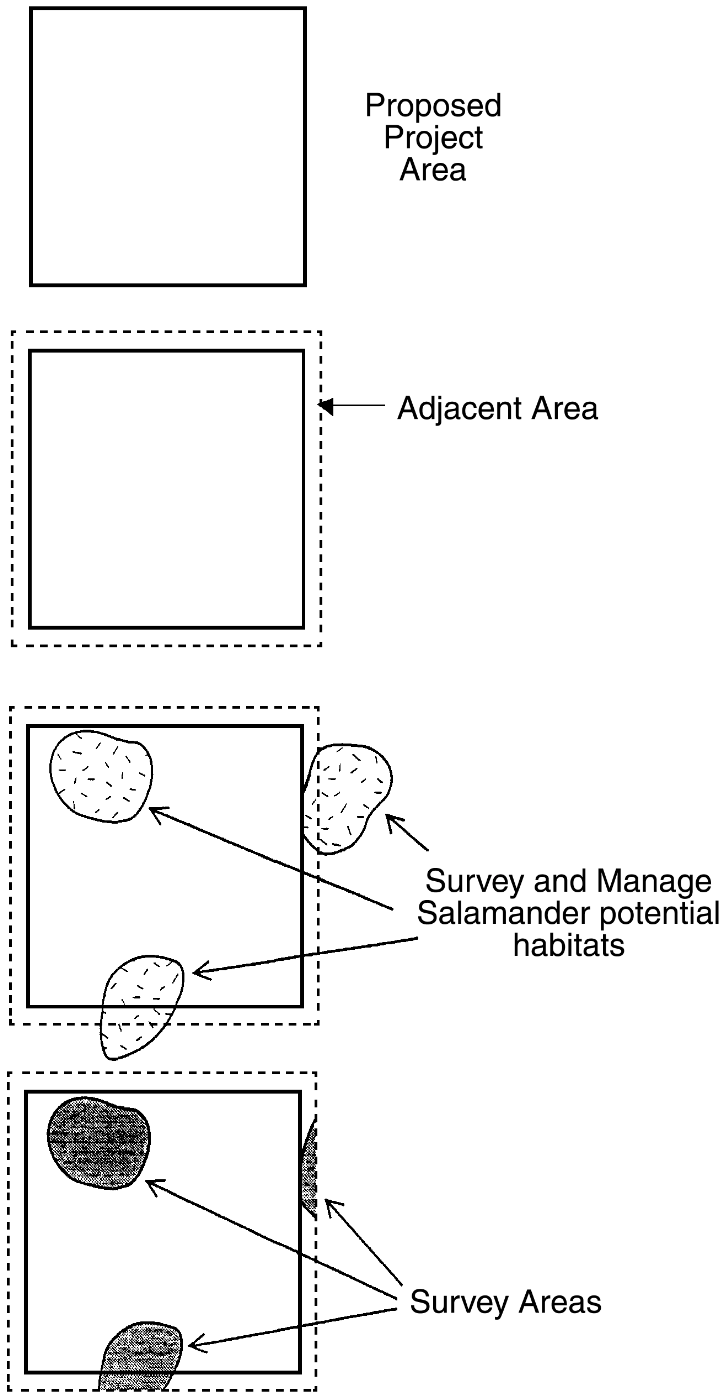


Plate V.1 Adult Del Norte salamander (*Plethodon elongatus*) (Photo by William P. Leonard).

Plate V.2 Adult Del Norte salamander (Photo by William P. Leonard).

Plate V.3 Del Norte salamander habitat (Photo by Lisa Ollivier).

Plate V.4 Del Norte salamander habitat - rock mixed with and covered by leaf litter (Photo by Lisa Ollivier).

Plate V.5 Del Norte salamander habitat (Photo by Lisa Ollivier).

Plate V.6. Del Norte salamander habitat. Close-up of habitat shown in Plate V.4. Interstitial spaces between rock filled by leaf litter and detritus. (Photo by L. Ollivier).


Plate V.1


Plate V.2


Plate V.3


Plate V.4


Plate V.5


Plate V.6

Appendix V.1: PLEL/PLST Data Forms and Instructions

PLEL / PLST SALAMANDER SURVEY FORM INSTRUCTIONS

SITE REFERENCE INFORMATION PAGE

Site Information (Mandatory)
Project Name. See list of projects for your area.
Unit Number. See project map.
Site Number. Record site number searched within the same project unit. Number the sites in chronological order.
Estimated Habitat Dimension. Record dimensions (approximate length times width, in feet or m) of habitat polygon.
Estimated Habitat Acreage. Use conversion from square feet to acres (or square meters to hectares) listed on survey form.
Minimum Search Time. Record calculated minimum search time based on estimated habitat acreage.

Location and Topography (Mandatory)
Forest. Record National Forest or BLM Resource Area name.
District. Record Ranger District or BLM District.
Legal. Township, Range, Section #, 1/4 section (NW, NE, SW, SE), 1/16 section (i.e. 1/4 section of the 1/4 section -- NW, NE, SW, SE). See quad map.
Quad #. see list of quad maps for your area.
Quad name. name of specific quad map.
Elevation. Record to the nearest meter, using an altimeter.
Aspect. Record aspect that the slope faces, using a compass (0-360 degrees).
Slope %. Record slope of the habitat patch, using a clinometer.
UTM_E. Will be added by office personnel.
UTM_N. Will be added by office personnel.
Location description. Directions to the site, describe how to get to the habitat polygon, using information such as mileage, road / spur names, topography (drainages, benches, saddles, etc.), specifying unmarked road forks, etc.

Suitable Habitat Substrate and Canopy (Canopy closure is Mandatory, other measures are Optional)
Dominant Rock Size. Circle one.
Rock Shape. Circle one. **Rubble** = round, **Slate** = flat and platy, **Mixed** = both rubble and slate.
Surface Water. Is water in the stand near search area? Circle all that apply. **Seep, Pond, Stream, None.**
Cover Type and Class. For each cover type listed, record the cover class using the codes listed on the data form.
Canopy. For each canopy element listed, circle yes or no for presence/absence and estimate % cover of habitat polygon.
Stand Age. Circle one. **Pre-canopy** = 0-30 yrs, **Young** = 31-99 yrs, **Mature** = 100-199 yrs, **Old-growth** = 200+ yrs.
Canopy closure. (Mandatory) Record canopy closure using a spherical densiometer (type B, concave not convex) at each soil station. Record amount of canopy closure (i.e. number of dots blocked out by vegetation) in each of the four cardinal directions (N, S, E, W), then average and multiply by 1.04. Then record average across all 5 sites to get average for habitat area.

Attach a Topographic Map (Mandatory)
Show the suitable habitat polygon, area surveyed.

PLEL / PLST SALAMANDER SURVEY DATA FORM
SITE REFERENCE INFORMATION

SITE INFORMATION (Mandatory)
Project Name: ____
Unit Number: ____________________ Site Number: ______________
Estimated Habitat Dimension: ________ (ft or m) X ________ (ft or m) = ________ (ft^2 or m^2)
Estimated Habitat Acreage ______________ (ft^2) X 0.00002295 = ________ (acres)
or ______________ (m2) X 0.0001 = __________ (hectares)
Minimum Search Time (person hours): __________

LOCATION AND TOPOGRAPHY (Mandatory)

Forest: ____________________ District: ____________________
Legal:T__________ R__________ section ________ 1/4 sec________ 1/16 sec________
Quad #: ________________ Quad Name: ________________
Elevation: ______________ Aspect: ____________ Slope %: __________
UTM_E: ________________ UTM_N: ________________
Location Description:_______________________________________
____
____

SUITABLE HABITAT – SUBSTRATE AND CANOPY (Optional, Except Canopy Closure)

Dominant Rock Size (circle one)

Gravel	(2-32mm)
Pebble	(33-63mm)
Cobble	(65-256mm)
Boulder	(>256mm)

Cover Type	Cover Class	Cover Codes
Surface Rock	________	0 = none
Moss	________	1 = 1-25%
DWD	________	2 = 26-50%
Litter	________	3 = 51-75%
Lichen	________	4 = 76-100%

Rock Shape (circle one)
Rubble / Slate / Mixed

Surface Water (circle all that apply)
Seep / Pond / Stream / None

Canopy (circle yes or no)			%
Conifer presence	yes	no	________
Hardwood presence	yes	no	________
Shrub presence	yes	no	________

Stand Age (circle one): Pre-canopy (0-30 yrs) Young (31-99) Mature (100-199) Old-growth (200+)

Canopy Closure % **(Mandatory)**

	1	2	3	4	5	
N	______	______	______	______	______	
S	______	______	______	______	______	
E	______	______	______	______	______	
W	______	______	______	______	______	Average Across
Average	______	______	______	______	______	Soil Stations
X 1.04	______	______	______	______	______	________

Attach a topo map that shows the suitable habitat polygon and TCS plot center.

PLEL / PLST SALAMANDER SURVEY DATA FORM INSTRUCTIONS

FIELD VISIT INFORMATION PAGE

Site Information (Mandatory)
Project Name. See list of projects for your area.
Unit Number. See project map.
Site Number. Record the site number searched within the same project unit. Number the sites in chronological order.
Visit Number. Record the visit number (1, 2, or 3) for the Project-Unit-Site listed above.
Date. Month, Day, Year
Start Time. Record the time when you arrive at plot center and begin to take habitat measurements. Use military 24-hour clock.
End Time. Record the time when you are done collecting habitat measurements or the search is complete, whichever is latest. Use military 24-hour clock.
Actual Search Time. Record total minutes searched.
Acres Searched. Record actual acreage of area searched.

Weather and Soil Conditions (Mandatory)
Microclimate in Protocol. Circle one (**Yes** or **No**)
Sky. Circle one (**Clear, Partly cloudy, Very cloudy**).
Moisture. Circle one (**Dry, Foggy, Intermittent rain, Light rain, Heavy rain**).
Wind. Circle one (**None, Light, Moderate, Strong**).
Air Temperature. Record air temperature in ºC, taken at beginning, middle and end of search.
Relative Humidity. Record air relative humidity % using a sling psychrometer before beginning search for animals, at the middle of the search and then when search is finished. Record both wet bulb and dry bulb temperatures, then convert to % using a table.
Froze last night. Circle one (**Yes, No** or **Unknown**).

Soil Stations (Mandatory)
Soil temperature. Record soil temperature (ºC) at 10cm below the surface at each soil station using a soil thermometer. Rrecord the average.
Soil moisture. Enter the correct code (**D** = dry by touch, **M** = moist by touch). Take this measurement under the first layer of cover.

Minutes Sampled (by Observer) (Mandatory)
Observer(s). First initial, Last name.
Start time. Record the start time for each person searching.
End time. Record the end time for each person searching.
 # Minutes. Record the length of search time for each person, in minutes.
Total Minutes Searched. Sum up the search times for all participants.

Detections (Mandatory)
Species. Record the 4-letter code for each species observed.
Stage. Record the life stage for each animal captured (**J** = juvenile, **S** = subadult, **A** = Adult).
Cover object. Record the code for the cover object each salamander was found under. (Cover types: **1** = Rock, **2** = Moss, **3** = Downed woody debris, **4** = Leaf litter, **5** = Lichen)
Substrate type. Record the code for what the salamander was found sitting on. (Substrate types: **1** = Rock, **2** = Moss, **3** = Downed woody debris, **4** = Leaf litter, **5** = Lichen, **6** = Soil).

Comments: (on back of form) Record any unusual and/or helpful information, such as a piece of equipment was not working, sudden unrecorded weather change, etc.

Attach a Topographic Map (Mandatory)
Show the suitable habitat polygon, area surveyed, location of captures of PLEL or PLST, occupied habitat.

Version 3.0

PLEL / PLST SALAMANDER SURVEY DATA FORM
FIELD VISIT INFORMATION

SITE INFORMATION (Mandatory)

Project Name: ______________________________

Unit Number: ____________ Site Number: ____________ Visit Number: ____________

Date: ____________ Start Time: ____________ End Time: ____________

Actual Search Time (person hours): ____________ Acres Searched: ____________

WEATHER AND SOIL CONDITIONS (Mandatory)

Met protocol for microclimate constraints? Yes No

Sky (circle one)
Clear / Partly Cloudy / Very Cloudy

Wind (circle one)
None / Light / Moderate / Strong

	Air Temp (ºC)	Relative Humidity Wet bulb	Dry bulb	%
Start	______	______	______	______
Middle	______	______	______	______
End	______	______	______	______

Moisture (circle one)
Dry / Foggy / Intermittent Rain / Light Rain / Heavy Rain

Froze last night? (circle one)
Yes No Unknown

Station Number

	1	2	3	4	5	Average
Soil temp. (ºC)	______	______	______	______	______	______
Soil moisture (D or M)	______	______	______	______	______	

Observer(s) **(Mandatory)**	Start time	End time	No. minutes
______	______	______	______
______	______	______	______
______	______	______	______
______	______	______	______
______	______	______	______
		Total minutes:	______

Stage	Cover / Substrate
J = juvenile	1 = rock
S = subadult	2 = moss
A = adult	3 = DWD
	4 = litter
	5 = lichen
	6 = soil

DETECTIONS (Mandatory)

Species	Stage	Cover Object	Substrate	Species	Stage	Cover Object	Substrate
______	______	______	______	______	______	______	______
______	______	______	______	______	______	______	______
______	______	______	______	______	______	______	______
______	______	______	______	______	______	______	______
______	______	______	______	______	______	______	______
______	______	______	______	______	______	______	______
______	______	______	______	______	______	______	______
______	______	______	______	______	______	______	______
______	______	______	______	______	______	______	______

Attach topo map that shows the suitable habitat, area surveyed, and location of occupied sites.

Chapter VI

Survey Protocol for the Van Dyke's Salamander (*Plethodon vandykei*)

Version 3.0

OCTOBER 1999

Lawrence L.C. Jones

AUTHOR

LAWRENCE L. C. JONES is a wildlife biologist, USDA Forest Service, Pacific Northwest Research Station, 3625 93rd Ave. SW, Olympia, WA 98512.

ABSTRACT

Van Dyke's salamander is one of five federally designated Survey and Manage amphibian species. It is endemic to the State of Washington. In accordance with the standards and guidelines of the Record of Decision for the Northwest Forest Plan, surveys for Van Dyke's salamanders within likely habitat need to be conducted in the southern and central Cascade Range of Washington prior to site disturbance. Three survey techniques are used as a standardized protocol to detect this species, each tiered to specific habitat conditions. Two survey techniques are described here in detail, one for streamside and lakeshore areas and the other for special habitat features, such as seepages and cave entrances. The third technique also targets Larch Mountain salamanders in upland habitats (where surveyors search for both species); the upland survey technique is addressed in the protocol for Larch Mountain salamanders (Chapter VII). The techniques incorporate both new and tested methods to optimize the likelihood of detection. Up to three surveys are conducted during the spring and/or fall, when the ground is wet, relative humidity is high, and temperatures are moderate. This protocol also includes a rationale for technique development, identification and natural history of the species, training needs, environmental parameters for surveys, a list of survey triggers and exemptions, and photographs of the species and its habitat. A standardized data form is included.

TABLE OF CONTENTS

INTRODUCTION

This survey protocol was developed in response to the Record of Decision for the Northwest Forest Plan (USDA and USDI 1994) for determining the likely presence of Van Dyke's salamander, *Plethodon vandykei* (PLVA), on federally owned and managed lands. It provides the conceptual framework and steps to conduct surveys in areas where site-disturbing projects have been proposed.

PLVA is a component/strategy 2 species of Survey and Manage Amphibian for the Cascade Mountains. Populations from coastal ranges (Olympic Mountains and Willapa Hills) were not designated as Survey and Manage by USDA and USDI (1994) because known localities were primarily on non-federal lands and those on federal lands were believed to be protected by Late-Successional Reserves.

Before initiating surveys, read this entire document and its companions. This protocol provides guidelines for surveys at stream and lakeside habitats and special features such as seeps and caves. Chapter I addresses general information and guidelines common to all Survey and Manage amphibian species. Chapter VII provides survey guidelines for PLVA in upslope habitats and for the Larch Mountain salamander (*P. larselli,* another Survey and Manage species that is largely sympatric in Washington). Surveys for both of these species are often integrated. For information on management recommendations at sites where PLVA has been detected, refer to Olson (1999) and Jones (1999).

Main Revisions and Clarified Procedures

This protocol is revised from the 1996 draft protocol (Olson et al. 1996). The list below summarizes the main revisions and clarified procedures specific to Van Dyke's salamander surveys. Revisions have resulted from new information, and extensive review comments provided by agency executives, managers, field specialists, species-experts, and non-agency scientists. Revisions were made for clarification and to refine procedures, but did not significantly alter the integrity of the 1996 draft protocol. Major elements of the revision include:

- **Flexible and fixed survey elements are clarified**
- **Survey triggers are defined and are discretionary**
- **Adjacent area survey distances are more discretionary, rather than 180 m**
- **Photographic plates of animals are included to aid species identification**
- **Photographic plates of habitats are included to aid habitat identification**
- **Summary of known site record compilation is included (Chapter II)**
- **Maps of known site locations (Figure VI.1), with various coverages (Chapter II)**
- **Revised Survey Zone**
- **Revised Data Forms**

Expanded species description is provided to avoid misidentification
Expanded habitat description is given for clarification
Spatial extent of survey coverage is changed
Streamside survey is simplified
Figures of survey methods are provided
For activities crossing streams (e.g., road), surveys are hierarchical
No surveys should occur if there has been freezing within previous 72 hours, or if snow is present
Air relative humidity is removed as a condition for survey
Expanded site delineation guidelines are provided

Survey Requirements

USDA and USDI (1994) states that PLVA is a Component 2 species, with provisions to “survey prior to activities and manage sites” (Table 3, p. C-59) in the Cascade Range. This chapter sets the parameters for triggering and conducting a survey to determine if the species is “present” or “not detected” at a site.

State regulations--A Washington State Scientific Collection Permit is needed for research or public display. The Van Dyke's salamander is a candidate for State Sensitive status. Although this status affords it no special protection, a Scientific Collection Permit is needed to actively search for this species, as well as retain specimens (K. McAllister, Washington Department of Fish and Wildlife, pers. comm.). Scientific Collection Permits should be requested well in advance of the survey date to ensure arrival before the onset of the field season. Surveyors will need to summarize their captures by area at the end of the year, at which time they may apply for a new permit. One permit may sometimes cover multiple permittees; check with the permitting agent for more details.

Surveyor training--It is imperative that anyone doing surveys for this species be well-versed on its identification and habits. Prior to conducting surveys for PLVA, field personnel need to be adequately trained. Surveyors must be able to identify PLVA (with special attention paid to variations and juvenile identification) and sympatric salamander species, identify PLVA habitats, understand the known ecology and behavior of this animal, and fully understand survey procedures for standardized implementation under field conditions. When the identification of a specimen is in doubt, it should be examined by a species expert.

Training Requirements

Two-day training session

One day of lecture and species identification
One day of field instruction

Surveyor skills include

Ability to identify all salamander species encountered
Ability to identify target species' likely habitat
Knowledge of species' microhabitat associations
Knowledge of species' microclimate associations
Knowledge of species' surface activity patterns
Knowledge of survey protocol and its implementation
Knowledge of documentation procedures, dataforms, and discretionary decisions

Presence--Presence is designated when one or more PLVA are detected and positively identified. For our purposes, it is assumed a population occurs at that site. Further surveying will help determine the extent of that population by delineating the boundaries (Site Delineation, below). The site will be managed according to management recommendations (Olson 1999).

Not detected--If the target species is not observed after the three surveys, it is designated as "not-detected" and the site does not need to be managed according to the PLVA management guidelines (the term "absence" is an absolute that cannot be ascertained after 3 site visits).

GENERAL BIOLOGY AND ECOLOGY

The Van Dyke's salamander is the least known woodland salamander, genus *Plethodon*, in the Pacific Northwest. It is a terrestrial salamander, as it lacks a free-living larval stage, yet is often found in semi-aquatic or near aquatic habitats such as seeps and streamside areas. It is a close relative of the Coeur d'Alene salamander (*P. idahoensis*) in Idaho. The biology and natural history of this species is more thoroughly reviewed in Olson (1999), and general references include Nussbaum et al. (1983), Stebbins (1985), Leonard et al. (1993), and Corkran and Thoms (1996)

Species Identification

PLVA is a relatively stocky, long-legged, short-tailed species of woodland salamander that reaches about 60 mm snout-vent length and 100 mm total length (Leonard et al. 1993). It is superficially similar to some other species, especially when young. In the Cascade Range (the only area where it is afforded Survey and Manage status), it occurs in both light and dark phases, although the dark phase is usually the sole or dominant form (Nussbaum et al. 1983; C. Crisafulli, pers. comm), especially at higher elevations (A. Wilson, pers. commun.). Adults of the light phase (Plate VI.1) have an overall ochre to reddish color with an indistinct dorsal stripe, due to a lack of melanin on the sides. Adult, light-phase animals are similar in appearance to the ensatina (*Ensatina eschscholtzii*). Dark phase animals (Plate VI.2) have a distinct dorsal stripe with dark sides. The venter is black with white speckles and the throat has a yellow patch (Plate VI.3). Dark phase animals may be confused with long-toed salamanders (*Ambystoma* *macrodactylum*) or other woodland. **Diagnostic characters also include "drips" of dorsal stripe coloration (sometimes lacking) on the sides (Plate VI.2), parotoid glands (Plate VI.4), 14 costal grooves (usually), and slightly webbed feet (Plate VI.5).** Juveniles of light phase animals also have dark sides (Plate VI.6), but this fades with age. Atypical (amelanistic, piebald, two-lined, and melanic color morphs) western red-backed salamanders, *Plethodon vehiculum*, are often misidentified as PLVA (Plates VI.17-19). General references for identification and basic natural history include Stebbins (1951, 1985), Nussbaum et al. (1983), Leonard et al. (1993), and Corkran and Thoms (1996).

Range

Van Dyke's salamander is endemic to the State of Washington (Leonard et al. 1993). The distribution of the Van Dyke's salamander is disjunct, even among populations in the Cascade Range. It is known from three population centers: the Cascade, Willapa, and Olympic Mountain Ranges. In the Cascade Range, it is known from only 28 sites west of the crest to the Puget Trough (Figure VI.1). Along the axis of the range, it is known from central Skamania County to the south, to the north end of Mt. Rainier, Pierce County, to the north. Populations may be small and disjunct from one another and much potential habitat appears to be unoccupied (Wilson et al. 1995). The range of PLVA is shown relative to federal land ownerships and allocations in Chapter II (Figures II.4 and II.9).

Habitat

Habitat affinities are poorly understood for PLVA and habitat associations for the Cascade Range populations have not been assessed. In some respects, PLVA appears a generalist, because it may be found in a variety of habitats at a large range of elevations (sea level to over 5,000 ft). This species has been found along streams (Wilson et al. 1995), in upland forests (Slater 1933), talus (Herrington 1988), along lake shores (C. Crisafulli, pers. comm.), at cave entrances (Aubry et al. 1987), and at seeps (Leonard et al. 1993). Within the different habitat types, PLVA tends to seek out cool and moist or wet cover. Some examples of habitats are shown in Plates VI.7-14.

<u>**Habitat**</u>: **lotic habitats (intermittent and perennial streams and river banks, seeps)**
forested habitats, all soils/substrates and seral stages
montane lake shores
cave entrances (includes lava tubes and sink holes)
rocky substrates (e.g., rock outcrops and roadcuts, fissured bedrock, colluvial slumps, and talus)
waterfall splash zones

Lotic Habitats--PLVA has been documented from lotic habitats across its entire range (Wilson et al. 1995). Likely habitat may occur from seeps and headwaters to larger streams and rivers. Streams and seeps may either be perennial, or spatially or temporally intermittent (e.g., water may flow below the surface during summer low flow and is not visible on the surface).

Ephemeral streams that only exhibit flow during peak conditions, such as after a heavy rain, are not believed to be likely haunts for PLVA. Also, sandbars and scoured cobbles along rivers are unlikely to harbor PLVA. Along streams, they have been found under colluvium from the wetted edge to the top of the valley wall[1] (Figure VI.2) and sometimes beyond. Rock outcrops, bedrock, colluvial slumps, talus (stable or unstable), suspended logs and logjams, moss mats, seeps, and splash zones associated with streams are potential “hotspots” for these animals. Seepages that are little more than a trickle in wet conditions may harbor PLVA; fractured rock (cracks and exfoliating slabs) and other debris in and near water are likely cover.

Lakeshores-At montane lakes, PLVA has been found under debris on the shore, but not in the water.

Caves--In caves, they are known from the twilight zone inside the entrance.

Forested Habitats--In upland situations, they have been found in forests of a variety of seral stages, even in areas of tree loss following natural disturbances. They are often found in microhabitats that retain moisture, such as north-facing slopes. Research is needed to more fully understand the habitat of PLVA, and in particular, its potential associations with forest habitat conditions.

SURVEY PARAMETERS AND RATIONALE

Triggers

Triggers are parameters that initiate the survey. These are generally project proposals that include ground disturbance or other activities that may negatively impact PLVA or their habitats. Triggers are cross-referenced to the management recommendations for this species (Olson 1999), such that if PLVA habitat protection is recommended in response to an activity, it may be considered a trigger.

[1]The valley wall is the relatively unstable portion of the streambank formed by stream erosion. It is usually marked by a break in slope (flatter above, steeper below); typically, trees grow above the top of the valley wall, but not below. This is not to be confused with the ridgeline, which is upslope of the valley wall. A valley wall is not present at all situations (e.g., seeps, small streams, and low gradient areas); for survey purposes, the treeline may be considered synonymous with the top of the valley wall.

Trigger Criteria--Surveys are triggered only when the proposed activity occurs:

1. **on federal lands covered by the Northwest Forest Plan, and**
2. **within the Survey Zone for PLVA, and**
3. **in an area in which there is suitable habitat for PLVA, and**
4. **the proposed project may affect animals directly or indirectly by altering habitat.**

As ground-disturbing activities occur on or in the substrate, they have the potential to severely affect this species. Adverse effects on the substrate microhabitat are the specific concerns. Surface microhabitat conditions important for this species include the physical structure and surface cover features, and the microclimate (e.g., temperature/moisture regime). Concerns for management include the maintenance of the integrity of substrate interstices and cool, moist surface regimes. Proposed management activities that may affect these habitat elements are survey triggers.

Activities with little or no ground-disturbance also may affect microhabitat for this species. For example, chemical applications may affect individual animals directly by creating inhospitable habitats. Some chemical applications (e.g., pesticides), also may affect amphibians indirectly by impacting their prey-base.

Trigger Decision Process— Land management activities should be evaluated on a case-by-case basis whether on not they represent obvious triggers. To make this management decision, the four above criteria should be evaluated. For the last criterion, managers should ask “does the proposed project affect the habitat conditions for the species or the individual animals?” Site managers are expected to have the greatest discretion with regard to this final criterion. Site conditions or project implementation methods or timing can affect whether or not a particular activity is a trigger (see also Chapter I).

Activities that May Not Trigger Surveys--Surveys may not be triggered for activities that are determined to have low potential to effect this species or its habitat. This may include activities that do not affect substrate integrity, or the microclimatic regime within suitable habitat. In addition, if a particular activity does not affect microhabitat conditions and it is timed so that the activity occurs when the animals are not surface active (e.g., during dry, summer months), and thus not expected to affect the animals themselves, the activity may not trigger surveys. If the scale of the activity is small and little damage to the population would occur, a survey may not be triggered. See also Chapter I for further discussion of triggers.

Specific examples of triggers and non-triggers:

A. Most proposed timber management activities, including thinning, restoration, regeneration harvest and salvage would trigger surveys. These types of activities involve reduction of canopy and high levels of disturbance to the substrate.

B. Road or trail construction or reconstruction would trigger surveys. Road construction and reconstruction can involve high levels of substrate disturbance and removal of overstory. Routine road maintenance or installation of cross-drains may not trigger surveys. Routine maintenance typically involves only those activities within the already disturbed road prism that is not likely to be habitat.

C. In-stream culvert placement, replacement, or removal would trigger surveys. Intermittent and perennial stream and streamside areas are likely habitat that may be affected by these activities.

D. Road decommissioning would not trigger surveys if only the substrate within the road prism (i.e., not likely habitat for PLVA) were affected during decommissioning. If suitable habitat for the species were affected, surveys would be triggered.

E. In-stream habitat restoration projects would trigger surveys, as these are likely to affect PLVA habitats.

F. Practices that alter stream course or water volume would trigger surveys.

G. Mining activities would trigger surveys. These are direct impacts to PLVA habitats.

H. Chemical applications (e.g. pesticides, herbicides, fertilizers) within suitable habitats would trigger surveys.

I. Recreational development, such as campground creation or expansion would trigger surveys. Routine facilities maintenance may not trigger surveys. Development or expansion of recreational sites can involve overstory reduction and substrate disturbance in likely habitat. Regularly disturbed sites may not provide likely habitat.

J. Replanting and timber stand improvement (pre-commercial thinning) of plantations thirty years old or less would not trigger surveys, unless PLVA habitats were expected to be affected.

K. Hazard tree removal and clearing blow-down from roads would not trigger surveys, unless PLVA habitats were expected to be affected.

L. Seeding of native species of grasses or plants would not trigger surveys. This type of activity has low potential to disturb PLVA habitat.

M. Construction or reconstruction of fences would not trigger surveys unless the construction would lead to increased disturbance within PLVA occupied habitat, such as might occur with livestock collection devices. Installation of posts, markers, or signs that have little impact outside a specific spot would not trigger surveys.

N. Special Forest Products: Surveys would not be triggered for removal of forest products such as bear grass, fir boughs, and Christmas trees because of low levels of potential for disturbance to PLVA habitat. Mushroom harvest would not trigger surveys unless the harvest method affects PLVA habitat.

O. Surveys would not be triggered for removal of small infestations of noxious weeds by hand pulling or digging because of the low potential for disturbance to PLVA habitat.

P. Areas proposed for concentrated wood cutting would trigger surveys due to the potential for canopy reduction, substrate disturbance, and impacts to microhabitat. Dispersed (single tree) wood cutting would not trigger surveys as this type of activity has a low potential to disturb substrate or reduce overall canopy within PLVA habitat.

Adjacent Area Surveys

Appropriate habitats within adjacent areas surrounding the proposed project area should be surveyed if the project may affect PLVA habitat in adjacent areas. Effects on microclimates (e.g., edge effects, Chen et al, 1995), microhabitats, water flow, and slope stability should be considered.

Surveys of areas adjacent to proposed site-disturbing activities should be considered on a case-by-case basis (see Table VI.1). Depending on site conditions and potential effects to habitat and microclimate, there is discretion when determining the width of adjacent area required for survey. An adequate analysis should be conducted and documentation of the decision should be provided (see also Chapter I). Guidelines for adjacent area surveys are provided in Table VI.1. The adjacent area guidelines are cross referenced to the management recommendations for the species so that the recommended surveys area for an activity matches to the corresponding management recommendations in the companion management document (Olson 1999). Although every attempt was made to address most potential activities, this should not be considered an all-inclusive list.

Justification for not surveying in adjacent areas may be considered under circumstances that are not expected to affect potential PLVA or their habitats. In particular, not surveying within adjacent habitat might be considered when: 1) there is no adjacent area ground disturbance expected that would cause salamander mortality; and 2) proposed activities are not expected to alter adjacent area microclimate or microhabitat conditions. For example, although trail construction may be a trigger of surveys along the trail alignment, adjacent areas along trails would not require surveys if adjacent area microclimates remain unaffected (e.g., no timber felling resulting in dominant canopy cover reduction is involved) and if adjacent area microhabitat will remain intact (e.g., blasting is not conducted).

Table VI.1: Examples of common management activities on federal lands within the Survey Zone of the Van Dyke's salamander (*P. vandykei)* and suggested adjacent areas to be included for upslope surveys and appropriate area-searches.

Management Activity	Disturbance Metrics	Recommended Adjacent Area for Survey*
Trail construction	Tread 60-120cm, (24-48 in) linear, disturbance very restricted	10 m; 5 m on each side of center-line, survey distance relates primarily to potential microhabitat concerns.
Trail construction	Tread 125-182 cm, (49-72 in) linear, disturbance very restricted	15 m; 7.5 m on each side of center-line, survey distance relates primarily to potential microhabitat concerns.
Signing, kiosk	Small area, typically< 100m^2	0-60 m depending on conditions, survey distance relates primarily to potential microhabitat concerns.
Road (secondary)	Roadbed 3-7 m, (10-20 ft), linear	60-80 m: 30-40 m on each side of the center-line, survey distance relates primarily to potential microhabitat concerns.
Road (primary)	Roadbed 7- 12 m,(20-40 ft) linear	100-160 m: 50-80 m on each side of center-line, survey distance relates primarily to potential microhabitat concerns.
Timber Harvest	Thinning, 40-60 % retention	40-60 m, survey distance relates primarily to potential microclimate concerns.
Timber Harvest	Thinning, 20-40% retention	80-120 m, survey distance relates primarily to potential microclimate concerns.
Timber Harvest	Regeneration, 0-20% retention	120-240 m, survey distance relates to combined microclimate/microhabitat concerns.
Mining/Quarries	small-scale quarrying, <500m^2 area	60-80 m, survey distance relates to combined microclimate/microhabitat concerns.
Mining/Quarries	>500m^2 area	120-200 m, survey distance relates to combined microclimate/microhabitat concerns.

* **These widths are intended only as general guidelines, site-specific analysis will determine actual adjacent area survey widths.**

For streams, adjacent area survey decisions may differ along streams (up- and down-stream, Figure VI.2) versus perpendicular to streams. Activities within the valley wall may not affect the upslope habitat, but may have up- or down-stream impacts. In general, areas above the valley wall, if affected by the disturbance, would be surveyed for both Larch Mountain and Van Dyke's salamanders.

Table VI.2. Distances (m) recommended to survey for PLVA up- and down-stream from an activity that crosses the stream (i.e., these are adjacent area distances longitudinally along streams).

	Small stream (< 1.5 m at riffle)		Large stream (> 1.5 m at riffle)	
	Upstream	Downstream	Upstream	Downstream
<1.5 m-wide Disturbance	30	50	50	75
>1.5 m-wide Disturbance	50	75	100	150

Site Location

Survey Zone–Figure VI.1 shows the Survey Zone for PLVA, the geographic area in Washington to survey for PLVA and Larch Mountain salamanders. The area includes conditions within which likely PLVA habitats may occur. The Survey Zone is broader than the area of current known sites because few, if any, systematic surveys for PLVA have been conducted in this region, especially for streambank amphibians.

Surveys will be conducted from the Columbia River to the south to Highway 2, as it crosses the Cascades, to the north. The western edge is the Puget Trough, specifically Interstate 5 from the Columbia River to U.S Route 2. The eastern edge is the Great Basin, specifically from the intersection of the Columbia River and State Route 142 (town of Lyle) northward to the intersection of State Route 97, and then north on State Route 97 to the intersection of U.S. Route 2. The Survey Zone only covers federal lands within the range of the Northwest Forest Plan, thus the eastern edge of the Zone is truncated by this range. Juniper and shrub-steppe habitats are beyond the eastern edge of the Survey Zone and are not considered potential habitat.

Survey Area--The site to be surveyed for PLVA is the Survey Area. It includes suitable PLVA habitat within the area of proposed site disturbance, and suitable PLVA habitat in adjacent areas that may be impacted by the disturbance. Portions of the Survey Area that cannot be safely searched may be omitted.

Survey Timing

Seasons--PLVA may have a longer period of surface activity than other lungless salamanders, especially when associated with lotic conditions. This means that it may be possible to encounter this species during the summer or winter, if the necessary environmental conditions are met. However, surveys will be conducted during the optimal time frame for Larch Mountain salamander, which probably coincides with optimal timing of surface activity of PLVA as well. Surveys are to be conducted in spring or fall, during acceptable environmental conditions. For planning purposes, the most predictable season to survey is spring. The period of mild temperatures between spring thaw and summer drought typically provides large blocks of amenable environmental conditions. Fall can provide excellent conditions for surveys but the window of opportunity between the onset of ground-soaking rains and snowfall may be very short.

Surveys in the spring are to be conducted after snowmelt and before summer drought. Fall surveys are conducted after the onset of fall rains and before cold temperatures set in.

Elevational considerations--Sites at high elevations typically have narrower windows of survey opportunity. The spring-thaw period is usually the preferred time to survey as the onset of precipitation during the fall may be in the form of snow. Spring thaw occurs later at higher elevations.

Site visits--A total of 3 visits done according to the survey protocol are needed to establish “not detected” site status. Site visits may be conducted in spring and/or fall: they are driven by environmental conditions rather than season. Environmental conditions must be acceptable during each visit.

Intervals between visits--Each site visit must be separated by at least 4 days. This interval allows for the further development of suitable environmental conditions for salamander surface activity, and hedges uncertainty in the surface activity patterns of these animals.

Environmental Conditions

Environmental conditions must be within certain limits before a survey can begin. Either the environmental conditions can be met, and surveying proceeds, or the conditions are not met and surveying cannot proceed.

Soil Moisture--The soil under the upper layer of surface objects (rocks, logs, etc.) and down to 30 cm must be moist or wet in order to conduct a survey, when measured 10 m from the wetted edge of aquatic habitat.

Temperature--The soil temperature must be between 4 and 14°C at the site during the survey. The daily minimum air temperature must have been above freezing during the preceding 72 hours. Our knowledge of these animals indicates that they are far less likely to be surface active if these conditions are not met (Chapter I; pers. observ.).

Surveys must not occur if it is snowing at a site or if snow has recently (<72 hrs) covered the ground, regardless of the soil/substrate temperature and moisture conditions. This statement is necessary because often time in the fall, the soil/substrate temperature and moisture will be in the acceptable range when it is snowing or a new layer of snow is blanketing the ground, yet the cool surface temperatures have caused the animals to move to subterranean retreats. Additionally, if there is a cold airmass aloft, causing it to snow at the ground surface at temperatures >0°C (32° F), the cooling effect of the melting snow on the ground surface can cause periods of inactivity for PLVA.

Species Verification and Voucher Specimens

Because there are so few sites of this species in the Cascade Range and it is possible to misidentify it, presence cannot be established unless at least one live or museum (fluid) specimen is verified by an expert. Due to morphological variation in this species (Plates VI.1-6 and Plate VI.15) and potential confusion with sympatric congeners (Plates VI.16-20), photographic vouchers are generally not acceptable for verification. When animals are collected for verification, they should be placed in a rigid, airtight container or sealable bag with some air and moist moss. They may be retained in a refrigerator, provided it is kept above freezing. Collection of museum specimens as vouchers is not mandatory under this protocol.

Reference Sites

The use of reference sites to determine when to proceed with surveys is not recommended for PLVA. Repeated site use may cause damage to the habitat and the population. Also, site conditions may differ between a reference site and a site to be surveyed.

Development of Methods

In order to effectively survey for PLVA, it helps to understand the basic principles underlying the design of this protocol. Techniques employed in this protocol address all habitat types known to be occupied by this species, but emphasize lotic situations. Survey approaches for streamside habitats for western North American salamanders have not been developed previously, and the rationale for the approach used in this protocol is provided.

The methods of this protocol involve components from area- and time-constrained sampling (Campbell and Christman 1982, Bury and Raphael 1983, Corn and Bury 1990), transect surveys (Organ 1961, Hairston 1987, Jaeger 1994), and opportunistic sampling.

Jaeger (1994) states that transect surveys are appropriate when working across gradients. The primary gradient in this case is the transition from stream to upland habitat. Surveying this gradient is important because distributions of streamside amphibians may shift toward or away from the stream during different seasons or during different climatic conditions (Dumas 1956, Organ 1961, Hairston 1987). PLVA also can have a spotty distribution along the longitudinal axis of the stream (unpubl. data). Scott and Woodward (1994) point out some other difficulties associated with streamside transects for amphibians. The streamside transect guidelines in this protocol address sampling gradients parallel and perpendicular to the stream. Following is a list of concepts contributing to the design of the design.

a. The goal of these surveys is the detection of PLVA.

b. The protocol assumes surveys will be conducted only when animals are surface-active.

c. Animals are not always equally distributed spatially or temporally--they may be clustered.

d. Time, cost, effort, and detectability were driving concerns.

Regardless of survey method used, there is a chance of not detecting PLVA when it is actually present. It has often been suggested that a good search image *may* prove more effective for detection than randomized or systematic sampling. To accommodate a good search image and unsampled habitat, a 1 person-hour (p-h) opportunistic search is added to all surveys in which the total area has not been searched.

SURVEY PROTOCOL

There are three types of surveys for PLVA: Streamside Transect, Area Search, and Upland Search (Table VI.3). These are the methods to be used as the federal survey protocol, and to establish "not detected" if no animals are found. All other surveys are optional and supplemental and may establish "presence." Supplemental surveys may be used as proposed project areas are being prioritized and general field reconnaissance of habitats is being conducted.

If PLVA is detected during a protocol survey, a more intensive site delineation survey may be warranted (see below).

Table VI.3. Survey types to assess presence of PLVA prior to ground-breaking activities. The habitat and constraints will determine which type is most appropriate.

Technique	Habitat and situations
Streamside transect	Streams, large seeps, and montane lakes
Area search	Seeps, caves, rockwalls, roadcuts, waterfalls, and other special habitats
Upland transect	Upland

Survey Ethics

Surveys should be conducted in a relatively non-destructive manner. Surface objects should be replaced to their original position. Rocky streams and hillsides should be kept relatively intact whenever possible. Bark may be pulled off of logs, but it should be done carefully, so that it can be replaced. Logs that are moderately decayed into large chunks or splits may be separated, but again, the pieces should be replaced as best possible. However, logs should not be completely destroyed. The intent here is not to abstain from any habitat alteration; that would be next to impossible and would make it difficult to detect salamanders. The intent is to be conscientious about minimizing disturbance to the habitat by using a light-handed approach.

Safety Issues

Field units implementing surveys should be discretionary regarding safety issues as required by site conditions. Safety of surveyors should not be compromised to complete surveys. As such case-by-case decisions are made, managers, supervisors, and field crews should be in communication. We recommend full documentation of the rationale supporting such a decision.

Project Configuration

Site-disturbing activities are either linear or non-linear. Linear projects may be parallel or perpendicular. Survey approaches are tiered to project configuration.

Non-linear--Non-linear projects affect broad areas. Examples of non-linear disturbances include broadcast treatment of chemicals and most timber harvest regimes. Non-linear projects are surveyed using the area or upland search methods.

Linear, parallel--Examples of this type of project include trails, roads, and pipelines that follow the axis of a stream. A streamside transect is used for this configuration.

Linear, perpendicular--Linear disturbances are perpendicular when the project crosses streams, seeps, lakes, or special habitats. Small streams form an extensive network over the forest landscape and are often encountered along linear projects. Streamside transects are used at all stream (or other feature) crossings.

Sampling Effort

A site visit to most small-to-moderate sized projects can be completed within a day. At least 50% of the project area must be searched. For a project that includes multiple perennial reaches, all reaches need to have ≥50% surveyed. One person-hour (p-h) opportunistic search may be added on to each reach or feature.

Coverage and Moving Rules

Because PLVA may be sparsely distributed, an effort should be made to cover as much of the project area as possible to maximize the chances of detection. On a small scale, the surveyor should not get "hung up" looking at specific spots for more than 5 minutes (a natural handicap of the best of herpers) and should keep moving. On the larger scale, the surveyor should periodically assess their position to make sure they can spatially cover the entire project area. For example, if the surveyor spends all of their time searching the south-facing bank, but there is an isolated cluster of PLVA on the north-facing bank, the species would remain undetected (Type II error, see Chapter I).

<u>Method 1: Streamside Transect</u>

Our current understanding suggests PLVA is usually associated with headwater streams, from the headwall (stream source) and small seeps and tributaries to first and second order intermittent and perennial streams. However, they also are found along rivers if favorable conditions exist. Salamanders are normally found under colluvial rock or wood (Wilson 1993, Wilson et al. 1995) on the floodplain, streambank, islands, or valley wall. The Streamside Transect is used around streams, large seeps, and montane lakes.

Linear, Perpendicular Projects--A streamside transect is conducted at all crossings. Table VI.2 shows the distances to survey up- and down-stream, based on the size of the stream and project width. However, if the stream does not extend the distance given in Table VI.2, the surveyor needs only to search 10 m beyond. Figure VI.3 demonstrates a search pattern for this type of project. Figure VI.4 (lower figure) shows an example of this type of project and how subpopulations may occur in a Survey Area.

Linear, Parallel Projects--A streamside transect is triggered for any linear, parallel project inside the valley walls (or treeline). For projects beyond the top of the valley wall, an upland search is always triggered. A streamside transect is also triggered if: (1) the area disturbed is > 1.5 m wide and < 60 m from the top of the valley wall or (2) the area disturbed is < 1.5 m wide and < 20 from the top of the valley wall.

The Technique:

a. Fill out header information on data form (Appendix VI.1). If environmental conditions are acceptable, proceed with the survey. An example of the search pattern is shown in Figure VI.3.

b. Begin the transect: start at the downhill margin of the survey area (for convenience, we will assume you are starting on the downhill side, but you can reverse the directions or start in the middle) on one side of the creek and proceed upstream. Search the wetted portion of the stream edge and seeps (only in water < 5 mm deep), as well as areas away from water.

c. Walk upstream in a zig-zag pattern, turning over surface objects as you encounter them, using a "walk and turn [hand-search] approach." The travel route will be from the wetted edge of the stream or lake to the top of the stream valley wall, start of the treeline, or 10 m beyond the wetted edge, whichever is greater.

d. Carefully look under surface objects while moving across the search area. Surface objects may be items on top of a fine substrate (e.g., a rock on soil) or may be interspersed (e.g., talus, gravel mixture). The "surface" is generally considered to be within the upper 30 cm of the top of the substrate. Do not get "hung-up" at any area. A maximum of 5 minutes should be spent at any specific spot (e.g., a large log or small seep). Search only under objects that are reasonably likely to conceal a salamander (> 4 cm diameter woody debris, > 5 X 5 cm rock; as a rule of thumb, larger objects tend to be more productive than smaller objects). Surface objects to search include a variety of potential salamander refugia: rocks, talus, rockwall debris, bedrock fissures, logs, slabs, bark piles, bark on logs, branches, logjams, anthropogenic structures (e.g., old boards or tires), and moss (particularly when it forms a mat). It is important to survey objects embedded in the valley wall (a prime microhabitat for PLVA), even if they are difficult to access. Valley wall sloughs may seem unlikely habitat due to exposure, distance from stream, and instability, but these may provide cover for PLVA.

e. You will have 1 p-h maximum to search special or missed habitats you encounter along the way. As you are conducting the survey, you have the option of searching these sites as encountered or marking and returning to them. There are pros and cons to both approaches; the point is to do the best job possible of surveying throughout the area, emphasizing areas that are likely to contain PLVA.

f. Whenever an amphibian is found, data are recorded as per code sheet. When a PLVA is captured, the location is marked on a map and the site is marked (refer to that section). The animal is released at the point of capture unless it is being retained as a voucher or for verification.

g. After the survey is completed, record information on time and area searched and sketch the area, highlighting any areas with a detection. Photograph the area if possible.

h. If a detection is made, the surveyor may or may not continue the survey, depending on management strategies. Refer to the section on Site Delineation, below.

Method 2: Area Searches

Area Searches are conducted at discrete sites other than stream, lakeside, or normal forested upland habitats. Examples of sites where Area Searches are appropriate include cave entrances, seepages, rockwalls, or other suspected habitats. *Note: there is a 1 p-h opportunistic search added on to Upland and Streamside Transects to search for target species in these special habitats. If 50% of the area of these special features cannot be surveyed during the course of the survey, then an Area Search should be conducted in addition to the Upland or Streamside Transect.*

a. Select the boundaries of the site, from the edge of the habitat (e.g., edge of rockwall or seep) to 10 m beyond (Figure VI.5). This may be on both sides of a band of habitat (e.g., for a cave, this might be the twilight zone and 10 m beyond, both inward and outward from band).

b. Fill out header information on the data form (Appendix VI.1) at the site, before the survey begins.

c. Search surface objects within the boundaries, using the walk and turn method, as per streamside transect.

d. Whenever an amphibian is found, data are recorded as per code sheet. When a PLVA is captured, the location is marked on a map and the site is marked. The animal is released at the point of capture unless it is being retained as a voucher or for verification.

e. If no PLVA are detected, spend up to 1 p-h opportunistically searching.

f. After the survey is completed, record information on time and area searched and sketch the area, highlighting any areas with a detection. The area should be photographed if possible.

g. Delineate the population at the site (may be done on a return visit). Refer to that section.

h. If a detection is made, the surveyor may or may not continue the survey, depending on management strategies. Refer to the section on Site Delineation, below.

Method 3: Upland Searches

Upland searches target both PLVA and Larch Mountain Salamanders. Because PLVA are sometimes found in upland sites, the surveyor should always look for both species. Refer to the Larch Mountain salamander protocol (Chapter VII) for details on the survey method.

Survey Follow-Up and Site Delineation

After the protocol surveys have been completed, the target species may or may not have been detected. **Records need to be kept on all surveys whether or not a detection is made.** Negative data are extremely helpful in assessments of habitat use patterns. Surveyed sites should be documented and mapped. Data forms and other documentation (e.g., field notes, maps) are to be retained at the local level (e.g., Ranger District, for National Forest System). At the end of the survey season in fall, there should be a joint meeting of all parties that conducted surveys to compare results. These guidelines are subject to modification and the status of the target species is subject to change when new information is gathered and analyzed.

Marking the Locality

The localities where PLVA are discovered need to be extremely accurate. The first detection location will become the "site" for the regional database. If only one specimen is found, a permanent marker should be left at the capture location. Permanent markers can be placed in the substrate (e.g., rebar) or a nearby tree may be marked with an aluminum tag. If more than one specimen is found, the marker should be placed in the epicenter of the known local distribution. Perhaps the most important aspect of marking the site is accurately recording where the specimen(s) was found with directions that other persons can use to relocate the site. It is wise to use a Global Positioning System to mark the site. The locality should be reported to the nongame program of the Washington State Department of Fish and Wildlife.

Site Delineation

Although the first detection location will be entered in the regional Known Site Database, management activities for PLVA are generally based on ameliorating potential effects to the population within the Survey Area, rather than the first detection location. If PLVA is detected within the Survey Area, land managers have 3 options on how to proceed with planned activities:

1. They may opt to terminate the activity. The remaining site visits of the Protocol surveys (Area, Streamside, or Upland) and Site Delineation surveys would not need to be conducted.

2. They may opt to treat all suitable habitat within the Survey Area as occupied. The remaining Protocol surveys and Site Delineation surveys would not need to be conducted. However, the entire Survey Area should be managed according to the Management Recommendations.

3. They may opt to proceed with the activity and manage only in areas known or believed to be occupied. If so, Site Delineation surveys must ensue.

Before initiating the Site Delineation survey(s), all three Protocol surveys must be completed in order to designate any portion of the Survey Area with “no detection.” After the third visit, the general distribution of the target species in the Survey Area will hopefully be revealed. Every detection location is flagged. Data are recorded on all target species detections and all other species are tallied.

The Site Delineation survey is more intensive than a Protocol survey, because it is intended to establish the spatial extent of the population within the Survey Area (Figure VI.4).

For our purposes, the “population” will be the area occupied by PLVA within the Survey Area. It may include a more or less contiguous distribution, may be confined to certain habitat types (e.g., only in rockslides or seeps), or it may be restricted to disjunct locations. It is important that the surveyors determine the true distribution and extent of the population, rather than delineation based on cursory survey efforts. It is also important to approach the concept of habitat liberally, as there may be short- or long-term migration in response to various natural history traits and environmental factors.

The general technique for a Site Delineation survey is similar to a Protocol survey: it involves walking and turning over objects only during good environmental conditions. However, as it is more intensive, there are some pertinent differences:

A. Walk-and-turn paths should not be > 5 m apart.

B. Walk-and-turn paths must cover the entire Survey Area for small-scale projects (Figure VI.4, upper figure); large-scale projects are oriented to all detection locations (Figure VI.4, lower figure). These become the focal points, with surveys radiating out to the perimeter of the Survey Area (if possible) or the apparent boundary of the population. The extent of the area searched on large projects is discretionary and the rationale for the area covered should be well documented by the lead biologist and land manager.

C. Walk-and-turn paths need not be in a zig-zag pattern, but they can be. If other walk-path patterns cover the area better, they should be adopted. For example, concentric rings or parallel transects may be more conducive to Site Delineation than a zig-zag pattern.

D. It is apropos to spend more time to determine if the species is present at a particular area–hence, moving rules do not apply. Search effort per unit area is usually greater with Site Delineation surveys.

E. Because the area is known to harbor the target species and extensive searching will be undertaken, great care must be taken to ensure that habitat is not destroyed.

Whenever a new peripheral detection location is made, the area to be searched enlarges, but not beyond the Survey Area.

The perimeter of the population within the Survey Area needs to be well marked and should be accurately mapped (i.e., with a Global Positioning System, GPS) for management purposes.

At least one site delineation survey needs to be conducted after protocol surveys. The lead biologist can determine if more than one is warranted.

The Optional Data Form should always be used for Site Delineation surveys, as well as the Standard Survey Data Form (Appendix VI.1).

OPTIONAL SAMPLING

Supplemental searches (Table VI.4) are those that do not count as a site visit, but might prove to be a quick and inexpensive way to detect a target species. Supplemental surveys are completely optional. The following are suggestions for supplemental searches. An important note about habitat-altering supplemental searches: they should not compromise the efforts of protocol searches. If a fair portion of the habitat will be altered by search efforts, it would be best to expend effort during a regimented protocol survey.

Table VI.4. Outline of supplemental surveys.

Technique	Habitat and situations	Comments
Night search	Any habitat, but probably best for rock faces and road-side haunts	This method is extensively used in the east but has received little testing in the west.
Off-season search	Any habitat	In summer for lotic situations; in winter at low elevations in mild conditions.
Coverboards	Usually done in typical forested situations (not very steep and rocky)	Little tested; readers should read the text before proceeding.
Marginal conditions	Any habitat	Caution: do not alter habitat that would be important during protocol searches.
Opportunistic	Any habitat	Anywhere, anytime, any way

Night Searches

Although PLVA and most other salamanders are nocturnal, searching for them at night with the aid of artificial light has met with varied success. However, because the technique can be productive, it should be attempted if the conditions are conducive and the opportunity presents itself (e.g., en route to other night-time activities). Ronald A. Nussbaum (Univ. Michigan, pers. comm.) has found PLVA to be numerous at some sites at night. This method is most readily used if the site is near a road, not only because of logistical and safety reasons, but also because roadcuts may expose rocky habitat. Searching seeps in fractured rock may be particularly rewarding. Slowly search the site with a flashlight, looking for the salamanders on the surface or in cracks. Search carefully, because only the head may be visible in dark recesses. As with other methods, relatively warm rainy nights in spring or fall are the preferred time. Driving slowly on back roads is productive for some animals such as snakes and ambystomatid salamanders, but is not likely to be so for PLVA due to their small size and supposed site fidelity.

Off-season Searches

Although the best time to survey is during the fall and spring, PLVA may be active almost any time of the year if the conditions are adequate. For example, during the summer, they may be active near water. Perennial streams, waterfalls, and seeps fall into this category. It is recommended that off-season searches be done according to the most appropriate survey method. During late summer or early fall rains, PLVA may be active during the day as well as night.

Coverboards

The use of coverboards (artificial cover, such as plywood boards) is a relatively new technique, so it is not known how effective it might be. There are pros and cons, so it is best to do further reading on the subject before initiating coverboard surveys (see Fellers and Drost 1994). Cover boards may be difficult to deploy in many situations where PLVA might occur.

Searching During Marginal Conditions

The need for good environmental conditions has been stressed for protocol surveys, but it may be possible to find salamanders when conditions are marginal. However, the number of specimens that are surface active is lower during poor conditions. This type of survey may be done if the crew finds less than adequate conditions upon arrival at a site and suitable habitat exists for subsequent surveys. For example, PLVA may be surface-active in wet situations when the ambient conditions away from water are dry.

Opportunistic Searches

Quite simply, an opportunistic search is done anywhere, anytime, by any method. It usually translates into "just going out and looking." However, it is always important to document the time and area effort and keep good records.

DOCUMENTATION OF SURVEY DECISIONS

Due to the discretionary nature of several survey elements (e.g., triggers, adjacent area distances), supporting rationale for case-by-case decisions is recommended to accompany activity proposals (see also Chapter I). In particular, if variance in survey procedures is implemented, the rationale should be documented and a qualitative assessment of the change in Type II error conducted (i.e., risk of not detecting the target species when it is in fact present at a site).

Recommended Elements for Documentation

Rationale for trigger decisions should be documented.
Rationale for trigger decisions should be separate from management recommendations.
Rationale for adjacent area survey decisions should be documented separately.
Rationale for any variance to protocol should be documented, with a qualitative assessment of changes to risk of Type II error.

It is important to note that only surveys conducted according to protocol (in addition to research results) are likely to be used to reassess habitat use patterns, which may in turn be used to refine habitats in which surveys are triggered.

ACKNOWLEDGMENTS

I thank other members of the Amphibian Subgroup of the Survey and Manage Team, especially D. Olson and C. Crisafulli, for their insight, support, and comments. C. Crisafulli and A. Wilson, Jr. have extensive knowledge of Cascade Mountains populations of Van Dyke's salamander. Their comments have helped to mold this protocol. Rich Nauman provided distribution maps, layout, and helpful suggestions for the text. I thank M. Raphael for support, W. Leonard for photographs, and J. Jones for editorial assistance. I thank the many people, anonymous and otherwise, who have commented on earlier drafts of the manuscript. They helped to bridge the gap between the written word and on-the-ground logistics and effectiveness. I thank the Survey and Manage Core Team of the Regional Ecosystem Office.

REFERENCES

Aubry, K.B.; Senger, C.M.; Crawford, R.L. 1987. Discovery of Larch Mountain salamanders *Plethodon larselli* in the central Cascade Range of Washington. Biological Conservation 42:147-152.

Bury, R.B.; Raphael, M.G. 1983. Inventory methods for amphibians and reptiles. In: Bell, J.F.; Atterbury, T., Renewable resource inventories for monitoring changes and trends: Proceedings of an international conference; 1983 August 15-19; Corvallis, OR. SAF 83-14. Corvallis, OR. Society of American Foresters: 416-419.

Campbell, H.W.; Christman, S.P. 1982. Field techniques for herpetofaunal community analysis. In: Scott, N. J., Jr., ed. Herpetological communities. Wildlife Research Report 13. Washington DC; US Department of the Interior, Fish and Wildlife Service: 193-200.

Chen, J.; Franklin, J.F.; Spies, T.A. 1995. Growing season microclimate gradients from clearcut edges into old-growth Douglas-fir forests. Ecological Applications 5: 74-86.

Corkran, C.C.; Thoms, C. 1996. *Amphibians of Oregon, Washington, and British Columbia*. Lone Pine Publishing. 175 p.

Corn, P.S.; Bury; R.B. 1990. Sampling methods for terrestrial amphibians and Reptiles. USDA Forest Service, Pacific Northwest Research Station, Portland, OR. General Technical Report PNW-GTR-256. 34 p.

Dumas. P. 1956. The ecological relations of sympatry in *Plethodon dunni* and *Plethodon vehiculum*. Ecology 37:484-495.

Fellers, G.M.; Drost, C.A. 1994. Sampling with artificial cover. In: Heyer, W.R.; Donnelly, M.A.; McDiarmid, R.W.;Hayek, L. C.; Foster, M.S., eds., *Measuring and monitoring biological diversity: standard methods for amphibians.* Smithsonian Institution Press. Pp 146-150.

Hairston, N. 1987. *Community ecology and salamander guilds*. Cambridge University Press. 230 p.

Herrington, R.E. 1988. Talus use by amphibians and reptiles in the Pacific Northwest. In: Szaro, R. C.; Severson, K. E.; Patton, D. R., eds., Management of amphibians, reptiles, and small mammals in North America. USDA Forest Service, Rocky Mountain Forest and Range Experiment Station, Fort Collins, CO. General Technical Report RM-166.

Jaeger, R.G. 1994. Transect sampling. In: Heyer, W.R.; Donnelly, M.A.; McDiarmid, R.W.; Hayek, L.C.; Foster, M.S., eds., *Measuring and monitoring biological diversity: standard methods for amphibians*. Smithsonian Institution Press. Pp 103-107.

Jones, L.L.C. 1999 (in review). Management Recommendations for the Van Dyke's salamander (*Plethodon vandykei*). In: Olson, D.H., ed., Management Recommendations for Survey and Manage Amphibians, Version 2.0. Interagency publication of the Regional Ecosystem Office, Portland, OR.

Leonard, W.P.; Brown, H.A.; Jones, L.L.C. ;McAllister, K.R.; and Storm, R.M. 1993. *Amphibians of Washington and Oregon*. Seattle Audubon Society. 168 p.

Nussbaum, R.A.; Brodie, E.D., Jr. 1983. *Amphibians and reptiles of the Pacific Northwest.* University Press of Idaho. 332 p.

Olson, D.H., ed. 1999. Management Recommendations for Survey and Manage Amphibians, Version 2.0. Interagency publication of the Regional Ecosystem Office, Portland, OR.

Olson, D.H. (ed.); Applegarth J.; Bury, R.B.; Clayton D.; Crisafulli, C.; Jones, L.L.C.; Ollivier, L.; Welsh, H.H., Jr. 1996. Survey protocols for Component/Strategy 2 amphibians. Portland OR: Special Interagency Publication, Regional Ecosystem Office, Survey and Manage species. 73 p.

Organ, J.A. 1961. Studies of the local distribution, life history, and population dynamics of the salamander genus *Desmognathus* in Virginia. Ecological Monographs 31:189-220.

Scott, N.J., Jr.; Woodward, B.D. 1994. Surveys at breeding sites. In: Heyer, W.R.; Donnelly, M.A.; McDiarmid, R.W.; Hayek, L.C.; Foster, M.S., eds., *Measuring and monitoring biological diversity: standard methods for amphibians*. Smithsonian Institution Press. p. 118-125.

Slater, J.R. 1933. Notes on Washington salamanders. Copeia 1933:44.

Stebbins, R.C. 1951. *Amphibians of western North America*. Univ. California Press, Berkeley. 539 p.

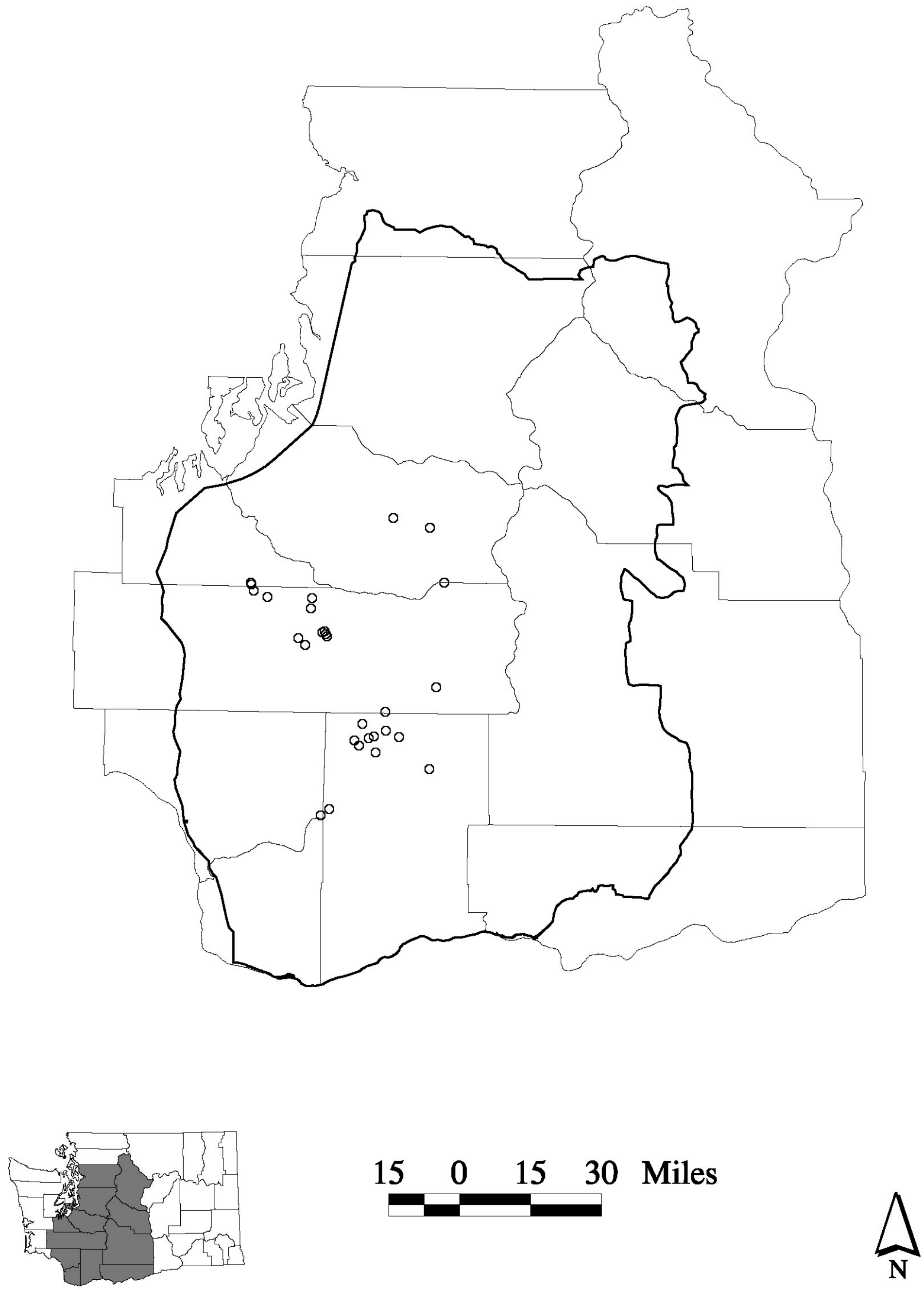
Stebbins, R.C. 1985. *A field guide to the western amphibians and reptiles*. Houghton Mifflin Co., Boston. 279 p.

USDA Forest Service, and Department of the Interior, Bureau of Land Management. 1994. Record of Decision: for amendments to Forest Service and Bureau of Land Management planning documents within the range of the northern spotted owl: Standards and Guidelines: for management of habitat for late-successional and old-growth forest related species within the range of the northern spotted owl. Portland, OR. Irregular pagination.

Wilson, A.G., Jr. 1993. Surveys for Van Dyke's salamander in Washington. Unpublished Report on file with Washington Department of Fish and Wildlife.

Wilson, A.G., Jr.; Larsen, J.H., Jr.; and McAllister, K.R. 1995. Distribution of Van Dyke's salamander (*Plethodon vandykei* Van Denburgh). American Midland Naturalist 134:388-393.

Figure VI.1. Known distribution of the Van Dyke's salamander in the Washington Cascades. The heavy line represents the species survey zone.



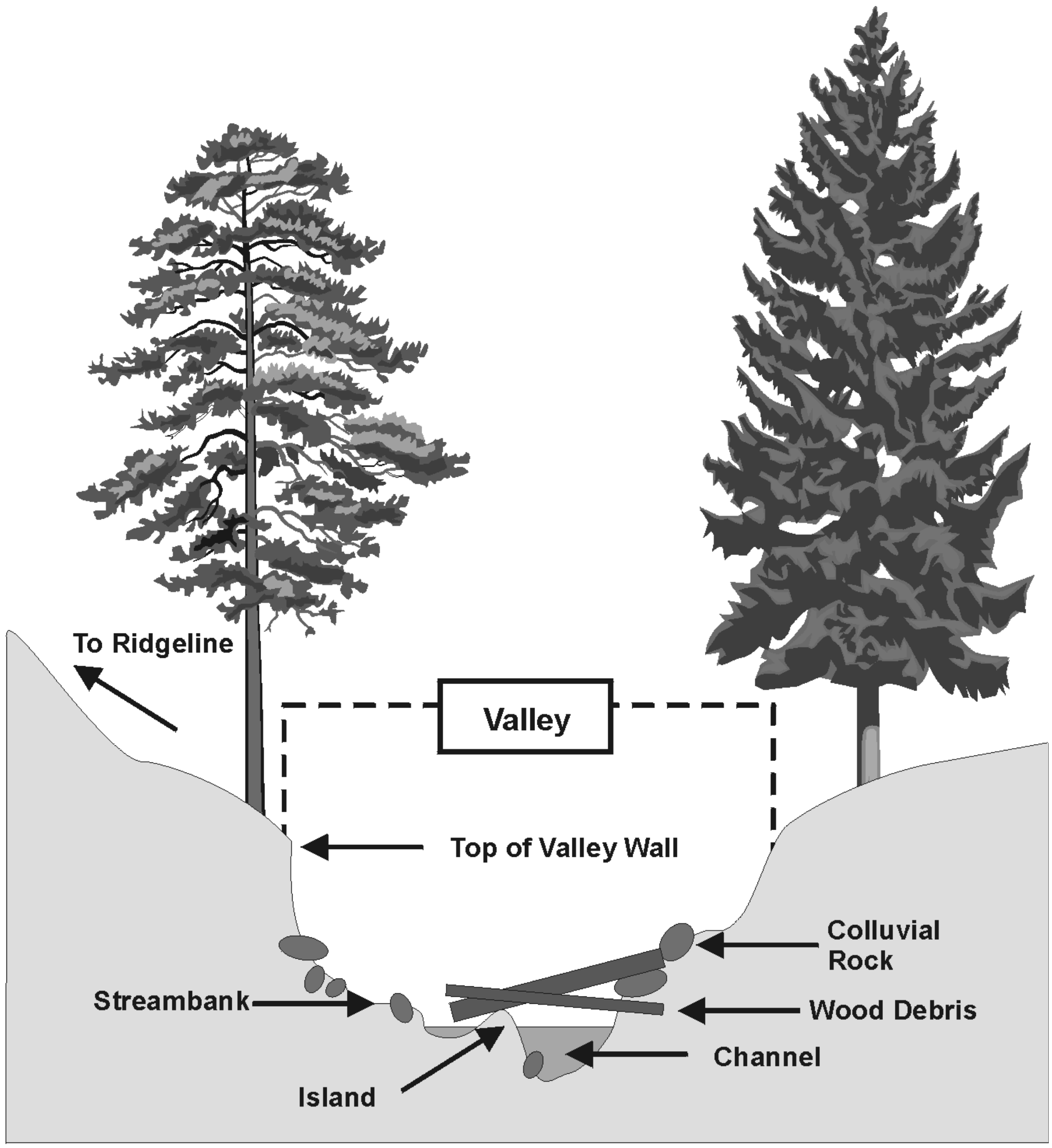


Figure VI. 2. Cross section of a stream valley (not always present). The eroded break-in-slope marks the top of the valley wall--it should not be confused with the ridgeline. The top of the valley wall usually coincides with the treeline. When a valley is not present, the treeline is synonymous. For streamside surveys, the area from the wetted edge to the top of the valley wall/treeline or out 10 m (whichever is greater) is surveyed (including islands and suspended logs). Colluvial rock, wood debris, and other cover should be searched. PLVA may be found under cover embedded in the valley wall. The area above the valley is surveyed for PLLA (hence also PLVA).

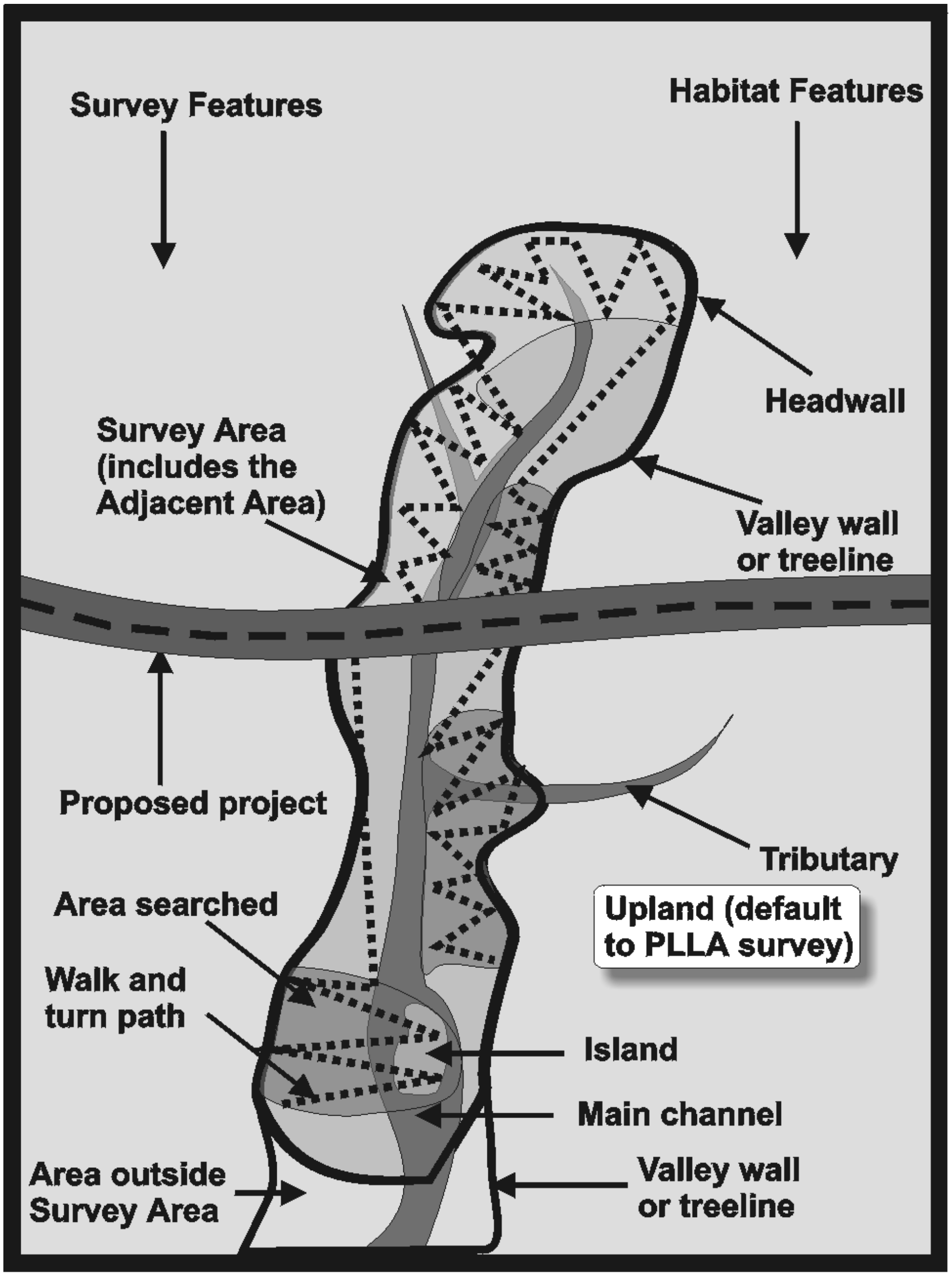


Figure VI.3. An example of a streamside transect, showing habitat features (right) and survey features (left), from above. In this example of a linear project perpendicular to the stream, the survey area is the area above and below the proposed road and culvert within the stream valley. The area upslope from the valley will be surveyed for PLLA (hence, PLVA). The walk and turn path zig-zags from the wetted edge to the top of the valley wall. Because 50% of this site does not get searched (pink), it should be searched during subsequent visits and/or during the 1 p-h opportunistic search. Tributaries should be searched if they could be affected by the project.

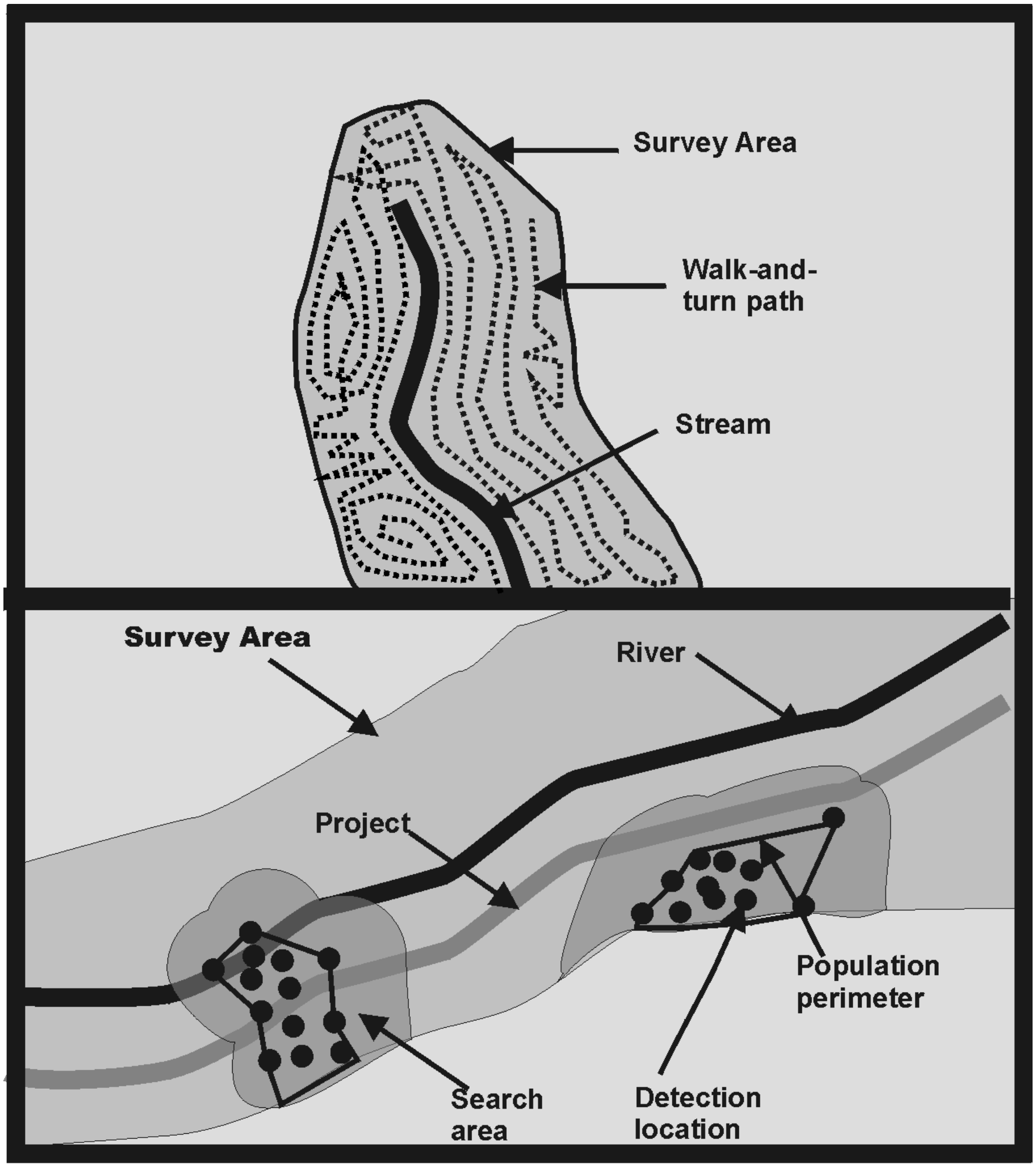


Figure VI.4. Examples of site delineation surveys. At this point, 3 protocol surveys would have been completed. In the above example, the project is small, as is the survey area. The survey team does an extensive site delineation survey by doing walk-and-turn over the entire area. Note that the search patterns are discretionary, changing shape to best afford coverage of the survey area. In the bottom example is a large-scale, linear-parallel project (e.g., a large trail along a river). During the protocol surveys, 2 populations (or subpopulations) were discovered. During the subsequent site delineation surveys (dark green search area), the extent of the subpopulations were revealed, as shown by the perimeter line. Now the survey area can be managed accordingly, focusing on the perimeter of the population in the survey area.

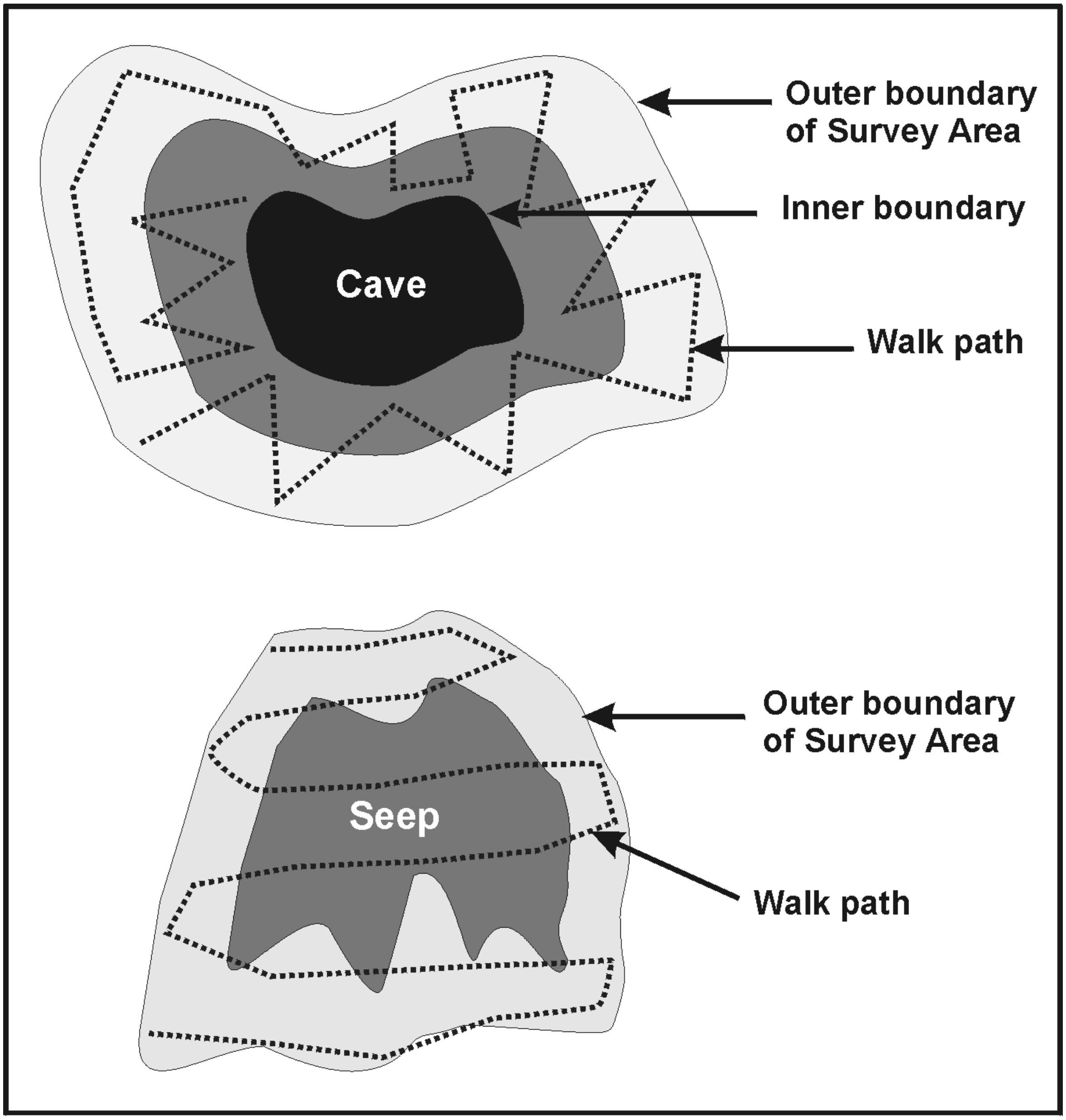


Figure VI. 5. Examples of area searches. In the upper example, a cave (sinkhole) is proposed to have a stairway installed for public access. The area to be surveyed extends 10 m inside and 10 m outside the entrance. The search pattern used here is a zig-zag. In the lower example, a seep is surveyed. The seep is small and less than 5mm deep, so the entire seep is surveyed, as well as 10 m beyond the edge of the seep. In this example, a parallel line search pattern is chosen as the most effective for coverage (at surveyor's discretion).

Plate VI.1 Adult Van Dyke's salamander (*Plethodon vandykei*), light phase (Photo by William P. Leonard).

Plate VI.2 Adult Van Dyke's salamander, dark phase. Note dorsal stripe color "dripping" on sides indicated by arrow (Photo by William P. Leonard).

Plate VI.3 Van Dyke's salamander, dark phase, ventral coloration. Note yellow throat patch indicated by arrow. Light phase animals also have yellow throat patch, but it blends in with ventral color, which is similar to dorsal color (Photo by William P. Leonard).

Plate VI.4 Close-up of the head of an adult Van Dyke's salamander (light phase), showing nasolabial groove and parotoid glands (Photo by Larry Jones).

Plate VI.5 Partially webbed foot of Van Dyke's salamander. Outer toe has one more phalanx (toe bone) than Larch Mountain salamander (Photo by William P. Leonard).

Plate VI.6 Juvenile Van Dyke's salamander, light phase. Dark lateral coloration will fade with age (Photo by Larry Jones).

Plates VI.7-14 Examples of Van Dyke's salamander habitats.

Plate VI.7 Splash zone of a waterfall (Photo by Larry Jones).

Plate VI.8 Colluvial debris (rock and wood) in a stream valley. Van Dyke's salamanders often congregate in such debris, outside or above the active channel (Photo by Larry Jones).

Plate VI.9 Seepage (Photo by Larry Jones).

Plate VI.10 Colluvial rock in valley wall - commonly used Van Dyke's salamander microhabitat (Photo by Larry Jones).

Plate VI.11 Steep-walled stream valley habitat (Photo by Larry Jones).

Plate VI.12 Montane lake habitat in Mt. St. Helens blast zone (Photo by Joseph Kling).

Plate VI.13 Cave (lava tube) habitat for Van Dyke's and Larch Mountain salamanders (Photo by Joseph Kling).

Plate VI.14 Steep-walled stream valley habitat and cascades (Photo by Larry Jones).

Plate VI.15 Light-phase adult Van Dyke's salamander guarding eggs (Photo by William P. Leonard).

Plate VI.16 Long-toed salamander (*Ambystoma macrodactylum*) (Photo by William P. Leonard).

Plate VI.17 Western red-backed salamander (*Plethodon vehiculum*) - normal color pattern (but dorsal stripe color highly variable) (Photo by Larry Jones).

Plate VI.18 Western red-backed salamander - two stripe (partially amelanistic) form (Photo by William P. Leonard).

Plate VI.19 Western red-backed salamander - melanistic form (Photo by Larry Jones).

Plate VI.20 Ensatina (*Ensatina eschscholtzii*) (Photo by William P. Leonard).


Plate VI.1

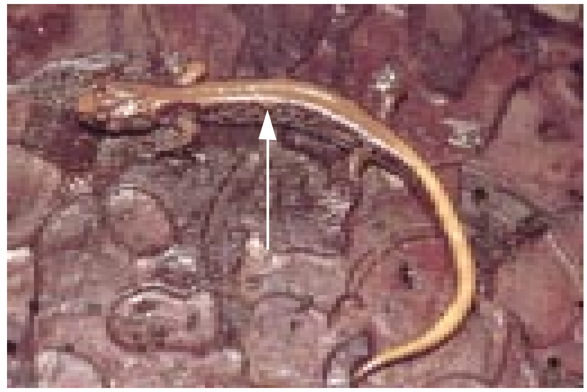


Plate VI.2


Plate VI.3


Plate VI.4


Plate VI.5


Plate VI.6

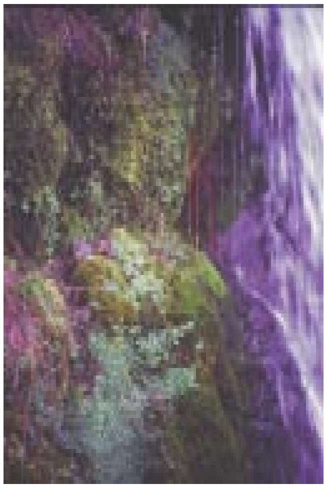
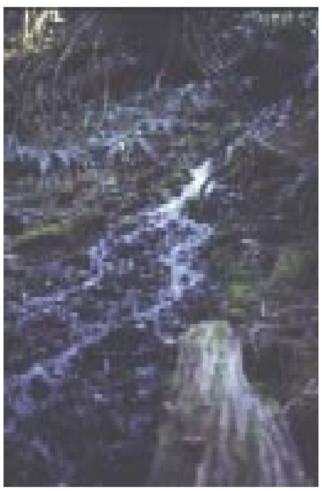


Plate VI.7

Plate VI.8



PlateVI.9

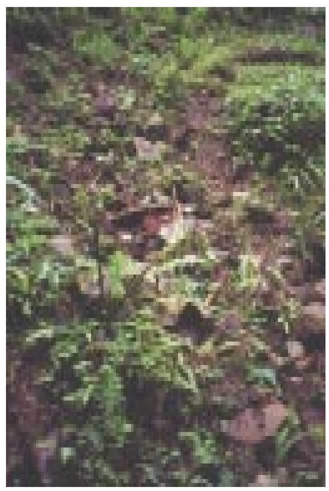


Plate VI.10

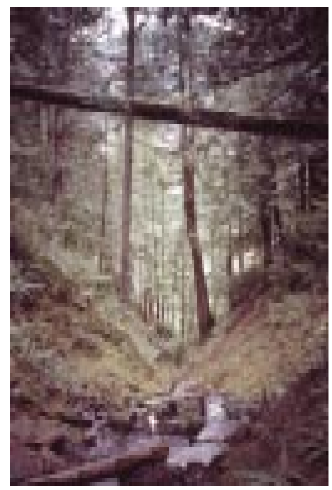


Plate VI.11

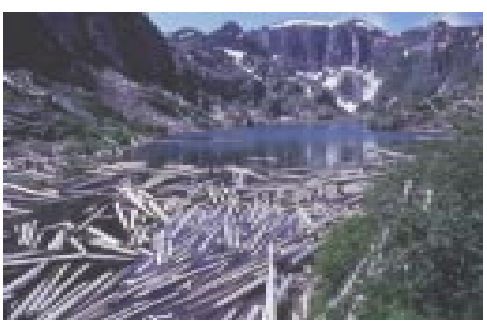


Plate VI.12

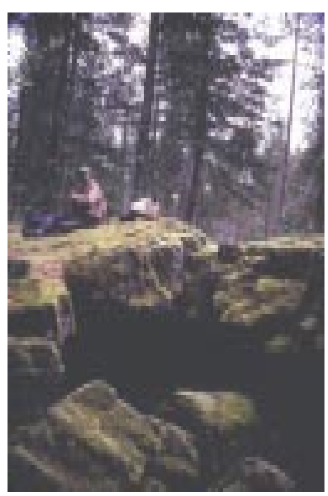


Plate VI.13

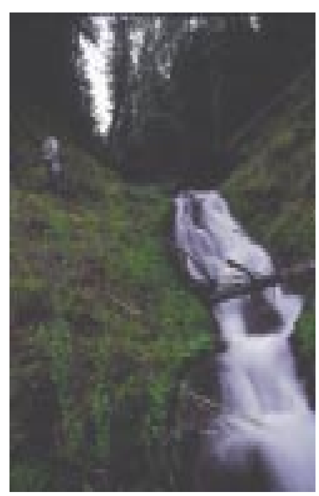


Plate VI.14


Plate VI.15


Plate VI.16


Plate VI.17


Plate VI.18


Plate VI.19


Plate VI.20

Appendix VI.1. Instructions and data forms for Van Dyke's salamander surveys. Use 1 form per site visit. The shaded area of the first form is only filled in if a target species is captured.

<u>Van Dyke's Salamander Survey Data Form</u>
<u>(to be used during all site visits)</u>

Recorder/Observers: Names of observers and the recorder, including middle initials.

Protocol/Supplemental: Circle the survey type that applies.

P__ of __: Page number of total pages for this particular site for this particular site visit.

Survey Team: This is the affiliation and location of the parties involved in surveying. For example, it might read, "surveys conducted for USDA Forest Service, Packwood RD, contracted through Schmill Biological Contracting, Schmillville, WA. Jill Schmill, survey team lead, 360-555-642-8941.

Protocol citation/date: Enter the citation and publication/draft date for the protocols being used. If other documentation exists (e.g., letters of guidance from Regional Ecosystem Office or Protocol Amendment) include those references also.

Project Identifier: The name or number assigned to the site-disturbing activity project area. This should be in permanent record with the land manager.

Survey __ of __: The sequential number of the survey for that site. For example, if it is the 2nd of 3 visits, it would be 2 of 3.

State: Two-letter state code.

Co: County name.

Environmental Conditions:

RH: Measured relative humidity of air in %, 1 m from ground, 10 m from edge of body of water or (for upland surveys) at starting point.

Air temp: Air temperature in ^{o}C, measured 1 m from the ground, 10 m from edge of body of water, in shade or (for upland surveys) at starting point.

Soil temp: Soil temperature, measured 1 m from the ground, 10 m from edge of water, in shade or (for upland surveys) at starting point.

Proceed?: Circle Yes or No, depending on environmental conditions. If they do not meet minimally acceptable, circle no, and do not proceed with survey unless it is done as a supplementary search.

Start and Finish: Date (month/day/year) and time (2400 h-clock) of start and finish of survey.

Detected?: If target species was detected, circle Yes. If not detected, circle No.

Survey Area: Estimate of the Survey Area (e.g., length * mean width) that was searched in m^2.

% Area: Percent of the Survey Area that was adequately surveyed.

Net time: The amount of time in person-hours (p-h) expended doing this survey. Always use net time (recording time, lunch, traveling, etc., not included).

Verified by: The name of the person(s) that verified the specimen(s) was a PLVA or Larch Mountain salamander.

Locality Data: Refers to starting point, locality of PLVA and/or Larch Mountain salamander. It could be for an individual capture or at the center of detections for that species.

T./R./S/QS: Township, range, section, and quarter section (1/16th or better should also be recorded). Sites need to be relocated to within 100 m.

UTM's Universal Transverse Mercator coordinates, N and E, to nearest m or best measure possible.

Elev: Elevation in m or feet (circle).

Aspect 1: Azimuth reading to nearest degree along downhill slope.

Aspect 2: Azimuth reading for the overall slope direction. For example, if target species is on a west-facing valley wall of a north-facing slope, aspect 1 is W and aspect 2 is N. Aspect 1 and 2 may be the same. Record to nearest cardinal direction (NSEW).

Drainage: The drainages involved in active project area, starting with smallest drainage and working towards larger drainage. For example, unnamed tributary of Salamander Creek, a tributary of the North Fork Tailed Frog River.

Locality of captures: Very important if target species are captured. This is a written description of how you got to the area and just where the species was detected. Use additional sheets if necessary and attach maps, photos, field notes, and GPS filenames.

Markers: Written descriptions of how the site was marked with particular reference to permanence of the markers.

Method: Circle the one(s) that applies.

Habitat: The type(s) of habitat that is/are being surveyed. Circle all that apply.

Species Tallies: Total count of captures for each species detected during survey.

<u>Optional but Recommended Data Form for Protocol Surveys</u>
<u>Always use this form for Site Delineation Surveys</u>

Species: Four-letter code (see attached) of species sampled. All species of amphibians are recorded. Each row entry is for a single individual.

Stage: H = hatchling (terrestrial species); J = juvenile (terrestrial species, includes subadults); A = adult (showing secondary sexual characters or of approximately reproducible size for terrestrial species; any fully metamorphosed aquatic species); L = larva (even if neotenic); M = metamorphosing (larval and metamorphosed characters present).

TL: Total length, in mm. Measured from tip of snout to tip of tail (tail may break, so SVL is important to record also).

SVL: Snout-vent length, in mm, to posterior margin of vent.

Cover: Cover object. S = on top of the substrate; R = rock; W = wood; O = other.

Moist: Moisture at point of capture. D = dry; M = moist; W = wet; S = saturated, a noticeable layer of water present.

DS: Distance in m to nearest dm to stream edge.

DW: Distance to other water, if closer, if applicable (if not enter N/A).

DV:	Distance to bottom of valley wall if applicable (if not, enter N/A). If below a valley wall bottom, number is negative; if above, number is positive.
DL:	Distance to linear project. If above the disturbance area (e.g., a road construction) the number is positive; below is negative.
Status:	C = collected for museum specimen; V = collected for verification (this animal is the one addressed in “Verified by” field); R = released; P = photographed; D = discarded.
Field_No:	Field number that will go on the tag of any vouchered specimens. Usually, it is someone's initials (cataloger) and a sequential number.
Comments:	Add anything that may be important.

Van Dyke's Salamander Survey Data Form (to be used during all site visits)

Recorder:	Observers:	Supplemental Protocol			P_____ of _____
Survey Team:					
Protocol citation/date:					
Project identifier:		Survey___of____	State:		Co:
Environmental Conditions:	RH:	Air Temp:	Soil Temp:		Proceed? Yes No
Start: Date:	Time:	Van Dyke's Salamander: Detected? Yes No			
Finish: Date:	Time:	Larch Mountain Salamander: Detected? Yes No			
Survey Area	% Area:	Net time: p-h	Verified by:		
Starting Point: T/R/S/QS		UTM's	Elev: ft. m.		Aspect 1 2
Van Dykes's T/R/S/QS		UTM's	Elev: ft. m.		Aspect 1 2
Larch Mountain T/R/S/QS		UTM's	Elev: ft. m.		Aspect 1 2
Drainage:					
Locality of capture(s):					
Markers:					
Method: (1) Upland Transect (2) Streamside Search (3) Area Search (4) Other:_________________________________					
Habitats: (1) Stream (2) Seep (3) Lake (4) Waterfall (5) Upland (6) Cave (7) Rockface (8) Talus (9) Other__________					
Species Tallies:					

Data Form for Sites with Target Species Detections
(Protocol Surveys: form is optional but recommended; Site Delineation Surveys: form is always used)

Species	Stage	TL	SVL	Cover	Moist	DS	DW	DV	DL	Status	Field_No
Comments											

Chapter VII

Survey Protocol for Larch Mountain Salamander (*Plethodon larselli*)

Version 3.0

OCTOBER 1999

Charles M. Crisafulli

AUTHOR

CHARLES M. CRISAFULLI is a research ecologist, USDA Forest Service, Pacific Northwest Research Station, 3625 93rd Avenue SW, Olympia, WA 98512 and the Mount St. Helens National Volcanic Monument, 42218 NE Yale Bridge Road, Amboy, WA 98601.

ABSTRACT

The Larch Mountain salamander (*Plethodon larselli*) is listed as a Survey and Manage Species under the auspices of the Northwest Forest Plan. The plan requires that surveys be performed for this species prior to most ground-disturbing activities on federal lands that are within the known or suspected range and habitats of the salamander. This chapter is the standardized survey protocol to detect this species at a site. Larch Mountain salamanders have a restricted range and are found in the northern Cascade Range of Oregon and the southern and central Cascade Range of Washington. They are known to occupy a diverse range of habitat types including: forests of various age and structural classes, non-forested scree and cave systems. Surveys are to be performed during spring or fall when environmental conditions maximize the probability of detecting animals. Within the survey windows, certain environmental conditions must be met: 1) soil and substrate temperatures must be from 4-14°C; 2) soil and substrate conditions must be wet; and 3) the survey site cannot have experienced freezing temperatures during the 72 hr preceding the survey. Three surveys are needed at each survey location, unless the species is detected during the first or second visit. The species is designated as "present" if one or more individuals are found during any of the surveys. The survey design uses belt transects arrayed parallel across a survey site and animals are systematically search for by turning cover objects (wood and rocks). The protocol describes the step-by-step procedures for conducting the surveys from initial planning through completion.

Version 3.0

TABLE OF CONTENTS

INTRODUCTION

This survey protocol was developed in response to the Record of Decision for the Northwest Forest Plan (USDA and USDI 1994) for determining the presence of the Larch Mountain salamander, *Plethodon larselli* (PLLA), on federally owned and managed lands. It is also the method used to assess Van Dyke's salamanders (*Plethodon vandykei*) in upslope forested habitats. It provides the conceptual framework and steps to conduct surveys in areas where site-disturbing projects have been proposed.

Before initiating surveys, read this entire document and its counterparts (Chapter I, this document; Olson 1999, the management recommendations), which include general information, and guidelines for Survey and Manage amphibians. Crisafulli (1999) provides a detailed overveiw on the general ecology, identification characteristics, habitat associations and management guidelines for the Larch Mountain salamander. This also should be reviewed before survey work is begun.

This survey protocol was developed specifically for PLLA. It should be noted however, that Van Dyke's salamander is another Survey and Manage species that has approximately the same geographic range in Washington (Figures VI.1 and VII.1; Chapter II, Figures II.5 and II.10). Although these species overlap in range, they tend to occupy disparate habitat types. PLLA is largely associated with upland environments and the Van Dyke's salamander is most often found along aquatic systems. Habitat associations are not well defined, however, and habitats used by these species can be temporally variable. At times they can be found sympatric in either upland or stream-side settings (Crisafulli, unpubl.). There has been a protocol specifically developed for the Van Dyke's salamander (Chapter VI, this document), which should be referenced when it is the target species. The Van Dyke's salamander protocol has a strong aquatic and riparian habitat emphasis, specifically tailored for intermittent, 1st and 2nd order streams and associated splash zones and seeps, and defaults to the PLLA protocol for upland forests searches. It is important to recognize, that the protocol described here for PLLA also will be used for Van Dyke's salamander in upland surveys. In this sense, the protocol described here will be conducted for both species at a given project area. Herein, when reference is made to PLLA surveys it should be explicitly understood that all information pertains to Van Dyke's salamander as well. The detection of either PLLA or Van Dyke's salamander at any site will invoke management restrictions, and in this sense, once one of the species is observed it may be possible to terminate the survey process, but this will need to be evaluated on a case-by-case basis.

Main Revisions and Clarified Procedures

This protocol is revised from the 1996 draft protocol (Olson et al. 1996). The list below summarizes the main revisions and clarified procedures specific to Larch Mountain salamander surveys. Revisions have resulted from new information, and extensive review comments provided by agency executives, managers, field specialists, species-experts, and non-agency scientists. Revisions were made for clarification and to refine procedures, but did not significantly alter the integrity of the 1996 draft protocol. Major elements of the revision include:

- **Flexible and fixed survey elements are clarified**
- **Survey triggers are defined and are discretionary**
- **Adjacent area survey distances are more discretionary, rather than 180 m**
- **Photographic plates of animals are included to aid species identification**
- **Photographic plates of habitats are included to aid habitat identification**
- **Summary of known site record compilation is included (Chapter II)**
- **Maps of known site locations are included**
- **Revised Survey Zones**
- **Revised Data Forms**
- **Expanded species description is provided to avoid misidentification**
- **Expanded habitat description is provided for clarification**
- **Spatial extent of survey coverage is suggested to be 40-100% of project area with likely habitat, depending on size of project**
- **No surveys should occur if there has been freezing within previous 72 hours (no freezing provision previously)**
- **Description of substrate moisture conditions is provided**
- **All 3 site visits may occur in the Fall or the Spring (i.e., Spring surveys are not required)**
- **Site delineation procedures are outlined**

Survey Requirements

The Northwest Forest Plan (USDA and USDI 1994, Table C-3, p.C-5 & C-51, C-28) identifies PLLA as a Component/Strategy 2 species, under the Survey and Manage provision, and as a Protection Buffer species. Component/Strategy 2 specifies to survey prior to ground-disturbing activities within the known or suspected range and at sites that contain habitat with which the species is associated. If animals are detected the habitat is managed according to specific management recommendations. Protection Buffer guidelines state that surveys must be performed using a standardized protocol.

The intent of this protocol is to determine whether PLLA is present at a survey location. Once a PLLA specimen has been observed, the survey requirement has been fulfilled and the current survey can be terminated. However, because our knowledge of this species is generally poor, I recommend surveying beyond the first detection. Options could include surveying: 1) for the full amount of time necessary to complete the current survey on the entire project area; and 2) to do #1 above and delineate the extent of area occupied by PLLA. The latter would require additional survey effort and is described in the site delineation section below. Data from these optional survey approaches could help expand our knowledge of the spatial patterns and relative abundance of PLLA across its range and be used to improve the management recommendations for this species. This protocol was developed to maximize the probability of detecting *P. larselli* individuals if they are present at a site. In order to standardize surveys for probability of detection (i.e., risk of Type 2 error, Chapter I), it is important that a protocol be followed. Procedures for conducting both the survey protocol and optional surveys (i.e., site delineation) for PLLA are provided below.

State Regulations--In Oregon, PLLA is a State Sensitive species, listed in the Vulnerable category, and considered Protected wildlife (OAR 635-44-130). A permit from the Oregon Department of Fisheries and Wildlife (ODFW) is needed to capture or take this species. In Washington, PLLA is a "State Sensitive" species. It was designated as such because it was viewed to be vulnerable or declining and would likely become threatened or endangered within the State without cooperative management or removal of the threats (Washington Department of Fish and Wildlife, 1993). As a State Sensitive species, the Washington Department of Fish and Wildlife (WDFW) requires that the species be considered prior to issuing permits where a particular action may jeopardize PLLA populations and/or habitat. A Scientific Collection Permit is needed to collect specimens for research or public display. Scientific Collection Permits can be obtained through ODFW and WDFW. Applicants should allow 2 to 3 months to receive their permit once they have submitted the appropriate paper work.

Surveyor Training--Prior to conducting surveys for PLLA, field personnel need to become acquainted with the species' general biology and ecology, habitat associations, geographical distribution, seasonal activity patterns and description, including the specific anatomical and morphological features that will lead to an unequivocal identification once a salamander is encountered. Species identification skills are paramount and each surveyor must be adept at identifying the target species and all other salamander species that are known to occur in the Survey Area. This includes all of the various color forms and age-dependent characteristics. Crew members must fully understand the survey procedures to ensure that the surveys will be conducted according to protocol design.

<u>Training Requirements</u>

- **Two-day training session**
  - **One day of lecture and species identification**
  - **One day of field instruction**
- **Surveyor skills include**
  - **Ability to identify all salamander species encountered**
  - **Ability to identify target species' likely habitat**
  - **Knowledge of species' microhabitat associations**
  - **Knowledge of species' microclimate associations**
  - **Knowledge of species' surface activity patterns**

Knowledge of survey protocol and its implementation
Knowledge of documentation procedures, dataforms and discretionary decisions

Presence-- The detection of a single individual constitutes "present" status. Additional surveys will not be necessary, however continuing surveys beyond first-detection is recommended due to our lack of knowledge about this species.

Not detected-- If three protocol surveys have been conducted and the target species was not observed the species is given "not detected" status. It should be noted however, that even after the minimum three surveys, each having negative results, it cannot be stated unequivocally that the species was "absent" from a site.

GENERAL BIOLOGY AND ECOLOGY

Crisafulli (1999) provides an overview of PLLA natural history and general ecology (see references therein for specific topics). General references for identification are Nussbaum et al. (1983), Stebbins (1985), Leonard et al. (1993) and Corkran and Thoms (1996), Petranka (1998).

Plethodon larselli is a member of the lungless salamander family, Plethodontidae. It is one of eight western species of woodland salamanders, genus *Plethodon*. As for all *Plethodon*, PLLA has an entirely terrestrial life history strategy, and is associated with forested and scree environments that provide cool, moist conditions. When climatic conditions are appropriate animals can be found on or near the surface, typically hiding under wood or rock substrates (cover objects). They are largely nocturnal animals, but occasionally can be observed active on the surface during daylight hours. Surface activity is thought to be largely governed by prevailing moisture/temperature conditions, and due to an apparent high sensitivity to these parameters (Chapter I), animals spend the majority of the year in subterranean environments. Total time of surface activity is probably on the order of 20 to 90 days annually, varying with latitude, altitude, site characteristics, and prevailing moisture and temperature conditions.

Species Identification

Characteristics of this species which distinguish it from possible sympatric congeners are its **pink-to-red abdomen (Plate VII.5), the dense and uniform iridophore pattern on its sides (Plate VII.11) and one phalanx on the fifth toe of the hind foot (Plate VII.7)**. Photographs with key identification characteristics for *P. larselli* and species with which it could be confused can be found in Plates VII.1-11**.**

Plethodon larselli is the smallest of the western *Plethodon* species. Adults range in size from 39 to 54 mm snout-vent length (SVL) and up to 103 mm total length. The smallest juvenile reported was 12 mm SVL (Crisafulli 1999). This species has 14-16 (modal 15) costal grooves. Adult males lack mental glands. Brodie (1970) reported significant differences in a number of morphological characters (e.g., number of teeth, dorsal stripe melanophore concentration and size) among populations.

Age-based variation in color and pigmentation occurs within populations (Brodie 1970, Crisafulli unpubl.). *Plethodon larselli* has an **uneven-edged dorsal stripe, red, orange, chestnut or brown in color, with moderate to heavy infusions of melanophores** (Burns 1954, 1962, 1964a, 1964b, Brodie 1970). In adults, the dorsal stripe terminates abruptly at the head but continues to the tip of the tail, where it is brightest. Flecks of the dorsal stripe color is often present on the head. Subadults and younger adults frequently have melanophore pigmentation in a herring bone pattern down the center of the dorsal stripe (Plate VII.3). With age, this pattern often becomes obscured as melanophore density increases and appears as blotches or as an irregular stripe (Plate VII.4). The ground color is black and is most conspicuous as a **narrow (i.e., 1-3 mm wide) stripe below the dorsal stripe (Plate VII. 11)**. On most individuals, the **sides have dense concentrations of iridophores (white and gold pigments), which obscure the black ground color of the sides**. The iridophores are present as a band below the black stripe bordering the dorsal stripe and continue to the margin of the venter. Within this band, the iridophores are uniform on the costal folds, but are often lacking in the costal grooves. The **ventral surfaces** of adults can be variable, **ranging from gray with pink hues to bright red in color**. The venter has few if any melanophores present. Juveniles differ from adults in having an even dorsal stripe margin with few or no melanophores present (Plate VII.8), and a black venter with a single or multiple blotches or flecks of red pigments. Consequently, the young superficially resemble the western red-backed salamander *(Plethodon vehiculum,* Plate VII.9*;* C. Crisafulli, unpubl. data).

Range

The Larch Mountain salamander is found along a 58 km (36 mi) stretch of the Columbia River Gorge, and in isolated populations to the north in the Washington Cascade Range (400-1200 m elevation, ~1300-3950 ft). Known Oregon populations are within about 22 km (~ 14 mi) of the Columbia River, in Multnomah and Hood River Counties. In Washington, they occur in Clark, Cowlitz, Skamania, Lewis, King, Klickitat, and Kittitas Counties, to 193 km (about 120 mi) north of the Columbia River Gorge. Known Washington State sites are within about an 11,194 km^2 (4,320 mi^2) area. The known distribution is shown in Figure VII.1. Within this area *P. larselli* is patchily distributed, and can be locally abundant. The current knowledge of the species range is likely incomplete and several range extensions have occurred over the past decade (Chapter II). Some of these extensions have increased the known range of *P. larselli* by more than 30 km. It is expected that additional range extensions will occur in the future, and will likely include areas to the north, south and east.

Habitat

Plethodon larselli has been characterized as a talus obligate by several investigators (e.g., Burns 1964c, Nussbaum et al. 1983, Herrington and Larsen 1985). However, more recent investigations have revealed that PLLA is associated with a much broader array of habitat types than originally proposed (Crisafulli, unpubl). PLLA is now known to occupy several structurally and compositionally distinct habitats throughout its range (e.g., Plates VII.12-19). While the majority of known sites possess some form of rocky substrates, ~ 22 of the 99 sites lack this habitat feature (Crisafulli, unpubl). The composition and quantity of vegetation components (e.g., overstory, shrub, herb and moss), substrates (e.g., soil, rock) and cover objects (e.g., wood debris, rock) ranges widely among occupied sites (Crisafulli, unpubl). Additionally, while it is typically thought of as an upland species, PLLA also can be found in close proximity (e.g., < 5 m) to streams, but where the vegetation is clearly an upland association.

Habitats that require surveys:

forests of variable age, composition and structure
areas dominated by rocky substrates (gravelly soil to scree) regardless of vegetation (non-vascular to old-growth forest communities)
cave systems (twilight zones, entrances)
occasionally in or around seeps

Habitats that <u>DO NOT</u> require surveys:

wetlands such as swamps, bogs, marshes
meadows and pastures
permanent snow fields and glaciers

Habitat Features:

Vegetation–The vegetation at known PLLA sites varies tremendously and ranges from areas dominated by non-vascular plants (lichens and mosses) to structurally complex old-growth forest communities.

Soils and Substrates– Soil and substrate are highly variable across known PLLA sites. Conditions range from well developed pumice-derived sandy loam soils to scree. Intermediate to these extremes are gravelly and cobble soils and areas of rocky substrates with little soil present.

Physical Site Conditions–The physical site conditions among known sites vary a great deal, including: elevation, slope (%), aspect, annual precipitation and snowpack amount and duration

(Crisafulli, unpubl). Animals have been captured at sites with aspects representing each of the cardinal directions and combinations thereof, and with slopes from 10 to >100 %.

Spatial Elements of Habitat–PLLA are believed to have small home ranges and limited dispersal capabilities. Consequently, animals may operate at very small spatial scales and can occur in small (e.g., <$100m^2$) pockets of refugia following disturbances. Refugia can be located on the edges of habitat or sporadically embedded within the matrix. Colonization from refugia into adjacent suitable habitat can be limited by the species' low fecundity, poor vagility, and by sharp habitat boundaries caused by contrasting environmental conditions, which restrict movement. Dispersing animals may be found in adjacent habitat of marginal quality under optimal environmental conditions (wet cycle), but probably undergo local extinctions during ecological crunches (*sensu* Wiens 1989). Another outcome of PLLA limited mobility and tolerance limits to environmental conditions is the widespread presence of unoccupied suitable habitat. Colonization may be a slow process that occurs by marginal expansion radiating from refugia. Stochastic processes can exert powerful influences on abundance and distribution patterns of species such as PLLA (see Brown 1995).

Relationships between Vegetation and Substrates–Suitable habitat for PLLA may result from several mixes of vegetation and substrate conditions. When rocky substrates (gravelly soil to scree) are present, a variety of vegetation compositions or cover types may occur. These include: closed forests; open forests; shrub or herb dominated communities; and sites dominated by non-vascular plants. In the absence of rocky substrates, a more restricted vegetation and cover types appear necessary (Crisafulli and Trippe, unpubl). Generally, known sites with loamy soils possess late-seral forest conditions (e.g., complex stand structure and moderate to high levels of woody debris). It should be noted that stand age is not always a good indicator of late seral condition, particularly if a system is recovering from natural disturbance, where there may have been significant retention of pre-disturbance components (i.e., biological legacies). Therefore, a forest stand where the dominant tree cohort is young (< 80 yr) may still have late seral features. Ongoing research and compilation of existing data is hoped to better define the habitat associations for this species along both vegetation and substrate gradients, and their hypothesized interactions.

SURVEY PARAMETERS

Triggers

Triggers are circumstances or conditions that serve as a catalyst for conducting surveys. Typically, these will be proposed ground-disturbing activities that could have deleterious effects on PLLA or their habitats.

Trigger Criteria: Surveys are triggered when the proposed activity occurs:

on federal lands covered by the Northwest Forest Plan, and
within the Survey Zone for PLLA, and
within suitable habitat for PLLA, and
the proposed project may affect animals directly or indirectly by degrading habitat.

Ground-disturbing activities that alter vegetation structure or substrates have the potential to negatively affect PLLA. Adverse effects on the microhabitat conditions are of specific concern. Microhabitat conditions important for PLLA include the three-dimensional physical structure of the substrate and surface cover features, and microclimate (e.g., temperature/moisture regime). Concerns for management include maintenance of the integrity of substrate interstices, surface debris (e.g., downed woody material), and cool, moist surface climate regimes. Proposed management activities that degrade these habitat elements are survey triggers.

Other forms of natural resource management activities (e.g., chemical and fertilizer treatments) that have little or no ground-disturbance may also affect animals. Chemical applications may affect animals directly through toxicity (mortality or by interrupting endocrine functions) or indirectly by creating inhospitable habitats. Some chemical applications (e.g., pesticides, fertilizers) may affect amphibians indirectly through their prey-base.

Trigger Decision Process--Land management activities should be evaluated on a case-by-case basis to determine if they are survey triggers. To determine whether a proposed project triggers a survey will require an evaluation of the four criteria listed above. With respect to the last criterion, surveys are triggered when the project is expected to either negatively affect PLLA habitat or cause direct mortality of individual salamanders. Site managers are expected to have the greatest discretion with regard to this final criterion. Site conditions and time of project implementation should be considered when determining if a particular activity is a trigger (see below).

Activities that May Not Trigger Surveys– Surveys may not be triggered for activities that are determined to have low potential to effect this species or its habitat. This may include activities that do not affect substrate integrity, or the microclimatic regime within suitable habitat. In addition, if a particular activity does not affect microhabitat conditions and it is timed so that the activity occurs when the animals are not surface active (e.g., during dry, summer months), and thus not expected to affect the animals themselves, the activity may not trigger surveys. See also Chapter 1 for further discussion of triggers.

Specific examples of triggers and non-triggers include:

1. Most proposed timber management activities, including thinning, regeneration harvest and salvage would trigger surveys. These types of activities involve reduction of canopy and high levels of disturbance to the substrates.

2. Road construction or reconstruction would trigger surveys. Routine road maintenance may not trigger surveys. Road construction and reconstruction can involve high levels of substrate disturbance and removal of overstory. Routine maintenance typically involves only those activities within the already disturbed road prism that is not likely to be habitat for PLLA.

3. Recreational development, such as campground development or expansion would trigger surveys. Routine maintenance may not trigger surveys. Development or expansion of recreational sites can involve overstory reduction and substrate disturbance, while maintenance only involves work in previously disturbed sites that may not be likely habitat.

4. Most mining activities, including new rock source development would trigger surveys. Rock removal at existing rock sources would not trigger surveys if no outward expansion of the site occurs and if activities are conducted when the animals are not active at the surface (generally July - September).

5. Chemical applications (e.g. pesticides, herbicides, fertilizers) within suitable habitats would trigger surveys. Surveys would not be triggered if applications are proposed within plantations less than 40 years old. Plantations are disturbed sites that generally do not provide suitable habitat due to the condition of their vegetation structure and disturbed substrates.

6. Prescribed fire as necessary for the reduction of fuel loads or stand management would generally not trigger surveys if burning is conducted when PLLA are not active at the surface (generally June - September), and no net loss of canopy would occur. If fire is introduced to a site when the animals are not active on or near the surface, direct effects to individuals should be negligible.

7. Road decommissioning - Surveys of roads would not be triggered for road decommissioning as it is unlikely the substrate affected within the road prism during decommissioning would be suitable habitat for the species. However, if the work is taking place in steep terrain (>40 %), which would require a large impact area during the decommissioning, surveys may need to be done.

8. Replanting and timber stand improvement (pre-commercial thinning) of plantations forty years old or less would not trigger surveys. Plantations are disturbed sites that generally do not provide suitable habitat due to low canopy closure and disturbed substrates.

9. Hazard tree removal of single trees and clearing blow-down from roads would not trigger surveys. This type of activity has low potential to impact to PLLA habitat.

10. Seeding of native species of grasses or plants would not trigger surveys. This type of activity has low potential to disturb PLLA habitat.

11. Construction or reconstruction of fences would not trigger surveys unless the construction would lead to increased disturbance within PLLA occupied habitat, such as might occur with livestock collection devices.
12. Special Forest Products: Proposed removal of rock would trigger surveys because of the potential for disturbance to PLLA substrate. Surveys would not usually be triggered for removal of forest products such as mushrooms, bear grass, fir boughs, and Christmas trees because of low levels of potential for disturbance to PLLA habitat.

13. Surveys would not be triggered for removal of small infestations of noxious weeds by hand pulling or digging because of the low potential for disturbance to PLLA habitat.

14. Areas proposed for concentrated wood cutting would trigger surveys due to the potential for canopy reduction, substrate disturbance, and impacts to microhabitat. Dispersed (single tree), wood cutting would not trigger surveys as this type of activity has a low potential to disturb substrate or reduce overall canopy within PLLA habitat.

15. Trail construction would trigger surveys due to alteration of substrates. Routine trail maintenance may not trigger surveys. Trail construction and reconstruction can involve high levels of substrate disturbance and removal of overstory. Routine maintenance typically involves only those activities within the already disturbed trail alignment that is not likely to be habitat for PLLA.

Survey Location

Survey Zone--The Survey Zone is defined as the geographic area where surveys may be triggered for PLLA. It includes the species' known range and adjacent areas beyond its range that have similar biophysical features (moisture and temperature regimes, geology, soils, plant communities, etc. (Figure VII.1). Areas that are contiguous to the species known distribution and with similar biophysical conditions are likely to support PLLA populations based on the species' inferred tolerance limits and the presence of suitable habitat. Few, if any, systematic surveys have been conducted in these areas and there is a reasonably high probability of PLLA occurrence. Moreover, during the past few years the range of this species has been extended considerable distances (e.g., 10-40 km) to the north, and to a lesser extent to the south. Within the Survey Zone, surveys are required only within the range of the Northwest Forest Plan, at sites containing suitable habitat (Figures II.5 and II.10). If suitable habitat occurs within a proposed project area or within the predetermined adjacent area (described below), then the protocol is triggered.

Survey Zone boundaries follow topographic or other mapped features of the landscape and are defined in Tables VII.1 and VII.2.

Survey Area-- Within the larger Survey Zone, the Survey Area includes the proposed project area for a site-disturbing activity and adjacent areas that contain PLLA habitat that may be affected by the proposed project (see below).

Project Area– An area where plans have been developed for potentially implementing some form of ground-disturbing activity is termed Project Area. On federally managed lands, common forms of project activities include: forestry practices, road and trail construction and mining (e.g., quarrying).

Table VII.1: Survey Zone boundaries for the Larch Mountain salamander in Oregon. Surveys are required on federal lands containing suitable habitat for the Larch Mountain salamander that are under the management direction of the Northwest Forest Plan.

Boundary	Description
Southern	From the mouth of Eagle creek east along the southern boundaries of the Eagle Creek 5th field watershed (hydrological Unit # 1709001105) and Salmon River 5th field watershed (1708000105) to the Pacific Crest Trail at the summit of the Oregon Cascades. The eastern part of the southern boundary extends from the Pacific Crest Trail to the east along the southern boundary of the White River 5th field watershed (Hydrological Unit # 1707030616) to where it intersects with the eastern boundary of the Mount Hood National Forest.
Northern	The Columbia River east from the confluence of the Sandy River to the Wasco/Hood River County line, about 2 miles west of Mosier.
Eastern	From the southeast boundary of the Mount Hood National Forest, follow the eastern edge of the National Forest boundary north until it meets the Hood River County line near Kechum Reservoir. Follow the Wasco/Hood River County lines north to the Columbia River, about 2 miles west of Mosier.
Western	The mouth of Eagle Creek north on the Range line between R. 3 E and R 4 E to the mouth of the Sandy River.

Table VII.2. Survey Zone boundaries for the Larch Mountain salamander in Washington. Surveys are required on federal lands containing suitable habitat for the Larch Mountain salamander that are under the management direction of the Northwest Forest Plan.

Boundary	Description
Southern	The Columbia River east from the Interstate 5 bridge to State Route 142 (town of Lyle).
Northern	From the intersection of U.S. Route 2 and Interstate 5 east along U.S. Route 2 to the intersection of State Route 97.
Eastern	From the Columbia River north on State Route 142 to the intersection of State Route 97 and then North on State Route 97 to the intersection of U.S. Route 2.
Western	From the Columbia River north on Interstate 5 to the intersection of U.S Route 2.

Adjacent Areas-- Adjacent areas are lands which are beyond the boundaries of a project area that potentially contain PLLA habitat or populations that could be deleteriously affected by the proposed management activity. This can be referred to as a neighborhood effect. Typically, the types of change that will be of concern within adjacent areas are: 1) altered moisture and temperature regimes (e.g., greater diel fluctuations, increased wind, insolation, and dessication, etc.); 2) changing hydrological and geomorphological processes affecting ground disturbance, such as erosion, mass wasting and sediment transport; and 3) reduced downed wood recruitment.

The influence that a given management activity may have on adjacent areas will depend on a number of factors including:1) the specific type, areal extent and intensity of the disturbance; 2) site specific characteristics; and 3) condition of adjacent areas. In general, the size of an adjacent area for PLLA surveys will be directly proportional to disturbance magnitude (severity and intensity), and area impacted. Consequently, adjacent areas may vary from 0 to 240 m (~ 730 ft). Under conditions where it is deemed the activity may have large influences on PLLA a larger adjacent area may be warranted. An example might be where a 20 ha regeneration harvest is proposed on a south exposure. Crisafulli (1999) provides detailed rationale for this approach.

Examples of management activities and suggested adjacent areas are provided in Table VII.3. The suggested adjacent areas should serve as general guidelines and each survey location should be evaluated on a site-specific basis. Identifying the extent to which the proposed activity will alter salamander habitat and microclimatic conditions should govern the size of adjacent area selected. This may include an analysis of factors such as exposure, elevation, condition of adjacent areas and site characteristics (e.g., edaphic conditions and forest structure). Ultimately, it will be left to the discretion of the field units to determine the size of adjacent areas. It will be incumbent on the responsible party (biologist or manager) to carefully document in writing the rationale for selecting the size of an adjacent area.

Survey Timing

Key Features:

two survey seasons, Spring and Fall
spring is the preferred season at elevations > 750 m elevation
three required site visits
there must be at least 4 days between surveys

Seasons--There are two general periods that provide suitable environmental conditions for conducting surveys, **spring** and **fall**. However, spring and fall refer to the temperature and precipitation patterns, and the associated phenology of the biota at a site. These “seasons” can vary markedly by elevation, such that spring conditions at 50 m in the Columbia River Gorge may occur in March, while in the Cascade Range at 1200 m spring conditions may not be present until June.

Table VII.3: Examples of common management activities on federal lands within the range of the Larch Mountain salamander (*P. larselli)* and suggested adjacent areas to be included for surveys.

Management Activity	Disturbance Metrics	Recommended Adjacent Area for Survey*
Trail construction	Tread 60-120cm, (24-48 in) linear, disturbance very restricted	10 m; 5 m on each side of center-line, survey distance relates primarily to potential microhabitat concerns.
Trail construction	Tread 125-182 cm, (49-72 in) linear, disturbance very restricted	15 m; 7.5 m on each side of center-line, survey distance relates primarily to potential microhabitat concerns.
Signing, kiosk	Small area, typically< $100m^2$	0-60 m depending on conditions, survey distance relates primarily to potential microhabitat concerns.
Road (secondary)	Roadbed 3-7 m, (10-20 ft), linear	60-80 m: 30-40 m on each side of the center-line, survey distance relates primarily to potential microhabitat concerns.
Road (primary)	Roadbed 7- 12 m,(20-40 ft) linear	100-160 m: 50-80 m on each side of center-line, survey distance relates primarily to potential microhabitat concerns.
Timber Harvest	Thinning, 40-60 % retention	40-60 m, survey distance relates primarily to potential microclimate concerns.
Timber Harvest	Thinning, 20-40% retention	80-120 m, survey distance relates primarily to potential microclimate concerns.
Timber Harvest	Regeneration, 0-20% retention	120-240 m, survey distance relates to combined microclimate/microhabitat concerns.
Mining/Quarries	small-scale quarrying, <$500m^2$ area	60-80 m, survey distance relates to combined microclimate/microhabitat concerns.
Mining/Quarries	>$500m^2$ area	120-200 m, survey distance relates to combined microclimate/microhabitat concerns.

* **These widths are intended only as general guidelines, site-specific analysis will determine actual adjacent area survey widths.**

Typically, the optimal survey period is the spring season when sites are at their hydrologic peak (fully recharged) and temperatures are moderate. The spring season often provides the appropriate conditions for surveying over a period of several weeks, and thus is considered the preferred season. The fall survey period is much less predictable than the spring, and tends to be most problematic for high-elevation sites (e.g., above ~ 750m) in the Cascade Range. This stems from two primary factors: 1) in early fall, sites are typically desiccated and at their hydrologic low; and 2) conditions often remain dry into the fall and when precipitation arrives temperatures are cool and comes in the form of snow. In either case, animals will not be surface active. It should be noted, however, that the fall survey season during some years can be outstanding. As a general rule, planning should lean heavily towards spring surveys at sites above 750 m in the Cascade Range. It is possible to conduct all three site visits (surveys) in either the spring or fall.

Site visits--A minimum of three site visits, each with negative survey results, are required before “not detected” can be designated. However, if PLLA is found during either the first (or second) survey then no return visits are necessary.

Survey intervals--If an animal is not observed during the first survey then subsequent visits cannot occur until at least 4 days have elapsed (i.e., a sampling frequency interval of 4 or more days).

Columbia River Gorge (OR & WA from 0-500 m elevation)-- There are two general periods of time when the appropriate environmental conditions are present for conducting surveys in this portion of the species' range: 1) late winter/spring (mid-February through late-May); and 2) autumn (late September through late-November). The specific times within these two general periods when sampling is most appropriate will vary, to some extent among sites, due to differences in elevation, exposure, edaphic conditions, plant community structure, orographic features, and also between and within years due to vagaries in temperature and moisture conditions.

Cascade Range of Washington and Oregon-- There are two general windows of time when environmental conditions are appropriate to conduct surveys in the Cascade Range: 1) spring/early summer (April through late June) and 2) autumn (late September through late November). Strong environmental gradients exist in this portion of the Larch Mountain salamander's range which can profoundly affect animal activity patterns. This is largely due to the general relationship between increased precipitation and decreased temperature with increasing elevation. As a result, lower elevation sites typically provide suitable environmental conditions earlier in the spring and later in the autumn. High elevation sites are usually available later in the spring and into early summer, but may be limited by cold weather and snow in the fall. There may also be significant differences in survey periods on the west verse east slope of the Cascade Range, due to the moist maritime conditions of the former and the generally drier, colder continental conditions of the latter.

Environmental Conditions

Environmental conditions must be within certain limits before a survey can begin. If these conditions are not met, then the survey cannot proceed. The surface-activity patterns of PLLA are tightly coupled to prevailing microclimatic conditions, particularly soil/substrate moisture and temperature. Past monitoring activities conducted for this species have revealed that both moisture and temperature should be within certain ranges or the likelihood of finding animals diminishes greatly (Crisafulli. unpubl.). It should be noted however, that animals may be found outside these conditions, but the protocol requirements serve to maximize the likelihood of detection.

Several measurements of temperature and particularly moisture are required. This is necessary because field crews often attempt to perform surveys under cusp conditions when moisture status is variable across a site, ranging from dry to wet. Factors such as slope position, subsurface hydrology, edaphic conditions, and vegetation can greatly influence moisture status at several scales. A frequently encountered situation occurs when a few days have elapsed since the last precipitation event, and transects low on a slope (near valley bottom) will have wet soil/substrate conditions, whereas transects located mid-slope or higher are moist or dry. Under these conditions it is appropriate to survey the lower transects, but all other lines should not be surveyed until moisture conditions improve.

Critical Elements:

- **soil and substrate (talus & cover objects) must be moist or wet (Table VII.4)**
- **soil and substrate temperatures must be between 4 and 14 °C**
- **air temperature must have been greater than 0°C during past 72 hr.**

Soil/substrate moisture--These animals are typically active on or near the surface (under cover objects) only when soil and substrate moisture levels are moist or wet. Currently, there are no inexpensive, portable instruments available on the market that yield accurate and precise soil moisture data. Therefore, a qualitative method that relies on a simple appraisal of moisture status by touch and sight (color) is required (Table VII.4). The soil/substrate down to a depth of at least 30 cm. (12 inches) and the underside of cover objects (e.g., woody debris, rock) need to be very wet (saturated). If this is not the case, then the survey should be terminated.

Soil/substrate temperature--PLLA appear to be very sensitive to temperature and are found consistently in the upper soil or talus strata and beneath cover objects only when temperatures in the top 30 cm of soil/talus and underneath cover objects are between 4 and 14°C (Crisafulli, unpubl.). If temperature is either above or below this range then surveys should not be conducted.

Table VII.4: Qualitative descriptors of substrate moisture status used to assess environmental conditions prior to and during surveys for the Larch Mountain salamander. Surveys may proceed only if soil and talus conditions are moist or wet and preferably saturated.

Moisture Condition	Soil	Talus
Dry	Soil is very friable (will not stick or ribbon), coloration is light, dust may be present.	Rock surfaces lack water, interstitial materials lack moisture, crumbles when squeezed, and does not ribbon or adhere when rolled in hand.
Moist	Soil coloration is dark and feels moist, but no drops of water can be squeezed out of clinched fist.	Rock surfaces contain moisture, but water is not beaded on surface or filling small surface depressions. Litter or soils in the interstices is dark in coloration and feels moist, but water can not be squeezed out.
Wet or saturated	When a handful of soil is tightly squeezed soil particles will stick together (ribbon), and water can be squeezed out (one or more drops). Coloration is dark.	Rock surfaces are wet and water is pooled in small surface depressions. Interstitial (soil and litter), if present, will stick together (ribbon) when squeezed in fist, and water can be wrung out (one or more drops).

Air temperature-- In order for a survey to proceed, freezing temperatures should not have occurred at the survey location during the preceding 72 hours. Surveys should not occur if it is snowing at a site or if snow has recently (< 72 hr) covered the ground, regardless of the soil/substrate temperature and moisture conditions. This statement is necessary because often times in the fall the soil/substrate temperature and moisture will be in the acceptable range when it is snowing or a new layer of snow is blanketing the ground, yet the cool surface temperatures have caused the animals to move to subterranean retreats. Additionally, if there is a cold airmass aloft, causing it to snow at the ground surface at temperatures >0° C (32 degrees Fahrenheit), the cooling effect of the melting snow on the ground surface can cause periods of inactivity for PLLA.

Reference Sites

The use of reference sites is not recommended for this species. Known PLLA sites are rare and should **not** be subjected to use as reference sites, which could lead to unacceptable levels of habitat degradation. Moreover, it is unlikely that known sites would be of much value as reference sites due to difficulties in matching site characteristics (elevation, geology, soils, vegetation, etc.) between survey locations and known sites.

Species Verifications

Animals captured during a survey that are believed to be individuals of the target species need to be retained (alive) and shown to a species expert for verification purposes. Retained specimens should be placed in a rigid container (e.g., vial, plastic tub) with moist moss and stored either in a cooler or refrigerator. The container should be labeled with the collector's name, survey site, specific capture location, collection date, species, animal number (from survey data sheet) and any notes that were recorded on the animal or its habitat should be included with the specimen. Unless there is tremendous variation in the animals captured (color, pigmentation, etc), a single, preferably an adult, animal will suffice.

Voucher Specimens

In most cases, preserved voucher specimens are not required for this species. This is largely due to the apparent rarity and legal status of the species, and also because of the skill and chemicals needed to prepare museum-quality specimens. The exception will be animals captured from locations that represent range extensions for the species. Under these circumstances voucher specimens should be retained and preserved by species-experts who have permits to conduct such work. Voucher specimens should be deposited in a reputable museum for permanent archival purposes. Photographic vouchers are not recommended at this time. Taking archival quality voucher photographs requires special equipment and considerable skill, and field personnel should not be expected to perform such duties.

Safety Issues

Field units implementing surveys should be discretionary regarding safety issues as required by site conditions. Safety of surveyors should not be compromised to complete surveys. As such case-by-case decisions are made, managers, supervisors, and field crews should be in communication. We recommend full documentation of the rationale supporting such a decision.

Survey Ethics

All surveys should be conducted in a relatively non-destructive manner. Surface objects are lifted and replaced to their original position. Hill sides should be kept relatively intact whenever possible. Bark may be pulled off of logs, but it should be done carefully, so that it can be replaced. Logs that are moderately decayed into large chunks or splits may be separated, but again, the pieces should be replaced as best as possible. However, logs should not be completely destroyed. Moss mats should be replaced. The intent here is not to abstain from any alteration; that would be next to impossible and would make it difficult to detect salamanders. The intent is to be conscientious about minimizing disturbance to the habitat by using a light-handed approach.

SURVEY PROTOCOL

Summary and Rationale

Larch Mountain salamanders tend to be patchily distributed, but locally abundant across the majority of their range (Crisafulli, unpubl). This type of distribution pattern coupled with the fact that PLLA occupy a variety of habitat types requires that a broad brush survey methodology be adopted in order to cover extensive areas that may support isolated (non-continuous or disjunct) populations of salamanders. The protocol described here utilizes belt transects that traverse a site at set intervals along slope contours (Figure VII.2). It represents a subsampling scheme rather than an attempt to survey the entire project area. The result is a method that has extensive coverage, and yet provides intensive searches that are confined to belts set at fixed intervals across a survey location. This approach maximizes the area covered by a survey, and has proven to be very effective in detecting *P. larselli*.

Flexibility is built into the survey design through a provision that allows surveyors to leave the belt transect to search habitat patches (e.g., bark heaps, rocky feature, etc.) that are located between transect lines. There are constraints on the number of departures that can be made from the transect and the length of time spent surveying any particular patch.

Premises of protocol include:

> **The protocol was developed to maximize the probability of detecting *P. larselli* when present at a survey site.**
>
> **The survey goal is the detection of PLLA within a specified area of suitable habitat. Specifically, this is not designed for population monitoring.**
>
> **The protocol assumes surveys will be conducted when animals are surface-active (i.e. seasonal and weather restrictions apply).**
>
> **Surveyor training is imperative for animal identification, habitat recognition, and uniform application of survey techniques.**

Search effort--An analysis of surveys conducted in 57 forested stands in the Washington Cascade Range yielded a mean acres per person-hour (acres/ph) value of 3.2 (range 0.8-7.2; C. Crisafulli unpubl.). These stands varied tremendously with respect to habitat complexity (i.e., type and amount of woody debris and rock substrates), forest structure, and age (90 to >500 years) and, thus cover the range of conditions anyone is likely to encounter while surveying for this species. Hence, the 3.2 acres/ph value, on average, should indicate the time required to implement surveys. If the area to be surveyed is small (e.g., <10 ac.) in most cases the survey could be performed by a single surveyor in a day, but if the area is >10 acres, a 2-4 member crew is strongly recommended. This would ensure that sites in the 20-40 acre range would be finished in a single day, thus reducing the likelihood that changes in salamander detection would occur due to variations in prevailing weather conditions.

Survey coverage--The extent (i.e., area) of transect coverage at a survey location will vary as a function of Survey Area shape and size and site characteristics. During the planning phase it is important to remember that the Survey Area includes both the project area and the adjacent area. Two general project shapes are considered: 1) linear (e.g, trails and roads) and 2) non-linear (e.g., forestry practices). Linear projects will typically have few (1-4) transects and relatively small (e.g, 0-15 m) inter-transect distances. In general, the number of transects and inter-transect distance will be proportional to the width of impact and severity of habitat alteration for any particular linear disturbance (Table VII.5). For non-linear type disturbances (projects) the extent of area covered by transects will be based on the size of the project area and site characteristics (Table VII.6). Three size classes are considered : 1) <0.5 acres (0.2 ha); 2) >0.5-2.5 acres (0.2-1.0 ha); and 3) >2.5 acres (1.0 ha). For a small Survey Area (<0.5 acres) the site should be treated as one transect and the entire area surveyed. The reason for this include: 1) areas of this size can be surveyed in their entirety in a short amount of time compared to the time it would take to install multiple small transects and survey them; and 2) when logistically possible, a complete area survey is preferred over a subsampling approach. For projects >0.5 and up to 2.5 acres, approximately 50 percent of the project area should be included within the belt transects. This will result in a reasonable balance between survey effort and probability of detecting the target organism. When surveys are required on larger project areas (e.g, >2.5->100 acres), 10m wide belt transects, spaced at 25m intervals, have proven very effective at detecting PLLA at survey locations in a relatively expedient way (Crisafulli, unpubl.).

There are situations where other options for transect layout may be warranted. Examples include talus sites or Survey Areas in the range of 0.5-2.5 acres where narrow transects (e.g., 5 m wide) or small inter-transect distances (e.g., 10 to 15 m) would be used. The rationale behind this is that for sites with rocky substrates cover density can be exceedingly high and it would be preferable to have several narrow transects rather than few wide transects. In the case of project areas in the range of 0.5 - 2.5 acres, if the inter-transect distances was wide (e.g., 25 m) there may only be room to “fit” in a couple of transects, depending on the shape of the area, and it would be preferable to have more narrow transects or smaller inter-transect distances, thus increasing the survey coverage.

Table VII.5: Suggested number of transects, transect width and inter-transect distance based on width of disturbance of linear projects, such as trails and roads.

Disturbance Width (m)	No. Transects	Transect Width	Inter-transect Distance
0.3-1.2	1	10	0
>1.2-3.0	1	15	0
>3.0-6.0	3	10	15
>6.0-12.2	4	10	15
>12.2-18.3	6	10	15

Table VII.6: Suggested number of transects, transect width and percent coverage (transect area) for non-linear projects, such as those related to forestry practices.

Project Size (ha)	No. Transects	Transect Width	Survey Coverage (%)
0.2	1 (total)	entire area	100
>0.2-1.0	2-4 (total)	10	50-90
>1.0	4-5 (per Ha)	10	40-50

Bias--The primary biases with this method stem from variation in habitat type and complexity among sites and surveyor-specific variation in search technique. Animal detection rates will vary by these factors and also will be influenced by prevailing weather conditions. Thorough training and adherence to the required environmental conditions can minimize these problems.

Search pattern--The crew member(s) will travel along the contour of the slope or across the project area, following a zig zag path, searching under available cover objects [woody debris (bark, branches, logs) and rocks] within the belt transect using a “walk-and-turn” method. The intent of the zig zag path is to allow the surveyor to search beneath either all (when cover object density is low) or high probability (when cover object density is high) cover objects or habitat patches that are found within the belt transects. In practice, the “walk-and-turn” method is performed as crew members continually move within and along the belt transect, pausing briefly to turn and thoroughly inspect beneath cover objects, returning the searched objects to their original positions and then moving on to the next object to search. The “walk-and-turn” method was selected to reduce the chances that a surveyor will linger at any particular location along the transect, and coupled with the zig zag path, provide ample search effort and coverage. This is accomplished using moving rules. A maximum of five minutes will be spent searching any one cover object or discrete habitat patch (e.g., bark heap, log). In most cases it will take only a few to perhaps 30 seconds to search a single cover object. If cover objects are clumped (e.g., pile of bark or rocks) it may take considerably more time to complete the search, but there should be adherence to the five minute search limit.

If high priority habitat features (cover objects) are observed between adjacent belt transects then the surveyor has the flexibility of leaving the transect and searching habitat patches or cover objects for a maximum of 5 minutes per stop.

Outline of Procedures: pre-survey work through survey documentation

Obtain necessary permits and training

Conduct field reconnaissance of project area

Review the survey protocol and all data forms and code sheets

Determine size of adjacent area

Determine transect width and inter-transect distance

Establish transects and identify habitat patches that are outside of the transects

Create project map with transects and habitat patches depicted

Gather all field equipment

Assess/measure environmental conditions

Conduct surveys

Mark capture locations

Data management

Procedures and Approaches

I. Prior to Sampling:

A) Review Survey Area

Review the Survey Area with maps having topography and road systems or by aerial photographs to identify access routes both for vehicular and foot travel and to determine if challenging features are present, such as rivers and cliffs. Then conduct a ground reconnaissance of the project area. Preferably a map created by the project planners will be available to use on this trip. Later this map will serve as a base map for entering the salamander survey transects and habitat patches.

B) Review the survey protocol and all data forms and code sheets. There are four data forms and code sheets.

1. Larch Mountain Salamander Transect and Habitat Patch Data Form and Code Sheet (Appendix VII.1a&b). This form is a master list of transects and habitat patches and includes the size and location of each within the Survey Area.

2. Larch Mountain Salamander Survey Environmental Data Form: Temperature and Moisture Conditions data form and Code Sheet (Appendix VII.2a&b). This form is used to record the soil/substrate temperature and moisture conditions at the time of a survey.

3. Larch Mountain Salamander Animal Survey Form and Code Sheet (Appendix VII.3a&b). This form is used to record animal capture and associated habitat data.

4. Larch Mountain Salamander Survey Effort Form and Code Form (Appendix VII.4a&b). This form is used to record the status of survey efforts of transects or habitat patches including: survey date, size of transect or habitat patch, begin and end time, breaks, end location and whether the sampling was completed.

C) Determine the size of the adjacent area (see text and Table VII.3).

D) Determine the transect width and the transect interval distance (see text and Tables VII.4 & VII.5**)**. These distances will be determined by site characteristics as well as project size.

E) Establish the transects and identify habitat patches. Transects and habitat patches will need to be adequately marked to: 1) ensure appropriate coverage of the site; 2) provide a means of keeping the surveyors on course; and 3) increase the repeatability should more than one survey be necessary. The approach taken to establish the transects will vary with the proposed activity.

For a linear project, such as a trail or road, there may be only 1-3 transects required. The transect(s) would be installed on and adjacent (parallel) to the proposed alignment (center line of trail or road) at selected distances. In some instances (e.g., trails) the surveyors may be able to conduct their search without establishing a transect, provided the alignment was adequately marked by the trail engineers.

For non-linear type projects the following method is offered as a means of installing transects. First establish a baseline, which will serve as the starting point for each transect line. In most cases, the baseline will be oriented upslope (i.e., perpendicular to the slope contour), and will run along the edge of the project area, extending from the bottom of the slope to the top. As used here, the project area includes the adjacent area too. The baseline is established with a meter tape and is marked with flagging as much as necessary to be conspicuous to the surveyors. At fixed interval distances (e.g., 25 m) along the baseline hang flagging marked with the distance from the starting point. These will serve as the beginning points of the survey transects. From these locations, traverse the survey site along a compass bearing (typically along the contour of slope) and attach flagging at distances that will allow the surveyors to easily identify the route of travel. Flagging should be marked with the transect number. The color of flagging may be alternated between neighboring lines.

It may be desirable to use a hipchain when installing transects. A hipchain can be used to mark the transect along its entire length, and as the transect is installed, flagging can be labeled and placed at fixed distances. Flagged distances along a transect will aid in relocating capture locations, habitat features, and starting and stopping survey locations.

F) Create project map with transects and habitat patches depicted. Using the project base map or an enlarged section of a U.S.G.S. 7.5 minute map draw transects and habitat patches.

G) Gather all field equipment needed to perform surveys (Appendix VII.5).

II. Conducting Surveys

The survey procedures used to assess the presence of PLLA according to the Survey and Manage provision of the Northwest Forest Plan are outlined below.

A) Fill out data form header (Appendix VII.3a) according to the data code form (Appendix VII.3b)

B) Measure (temperature) and assess (moisture) the environmental conditions at three locations at the beginning, middle and end of each transect and at one location for habitat patches that are located outside of the belt transects. These locations are referred to as environmental cluster measurements and at each one of them there will be three temperature and moisture values recorded on the temperature and moisture data form (Appendix VII.2a). Moisture categories are provided in Table VII.4. Thermometers should be placed within the soil or talus to a depth of between 10 and 20 cm or under cover objects. Moisture conditions should be assessed from the surface down to a depth of 30 cm and beneath cover objects.

C) The procedure for implementing a survey is as follows (see Fig. VII.2). First, the surveyor(s) locates one of the lower corners of the Survey Area (project area plus adjacent area perimeter extension) and walks along the baseline to the first transect line. The crew member(s) will travel along the contour of the slope, following a zig zag path, searching under available cover objects [woody debris (bark, branches, logs) and rocks] within the belt transect line. Once a surveyor has traveled across the site (along a transect line) reaching the distal side, they position themselves upslope at the next transect location and survey back across the slope as described above. This is continued until the entire area has been surveyed. During the survey pay special attention to features such as pockets of late seral forest, cliffs, talus, large snags with bark heaps at their base, and areas of steep terrain (>40%). Features such as these may be more likely to harbor PLLA than the surrounding area. In the event that the belt transects do not bisect these features they will need to be surveyed according to a timed habitat-patch survey either: 1) when the surveyor is adjacent to the feature during a transect survey; or 2) once the belt surveys have been completed. In either case, a maximum of 5 minutes should be spent searching in each spatially distinct patch. Each patch searched should be identified on the map and the time spent searching recorded on the Larch Mountain Salamander Survey Effort Data Form (Appendix VII.4a). If the surveyor opts to search these patches as they are encountered, then the time of departure and return to the transect should be recorded (Appendix VII.5a). Keep in mind that the interval distance between transects will typically be less than 25 m, so only relatively small habitat patches would be missed by parallel transects, and thus, require timed searches. All cover objects searched should be carefully returned to their original position.

D) When an animal is captured, record the appropriate measurement on the data form (Appendix VII.3a) in accordance with the data code sheet (Appendix VII.3b). **Please note that only entries 1-21 are required. The remaining entries (i.e., 22-30) are optional.**

E) When a target animal is found, its location should be conspicuously marked and documented. The location should be flagged, and marked with a plastic or aluminum tag. The tag should be labeled with the following information: species, specimen identification number, date, transect line or habitat patch number and the name of the surveyor who found the animal. Ideally, there will be a follow up visit to each known capture site with a Global Positioning System (GPS). With this technology sites can be located to sub-meter accuracy, if a differential correction is performed on the data.

F) After an animal has been measured and all pertinent data recorded, the animal should be released at the exact point of capture (unless retained as a voucher specimen).

III. Data Management

Each Administrative Unit (USFS, BLM) should retain the completed data forms and associated maps and field notes in their office files. This is a crucial aspect of any survey project and a standard format and approach should be adopted across all units conducting surveys.

Site Delineation

Delineation of the area (i.e., location and areal extent) occupied by PLLA at a site where it has been found will likely be an important part of the survey process, as this information will greatly influence the proposed project as well as the way in which the habitat will be managed in accordance with the species Management Recommendations. Depending on the proposed project under consideration and the resources available there are a number of approaches that could be used to delineate occupancy. The simplest, but least informative approach would be to consider all suitable habitat contiguous with the capture location and all like habitat in the project area as occupied and conduct no additional surveys. If making the assumption that similar, but non-contiguous habitat in the project area is occupied is unacceptable, than additional surveys must be conducted.

To accurately determine the area and location of occupancy, a finer-scale site delineation will be accomplished by additional, more intensive surveys performed at locations of individual captures. These could be conducted along multiple transects radiating outward from the original capture location, or in a circular path spiraling out from the capture site. In most cases these transects, or circular searches would extend outward along some environmental gradient, biotic or abiotic. What ever method used to delineate occupancy, it will be incumbent on the surveyor to document which approach was used and to map areas where animals have been located.

Site Delineation Procedures– Before initiating the Site Delineation survey(s), we recommend that all three Protocol surveys be completed. This addresses the survey condition that for areas to be designated as PLLA "not detected," 3 site visits should be conducted. During these 3 Protocol surveys, every detection location is flagged. Data are recorded on all target species detections and all other species are tallied. After the third visit, the general distribution of the target species in the Survey Area hopefully will be revealed.

The Site Delineation survey is more intensive than a Protocol survey, because it is intended to establish the spatial extent of PLLA within the Survey Area.

The general technique for a Site Delineation survey is similar to a Protocol survey: it involves walking and turning over objects only during acceptable environmental conditions. However, as it is more intensive, there are some pertinent differences:

> Survey paths should not be > 5 m apart.
>
> Survey paths must cover the entire Survey Area for small-scale projects. For large-scale projects, surveys are oriented around all flagged detection locations. These become the focal points, with surveys radiating out to the perimeter of the Survey Area (if possible) or the apparent boundary of the population. The extent of the area searched on large projects is discretionary and the rationale for the area covered should be well documented by the lead biologist and land manager.
>
> Search paths may be in a zig-zag pattern, concentric rings, spiral, or parallel transects.
>
> It is apropos to spend more time to determine if the species is present at a particular area–hence, moving rules are not necessary. Search effort per unit area is usually greater with Site Delineation surveys.
>
> Because the area is known to harbor the target species and extensive searching will be undertaken, great care must be taken to ensure that habitat is not destroyed.

Whenever a new peripheral detection location is made, the area to be searched enlarges, but not beyond the Survey Area.

The perimeter of the population within the Survey Area needs to be well marked and should be accurately GPSed for management purposes.

DOCUMENTATION OF SURVEY DECISIONS

Due to the discretionary nature of several survey elements (triggers, adjacent area distances), supporting rationale for case-by-case decisions is recommended to accompany activity proposals. In particular, if variance in survey procedures is implemented, the rationale should be documented and a qualitative assessment of the change in Type II error conducted (i.e., risk of not detecting the target species when it is in fact present at a site). Relative to triggers, such rationale should include statements regarding the 4 trigger criteria, listed above. For the fourth criterion, statements should be included regarding the anticipated impacts of the project on: 1) the animals themselves; and 2) habitat conditions (e.g., structure, microclimate). The record of the adjacent area decision rationale should be distinct from the project area trigger decision rationale. Likewise, decisions to survey should be documented separately from decisions on how to manage sites.

Recommendations for Documentation

Rationale for trigger decisions should be documented.
Rationale for trigger decisions should be separate from management recommendations.
Rationale for adjacent area survey decisions should be documented separately.
Rationale for any variance to protocol should be documented, with a qualitative assessment of changes to risk of Type II error.

ACKNOWLEDGMENTS

I thank Louise Trippe, Joseph Kling, Richard Nauman and Aleah Yung for their efforts conducting field work which provided the initial information that formed the basis of this protocol. I am especially grateful to Louise Trippe who has provided valuable insights into the natural history and distributional patterns of the Larch Mountain salamander and who has spent the vast majority of her life over the past few years gaining much needed information on this species. I thank Richard Nauman for compiling the known site data base, creating figure photo plates and for generating the survey zone and species distribution maps. A special thanks is owed to Deanna Olson who led the Survey and Manage Amphibian Subgroup, her guidance, editing and patience were outstanding. This protocol has benefitted from discussions and reviews by members of the Amphibian Taxa Team: Dave Clayton, Larry Jones, Richard Nauman, Lisa Ollivier, Deanna Olson and Hart Welsh. I also thank the numerous field biologists who put the initial draft to test and provided important feedback, hopefully leading to an improved protocol.

REFERENCES

Brodie, E.D., Jr. 1970. Western salamanders of the genus Plethodon: systematic and geographic variation. *Herpetologica.* 26:468-516.

Brown, J.H. 1995. *Macroecology*. The University of Chicago Press, Chicago, IL, 269 p.

Burns, D.M. 1954. A new subspecies of the salamander *Plethodon vandykei. Herpetologica* 10: 83-87.

Burns, D.M. 1962. The taxonomic status of the salamander *Plethodon vandykei larselli*. Copeia 1962:177-181.

Burns, D.M. 1964a. *Plethodon larselli*. Cat. Amer. Amphib. Rept: 13.1

Burns, D.M. 1964b. *Plethodon larselli*. in: Catalogue of American amphibians and Reptiles, ed. W.R Riemer, 13 Kensington, Maryland, American Society of Icthyologists and Herpetologists.

Burns, D.M. 1964c. The taxonomic status of the salamander *Plethodon vandykei larselli*. Copeia 1:177-181.

Corkran, C.C.; Thoms, C.R. . 1996. *Amphibians of Oregon, Washington and British Columbia.* The Lone Pine Publisher. Edmonton, Alberta, Canada. 175 p.

Crisafulli, C.M. 1999 (in review). Management Recommendations for the Larch Mountain salamander, *Plethodon larselli*. *In*: Olson (ed.). Management Recommendations for Component/Strategy 2 Amphibian Species. Special Interagency Publication.

Herrington, R.E. and J.H. Larsen, Jr. 1985. Current status, habitat requirements and management of the Larch Mountain salamander Plethodon larselli Burns. Biol. Conserv. 34:169-179.

Leonard, W.P.; Brown, H.A.; Jones, L.L.C.; McAllister, K.R.; Storm, R.M. 1993. Amphibians of Washington and Oregon. Seattle Audubon Society, Seattle, WA. 168 p.

Nussbaum, R.A.; Brodie, E.D., Jr.; Storm, R.M. 1983. *Amphibians and Reptiles of the Pacific Northwest.* The University Press of Idaho. Moscow, ID. 332 p.

Olson, D.H. (ed.) 1999 (in review). Management Recommendations for Component/Strategy 2 Amphibian Species. Special Interagency Publication.

Olson, D.H. (ed.); Applegarth J.; Bury, R.B.; Clayton D.; Crisafulli, C.; Jones, L.L.C.; Ollivier, L.; Welsh, H.H., Jr. 1996. Survey protocols for Component/Strategy 2 amphibians. Portland OR: Special Interagency Publication, Regional Ecosystem Office, Survey and Manage species. 73 p.

Petranka, J. W. 1998. *Salamanders of the United States and Canada*. Washington DC: Smithsonian Institution Press. 587 p.

Stebbins, Robert C. 1985. *Western amphibians and Reptiles*. Boston, MA., Houghton Mifflin Co. 336p.

U.S. Department of Agriculture, Forest Service; U.S. Department of the Interior, Bureau of Land Management. 1994. Record of Decision: for amendments to Forest Service and Bureau of Land Management planning documents within the range of the northern spotted owl. [place of publication unknown]. 74 p. [plus attachment A: Standards and Guidelines: for management of habitat for late-successional and old-growth forest related species within the range of the northern spotted owl].

Washington Department of Fish and Wildlife. 1993. Status of the Larch Mountain salamander (*Plethodon larselli*) in Washington. Unpubl. Rep. Wash. Dept. Wildl., Olympia, WA.

Wiens, J.A. 1989. *The ecology of bird communities*. Cambridge University Press, Cambridge, UK.

Figure VII.1 Known distribution of the Larch Mountain salamander. The heavy line represents the species survey zone.

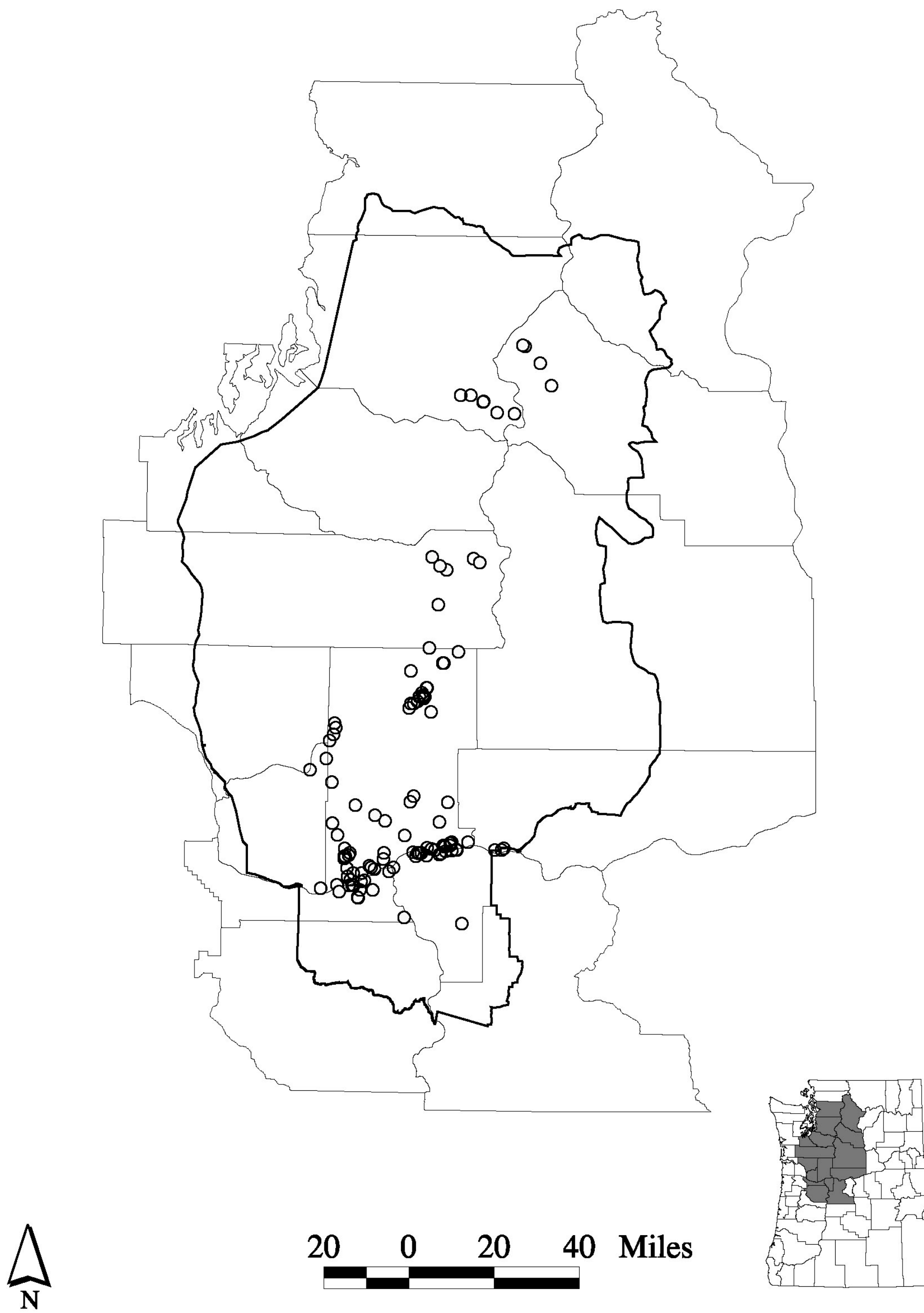


Figure VII.2: Larch Mountain Salamander Survey Design

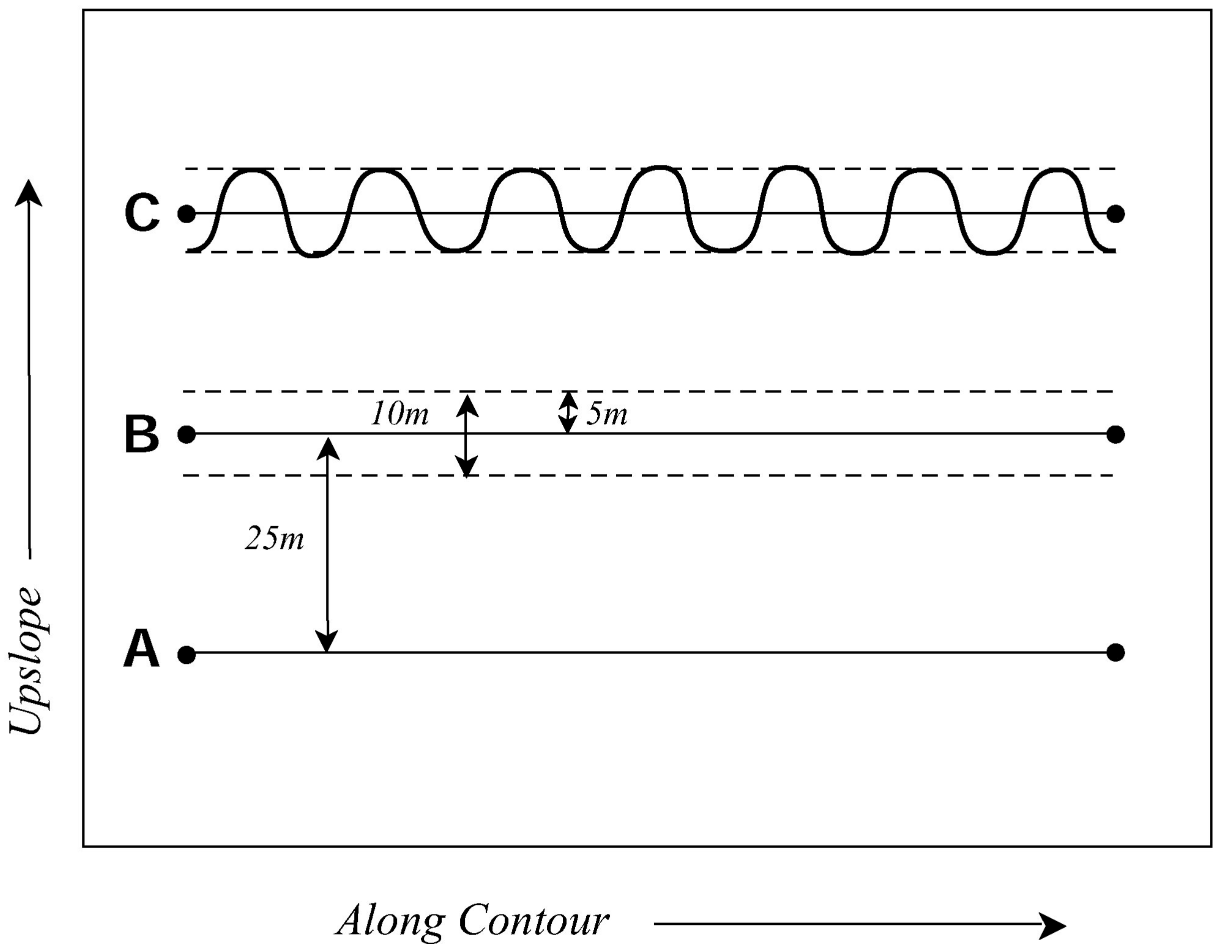


Plate VII.1 Larch Mountain salamander (*Plethodon larselli*) adult red/orange form. (Photo by Charlie Crisafulli).

Plate VII.2 Larch Mountain salamander adult chestnut form. (Photo by Charles M. Crisafulli).

Plate VII.3 Larch Mountain salamander adult with herringbone pattern on dorsal stripe. (Photo by Charlie Crisafulli).

Plate VII.4 Larch Mountain salamander adult with dense profusion of melanophores partially obscuring the dorsal stripe. (Photo by Charlie Crisafulli).

Plate VII.5 Larch Mountain salamander ventral view showing the typical salmon coloration. Note: hind foot showing greatly reduced outer digit. (Photo by Charlie Crisafulli).

Plate VII.6 Western red-backed salamander (*Plethodon vehiculum*) adult ventral view showing black ground color with abundant iridophores. Note eleven developed ova in abdomen. (Photo by Charlie Crisafulli).

Plate VII.7 Larch Mountain salamander adult dorsal view. (Photo by Charlie Crisafulli).

Plate VII.8 Juvenile Larch Mountain salamander showing straight margins of dorsal stripe (compare to dorsal stripe of adults above). (Photo by Charlie Crisafulli).

Plate VII.9 Western red-backed salamander (may be confused with Larch Mountain salamander) adults, note straight margins of the dorsal stripe. (Photo by Charlie Crisafulli).

Plate VII.10 Western red-backed salamander adult lateral view showing the broad dark stripe between the dorsal stripe (indicated by arrow) and the iridophores on the lower lateral surface. (Photo by Charlie Crisafulli).

Plate VII.11 Larch Mountain salamander showing narrow dark stripe between the dorsal stripe (indicated by arrow) and the iridophores on the lower lateral surface. (Photo by Charlie Crisafulli).

Plates VII.12-19 Photographs showing the wide variety of habitat types that the Larch Mountain salamander is known to occupy.

Plate VII.12 Stand-view of late seral forest. (Photo by Charlie Crisafulli).

Plate VII.13 Habitat view of late seral forest. (Photo by Joseph Kling).

Plate VII.14 Habitat view of forested talus. (Photo by Charlie Crisafulli).

Plate VII.15 Habitat view of shrub-dominated talus. (Photo by Charlie Crisafulli).

Plate VII.16 Habitat view of open talus (no vascular plants present). (Photo by by Joseph Kling).

Plate VII.17 Cave opening where animals inhabit the dimly lit twilight zone. (Photo by Joseph Kling).

Plate VII.18 Mixed woodland found at the eastern end of the known range in the Columbia Gorge. (Photo by Charlie Crisafulli).


Plate VII.1


Plate VII.2


Plate VII.3


Plate VII.4


Plate VII.5


Plate VII.6


Plate VII.7


Plate VII.8


Plate VII.9

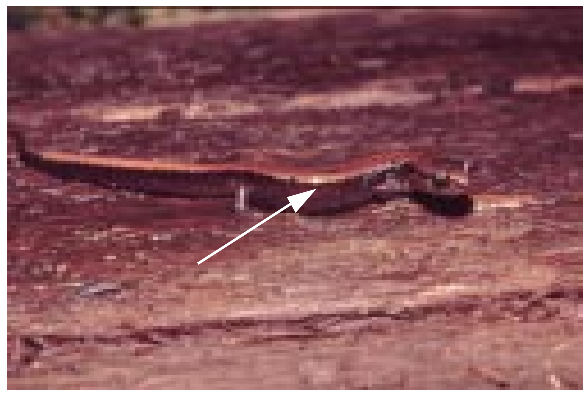


Plate VII.10


Plate VII.11


Plate VII.12


Plate VII.13

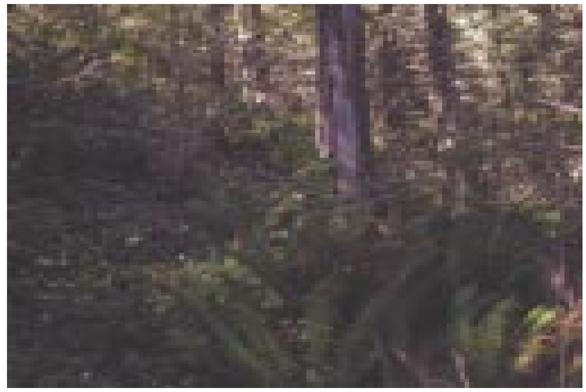


Plate VII.14


Plate VII.15

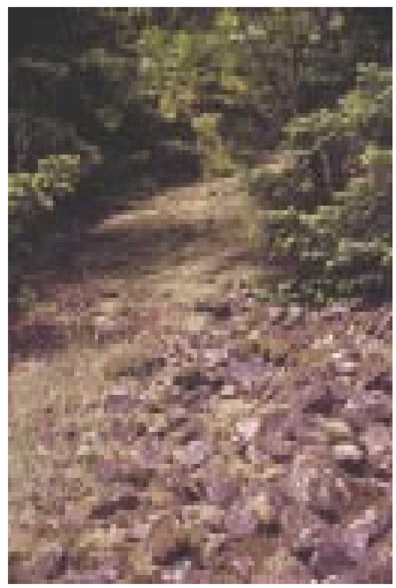


Plate VII.16

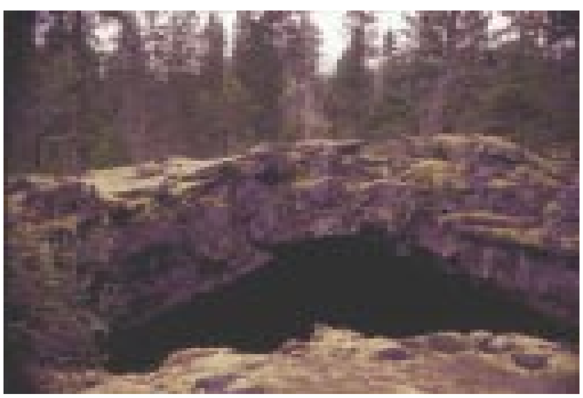


Plate VII.17


Plate VII.18

APPENDICES

Appendix No.	Description
VII.1 a&b	Larch Mountain salamander transect and habitat patch data form and code sheet.
VII.2 a&b	Larch Mountain salamander survey environmental data form.
VII.3 a&b	Larch Mountain salamander transect and habitat patch survey form and code sheet
VII.4 a&b	Larch Mountain salamander survey effort data form and code sheet
VII.5	Larch Mountain salamander field equipment checklist

APPENDIX VII.1a

Larch Mountain Salamander Transect and Habitat Patch Data Form

Page: _____ Of: _____

Project Name: ______________________________ Date: __________________________ State:________ County: _________________

UTM: _________________ Quad: ______________________ T: _______ R: _______ S: ______ 1/4S: _____

Transect/ Patch #	Patch Dist. A	Patch Dist. B	Patch Azim.	Size Length	Size Width	Inter-Transect Distance (m)	Comments

APPENDIX VII.1b

Larch Mountain Salamander
Transect and Habitat Patch Form Code Definition Sheet

1. Project Name:	Record the project name or Survey Area.
2. Date:	Record day, month and year (e.g., 05May 1998)
3. Page:	Enter the page number for each completed data form. At the end of the survey, record the total number of pages in the space following "OF".
4. State:	Record either Washington (WA) or Oregon (OR)
5. County:	Record the County where the survey is conducted.
6. UTM:	Record Universal Transverse Mercator coordinates, north and east, to nearest m possible.
7. Quad:	Record the name of the U.S.G.S. 7.5 minute Quad map.
8. Legal Description:	Record Township, Range, Section and 1/4 Section.
9. Transect/Patch #:	Record the Transect or Habitat Patch that will be surveyed.
10. Patch A Dist.:	This entry should be completed only for surveying Habitat Patches that are outside belt transects. Record the distance (m) along the transect to Habitat Patch.
11. Patch B Dist.:	This entry should be completed only for surveying Habitat Patches that are outside belt transects. Record the distance (m) from the transect to Habitat Patch.
12. Patch Azimuth.:	This entry should be completed only for surveying Habitat Patches that are outside belt transects. Record the azimuth from the transect to the Habitat Patch.
13. Size Length:	Record the length of the Transect or Habitat Patch to the nearest m
14. Size Width:	Record the width of the Transect or Habitat Patch to the nearest m.
15. Inter-Transect Dist.	Record the distance between neighboring transects.
16. Comments:	Record any notes on specific features of transect or patch, or location.

APPENDIX VII.2a

Larch Mountain Salamander Survey Environmental Data Form
Temperature and Moisture Conditions

Surveyors: ____ Survey: ______ Of: _______ Page: _______ Of: _______

Project Name: ____ Date: ______________________ State: _______

County: __________________ UTM: N_____ , E_______ Quad: _________________ T: ______ R: ______ S: ______ 1/4 S: _______

	Cluster A						Cluster B						Cluster C					
	1		2		3		1		2		3		1		2		3	
Tran/Patch	T	M	T	M	T	M	T	M	T	M	T	M	T	M	T	M	T	M

Crisafulli, PNW, Olympia (1999)

APPENDIX VII.2b

Larch Mountain Salamander
Environmental Data Form Code Sheet

1. Surveyors:	Starting with your name first, list the names of all people participating in the survey.
2. Page:	Enter the page number for each completed data form. At the end of the survey, record the total number of pages in the space following “OF”.
3. Project Name:	Record the project name or Survey Area.
4. Date:	Record day, month and year (e.g., 05May 1998)
5. Survey Number:	Record which of the three surveys is being conducted (1,2 or 3).
6. State:	Record either Washington (WA) or Oregon (OR)
7. County:	Record the County where the survey is conducted.
8. UTM:	Record Universal Transverse Mercator coordinates, north and east, to nearest m possible.
9. Quad:	Record the name of the U.S.G.S. 7.5 minute Quad map.
10. Legal Description:	Record Township, Range, Section and 1/4 Section.
11. Tran/Patch:	Record the transect or habitat patch that is being surveyed.
12. T:	Record the temperature to the nearest (°C). Transects will have a total of nine measurements (3 for each Cluster, A-C). Habitat patches will have three measurements (i.e., Cluster A).
13. M:	Record the soil/substrate moisture condition (WET, MOIST, DRY). Transects will have a total of nine measurements (3 for each Cluster, A-C). Habitat patches will have three measurements (i.e., Cluster A).

APPENDIX VII.3a

Larch Mountain Salamander Animal Survey Form

Surveyors: ____ Page: _______ Of: _______

Project Name: ____ Date: ______________________ Survey: _______ Of: _______

State: _______ County: __________________ Quad: ____________________ T: ______ R: ______ S: ______ 1/4 S: _______

UTM: N; _______, E; _______ Begin Time: ____________ End Time: _____________

Weather last 24 hrs.: ____ Environmental Conditions Acceptable: ______

Freezing Temperatures Past 72 Hrs.: __________

Current Weather: Skies; ________________, Air Temperature: __________, Wind: ____________

Tran. #	Location	Azim	Dist.	Species	Stage	ID #	Habitat	SVL	TL	Microhab	Cover Obj.	Sur. Rock	% Slope	Aspect

APPENDIX VII.3a

Larch Mountain Salamander Animal Survey Form
Continuation Sheet

Surveyors: ____ Survey: ______ Of: _______ Page: _______ Of: _______

Project Name: ____ Date: _______________________ State: _______

County: ___________________ UTM: N; _______, E; _______Quad: ____________________ T: ______ R: ______ S: ______ 1/4 S: ______

Tran. #	Location	Azim	Dist.	Species	Stage	ID #	Habitat	SVL	TL	Microhab	Cover Obj.	Sur. Rock	% Slope	Aspect

APPENDIX VII.3b

Larch Mountain Salamander (*Plethodon larselli*)
Animal Survey Form Code Definition Sheet

<u>Required elements are: 1- 21</u>

1. Surveyors:	Starting with your own name first, list the names of all people participating in the survey in a given Survey Area.
2. Page:	Enter the page number for each completed data form. At the end of the survey, record the total number of pages in the space following "OF".
3. Project Name:	Record the project name or Survey Area.
4. Date:	Record day, month and year (e.g., 05May 1998)
5. Survey Number:	Record which of the three surveys is being conducted (1,2 or 3).
6. State:	Record either Washington (WA) or Oregon (OR)
7. County:	Record the County where the survey is conducted.
8. Quad:	Record the name of the U.S.G.S. 7.5 minute Quad map.
9. Legal Description:	Record Township, Range, Section and 1/4 Section.
10. UTM:	Record Universal Transverse Mercator coordinates, north and east, to nearest m possible.
11. Begin Time:	Record the time the survey was started.
12. End Time:	Record the time the survey was completed.
13. Weather last 24 hrs.:	Describe the weather over the last 24hrs. (freezing temps, frost, rain, high winds, etc.)
14. Freezing Temperatures:	Indicate whether there has been freezing temperatures during the past 72 hours. Record "yes" or "no".
15. Current Weather Conditions:	
Skies	Clear, overcast, partly cloudy, drizzle, light rain, rain, snow
Temp.	Record the ambient temperature 1 m. Above ground (be certain to avoid direct sunlight when measuring temperature)
Wind	Calm, light, moderate, high
16. Transect Number:	Record the transect that the animal is captured on.
17. Location:	Record to the nearest meter the distance along the transect where the animal was captured.
18. Azim:	If a habitat patch is surveyed outside of a belt transect indicate the azimuth from the transect line to the habitat patch.
19. Dist.	If a habitat patch is surveyed outside of a belt transect indicate the distance from the transect line to the habitat patch to the nearest decimeter (10 cm).

APPENDIX VII.3b

20. Species: Use four letter code of latin binomial; first two letters of the genus and first two letters of the specific name. For example: *Plethodon larselli* would be recorded as PLLA.

21. Stage: Categories will vary among species, but will include the following: AD = adult, SA = sub-adult, JUV = juvenile

Optional elements are: 22 - 30

22. ID #: Assign specific ID #s to all animals retained as vouchers specimens.

23. Habitat: Con = conifer, DEC = deciduous, MIX = mixed con/dec, TALUS, CLIFF, STREAM, SEEP, SPZ = splash zone (e.g., an area adjacent to a waterfall where there is a constant misting or light spray), POND, BANK, OTH = specify in notes.

24. SVL: Snout-vent length is measured in millimeters (mm). It is defined as the distance from the tip of the snout to the anterior margin of the vent.

25. TL: Total length is measured in millimeters (mm). It is defined as the distance between the tip of the snout to the tip of the tail.

26. Microhab: Record the microhabitat where the animal was captured. BH = bark heap, RP = rock pile, ROC = rock outcrop, SNAG, Wood (see description under Cover Object), OTH = give detailed description in notebook.

27. Cover Object: Cover objects are defined as the object under which the animal was found.
ROCK: Grav = gravel; COB = cobble; Boul = boulder,
WOOD: Bark; Slab = non-round; Bran = <10cm dia. LOG1 = 11-25 cm dia.; LOG2 = 26-50cm. dia.; LOG3 = 51-100cm. dia.; LOG4 = >100

28. Sur. Rock: Record if surface rock is present within the microhabitat where the animal was captured.

29. % Slope at level slope measured down aspect. Measurements should be taken over the longest distance possible. Do not include land of a different slope than that where the animal was captured.

30. Aspect: Cardinal directions and combinations (e.g., N, NE, S, SW)

APPENDIX VII.4a

Larch Mountain Salamander Survey Effort Data Form

Page: _____ Of: _____

Project Name: ____________________________________ State: _________ County: _________________

UTM: N: _______, E: ________ Quad: __________________ T: _________ R: ________ S: ________ 1/4 S: ________

Transect/ Patch #	Survey Date	Size Length	Size Width	Breaks	Begin Time	End Time	Total Time	End Location	Completed

APPENDIX VII.4b

Larch Mountain Salamander
Survey Effort Form Code Definition Sheet

1. Project Name:	Record the project name or Survey Area.
2. Page:	Enter the page number for each completed data form. At the end of the survey, record the total number of pages in the space following “OF”.
3. State:	Record either Washington (WA) or Oregon (OR)
4. County:	Record the County where the survey is conducted.
5. UTM:	Record Universal Transverse Mercator coordinates, north and east, to nearest m possible.
6. Quad:	Record the name of the U.S.G.S. 7.5 minute Quad map.
7. Legal Description:	Record Township, Range, Section and 1/4 Section.
8. Transect/Patch #:	Record the Transect or Habitat Patch where the animal was captured.
9. Date:	Record day, month and year (e.g., 05May 1998)
10. Size Length:	Record the length of the Transect or Habitat Patch to the nearest m
11. Size Width:	Record the width of the Transect or Habitat Patch to the nearest m.
12. Breaks:	Record breaks from surveying (e.g., lunch, rests, consultations).
13. Begin Time:	Record the time that surveying or breaks begin.
14. End Time:	Record the time that surveying or breaks end.
15. Total Time:	Record the total time spent surveying or on break.
16. End Location:	Record distance (location) along transect (or patch) where survey ended for the day.
17. Completed:	Record if the survey of the transect or patch was completed (“yes” or “no”).

APPENDIX VII.5

Equipment list for performing surveys for the Larch Mountain salamander.

Equipment	Number (per crew member)	Use
compass	1	installing transects and determining aspect of survey sites and capture locations.
Flagging	several (3 colors)	marking transects and capture locations
measuring tape	1- 50 or 100 m	transect installation and measuring distance of habitat patches and capture locations.
String box (hip chain)	1	described above for measuring tape
Clinometer (optional)	1	measure gradient of site
Clipboard	1	hold data forms
pencil & markers	3 each	writing on data forms and flagging
thermometer	2	measure microclimatic conditions
garden trowel	1	dig soil pits to evaluate moisture
rulers (15 cm, optional)	3	measure captured animals
plastic bags	several	secure captured animals for measuring
rigid plastic container	2	hold retained specimens
water resistant paper	12 notebooks	record field notes
data forms/code sheets	complete sets	record field data
collapsible cooler	1	keep retained animals cool
field guides	1 or 2	aid in identifications
back pack (day)	1	carry field equipment and personal gear