National Park Service
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San Juan Island National Historical Park Amphibian Inventory 2002

Natural Resource Technical Report NPS/NCCN/NRTR—2013/731

ON THE COVER
Top: *Pseudacris regilla;* Bottom: *Rana aurora*,
Photograph by: Michael Layes

San Juan Island National Historical Park Amphibian Inventory 2002

Natural Resource Technical Report NPS/NCCN/NRTR—2013/731

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Contents

Page

Figures v

Tables vii

Appendices ix

Executive Summary xi

Acknowledgments xiii

Introduction 1

Study Area 3

Methods 5

- Aquatic Surveys 7
- Terrestrial Surveys 7
- Incidental surveys 8
- Photographic Voucher Specimens 8

Results 9

Discussion 17

- Pacific Treefrog (*Pseudacris regilla*) 17
- Northern Red-legged Frog (*Rana aurora*) 17
- Other Species 19
- Plethodontids 19

Threats 21

- Climate Change 21
- Disease and Pathogens 21
- Contaminants 22
- Habitat Alteration 22

Contents (continued)

Page

Roads 23

Recommendations 25

Summary 27

Literature Cited 29

Figures

Page

Figure 1. Map of San Juan Island National Historical Park.. 3

Figure 2. San Juan Island National Historical Park amphibian survey locations. 5

Figure 3. Observations of Pacific treefrogs (*Pseudacris regilla*) and northern red-legged frogs (*Rana aurora*) based on amphibian surveys conducted at English Camp, San Juan Island National Historical Park, 2002.. 11

Figure 4. Northwestern garter snake (*Thamnophis ordinoides*), English Camp, San Juan Island National Historical Park.. 12

Figure 5. Observations of Pacific treefrogs (*Pseudacris regilla*) based on amphibian surveys conducted at American Camp, San Juan Island National Historical Park, 2002.. 12

Figure 6. Course woody debris (CWD) decay classes documented for each terrestrial survey transect. 15

Figure 7. Northern red-legged frog *(Rana aurora)*, English Camp, San Juan Island National Historical Park.. 18

Figure 8. Northwestern garter snakes (*Thamnophis ordinoides)*, English Camp, San Juan Island National Historical Park.. 20

Appendix Figures

Figure A-1. Aquatic amphibian inventory data sheets... 44

Figure A-2. Scientific and common names of amphibians and reptiles found in the Pacific Northwest.. 47

Figure C-1. Terrestrial amphibian inventory data sheets.. 73

Tables

Page

Table 1. Amphibian species expected to occur in San Juan Island National Historical Park, and their special status designation. 2

Table 2. Amphibian survey sample site locations, American Camp, San Juan Island National Historical Park and associated Universal Transverse Mercator (UTM) coordinates. 6

Table 3. Amphibian survey sample site locations, English Camp, San Juan Island National Historical Park and associated Universal Transverse Mercator (UTM) coordinates. 6

Table 4. Habitat decay class descriptors. 7

Table 5. Results of amphibian surveys at San Juan Island National Historical Park. 9

Table 6. Species detected by terrestrial surveys at English Camp, San Juan Island National Historical Park. 13

Table 7. Species detected by incidental surveys at English Camp, San Juan Island National Historical Park. 13

Table 8. Species, life stage, and numbers detected by aquatic visual encounter surveys at American Camp, San Juan Island National Historical Park. 13

Table 9. Species, life stage and numbers detected by incidental surveys at American Camp, San Juan Island National Historical Park. 13

Table 10. Environmental conditions for survey sites. 14

Table 11. Forest canopy cover for terrestrial survey sites. 15

Table 12. Amphibian species detected in San Juan National Historical Park, and their status. 27

Table 13. Reptile species documented in San Juan National Historical Park. 27

Tables (continued)

Appendix Tables

Page

Table B-1. Aquatic habitat measurements and descriptors. 49

Table B-2. Water quality descriptions for aquatic breeding sites, species present, and fish presence.. 49

Table B-3. Dominant substrate and percent vegetation cover for Site AC1. 49

Table B-4. Terrestrial habitat characteristics associated with species detection.......................... 50

Table B-5. Incidental habitat characteristics associated with species detection. 50

Table B-6. Overstory cover species and stem density size class. 51

Table B-7. Understory species and percent cover for terrestrial survey sites. 53

Table B-8. Plant species codes. 57

Table B-9. Terrestrial survey woody debris transects.. 61

Appendices

Page

Appendix A: NCCN aquatic amphibian survey protocols and datasheets. 37

Appendix B: Terrestrial, incidental, and aquatic habitat characteristics. 49

Appendix C: NCCN terrestrial survey protocols and datasheets... 71

Executive Summary

This document details amphibian inventories conducted at San Juan National Historical Park (SAJH). These inventories were part of a larger effort to document species presence at five North Coast and Cascades Network (NCCN) parks: Mount Rainier National Park (MORA), Ebey's Landing National Historical Reserve (EBLA), Lewis and Clark National Historical Site (LEWI), Fort Vancouver National Historic Site (FOVA), and San Juan Island National Historical Park (SAJH). Four of these NCCN parks (EBLA, FOCL, FOVA, and SAJH) had incomplete amphibian lists based on limited or undocumented data. Our primary goal was to meet the National Park Service Inventory and Monitoring program goal to better assess the status of amphibian species listed as "expected" in the parks and to verify the occurrence of 90% of these species. Species occurrences were documented or verified by written records and photographs; no specimens were collected in this inventory. Prior to this inventory, SAJH had no verified list of amphibians or reptiles occurring in the park, however a wetland study conducted by Holmes (1998) documented incidental observations of two frog species. Additional searches of museum specimens and state records have not been completed.

Our primary goal for SAJH was to search for the presence of expected species: Ensatina (*Ensatina eschscholtzii*), western red-backed salamander (*Plethodon vehiculum*), northern red-legged frog (*Rana aurora*), Oregon spotted frog (*Rana pretiosa*), American bullfrog (*Lithobates catesbeianus*), Pacific treefrog (*Pseudacris regilla*), and western toad (*Anaxyrus boreas*).

Inventories of reptiles were not targeted during this project; however they were documented when encountered and are reported in this document.

This report provides an updated list of amphibian species present within SAJH, describes the methods used for and results of the surveys, and discusses each species detected. The results include a summary of species documented at each survey site, information on species life stage and habitat, and maps showing the spatial distributions of amphibians in the park. The appendices include more details on information documented in the inventory. Microsoft EXCEL spreadsheets that provide records documenting sampling events, ArcMap GIS themes depicting locations, slide photographs of sites surveyed, and digital (and slide) voucher photos for new species documented have been submitted to the NCCN Data Manager.

Voucher specimens were not collected for this project. One voucher photograph was taken for the northern red-legged frog observation. Voucher specimens for amphibians and reptiles exist for many NCCN species in various park collections and at other institutions. These collections, along with new data provided through this inventory, represent an historic amphibian collection for additional research in the future.

Fourteen surveys were conducted at American Camp and 15 surveys at English Camp. We confirmed the presence of two species in SAJH in this inventory: northern red-legged frog and Pacific treefrog.

Amphibian habitat is sparse on San Juan Island and within SAJH, one of the driest parks within the NCCN, with only one permanent pond located at American Camp and no perennial streams. Several surveys of palustrine wetlands did not result in amphibian detections. This inventory was

conducted during April 2002 and when surveys were initiated, many areas were already too dry to support amphibians. A follow up survey in late February and early March could possibly yield additional amphibian species detections.

Species names have been verified and updated as needed based on Crother et al. (2008). Note that the Genus name for the American bullfrog has been changed from *Rana* to *Lithobates*, and for the western toad from *Bufo* to *Anaxyrus*.

Species absence is extremely difficult to determine and it is possible that some species recorded historically or occasionally but not detected during our survey efforts may still be present in the park. Additional surveys of targeted habitats and species should be conducted.

In addition to this inventory, a separate project was funded, as part of the NCCN amphibian inventories, to provide a network wide amphibian database (Galvan et al. 2005), including North Cascades and Olympic National Parks. We developed this database by consolidating existing network databases containing information relevant to amphibian distributions into one functional relational database, including data resulting from this inventory. The consolidated database describes the locations of amphibians in various life stages identified in pond, stream, and terrestrial surveys conducted within the NCCN. The database includes fields relevant to the study years, Park names, survey types, coordinates, elevations, scientific and common names, and life stages. The park natural resource staff and the NCCN data managers will assume maintenance responsibilities for the database, including updating it to ensure compliance with NPS data management mandates. Metadata for the database was also included.

Acknowledgments

Funding for this inventory was provided by the NPS's Inventory and Monitoring Program and Mount Rainier National Park.

We thank Matt Grove and Brian Hasebe, for their field assistance. We thank Robert Hoffman, Mark Huff, and Regina Rochefort for their review of this document and comments made to improve it. We thank Mike Adams for his technical assistance in developing the amphibian protocols for the NCCN inventories. We also thank Natalya Antonova for assistance with maps and Lise Grace for assistance with formatting and editing.

Introduction

The status of amphibian populations has long been a concern in the Pacific Northwest (USDA Forest Serve and DOI Bureau of Land Management 1994, Bury et al. 1980, Bury 1999). Habitat requirements of amphibians in late-successional forests of the Pacific Northwest have received some attention from the U.S. Forest Service over the past 15 years, but further work is needed to better understand how habitat variation affects population viability. Because amphibian species are associated with riparian systems, understanding the relationships between riparian management and amphibian population dynamics is a high priority. In addition, further work is needed to better understand the population dynamics of rare and locally endemic species.

Amphibians are important members of terrestrial and aquatic ecosystems because they occupy key trophic positions in food webs. As adults they can be top carnivores, and as eggs, larvae or juveniles, they may be the major food source of many other species including birds, mammals, fish, and invertebrates. In some forest ecosystems, amphibians may comprise the major component of the vertebrate biomass (Burton and Likens 1975, Bury 1988). Moreover, amphibians are good “bioindicators” of environmental stress because of their complex life histories. Amphibian declines may be an early warning signal that other organisms also may be in danger of decline or extinction (Bury et al. 1980, Blaustein and Wake 1990, Phillips 1990, Wyman 1990, Wake 1991).

Recent Vital Signs workshops for several of the North Coast and Cascades Network (NCCN) parks identified amphibians as a high priority taxonomic group for long-term ecological monitoring. Assessments of the status of amphibian populations in the Pacific Northwest have been difficult to complete because the number of long-term inventory and monitoring efforts has been limited and few if any comparable data sets are available (Olson and Leonard 1997). Yet, human-related activities have disturbed many amphibian habitats (Fellers and Drost 1993, Blaustein and Wake 1995, Bury 1999); for example, fish stocking, logging practices, and alteration of streams, wetlands, and riparian areas, have potentially had widespread effects on amphibian communities.

The primary goal of this inventory was to document amphibian, and incidental reptile species presence in San Juan National Historical Park (SAJH) because the park’s lists were incomplete based on limited or undocumented data. Our primary objective was to document, through written records or photographs, 90% of the amphibian species expected to occur in SAJH (i.e., 90%verification level). Prior to this inventory, SAJH had limited documentation of amphibians or reptiles in the park.

Table 1 lists the amphibian species expected to be encountered in SAJH. State and federal species documentation lists, published references and local expertise were used to determine which species are expected to occur in the Park.

Table 1. Amphibian species expected to occur in San Juan Island National Historical Park, and their special status designation. C = confirmed present prior to this inventory; + = expected to occur; ** = federal or state listed species of concern; # = introduced species.

Genus and Species	Common Name	Code	Special Status Species	Non-native Species	SAJH
Terrestrial breeding species					
Caudata — salamanders					
Ensatinas					
Ensatina eschscholtzii	Ensatina	ENES			+
Woodland salamanders					
Plethodon vehiculum	Western red-backed salamander	PLVE			+
Aquatic breeding species					
Anurans					
True frogs or brown frogs					
Rana aurora	Red -legged frog, Northern red-legged frog	RAAU	**		*C*
Rana pretiosa	Oregon spotted frog	RAPR	**		+
American water frogs					
Lithobates catesbeianus (formerly Rana catesbeiana)	American bullfrog	RACAT		#	+
Chorus frogs					
Pseudacris regilla	Pacific treefrog, Pacific chorus frog	PSRE			*C*
North American toads					
Anaxyrus boreas (formerly Bufo boreas[1]*)*	Western toad	BUBO	**		+
Caudata — salamanders					
Pacific newts (Family Salamandridae)					
Taricha granulosa	Rough-skinned newt	TAGR			+

[1]Olson 2009 reported that molecular analyses have resulted in re-naming western toad from *Bufo boreas* to *Anaxyrus boreas* but this is being refuted and another proposal has been made that the new name be considered as a Subgenus classification. In this scheme western toad would be *Bufo Anaxyrus boreas*. Olson reports that this is a dynamic situation and more changes can be anticipated.

Study Area

San Juan Island National Historical Park (SAJH), established in 1966, comprises 1752 ac. The purpose of SAJH is to preserve the historic sites of American and English Camps on the island (Figure 1). The park also commemorates and interprets the historic events that occurred from 1853 to 1871 on the island in connection with the final settlement of the Oregon Territory boundary dispute, including the Pig War of 1859, and commemorates the arbitration and resolution of an international dispute and the establishment of a lasting peace between nations. The park is the largest public open space on San Juan Island. In addition to the historical buildings and features at both camps, the park contains important prehistoric Indian sites.

Figure 1. Map of San Juan Island National Historical Park.

Natural resources within the park are varied and reflect the influence of the coastal marine shoreline and its location within a major marine confluence zone. These resources include: 6.1 miles of shoreline and intertidal habitat; 92 ac of wetlands, including three marine lagoons; 900 acres of grassland, which supports varied raptor and songbird populations; a slightly smaller acreage of largely second-growth fir, cedar, and maple forests and Garry oak woodland. The effects of past logging, grazing, and cultivation are evident at both camps, but small pockets of old-growth forest remain.

The major surface water resources in the park are three tidal lagoons located along the north shore of Griffin Bay at American Camp. Freshwater resources in the park consist of groundwater (accessed through wells), small springs, seeps, a perennial pond, intermittent ponds or wetlands, and an intermittent stream. The freshwater perennial and intermittent ponds and wetlands are the primary sources of freshwater that provide habitat to wildlife populations such as migratory birds and amphibians. An intermittent stream at English Camp drains several pond and wetland areas. As the largest natural area on the island, the park is subject to ever-increasing pressures from near-park development, increasing visitation, different kinds of recreational uses, and climate change.

Thirty-five SAJH wetlands were mapped and surveyed in 1998, 26 in the American Camp unit and nine in the British Camp unit (Holmes 1998). During these surveys, Pacific treefrogs (*Pseudacris regilla*) and northern red-legged frogs (*Rana aurora*) were found.

Groundwater quality is the main water quality issue in the park (Klinger et al. 2006). Since 1981, increased levels of chloride, manganese, and dissolved solids have been found in the domestic supply well at American Camp. Chloride concentrations in ground water can indicate the presence of sea water intrusion. The park and most island residents rely on groundwater as the source of domestic water supply. Acting to prevent saltwater intrusion is of utmost concern for park managers, particularly at American Camp, in order to maintain an adequate freshwater supply.

In 1999, the USGS Water Resource Division conducted a baseline water quality inventory at SAJH (Weber et al. 2009). Sites sampled included a well and an unnamed creek at English Camp, and a well, spring, and pond at American Camp. Results of the report indicated that the overall quality of ground and surface water in the study area was generally good; however, there was some evidence that land use activities might be affecting water quality at the park. The well at American camp had elevated conductance and chloride concentrations, indicating seawater intrusion. Manganese concentrations at this site were also found to be high. Samples from all surface water sites had concentrations of bacteria, and *E. coli* was found in samples from water at a spring located in American Camp.

Methods

Surveys were conducted in spring 2002 during a narrow three week period, and consisted of aquatic and terrestrial surveys, and incidental observations. Sample sites were selected from a previous wetland survey (Holmes 1998) and all wetlands with suitable habitat at the time of the survey were surveyed for amphibians. Sites for terrestrial surveys were non-randomly selected within suitable forested habitat at American and English Camps. A map of samples sites surveyed in 2002 is shown in Figure 2 and information on the survey site locations is displayed in Tables 2 and 3. Surveys were conducted during the months of April and May.

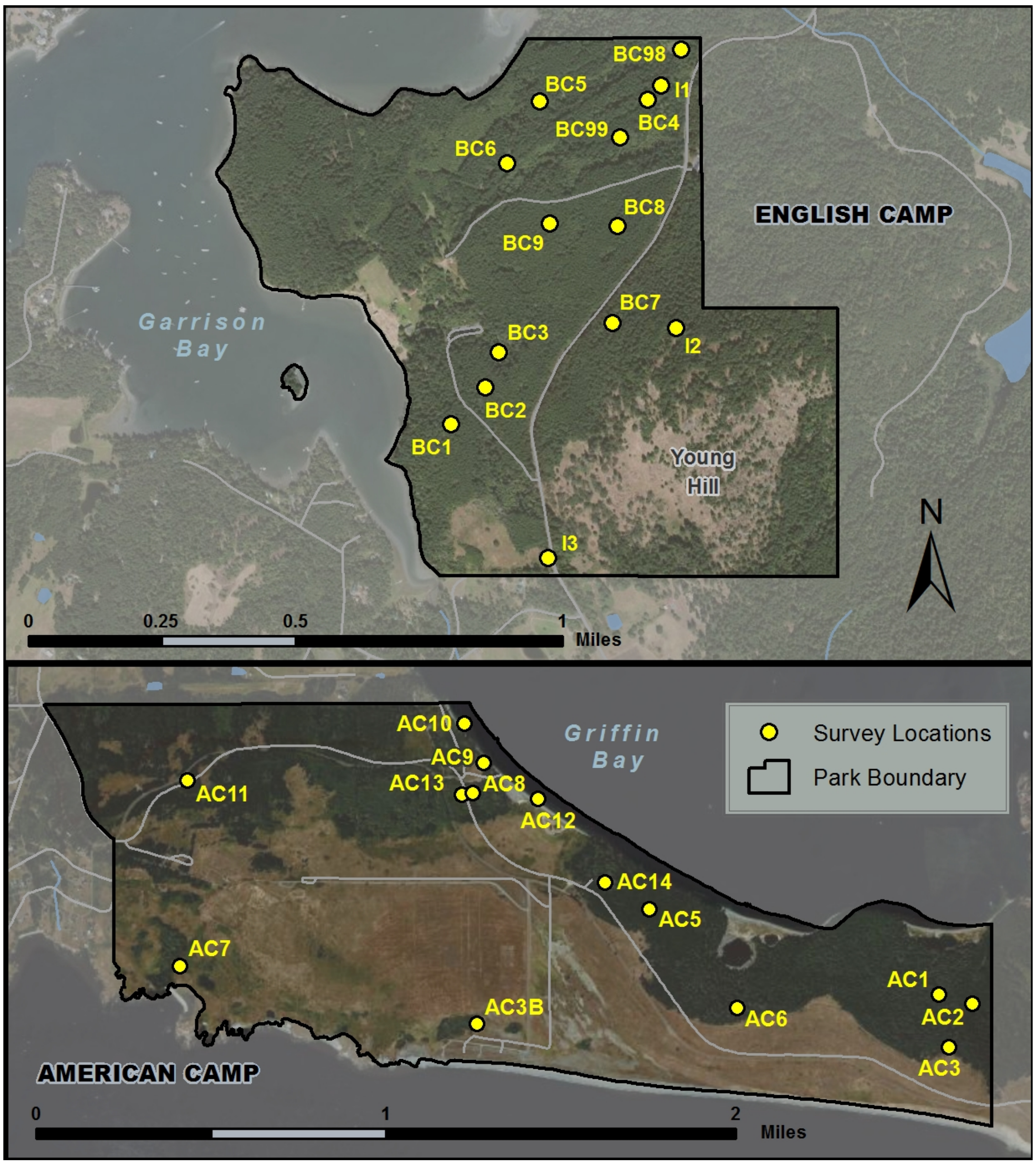

Figure 2. San Juan Island National Historical Park amphibian survey locations.

Table 2. Amphibian survey sample site locations, American Camp, San Juan Island National Historical Park and associated Universal Transverse Mercator (UTM) coordinates.

Field Site ID	Location Description	UTM N NAD27	UTM E NAD27	Elevation (ft)
AC1	Small pond on North shore of American Camp, South of third lagoon	5367106	501772	16
AC2	North shore of American Camp, South of third lagoon	5367063	501929	40
AC3	South of AC1 and AC2, East of Mt Finlayson	5366862	501819	70
AC3B	American Camp, Wetland # AM03	5366970	499649	80
AC5	American Camp North side, East of AC14	5367499	500440	80
AC6	West of Jakle's Lagoon, American Camp	5367043	500844	80
AC7	American Camp Wetland # AM16	5367238	498280	90
AC8	American Camp Wetland # AM11	5368033	499628	35
AC9	American Camp Wetland # AM12	5368172	499678	15
AC10	American Camp, Wetland#AM14	5368353	499591	10
AC11	American Camp Wetland# AM18	5368092	498317	145
AC12	American Camp Wetland # AM 9 and AM #10	5368008	499930	10
AC13	American Camp Wetland# AM15	5368027	499577	40
AC14	North side of American Camp	5367622	500236	15
AC NITE	AC8, AC9, AC10, AC11, AC12	Multiple	Multiple	

Table 3. Amphibian survey sample site locations, English Camp, San Juan Island National Historical Park and associated Universal Transverse Mercator (UTM) coordinates.

Field Site ID	Location Description	UTM N NAD27	UTM E NAD27	Elevation (ft)
BC1	English Camp	5380996	489189	138
BC2	English Camp	5381107	489291	140
BC3	English Camp	5381211	489332	110
BC4	English Camp	5381975	489781	120
BC5	English Camp	5381969	489457	60
BC6	English Camp	5381782	489357	90
BC7	English Camp	5381300	489676	280
BC8	English Camp	5381594	489690	200
BC9	English Camp	5381600	489487	130
BC98	Wetland # BR06, NE corner	5382125	489882	115
BC99	Wetland # BR07, 200m north on service road, 50m west	5381860	489699	125
I1	British Camp, North End	5382016	489821	115
I2	Mt. Young Trail, English Camp	5381285	489868	500
I3	English Camp, South Park Boundary, W side of road	5380591	489480	140
BC NITE	English Camp aural survey	no data	no data	no data

Aquatic Surveys

Wetland maps were used to locate palustrine wetland complexes. At the time of the survey, only one pond with sufficient water depth suitable for an aquatic survey was located among all of the mapped wetlands by Holmes (1998). The aquatic survey was completed for site AC1. A survey of this site was conducted using the visual search protocol developed by Dr. Michael J. Adams, USGS-BRD (see Appendix A). Surveyors walked the perimeter of the wetland, stopping every 10 m or at 20 evenly spaced stations to scan for embryos and larvae. One person waded and the other person walked on shore. Dip net sweeps were made to capture individuals to ensure definitive species identification. Identified animals were released at the point of capture. Cover items were moved to check for larvae. Vegetated areas and other habitats likely to harbor embryos and larvae were also searched (Appendix B, Tables B-1 and B-2).

Terrestrial Surveys

Before going into the field, USGS topographic maps were searched for all suitable habitats for which a safe access route could be found. For each area with suitable habitat, searches for amphibians were made of the entire area for a minimum of 30 min. Search time was doubled or tripled in some cases if amphibian habitat was spatially complex. Each plot was searched for a minimum of 30 worker-minutes during daylight (> one hour after sunrise and before sunset). A search consisted of workers methodically visually searching for amphibians over the entire area of the plot and looking under as much loose wood, bark, or rock that could be lifted and restored to a condition relatively similar to its original state.

Course woody debris (CWD) was documented along transects established within the terrestrial survey areas. CWD includes fallen trees and large branches as well as logs and large pieces of wood left on the ground. Decay classes (Table 4) were recorded for CWD encountered along the transect.

Table 4. Habitat decay class descriptors.

Log Characteristics	Log Decay Class				
	1	**2**	**3**	**4**	**5**
Bark	intact	intact	trace	absent	absent
Twigs <3cm (1.18in)	present	absent	absent	absent	absent
Texture	intact	intact to partly soft	hard, large pieces	small, soft, blocky pieces	soft and powdery
Shape	round	round	round	round to oval	oval
Color of wood	original color	original color	original color to faded	light brown to faded brown or yellowish	faded to light yellow or gray
portion of log on ground	log elevated on support points	log elevated on support points but sagging slightly	log is sagging near ground	all of log on ground	all of log on ground

Additional field habitat measurements were taken to aid in future studies, but analysis of these data was beyond the scope of this inventory. Field habitat measurements are presented in Appendix B, Tables B-4 and B-6 through B-9. Additional details on terrestrial survey protocols are provided in Appendix C.

Incidental surveys

Incidental surveys were conducted when unmapped amphibian habitat was encountered, or for previously identified wetlands that lacked sufficient water for an aquatic survey. Workers surveyed these areas and recorded: general habitat description, location coordinates, species encountered and life stage (Appendix B, Table B-5). Incidental surveys were also used in areas of thick brush such as Himalayan Blackberry and Wild Rose. Incidental night surveys using spotlights were also conducted for all of English Camp and six wetlands in American Camp.

Photographic Voucher Specimens

All amphibians encountered were recorded on data sheets. Photographs depicting key identification characteristics were taken for one frog species and one snake species.

Results

Approximately 44,803 m^2 were surveyed at SAJH for 7,294 search-minutes. At American Camp, a total of 14 surveys were completed over three days, one night survey was conducted, and over 19,000 m^2 were surveyed for 2,460 search-minutes. At English Camp, a total of 15 surveys were completed in six days, one night survey was conducted, and approximately 25,803 m^2 were surveyed for 4,834 search-minutes (Table 5). No aquatic surveys were conducted at English Camp due to a lack of suitable habitat.

Only two out of eight expected amphibian species were detected at SAJH (Tables 6-9). Two species of amphibians, Pacific treefrog and northern red-legged frog were detected at English Camp. The northwestern garter snake (*Thamnophis ordinoides*) was observed at two locations in English Camp. Only Pacific treefrogs were detected at American Camp. See Figures 3 to 5 for maps of locations of detected species at American Camp and English Camp.

Table 5. Results of amphibian surveys at San Juan Island National Historical Park.

Field Site ID	Location Description	Date	Survey Type	Square Meters Surveyed	Search Minutes	Species
AC1	Small pond on North shore of American Camp, South of third lagoon	4/16/2002	Aquatic	1225	280	PSRE
AC2	North shore of American Camp, South of third lagoon	4/16/2002	Terrestrial	2827 (30m radius plot)	30	None
AC3	South of AC1 and AC2, East of Mt Finlayson	4/16/2002	Terrestrial	2827 (30m radius plot)	30	None
AC3B	American Camp, Wetland # AM03	4/17/2002	Incidental	100	120	None
AC5	American Camp North side, East of AC14	4/17/2002	Terrestrial	2827 (30m radius plot)	120	None
AC6	West of Jakle's Lagoon, American Camp	4/17/2002	Terrestrial	2827 (30m radius plot)	60	None
AC7	American Camp Wetland # AM16	4/17/2002	Incidental	100	120	None
AC8	American Camp Wetland # AM11	4/17/2002	Incidental	60	200	None
AC9	American Camp Wetland # AM12	4/17/2002	Incidental	120	120	None
AC10	American Camp, Wetland #AM14	4/17/2002	Incidental	200	60	None
AC11	American Camp Wetland #AM18	4/17/2002	Incidental	1000	240	PSRE
AC13	American Camp Wetland# AM15	4/18/2002	Incidental	1000	480	None
AC14	North side of American Camp	4/18/2002	Incidental	2000	480	None
AC NITE	AC8, AC9, AC10, AC11, AC12	4/17/2002	Night Survey	2000 (estimate)	300	PSRE

Table 5. Results of amphibian surveys at San Juan Island National Historical Park (continued).

Field Site ID	Location Description	Date	Survey Type	Square Meters Surveyed	Search Minutes	Species
BC1	English Camp	4/9/2002	Terrestrial	2827 (30m radius plot)	30	None
BC2	English Camp	4/9/2002	Terrestrial	2827 (30m radius plot)	30	None
BC3	English Camp	4/9/2002	Terrestrial	2827 (30m radius plot)	60	PSRE
BC4	English Camp	4/10/2002	Terrestrial	2827 (30m radius plot)	30	PSRE
BC5	English Camp	4/10/2002	Terrestrial	2827 (30m radius plot)	60	PSRE
BC6	English Camp	4/10/2002	Terrestrial	2827 (30m radius plot)	30	None
BC7	English Camp	4/11/2002	Terrestrial	2827 (30m radius plot)	30	None
BC8	English Camp	4/11/2002	Terrestrial	2827 (30m radius plot)	30	None
BC9	English Camp	4/11/2002	Terrestrial	2827 (30m radius plot)	30	None
BC98	Wetland # BR06, NE corner	5/22/2002	Incidental	40	2100	PSRE
BC99	Wetland # BR07, 200m north on service road, 50m west	5/22/2002	Incidental	40	400	RAAU
BC NITE	Night Survey, Whole Park	4/9/2002	Night Survey	240	2000	PSRE
I1	British Camp, North End	4/10/2002	Incidental	10	2	PSRE
I2	Mt. Young Trail, English Camp	4/4/2002	Incidental	10	1	THOR
I3	English Camp, South Park Boundary, W side of road	4/18/2002	Incidental	20	1	THOR

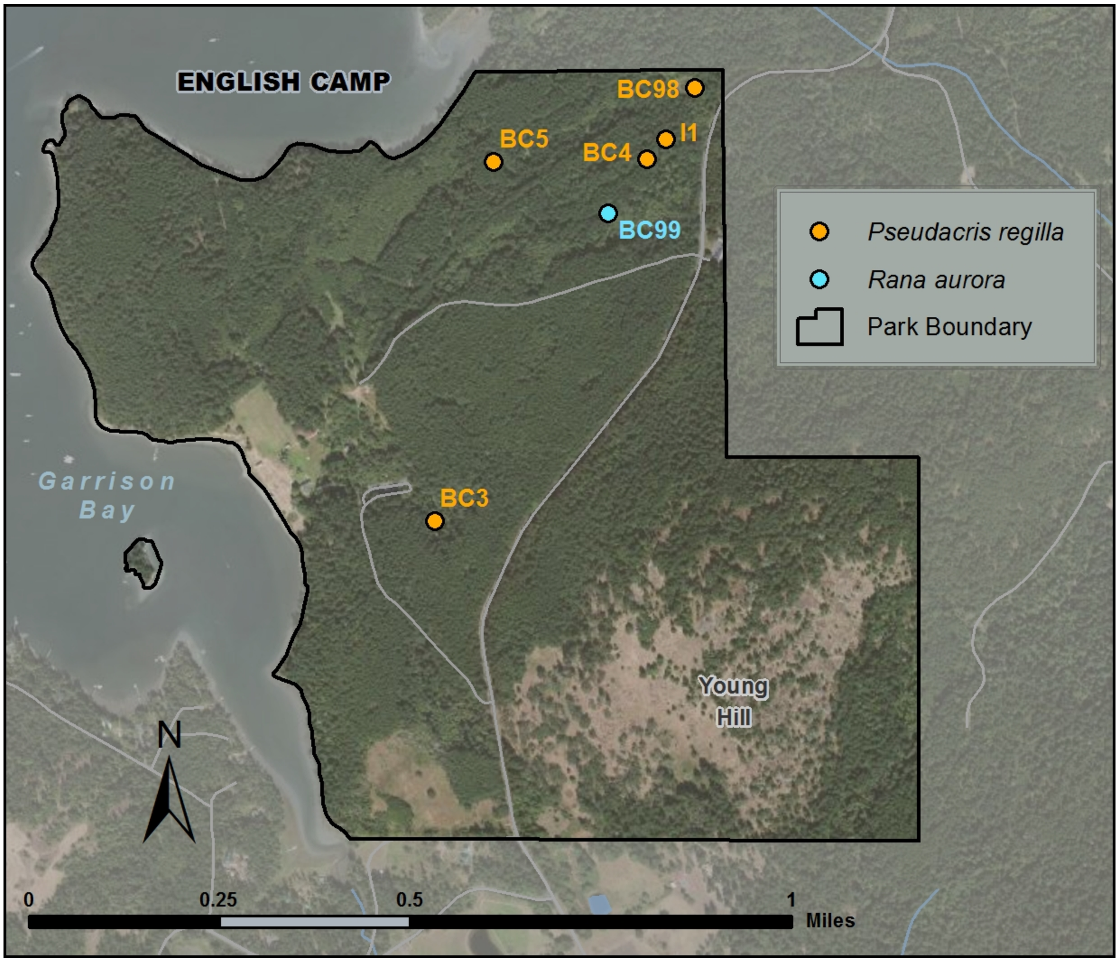

Figure 3. Observations of Pacific treefrogs (*Pseudacris regilla*) and northern red-legged frogs (*Rana aurora*) based on amphibian surveys conducted at English Camp, San Juan Island National Historical Park, 2002.

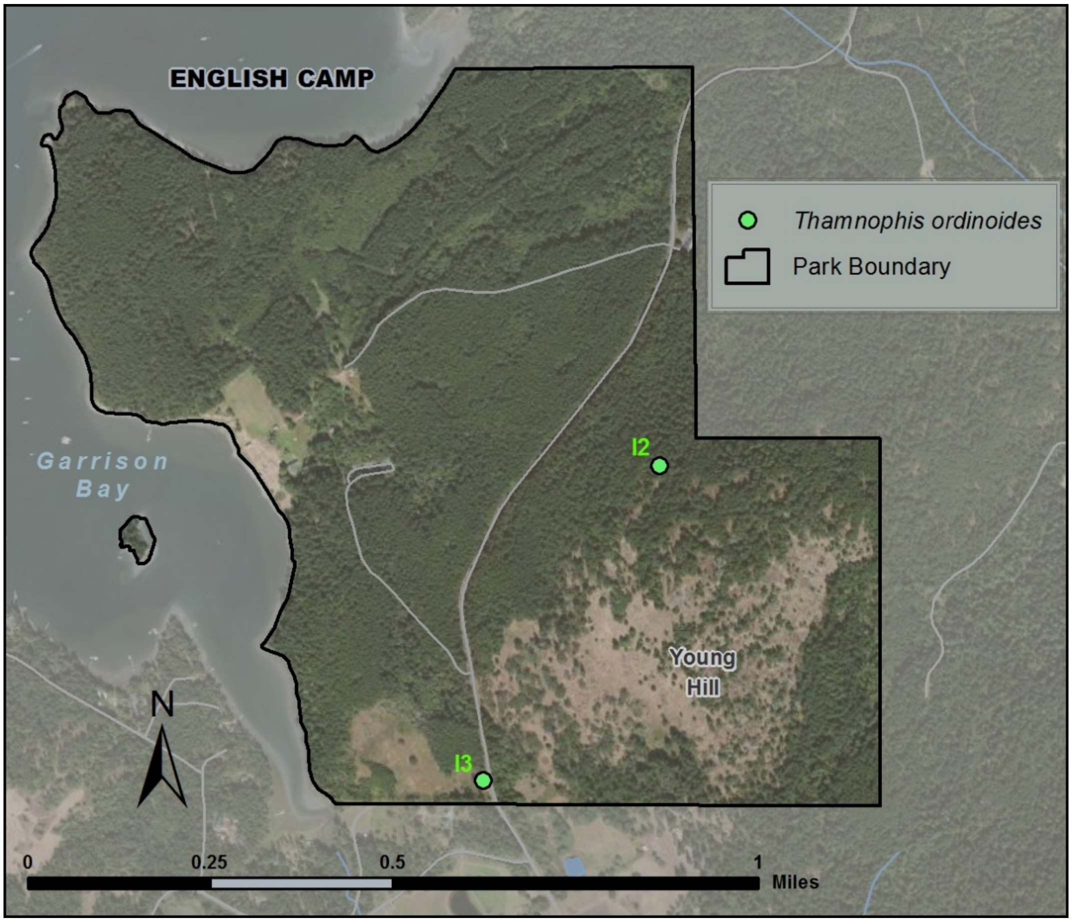

Figure 4. Northwestern garter snake (*Thamnophis ordinoides*), English Camp, San Juan Island National Historical Park.

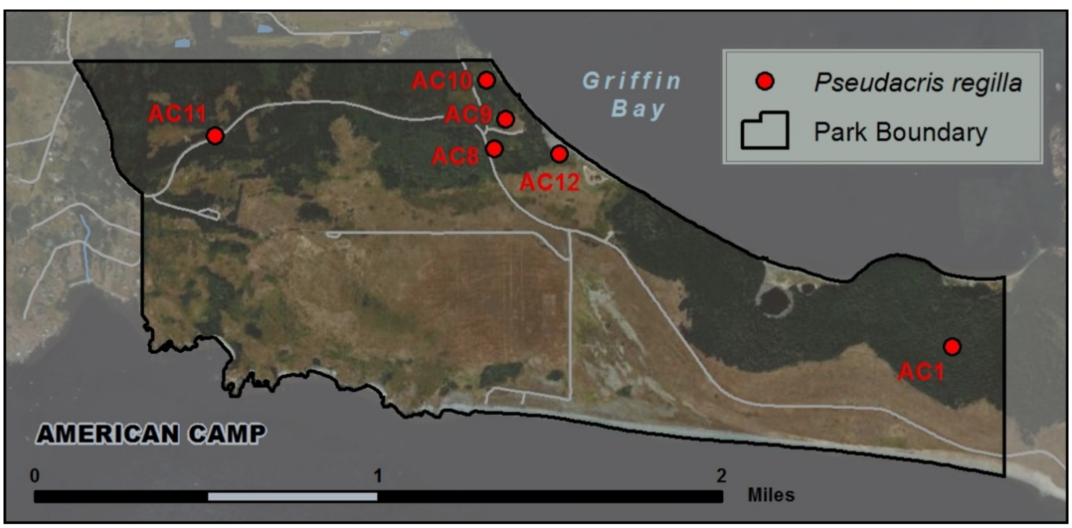

Figure 5. Observations of Pacific treefrogs (*Pseudacris regilla*) based on amphibian surveys conducted at American Camp, San Juan Island National Historical Park, 2002. Sites AC8, AC9, AC10, AC11, and AC12 were all aural detections detected during a night light survey (AC NITE) and total numbers were estimated. Site AC1 was a visual detection.

Table 6. Species detected by terrestrial surveys at English Camp, San Juan Island National Historical Park.

Date	Site ID	Species	Stage	Count
4/9/2002	BC3	PSRE	A	1
4/10/2002	BC4	PSRE	A	1
4/10/2002	BC5	PSRE	A	2

Table 7. Species detected by incidental surveys at English Camp, San Juan Island National Historical Park.

Date	Site ID	Species	Stage	Count
5/22/2002	BC98	PSRE	J	1
5/22/2002	BC99	RAAU	A	1
4/10/2002	I1	PSRE	A	1
4/4/2002	I2	THOR	A	1
4/18/2002	I3	THOR	A	3
4/09/2002	BC Nite aural (roads, trail, main parade, wet meadows)	PSRE	not recorded	1

Site AC1 was the only pond available to survey with suitable aquatic species breeding habitat at the time of the survey. A detailed description of this site is provided in Appendix B, Tables B-1 through B-3. Species detected at this site are presented in Table 8.

Table 8. Species, life stage, and numbers detected by aquatic visual encounter surveys at American Camp, San Juan Island National Historical Park.

Date	Site ID	Species	Stage	Count
4/16/2002	AC1	PSRE	A	2
		PSRE	EM	6

Table 9. Species, life stage and numbers detected by incidental surveys at American Camp, San Juan Island National Historical Park.

Date	Site ID	Species	Stage	Count
4/17/2002	AC11	PSRE	L	20
4/17/2002	AC NITE* Sites: AC8, AC9, AC10, AC11, AC12	PSRE	A	100

*AC NITE was a night light survey and all detections were aural. Counts were estimated as a total count for site locations AC8, AC9, AC10, AC11, and AC12.

Environmental conditions for survey sites are presented in Table 10. Air temperature ranged from 7 to 18°C for all sites. Soil temperature ranged from 6 to 14°C for terrestrial survey sites. Weather was generally dry during the survey period.

Table 10. Environmental conditions for survey sites.

Site ID	Survey Type	Weather	Wind	Air Temp (°C)	Relative Humidity (%)	Soil Temp (°C)
AC1	Aquatic	Overcast	Gusty	8.5		
AC2	Terrestrial	Dry	Light Breeze	9	74	7
AC3	Terrestrial	Dry	Calm	8	74	8
AC3B	Incidental	Dry	Calm	12		
AC5	Terrestrial	Dry	Calm	8	87	12
AC6	Terrestrial	Dry	Calm	9	no data	8
AC7	Incidental	Dry	Calm	11	no data	no data
AC8	Incidental	Dry	Calm	12	no data	no data
AC9	Incidental	Dry	Calm	14	no data	no data
AC10	Incidental	no data	no data	no data	no data	no data
AC11	Incidental	Clear	Calm	10	no data	no data
AC12	Incidental	Dry	Calm	8	no data	no data
AC13	Incidental	Dry	Calm	12	no data	no data
AC14	Incidental	Dry	Calm	13	no data	no data
BC1	Terrestrial	Light Rain	Calm	10	no data	9
BC2	Terrestrial	Mist	Calm	7	no data	11
BC3	Terrestrial	Mist	Calm	12	no data	8
BC4	Terrestrial	Dry	Light Breeze	14	no data	6
BC5	Terrestrial	Dry	Calm	16	no data	7
BC6	Terrestrial	Mist	Calm	15	no data	10
BC7	Terrestrial	Dry	Calm	13	no data	12
BC8	Terrestrial	Dry	Light Breeze	14	no data	12
BC9	Terrestrial	Mist	Calm	13	no data	14
BC98	Incidental	Dry	Light Breeze	17	no data	no data
BC99	Incidental	Dry	Calm	11	no data	no data
BCNITE	Incidental	Light Rain	Calm	9	no data	no data
I1	Incidental	Dry	Calm	11	no data	no data
I2	Incidental	Dry	Calm	18	no data	no data
I3	Incidental	Dry	Calm	15	no data	no data

Course woody debris (CWD) was measured in terrestrial surveys because Ensatinas (Bury and Corn 1988, Welsh and Lind 1991, Butts and McComb 2000) and western red-backed salamanders (Dupuis et al. 1995) are positively associated with CWD. In addition, Plethodons favor logs in medium to advanced stages of decay (Aubry et al. 1988, Corn and Bury 1991). Detailed CWD data are presented in Appendix B, Table B-9. Number of CWD decay classes for each transect is presented in Figure 6. Canopy cover, also important for Plethodon habitat (Alkaslassy 2005), is presented in Table 11.

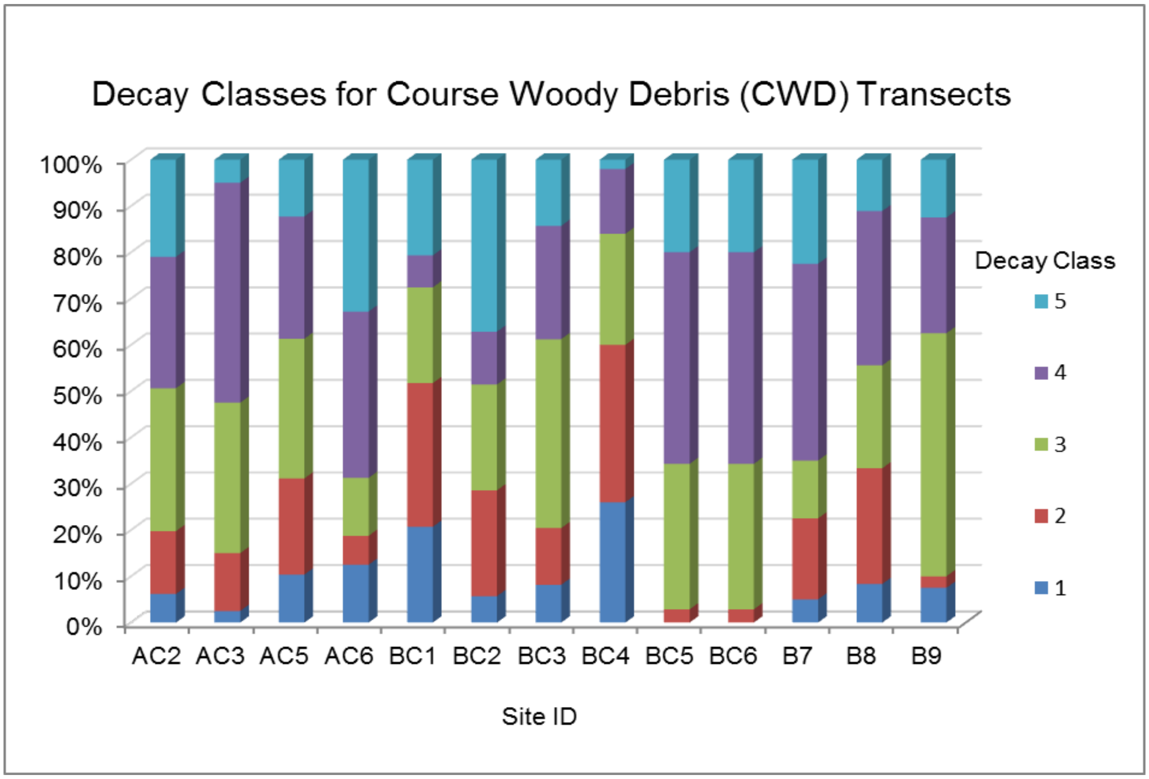

Figure 6. Course woody debris (CWD) decay classes documented for each terrestrial survey transect. Decay class descriptions are provided in Table 4. 1 = least decayed; 5 = most decayed.

Table 11. Forest canopy cover for terrestrial survey sites.

Site ID	Canopy Cover (%)
AC2	40
AC3	80
AC5	100
AC6	80
BC1	80
BC2	100
BC3	80
BC4	80
BC5	100
BC6	80
BC7	100
BC8	100
BC9	100

Discussion

Pacific Treefrog (*Pseudacris regilla*)

Pacific treefrogs were detected at both American Camp and English Camp, and in a variety of habitats at English Camp (palustrine forested and emergent wetlands; meadows; lagoons; seeps and springs; thickets; areas with overstory canopies of Douglas-fir (*Pseudotsuga menziesii*), alder (*Alnus sp.*), and western red cedar (*Thuja plicata*); areas with understories of salal (*Gaultheria shallon*), sword fern (*Polystichum munitum*), Oregon Grape (*Berberis nervosa*), and rose thickets (*Rosa sp*.)). Over 100 frogs were estimated from aural surveys conducted during night time hours along park roads and trails.

The Pacific treefrog is the smallest and most common of the frogs in Washington, and is found in a variety of habitats including wetlands, woodlands, brush and disturbed areas (Corkran and Thoms 2006). They breed in shallow quiet waters with submerged vegetation, and will lay their eggs in almost any small body of water, including ephemeral ponds that may dry up before metamorphosis occurs (Nussbaum et al. 1983). Slater (1955) documented Pacific treefrog in Friday Harbor.

Breeding occurs associated with warm winter or early spring rains, with most egg laying occurring in mid-February at lower elevations (Hallock and McAllister 2005a). Breeding may occur over a period of months. Eggs hatch in three to five weeks, and larval development typically takes 1 ½ to 2 ½ months to complete (Hallock and McAllister 2005a).

Threats to Pacific treefrogs include the introduction of fish to breeding areas, pollutants, and chemical contaminants. Hallock and McAllister (2005a) reported that frogs that breed in ponds with high levels of nutrients from fertilizers, cattle or other sources may be at higher risk for developing malformations.

Northern Red-legged Frog (*Rana aurora*)

Only one northern red-legged frog was documented during this inventory. An adult, 51 mm SVL (snout/vent length) was found in a palustrine wetland at English Camp though an incidental observation. Slater (1955), however, documented this species in San Juan County, and northern red-legged frogs were documented in SAJH by Holmes (1998).

Northern red-legged frogs are found at lower elevations in moist forested habitats with access to suitable breeding sites which have vegetation suitable for egg mass attachment, and they are uncommon or absent in sites with fish (Hallock and McAllister 2009a). Breeding sites can be permanent or temporary, with inundation usually necessary into June for successful metamorphosis (Nussbaum et al.1983). Breeding is initiated when water temperatures exceed 6°C (42.8°F), generally in February or March in northwestern Washington at lower elevations (Nussbaum et al. 1983). Eggs hatch in about 30 to 40 days and metamorphosis occurs in about 11 to 16 wk. Juveniles often remain around edges of breeding ponds for days to weeks before dispersing (Pearl 2009). Juvenile summer habitat includes moist, densely vegetated riparian microhabitats.

The northern red-legged frog is a common species that remains widespread throughout its historical habitat in western Washington; however, substantial recent declines have been

documented for this species in other states (Hallock and McAllister 2009a). Reasons for the declines have been attributed to habitat loss and alteration, impacts of introduced fishes, introduced American bullfrogs (*Lithobates catesbeianus*), changes in hydrology, the presence of endocrine disruptors, and an increase in the concentrations of nitrogen compounds and toxicants, and potentially sub-lethal effects from UV radiation (Lanoo 2005). Hallock and McAllister (2009a) report that road mortality associated with increased urbanization is an under-studied potential threat.

Northern red-legged frogs may overwinter in terrestrial habitat (under ferns or in duff, under woody debris, and within stream banks) for at least part of the season, but move into water when conditions are colder. They remain active throughout the winter at low elevation sites when temperatures are above freezing (Hallock and McAllister 2009a).

We recommend additional surveys be conducted for northern red-legged frogs in suitable breeding habitat.

Figure 7. Northern red-legged frog *(Rana aurora)*, English Camp, San Juan Island National Historical Park.

Other Species

Slater (1941, 1955) documented western toad (*Anaxyrus boreas*, formerly *Bufo boreas*) in Friday Harbor. This species was not documented in this inventory but Hallock and McAllister (2005b) report that western toad was present in San Juan County prior to 1990. Western toads occur in a variety of terrestrial habitats including prairies, forests, and grasslands (Hallock and McAllister 2005b). Juveniles and adults are primarily terrestrial but often stay near water. Breeding habitat includes permanent ponds, lakes, wetlands and slow flowing streams or backwater channels. Anecdotal reports indicate that many populations return to the same egg laying location every year (Hallock and McAllister 2005b). Winter habitat has not been described for the western toad, but searches should be made in forested areas under duff and wet vegetation as well as in animal burrows. The western toad is listed as a state candidate species and federal species of concern within the SAJH area.

Slater (1941, 1955) documented rough-skinned newt (*Taricha granulosa*) on Orcas Island. Hallock's and McAllister's (2005c) distribution map for this species shows it as present on San Juan Island. However, we did not observe this species during this inventory. Additional surveys should be conducted in forest habitat (year round) and in breeding habitat in wetlands, ponds, and road ditches, as early as January but generally in March and April.

The American bullfrog was not detected in this inventory. Neither Slater (1955) or IUCN et al. (2004a) list this species as occurring on San Juan Island. However, bullfrog has been documented by E-Fauna BC on nearby Vancouver Island in Saanichton (Klinkenberg 2012). American Bullfrogs are found in lowland permanent water bodies including wetlands and ponds and breed in permanent, still water bodies (Hallock and McAllister 2009b). American bullfrog, an introduced species, can have significant effects on native amphibian species and future surveys should continue to focus on this species.

Plethodontids

Course Woody Debris provides habitat for both Ensatina and red-backed salamanders (Aubry et al. 1988). These plethodontids rely on both CWD and canopy closure to avoid desiccation (Ray 1958, Spotila 1972, Feder 1983). Canopy cover helps create the cool and moist conditions required by plethodontids and may be more important to these species than forest age (Alkaslassy 2005). CWD measured along transects along with decay classes and canopy covers (Table 11) suggest habitat for these species does exist in the park (Appendix B, Table B-9).

Western red-backed salamanders (*Plethodon vehiculum*) were not detected in this inventory and are not noted by Hallock and McAllister (2004d) as occurring in the San Juan Islands. However, distribution shown by IUCN et al. (2004b) includes this species as a permanent resident on nearby islands in Canada. Western red-backed salamanders inhabit forested stands of all ages and often are found under cover objects such as rocks, understory vegetation, forest litter and moist woody debris. Suitable habitat does exist for Plethodon species but conditions during survey were dry and not optimal for detecting this species. Additional searches should be conducted during early spring to verify the presence or absence of this species within the Park.

Ensatina (*Ensatina eschscholtzii)* were not detected in this inventory and are not noted by Hallock and McAllister (2005e) as occurring in the San Juan Islands. However, distribution shown in IUCN et al. (2004c) includes this species as a permanent resident nearby in Canada on

Vancouver Island, and E-Fauna BC shows Ensatina on Gambier Island in Canada (Klinkenberg 2012). Ensatina are generally found under down decaying woody debris and bark (Aubry et al 1988), and prefer moist, but unsaturated, soils. Like the western red-backed salamander, suitable habitat does exist but conditions may not have been optimal for detecting this species. Additional searches should be conducted during early spring to verify the presence or absence of this species within the Park.

Slater reported Oregon spotted frogs (*Rana pretiosa*) in San Juan County but not on San Juan Island. None were detected in this survey and although the historic geographical range included the Puget Trough ecoregion, Hallock and McAllister (2005f) report only six populations known as of 2005, in Thurston and Klickitat counties. Hallock and McAllistor (2005f) note that dramatic declines from the original distribution have occurred due to alteration of wetlands. Consequently, it is unlikely that this species occurs in the Park.

Northwestern garter snakes were observed at two locations in English Camp. Slater (1963) reported this species in Friday Harbor and other locations in San Juan County. He also noted the western terrestrial garter snake (*Thamnophis elegans*) in Friday Harbor and Cattle Point (in American Camp), the common garter snake (*Thamnophis sirtalis*) in Friday Harbor and Garrison Bay, and the northern alligator lizard (*Elgaria coerulea*) at Sportsman Lake (off of Roche Harbor Road, southeast of English Camp). However, the western terrestrial and common garter snakes were not detected in this inventory. The northern alligator lizard was not detected in this inventory but has been observed by park staff in recent years (Chris Davis, pers. communication).

Figure 8. Northwestern garter snakes (*Thamnophis ordinoides),* English Camp, San Juan Island National Historical Park.

Threats

In western North America, a disturbingly large percentage of native anurans (toads and frogs) have suffered severe declines and local extinctions even in our most pristine and remote reserves (Lanoo 2005). Direct declines have been attributed to habitat decline and the spread of invasive species. Widespread anthropogenic stressors such as increased ultraviolet-B radiation, deposition of air-borne chemical pollution, and global climate change, in addition to having direct effects on amphibian survival, reproduction, and growth, may also act by reducing immune system functioning and thereby facilitate the emergence of infectious diseases (Daszak et al. 2003).

Climate Change

Climate change may have significant effects on amphibian populations. Aquatic amphibians breed in shallow wetlands, ponds, and lakes which may experience changes in water levels, temperature, and water quality as a result of climate change (Lawler and Mathias 2007). Amphibian populations are sensitive and respond strongly to changes and variability in air and water temperature, precipitation, and hydroperiod (Carey and Alexander 2003). As breeding habitat becomes more variable, especially in ephemeral waters, breeding phenology may change (Beebee 1995) and warmer temperatures may cause physiological stresses (Lind 2008).

Disease and Pathogens

Recent studies have suggested that an increase in the distribution of disease and pathogens may be responsible for amphibian extinctions (Pounds et al. 2006, Johnson et al. 2006, Hayes et al. 2010). A leading hypothesis for these declines is infection by the chytrid fungus, *Batrachochytrium dendrobatidis* (*Bd*), which has been detected in Pacific Northwest amphibians. Chytridiomycosis is linked to devastating population declines and species extinctions (Berger et al. 1998, Skerratt et al. 2007, Fisher et al. 2009). Infection with *Bd* occurs inside the cells of the outer skin layers that contain large amounts of Keratin, the material that makes the outside of the skin tough and resistant to injury. Chytridiomycosis causes the skin to become thick (hyperkeratosis), which interferes with the amphibians ability to breathe and absorb water and electrolytes. Chytridiomycosis causes mortality in some amphibian species, but some species show no mortality (Briggs et al. 2010)**.**

Additional emerging diseases, for example the water mold (fungus) *Saprolegnia* and other oomycetes, have also been associated with the wholesale reproductive failure of amphibians in the Pacific Northwest (Blaustein et al. 1994). Saprolegniasis is a common disease found in fish, especially those reared in hatcheries (Richards and Pickering 1978 as cited in Kiesecker et al. 2001b). Many fish stocked in lakes of the Pacific Northwest are common carriers of *Saprolegnia*, including *S. ferax* (Wood and Willoughby 1986). Kiesecker et al. (2001b) found significantly greater mortality in Western Toad (*Anaxyrus boreas*) embryos when exposed to Rainbow Trout (*Oncorhynchus mykiss*) infected with *S. ferax*. Ranaviruses also infect insects, fish, and amphibians but not humans or other warm-blooded animals (Gray et al. 2009). In the western United States, die-offs attributed to ranaviruses have occurred in Tiger salamanders (*Ambystoma tigrinum*); however, recent testing has detected the virus in Columbia spotted frogs (*Rana lutieventris*) in Montana (USGS 2011); and mountain yellow-legged frogs (*Rana mucosa*) (ICUN 2005), and long-toed salamanders (*Ambystoma macrodactylum*) in California (NPS 2009). Usually, the infection occurs in larvae and individuals who have just completed metamorphosis. Die-offs of amphibians due to ranavirus have occurred in at least 15 states,

including California, Arizona, Utah, Idaho, Montana, North Dakota, Wyoming and Colorado (USGS 2011, NPS 2009). Field surveys and experiments have also recently established trematode **(***Ribeiroia ondatrae*) infection as a widespread cause of amphibian limb malformations, including missing, malformed, and extra limbs or digits (Sessions and Ruth 1990, Johnson et al. 1999, 2002, Schothoeffer et al. 2003).

Kiesecker et al. (2001a) concluded that a complex series of interactions involving changes in both physical (water depth and ultraviolet-B exposure) and biotic (disease outbreaks) factors alter mortality patterns. They hypothesized that because the survival of amphibians is linked closely to water availability, changes in climate that alter hydrology may be the precursor for similar mortality events that are believed to contribute to other population declines, including those that have been attributed to disease outbreaks. Baseline disease screening should be conducted within SAJH to determine the presence of amphibian diseases. Any observed incidences of mortality involving a large number of animals should be investigated.

Contaminants

Many studies suggest that chemical contaminants have affected amphibian declines (Blaustein et al. 2003). Persistent and bioaccumulative toxic chemicals were sampled in fish tissue from 25 sites across Washington State from 2001 to 2008 (Seiders and Deligeannis 2008). Pesticides, mercury, PCBs, PBDE flame retardants, dioxins, and furans were documented in 268 fish tissue samples collected from13 freshwater fish species from 129 sites. PCBs, DDT, PBDE, Chlordane, and mercury were found in fish from lakes throughout the State, including on Orcas Island, about six miles from San Juan Island (Seiders et al. 2007).

The USGS (2000) reported that samples from surface waters at American Camp's pond and spring and the English Camp stream had concentrations of bacteria. *E. coli* was also found in samples from the American Camp spring and English Camp stream. In addition, they reported that nitrate concentrations in the spring and stream were elevated.

Chemical contaminants can affect growth, development, and behavior of amphibians, which could lead to developmental and behavioral abnormalities (Bridges 1997, Bridges 2000), and may affect amphibian's susceptibility to predation (Bridges 1999a) and their ability to compete with other animals, and reproduce successfully (Bridges 1999b, Relyea and Mills 2001, Boone and Semlitsch 2002). Chemical contaminants may also affect amphibian's immune system, resulting in an increased susceptibility to parasites, disease, and ultraviolet radiation (Blaustein and Johnson 2003, Blaustein et al. 2003, Christin et al. 2003, Daszak et al. 2003, Gendron et al. 2003).Surface water quality monitoring programs conducted in SAJH should include amphibian breeding areas and, where possible, screening for contaminants should be conducted.

Habitat Alteration

An increasing number of human development projects can directly or indirectly alter amphibian habitat. Wetlands are important to many amphibians and reptiles and should be protected from development or alteration. Trail- and road-stream crossing structures (such as culverts) can alter natural water courses and habitat, and act as passage barriers for aquatic species. Care should be taken when planning to place structures at a trail- and road-stream crossings, and when cleaning or replacing culverts which are often inhabited by native frogs. Trail- and road-stream crossing structures that maintain natural watercourses and habitat are, of course, preferred. Frogs also are

often found breeding in roadside ditches, and so the cleaning of roadside ditches should be delayed until after tadpoles have metamorphosed and moved from the ditch habitat.

Roads

Vehicle travel along roads can have a profound effect on anuran species well beyond 1000m from the road, and most anurans are likely to have reduced abundances near roads. The noise and barrier effect of very high nighttime traffic volumes can also lead to negative effects of roads even on species that are relatively unaffected by direct road mortality (Eigenbrod et al. 2009). A synthesis of the effects of roads on the abundance of amphibians and other species was conducted by Fahrig and Rytwinski (2009) who found scientific evidence of population effects of roads and traffic strong enough to merit routine consideration of mitigation of these effects on all road construction and maintenance projects.

Recommendations

Amphibian habitat is sparse on the island and within SAJH, which is one of the driest parks within the NCCN, only one permanent pond located at American Camp, and no perennial streams. No amphibians were detected at several palustrine wetlands that were surveyed, but the timing of the surveys (April 2002) was not optimal because many areas at SAJH were already too dry to support amphibians. A follow up survey should be conducted in late February or early March to detect additional amphibian breeding sites. Breeding sites should be surveyed annually, if possible, to monitor for changes in water temperature and the presence of amphibians. Additional aquatic breeding surveys targeting northern red-legged frogs, western toads, and rough-skinned newts should be conducted. The presence of *Bd*, *Saprolegnia*, and other pathogens should be verified. Additional surveys of forested areas should be conducted for western red-backed salamanders and Ensatina, focusing on moist but unsaturated habitat and, down woody debris, especially in decay class 3, 4, and 5.

Reptiles were documented incidental to the amphibian inventories. We recommend that targeted surveys in suitable habitat be conducted to further document the presence of reptile species within the Park. Amphibian and reptile surveys could be suitable citizen science projects for the park to coordinate. We also recommend that the NPS develop an education program to work with residents and landowners with the objective of minimizing threats to amphibian (and reptile) habitat, especially habitat for aquatic breeding species.

Summary

An updated amphibian list is presented in Table 12. The northwestern garter snake was also documented in this inventory (Table 13).

Table 12. Amphibian species detected in San Juan National Historical Park, and their status. *C = previously identified as “expected to occur” and confirmed present in this inventory; ** = federal or state listed species of concern; # = introduced species.

Genus and Species	Common Name	Species Code	Special Status Species	Non-native Species	Detected
Terrestrial breeding species					
Caudata — salamanders					
Ensatinas					
Ensatina eschscholtzii	Ensatina	ENES			No
Woodland salamanders					
Plethodon vehiculum	Western red-backed salamander	PLVE			No
Aquatic breeding species					
Anurans					
True frogs or brown frogs					
Rana aurora	Red -legged frog, Northern red-legged frog	RAAU	**		*C
Rana pretiosa	Oregon spotted frog	RAPR	**		No
American water frogs					
Lithobates catesbeianus (formerly *Rana catesbeiana*)	American bullfrog	RACAT		#	No
Chorus frogs					
Pseudacris regilla	Pacific chorus frog	PSRE			*C
North American toads					
Anaxyrus boreas (formerly *Bufo boreas*)	Western toad	BUBO	**		No
Caudata — salamanders					
Pacific newts (Family Salamandridae)					
Taricha granulosa	Rough-skinned newt	TAGR			No

Table 13. Reptile species documented in San Juan National Historical Park.

Genus and Species	Common Name	Species Code	Detected
Elgaria coerulea	Northern alligator lizard	ELCO	Yes[1]
Thamnophis elegans	Western terrestrial garter snake	THEL	No
Thamnophis ordinoides	Northwestern garter snake	THOR	Yes
Thamnophis sirtalis	Common garter snake	THIS	No

[1]The Northern Alligator Lizard (*Elgaria coerulea*) was confirmed by park staff, after this inventory was conducted (Chris Davis, pers. comm.).

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Appendix A: NCCN aquatic amphibian survey protocols and datasheets.

NCCN Amphibian Inventory
Standard Operating Procedure for Aquatic Amphibian Surveys 2001

Michael J. Adams [1]

CONTENTS

Materials
Procedures
Water Sample Collection
Survey Form Field Definitions
Species List and Codes
ARMI Survey Form 2001

This survey protocol is designed for use in the North Coast and Cascades Network (NCCN) Amphibian Inventory for lentic habitat. Each wetland will be sampled for amphibians, a variety of habitat variables measured, and water samples collected for analysis in a lab. It is important that standardized methods be used to collect these data, so that they are comparable among wetlands within the Network.

Field crews will have read all appropriate SOPs prior to starting field work. Sampling procedures will be checked by an experienced staff member (e.g., subproject lead) prior to sending novice samplers out into the field.

MATERIALS

1. map of study area - indicating location of wetland patches to be characterized
2. data notebook – blank datasheets copied on waterproof paper (sample datasheet attached)
3. thermometer - for measuring air and water temperatures
4. GPS - for determining wetland location and area
5. dipnets - net mesh suitable for capturing small amphibian larvae
6. pH meter - for characterizing H+ ion content
7. TDS/conductivity meter - for characterizing aquatic conductivity
8. DO meter or BOD bottles
9. water sample containers - 120ml and 250ml plastic bottles
10. voucher specimen vials 1/2 filled with formalin
11. waders and wading shoes
12. ruler- to measure amphibian lengths

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PROCEDURES

Survey Techniques:

*Note: Although all of the tasks below need to be completed at each wetland, the specific order of completion is not critical. If amphibian sampling will stir up too much sediment to get clean water samples, these sensitive tasks should be completed first. Otherwise it is up to the discretion of the team to determine which tasks to complete in what order.

Datasheet Management:
Upon arrival at each wetland to be sampled begin a new data sheet. If multiple discrete bodies of water are encountered when the crew approaches a site, fill out a separate form for each. If ponds are not discrete (are connected with channels or are part of a wet meadow) cover the area as a single site on one sheet.

Mapping:
1. Draw a map of the wetland perimeter (use box on page 2 of data sheet)
    - -be sure to orient drawing to North arrow on map
    - -use codes to indicate approximately where each survey activity is conducted (e.g., water Samples, Temperature, GPS)
2. Include details of habitat on map (where large concentrations of emergent veg occur, overhanging veg, etc.)

GPS Location:
1. Find location along the shoreline where the GPS unit receives a strong signal, indicate location on map.
2. Log points at that location for 1-2 minutes (use UTM NAD27 format)
    a. Record the UTM Zone, coordinate locations, and the estimate of error (EPE preferably <5m) on the data sheet.
    b. Record the filename as it was saved.
   -do not record elevation from the GPS, it is not very accurate. Determine elevation from topography map.

Amphibian Surveys:
1. These surveys will generally be conducted by teams of 2 individuals and can be conducted at the same time as the aquatic habitat characterizations or separately (depending on crew size).

    a. Record all stages of development observed for each species (see attached species list)

    b. Walk the perimeter of the wetland, stopping every 10 meters, or at 20 evenly spaced stations, to scan for embryos and larvae. One person wades, the other walks on shore.

    c. At each of the stations, look for amphibians and make dipnet sweeps to capture individuals to ensure definitive species identification (*Only continue dipnetting while potentially occurring species remain undetected). Release identified specimens at the point of capture. If moveable cover items are present move them to see if larvae are

hiding beneath them. Identify any embryos or larvae to species, or if not possible preserve a voucher specimen in a labeled vial of 10% buffered formalin.

d. Vegetated areas and other habitats likely to harbor embryos and larvae will also be intermittently sampled using dipnets

e. Once evidence of current breeding activity for a species is detected (i.e., embryos, tadpoles, or metamorphs from the current breeding season) and recorded, searches for that species/stage should cease (to conserve time).

f. If one or more species remain undetected following a complete circuit of the wetland, other habitats where they are likely to occur (e.g., vegetated areas away from the shoreline) should be searched prior to declaring them absent.

2. Each team should collect voucher specimens (generally a single larva of each species present) at 10% of the ponds located in each randomly chosen watershed. Sufficient information will be recorded on the labels and data sheets such that it can be determined where the sample was collected and what species are represented. A subsample (about 10 of a stage per species) of amphibians will be measured and a few individuals will be collected as vouchers and for the health and disease survey (see the Animal Collection SOP).

3. Each species detected will be recorded on a separate line on the datasheet. The species name (or a set abbreviation) will be recorded and if a voucher was preserved "Y" will be circled. Counts or estimates of individuals will also be recorded. If the numbers of larvae are too high to count, the field crew will estimate the numbers of individuals seen. For egg masses, if they are distinct they will be counted. If masses can't be counted, the number of eggs seen at the site will also be estimated (for example, a crew member can count all the eggs/larvae found within a square quarter-meter and extrapolate to estimate the total number observed). Also note any frog or toad species heard calling, and/or metamorphosed amphibians incidentally encountered around the area of the wetland.

Aquatic Habitat Characterization:

1. Estimate the percent of the surface area with floating (reaching the surface) or emergent aquatic vegetation.

2. Estimate the percent of the pond bottom made up by each of the substrate categories.

Fish Presence/Absence:

While characterizing habitat and surveying for amphibians watch for any evidence of the presence of fish.

a. Watch for fish in shallows and rising to feed on the surface
b. If not yet detected, search 30 meters up inlet and outlet streams where fish may be more visible.
c. If present indicate species, if determined, on the Species list of the datasheet.

Water Quality Characterization:

1. Record air temperature (in the shade and 1 m above ground) and water temp (in the sun and 10 cm below the surface) in Celsius.
2. pH and conductivity measurements.
    a. Calibrate both meters at the beginning of each day. Calibrate pH meter using pH 4 and 7 stock buffers. Measure the check solution to see if is accurate.

    b. Rinse cup 3 times with site water, collect sample of water in cup, insert pH meter and follow procedures for measuring pH.

    c. Rinse cup 3 times with site water, collect new sample, insert conductivity meter and allow equilibrating, recording reading. If meter does not stabilize after 2 minutes record the low and high range of the current readings.

    d. Store pH and conductivity meters as required by the manufacturer and the MORA QA/QC protocol.
    e. If a raft is used, take DO and Temperature profiles beginning at the surface. If a shoreline sample is taken, follow Mount Rainier National Park QA/QC protocols for using the DO meter or collecting a sample in a BOD bottle.
    f. Collect a sample (see below) to analyze for ANC (alkalinity).

Notes:

1. The remaining space on the data sheets should be used to record any additional notes.
2. Team members are encouraged to write extensive notes about features of each site not encompassed by the required data fields. Notes can also explain that data which may look weird are actually correct. For example if the pH readings never stabilized this would be a good place to note this fact. The notes will help those of us who are not there understand the data that you collect, the conditions at that site, how difficult it was to get to that site, etc.
3. Think of the notes as a journal where you can record anything.

Data Management:

1. Prior to leaving each site one crew member (preferably one who was not recording data) will check over the datasheet to make sure that all fields have been filled (data or NA), that all recorded data is clearly legible, and that the reported data do not have any obvious errors.
2. Once the data is checked the crew member should initial the ‘Field Checked’

WATER SAMPLE COLLECTION

1. When collecting water samples avoid areas of dense aquatic or overhanging vegetation. Collect samples as far from shore as practical from a depth of 25 cm (10 in) where possible. Avoid inclusion of surface film and suspended sediments or organic material. Sampling is to be done first and/or in an area not disturbed by other sampling procedures.

2. Collect water in 1 L plastic bottle in the area of amphibian habitat. Take care not to introduce surface “scum” into the bottle. Avoid stirring up the pond bottom. If filtering is required, filter the sample immediately at the site.

3. Label with site name, date, time, data sheet number, and other pertinent information. Store sample bottles on ice in cooler.

SURVEY FORM FIELD DEFINITIONS

Date - Write the date as month, day, year (e.g. 11 Aug, 1993). The three letter abbreviation for the month is less ambiguous and more readily recognized than 8-11-93.

Begin Time - Record the time that your survey began, not time you arrived at the locality.

End Time - Record the time when the survey ended, not time you finished taking notes and gathering up equipment.

Search Minutes - This is the total time (in minutes) spent searching for amphibians multiplied by the number of active observers. Do not include time spent processing specimens, recording notes, or taking photographs. If two or more people spend differing amounts of time searching, use the average time.

Site ID – A unique identifier for the site represented by the data sheet. In ONP we are using the naming convention of 2 letters designating what major drainage the site is in followed by a number. No spaces or dashes between the letters or numbers. If a new pond is found by one already named, the new pond can be named with the name of the nearby pond followed by an “a”, then “b” for a 2nd new pond, etc. Example: Eagle Lakes in the Lyre drainage or named LY1, LY2, LY3.

Observers - Enter the initials of the observers present.

Sentinel Site – Circle NO. There are no sentinel sites in this inventory.

Location - This is a description that would allow someone not familiar with the area to find the pond again. For example: 200m NE of Lake Constance. Also, it is a good place to put the name of a lake if it has an official name (Hidden Lake). Use mapped landmarks that are not likely to change. Some localities are difficult to describe and the UTM coordinates will be the most descriptive, but a narrative description is important to confirm the general location.

State - Enter state name.

County - Enter county name.

Ownership – Indicate land ownership

Index Area - Many sites will be in designated index areas. If so, enter the name of the area.

Sample Unit (HUC #) - Index areas will be broken down into sample units, in our case these are 6th field watersheds.

UTM Zone - Enter the zone number, which in the continental United States ranges from 10 on the west coast to 19 in the east. UTM zones are always indicated in the lower left corner of USGS topographic maps.

UTM Coordinates - This is a pair of numbers that are x and y coordinates. In North America, the two numbers are northings and eastings. Location of each site will be recorded using a hand held GPS unit in the field. If you survey more than 1 km of a creek, stream, or river, you should enter the UTM coordinates for both the beginning and ending location. For lakes and ponds, enter the coordinates for the edge of the water if you are using a GPS or from the center of the water body if you are obtaining the coordinates from a USGS 7.5' topographic map.

Datum (Database only) - This refers to the base map projection. The datum is always indicated in the lower left corner of USGS topographic maps. If you are using a GPS unit to get UTM coordinates, you need to check the GPS setup menu to see which datum is being used. UTM coordinates are generally associated with either the 1927 North American datum or 1983 North American datum. Latitude/longitude coordinates are usually given in reference to the WGS84 datum. Using the wrong datum can result in significant positional errors.

Error – error estimate of Garmin 12XL GPS unit (preferably this is less than 5m).

GPS File – the name of the saved waypoint marking the location of a wetland.

Elevation - This should be taken from a 7.5' topographic map (or ArcView data) since elevations from GPS units are not sufficiently accurate. Make sure to indicate the elevational units.

Species Present At Site – All amphibians and a selected group of other organisms will be recorded in these fields including garter snakes, some invertebrates, and fish. Each species is recorded in one line.

Amphibians - Indicate the number of adults, paedomorphs (rarely seen and difficult to determine– adult amphibians but in aquatic physical form permanently), juveniles, larvae, eggs and egg masses observed for each amphibian species at a site. Adults and juveniles can typically be counted, but it is often necessary to estimate the number of anuran and salamander larvae. Circle E if you estimated or C if you actually counted all the larvae or egg masses. Note that this is not an estimate of the total number that might occur at the survey site, but the actual number of individuals seen during the survey. Some amphibian larvae do not metamorphose within one year. If you can clearly distinguish size classes, record a count for each size-class. If you can count the number of egg masses then do so and record as EM, #, C. If you cannot separate egg masses then either estimate the number of eggs or egg masses and record as E or EM, #, E.

Fish Species - List the kinds of fish observed. If fish cannot be identified to the species level, use the lowest taxonomic level possible, e.g. families: salmonidae, centrarchidae, cyprinidae.

Garter Snakes - Indicate if any were seen and list species if you can identify them.

Inverts - Indicate if certain predatory invertebrates were detected.

Method – Record how the animals were identified. Were they captured and held in a hand for close inspection (H), see from a distance but not held (V), or heard calling only (A).

* Remember to record other interesting/unusual species sightings in the notes section on the back of the datasheet.

Physical and Chemical Environment

Weather - Circle one of the choices: clear overcast, rain, snow.

Wind - Circle one of the choices: calm, light, gusty, strong

Beaver Sign – Use only one code, choosing the strongest indicator for your location (1=see beaver, 2=hear beaver, 3=lodge, 4=current dam, 5=old dam, 6=cuttings).

pH - Record pH.

Air Temperature - Measure the air temperature in the shade at approximately 1 meter off the ground. Centigrade.

Water Temperature - Measure the water temperature near the surface either in the vicinity of any amphibians that are located, or approximately 0.5 meter out from the edge of the water. Since temperature can be quite variable in standing water, try to select a location that is representative of the site. Centigrade.

Conductivity - Measure with meter.
Color - Indicate if water appears to be clear or stained (i.e. from leaf tannins)
Turbidity - Is the water clear or cloudy?

Site Description

Habitat Origin - Circle one of the choices: natural, man-made, or man altered.

Drainage - Circle one of the choices: permanent, seasonal. If you are not certain, consult a 7.5' USGS topographic map. Seasonal streams are generally indicated with a broken blue line and seasonal ponds/lakes are hatched.

Description - Circle only **<u>one</u>** of the choices: lake/pond, river/stream, ditch, spring/seep, meadow/wetland, oxbow/backwater, beaver pond.

Shallows - Indicate the percent of the total site area that is <0.5 m deep.

Average Site Width (m) - This is the average width of the aquatic habitat.

Average Site Length (m) – Estimate the average length of the site.

Maximum Depth (m) - Circle one of the choices: <1.0, 1.0-2.0, >2.0

Percent of site edge searched: Estimate how much of entire site edge was searched.

Emergent/Floating Vegetation - Indicate the percent cover for emergent/floating vegetation for the entire site.

Substrate and Veg Cover – In many cases, the field site will be too large to sample as a single station so stations can be placed roughly every 10 meters or up to 20 evenly spaced stations as the crew surveys the site. Typically, a site needs to be subsampled if you cannot see the entire pond from the shore (15m X15m). Each station (or transect) consists of a 2 meter portion of the shoreline and 3 meters out from the shore into the pond making a rectangle of area to be surveyed. Estimate the percent cover (to the nearest 10%) provided by emergent or floating vegetation for each station. At each station circle the most dominant substrate (circle only one): boulder/bedrock, cobble, mud/silt, sand/gravel, leaves/grass, downed wood.

Field Checked – A team member will initial this box after making a final check of the datasheet before leaving the field site.

Entered – Check box when data have been entered into database

Field QA ______ Entered By ______ **Page 1**

SITE LOCATION:							
Index ID		**Site ID**		**Drain-age**			
State	**WA**	**Co.**		**Owner-ship**		**Senti-nel?**	**Y N**
UTM Zone	**10**	**E**		**N**		**Error (m)**	
Elev.	**m ft**	**GPS File**		**HUC #**			
Loca-tion							
SITE VISIT:							
Date		**Visit #**		**Crew**			
Start Time		**End Time**		**Search Minutes (minutes times # of surveyors)**			
Weather	**Clear Overcast Rain Snow**	**WIND**	**Calm Light Gusty Strong**	**Air Temp**		**Water Temp**	
pH		**Condctivity**		**Water Sample: 120-ml FCC (filtered, brown)**	**Y N**	**Water Sample: 250-ml RU (unfilter, white)**	**Y N**
POND (all measurements in meters):							
Length		**Width**		**Max Depth**	**<1 1-2 >2**	**% Shallow (<0.5m)**	
Color	**Clear Stained**	**Turbid-ity**	**Clear Cloudy**	**% Emergent Veg Cover**		**% of Site edge Searched**	
Wetland Type	**Lake/Pond Meadow/Wetland Ditch Beaver-pond River/Stream Spring/Seep Oxbow/Backwater**			**Perman-ance**	**Permanent Seasonal**		
Site Origin	**Natural Man-Made Altered**			**Beaver Sign**	**See Beaver Hear Beaver Lodge Current Dam Old Dam Cuttings**		

Figure A-1. Aquatic amphibian inventory data sheets.

Map

N ↑

Mark Locations: S = water samples, T = temperature, G = GPS location
Sketch emergent vegetation using dotted lines.

Dominant Substrate & Percent Veg Cover (up to 20 transects per site)					
% Cover					
Substrate	**B D C G S M L W**	**B D C G S M L W**	**B D C G S M L W**	**B D C G S M L W**	**B D C G S M L W**
% Cover					
Substrate	**B D C G S M L W**	**B D C G S M L W**	**B D C G S M L W**	**B D C G S M L W**	**B D C G S M L W**
% Cover					
Substrate	**B D C G S M L W**	**B D C G S M L W**	**B D C G S M L W**	**B D C G S M L W**	**B D C G S M L W**
% Cover					
Substrate	**B D C G S M L W**	**B D C G S M L W**	**B D C G S M L W**	**B D C G S M L W**	**B D C G S M L W**

B: Bedrock **D**: Boulder **C**: Cobble **G**: Grass **L**: Leaves **M**: Mud **S**: Silt **W**: Wood

Figure A-1. Aquatic amphibian inventory data sheets (continued).

SITE ID		Drainage		Date	

SPECIES – AMPHIBIANS, FISH, INVERTEBRATES						
Species	Life Stage	Count	E / C	SVL Range	Method	Notes and Voucher #
			E C		H V A	Y N
			E C		H V A	Y N
			E C		H V A	Y N
			E C		H V A	Y N
			E C		H V A	Y N
			E C		H V A	Y N
			E C		H V A	Y N
			E C		H V A	Y N
			E C		H V A	Y N
			E C		H V A	Y N
			E C		H V A	Y N
			E C		H V A	Y N

Life Stage: **E**gg, **EM** Egg Mass, **L**arval, **J**uvenile, **P**aedomorph, **A**dult.
E / C: Is the "count" number **E**stimated or precisely **C**ounted.
SVL Range (for larvae only): **<15mm, 15-35mm, >35mm**
Method: **H**and Collected (catch and see), **V**isual (see from a distance only),
Aural (heard calling only).

NOTES:

Figure A-1. Aquatic amphibian inventory data sheets (continued).

Appendix 1

Table 6-Scientific and common names of amphibians and reptiles found in the Pacific Northwest west of the Cascade Range from northern California to British Columbia

Scientific name[a]	4-letter code	Common name[a]
Amphibia, order Urodela (salamanders):		
Family Ambystomatidae-		
Ambystoma gracile	AMGR	Northwestern salamander
A. macrodactylum	AMMA	Long-toed salamander
Family Dicamptodontidae-		
Dicamptodon copei	DICO	Cope's giant salamander
D. ensatus	DIEN	California giant salamander
D. tenebrosus	DITE	Pacific giant salamander
Rhyacotriton olmpicus	RHOL	Olympic salamander
Family Plethodontidae-		
Aneides ferreus	ANFE	Clouded salamander
A. flavipunctatus	ANFL	Black salamander
A. lugubris	ANLU	Arboreal salamander
Batrachoseps *attenuatus*	BAAT	California slender salamander
B. wrighti	BAWR	Oregon slender salamander
Plethodon dunni	PLDU	Dunn's salamander
P. elongatus	PLEL	Del Norte salamander (includes *P, stormi)*
P, larselli	PLLA	Larch Mountain salamander
P. vandykei	PLVA	Van Dyke's Salamander
P. ***vehiculum***	PLVE	Western red-backed salamander
Family Salamandridae-		
Taricha granulosa	TAGR	Rough-skinned newt
T. rivularis	TARI	Red-bellied newt
T. torosa	TATO	California newt
Amphibia, order Anura (frogs and toads):		
Family Leiopelmatidae, *Ascaphus truei*	ASTR	Tailed frog
Family Bufonidae, *Bufo boreas*	BUBO	Western toad
Family Hylidae, *Hyla regilla*	HYRE	Pacific treefrog
Family Ranidae-		
Rana aurora	RAAU	Red-legged frog
R. boylii	RABO	Foothill yellow-legged frog
R. cascadae	RACA	Cascades frog
R. catesbeiana	RACT	Bullfrog (introduced)
R. clamitans	RACL	Green frog (introduced)
R. pretiosa	RAPR	Spotted frog
Reptilia, order Chelonia (turtles):		
Family Emydidae-		
Chrysemys picta	CHPI	Painted turtle
Clemmys marmorata	CLMA	Western pond turtle
Reptilia, order Squamata (lizards and snakes):		
Family Anguidae-		
Gerrhonotus coeruleus	GECO	Northern alligator lizard
G. multicarinatus	GEMU	Southern alligator lizard
Family Iguanidae-		
Phrynosoma douglassii	PHDO	Short-horned lizard
Sceloporus graciosus	SCGR	Sagebrush lizard
S. occidentalis	SCOC	Western fence lizard
Family Scincidae, *Eumeces skiltonianus*	EUSK	Western skink
Family Boidae, *Charina* bottae	CHBO	Rubber boa
Family Colubridae-		
Coluber constrictor	*COCA*	Racer
Contia tenuis	COTE	Sharptail snake
Diadophis punctatus	DIPU	Ringneck snake
Lampropeltis getulus	LAGE	Common king snake
L. zonata	LAZO	California mountain kingsnake
Masticophis taeniatus	MATE	Striped whipsnake
Pituophis melanoleucus	PIME	Gopher snake
Thamnophis couchi	THCO	Sierra garter snake
T. elegans	THEL	Western terrestrial garter snake
T. ordinoides	THOR	Northwestern garter snake
T. sirtalis	THSI	Common garter snake
Family Crotalidae, *Crotalus viridis*	CRVI	Western rattlesnake

[a] Scientific and common names follow Banks and others (1987).
Sources: Nussbaum and others (1983) and Stebbins (1985).

Figure A-2. Scientific and common names of amphibians and reptiles found in the Pacific Northwest (Corn and Bury, 1990).

Appendix B: Terrestrial, incidental, and aquatic habitat characteristics.

Table B-1. Aquatic habitat measurements and descriptors.

Date	Site ID	Length (m)	Width (m)	Max Depth (m)	% Shallow Area (<.5m)	Color of water	Turbidity	Emergent Vegetation Cover %	% of Site Edge Searched	Wetland Type	Permanence	Site Origin
4/16/2002	AC1	35	35	<1	100	Stained	Clear	100	100	Lake/Pond	Permanent	Natural

Table B-2. Water quality descriptions for aquatic breeding sites, species present, and fish presence.

Site ID	Location Description	Date	Species Present	Life Stage	SVL (mm)	Water Temp (°C)	pH	Conductivity (µS/cm)	ANC (µeq/L)	Egg Fungus Presence	Fish Presence
AC1	Small pond on north shore of American Camp	04/16/2002	PSRE	A and EM	32	6	6.03	53.8	490.79	No	No

Table B-3. Dominant substrate and percent vegetation cover for Site AC1.

Station	Vegetation Cover	Substrate	Station	Vegetation Cover	Substrate
1	90	mud	11	80	wood
2	80	mud	12	100	wood
3	90	wood	13	0	mud
4	90	mud	14	80	mud
5	70	mud	15	100	wood
6	10	mud	16	100	wood
7	80	mud	17	100	mud
8	70	mud	18	70	mud
9	60	mud	19	90	mud
10	40	mud	20	80	wood

Table B-4. Terrestrial habitat characteristics associated with species detection. Dominant forest type, soil temp, and slope recorded at center of plot. See Table B-8 for description of overstory and understory species.

Survey date	Field Site ID	Species Code	Stage	SVL (mm)	Seep	Stream	Overstory and Understory Description	Soil Temp (°C)	Slope (%)
4/9/2002	BC3	PSRE	A		Y	N	Mixed Forest (overstory mostly ALRU, PSME; understory GASH, SYAL, BENE; and L.O. Debris*)	7	5
4/10/2002	BC4	PSRE	A	35	Y	N	Mixed Forest (overstory mostly ALRU, PSME; understory mostly GASH, SYAL, BENE understory; and L.O. Debris*)	5	10
4/10/2002	BC5	PSRE	A		N	Y	Mixed Forest (overstory mostly PSME, THPL, ACMA; understory GASH, BENE understory; and L.O. Debris* and some mosses)	7	15

* L.O. Debris = large organic debris

Table B-5. Incidental habitat characteristics associated with species detection.

Survey Date	Field Site ID	Location Description	Species Code	Count	Life Stage	Slope	Aspect	Habitat Description
4/17/2002	AC11	American Camp Wetland # AM18	PSRE	20	L		360	Old ditch, pools on road side
4/17/2002	AC NITE	Night Survey, American Camp Field Sites ID: AC8, AC9, AC10, AC11, AC12	PSRE	>100	A	Multiple	Multiple	Meadows, lagoons, roadside, thickets
5/22/2002	BC98	Wetland # BR06, NE corner British camp	PSRE	1	J	1	270	Saturated Meadow
5/22/2002	BC99	Wetland # BR07, 200m north on service road, 50m west	RAAU	1	A	0		Forested Wetland, Standing water
4/9/2002	BC NITE	Whole Park Night Survey	PSRE	1	U (either J or A)	no data	270	English Camp Roads, Trails, Parade, Wet Meadows
4/10/2002	I1	British Camp, North End	PSRE	1	A	2	360	Shallow Spring/Seep
4/4/2002	I2	Mt. Young Trail, British Camp	THOR	1	A	30	315	Rocky Slope
4/18/2002	I3	British Camp, South Park Boundary, W side of road	THOR	3	A	15	270	Grassy Field

Table B-6. Overstory cover species and stem density size class.

Site	Species	Percent Canopy Cover (%)	Stem density Size Classes (%)					Comments
			Class1 (0-23)	Class2 (23-53)	Class3 (53-81)	Class4 (81-122)	Class5 (>122)	
BC1	ABGR	10	0	100	0	0	0	
BC1	ARME	10	40	10	0	0	50	
BC1	PSME	80	35	60	5	0	0	
BC2	ABGR	5	100	0	0	0	0	
BC2	ARME	15	20	70	10	0	0	
BC2	PSME	80	45	50	5	0	0	
BC3	ABGR	5	50	50	0	0	0	
BC3	ALRU	40	30	70	0	0	0	
BC3	PSME	40	25	50	25	0	0	
BC3	THPL	15	0	50	50	0	0	
BC3	TSHE	5	100	0	0	0	0	
BC4	ARME	20	10	65	25	0	0	
BC4	PSME	80	70	10	10	10	0	
BC5	ALRU	10	20	20	60	0	0	
BC5	ARME	5	0	0	100	0	0	
BC5	PSME	60	30	40	30	0	0	
BC5	THPL	25	20	40	40	0	0	
BC6	ABGR	5	70	30	0	0	0	
BC6	ACMA	25	20	20	60	0	0	
BC6	ALRU	5	100	0	0	0	0	
BC6	PSME	60	20	30	40	0	0	error in total % stem density (10% missing)
BC6	THPL	5	50	50	0	0	0	
BC7	ABGR	5	100	0	0	0	0	
BC7	ACMA	5	0	100	0	0	0	
BC7	ALRU	15	20	80	0	0	0	
BC7	PSME	40	0	0	80	20	0	
BC7	THPL	35	20	20	20	40	0	

Table B-6. Overstory cover species and stem density size class (continued).

Site	Species	Percent Canopy Cover (%)	Stem density Size Classes (%) Class1 (0-23)	Class2 (23-53)	Class3 (53-81)	Class4 (81-122)	Class5 (>122)	Comments
BC8	ABGR	5	100	0	0	0	0	
BC8	ARME	10	100	0	0	0	0	
BC8	PSME	85	15	80	5	0	0	
BC9	ABGR	5	50	50	0	0	0	
BC9	ALRU	5	100	0	0	0	0	
BC9	ARME	10	30	70	0	0	0	
BC9	PSME	70	10	80	10	0	0	
BC9	THPL	10	40	60	0	0	0	
AC2	ABGR	5	100	0	0	0	0	
AC2	ALRU	50	0	100	0	0	0	
AC2	THPL	10	60	40	0	0	0	
AC2	TSHE	35	80	20	0	0	0	
AC3	ABGR	10	0	100	0	0	0	
AC3	ACMA	60	0	20	80	0	0	
AC3	ALRU	5	0	100	0	0	0	
AC3	THPL	10	0	50	50	0	0	
AC3	TSHE	15	20	60	20	0	0	
AC5	ABGR	10	100	0	0	0	0	
AC5	PSME	15	30	50	20	0	0	
AC5	THPL	65	10	20	20	50	0	
AC5	TSHE	10	40	60	0	0	0	
AC6	ABGR	5	100	0	0	0	0	
AC6	ALRU	5	100	0	0	0	0	
AC6	PSME	10	75	25	0	0	0	
AC6	THPL	40	25	50	0	25	0	
AC6	TSHE	35	80	20	0	0	0	
AC6	ACCI	5	100	0	0	0	0	

Table B-7. Understory species and percent cover for terrestrial survey sites. Percent cover categories: 0=0%, 1=<1%, 2=1-5%, 3=6-25%, 4=26-50%, 5=51-75%, 6=76-100%. See Table B-8 for description of plant species description.

Site ID	Category	Grasses, Mosses, Large Organic (L.O.) Debris	Species 1	Cover 1	Species 2	Cover 2	Species 3	Cover 3
BC1								
BC1	Ferns		POMU	1				
BC1	Forbs		LIBO	3	RANU	3		
BC1	Shrubs		GASH	3	ROSP	2		
BC1	Understory Coniferous		PSME	3	ABGR	1		
BC1	Understory Deciduous		HODI	3				
BC1	Grasses	4						
BC1	Mosses	5						
BC1	L.O. Debris*	4						
BC2	Ferns		LIBO	1				
BC2	Forbs		POMU	1				
BC2	Shrubs		GASH	4	BENE	2		
BC2	Understory Coniferous		PSME	2	ABGR	1		
BC2	Understory Deciduous		HODI	3				
	Grasses	3						
	Mosses	6						
	L.O. Debris*	4						
BC3	Ferns		POMU	2				
BC3	Forbs		0					
BC3	Understory Coniferous		PSME	1	AMGR	1		
BC3	Understory Deciduous		ALRU	1				
BC3	Shrubs		GASH	3	BENE	2	SYAL	4
BC3	Grasses	1						
BC3	Mosses	2						
BC3	L.O. Debris*	3						
BC4	Ferns		0					

Table B-7. Understory species and percent cover for terrestrial survey sites. Percent cover categories: 0=0%, 1=<1%, 2=1-5%, 3=6-25%, 4=26-50%, 5=51-75%, 6=76-100%. See Table B-8 for description of plant species description (continued).

Site ID	Category	Grasses, Mosses, Large Organic (L.O.) Debris	Species 1	Cover 1	Species 2	Cover 2	Species 3	Cover 3
BC4	Forbs		0					
BC4	Understory Coniferous		PSME	2				
BC4	Understory Deciduous		HODI	1				
BC4	Shrubs		GASH	2	BENE	3	ROSP	3
BC4	Grasses	2						
BC4	Mosses	2						
BC4	L.O. Debris*	5						
BC5	Ferns		POMU	5				
BC5	Forbs			1				
BC5	Understory Coniferous		THPL	1	PSME	1		
BC5	Understory Deciduous		ALRU	2	HODI	2		
BC5	Shrubs		GASH	3	BENE	3	ROSP	2
BC5	Grasses	2						
BC5	Mosses	3						
BC5	L.O. Debris*	5						
BC6	Ferns		POMU	2				
BC6	Forbs			1				
BC6	Shrubs		SYAL	4	ROSP	3		
BC6	Understory Deciduous		ACCI	2	HODI	2		
BC6	Understory Coniferous		ABGR	2	THPL	2	TABR	1
BC6	Grasses	2						
BC6	Mosses	3						
BC6	L.O. Debris*	6						
BC7	Ferns		POMU	5				
BC7	Forbs			1				
BC7	Shrubs		GASH	5	BENE	3		
BC7	Understory Coniferous		THPL	2				

Table B-7. Understory species and percent cover for terrestrial survey sites. Percent cover categories: 0=0%, 1=<1%, 2=1-5%, 3=6-25%, 4=26-50%, 5=51-75%, 6=76-100%. See Table B-8 for description of plant species description (continued).

Site ID	Category	Grasses, Mosses, Large Organic (L.O.) Debris	Species 1	Cover 1	Species 2	Cover 2	Species 3	Cover 3
BC7	Understory Deciduous		HODI	2				
BC7	Grasses	0						
BC7	Mosses	3						
BC7	L.O. Debris*	5						
BC8	Ferns		POMU	1				
BC8	Forbs		LIBO	1				
BC8	Understory Coniferous		ABGR	1				
BC8	Understory Deciduous		HODI	2				
BC8	Shrubs		GASH	6	BENE	2	ROSP	2
BC8	Grasses	0						
BC8	Mosses	3						
BC8	L.O. Debris*	6						
BC9	Ferns		POMU	1				
BC9	Forbs		various sp.	1				
BC9	Understory Coniferous		THPL	2	ABGR	2		
BC9	Understory Deciduous		HODI	1				
BC9	Shrubs		GASH	6	BENE	3	ROSP	1
BC9	Grasses	1						
BC9	Mosses	2						
BC9	L.O. Debris*	5						
AC2	Forbs		URDI					
AC2	Understory Coniferous		TSHE	2	THPL	2		
AC2	Understory Deciduous		ACCI	4				
AC2	Shrubs		SARA	5	RUSP		ILAN	1
	Ferns		POMU	3				
AC2	Grasses	0						
AC2	Mosses	6						

Table B-7. Understory species and percent cover for terrestrial survey sites. Percent cover categories: 0=0%, 1=<1%, 2=1-5%, 3=6-25%, 4=26-50%, 5=51-75%, 6=76-100%. See Table B-8 for description of plant species description (continued).

Site ID	Category	Grasses, Mosses, Large Organic (L.O.) Debris	Species 1	Cover 1	Species 2	Cover 2	Species 3	Cover 3
AC2	L.O. Debris*	6						
AC3	Ferns		POMU	6				
AC3	Forbs		URDI	2				
AC3	Understory Coniferous		TSHE	1				
AC3	Understory Deciduous		ACCI	1				
AC3	Shrubs		RUSP	1	GASH	1	RILA	1
AC3	Grasses	0						
AC3	Mosses	2						
AC3	L.O. Debris*	6						
AC5	Ferns		POMU	2				
AC5	Forbs		LOCI					
AC5	Understory Deciduous		ACCI	3	HODI	3		
AC5	Shrubs		SYAL	2	RUSP	2	ROSP	2
AC5	Understory Coniferous		ABGR	3	TSHE	2	TABR	1
AC5	Grasses	1						
AC5	Mosses	3						
AC5	L.O. Debris*	6						
AC6	Ferns		POMU	5				
AC6	Forbs		GAAP	3				
AC6	Understory Coniferous		TSHE	2	THPL	2		
AC6	Understory Deciduous		ACCI	3	ALRU	2	HODI	3
AC6	Shrubs		RIDI	2	ROSP	2	RUSP	2
AC6	Grasses	1						
AC6	Mosses	2						
AC6	L.O. Debris*	5						

*L.O. Debris = large organic debris

Table B-8. Plant species codes.

Code	Type	Common Name	Scientific Name
ABAM	Tree	Pacific silver fir	*Abies amabilis*
ABGR	Tree	grand fir	*Abies grandis*
ABLA	Tree	subalpine fir	*Abies lasciocarpa*
ACCI	Shrub	vine maple	*Acer circinatum*
ACGL	Shrub	Douglas maple	*Acer glabrum*
ACMA	Tree	bigleaf maple	*Acer macrophyllum*
ACMI	Groundcover	yarrow	*Achillea millefolium*
ACTR	Groundcover	vanilla leaf	*Achlys triphylla*
ADAL	Fern	maidenhair fern	*Adiantum aleuticum*
ADBI	Groundcover	pathfinder	*Adenocaulon bicolor*
ALCE	Groundcover	nodding onion	*Allium cernuum*
ALL	Tree	all canopy	
ALRU	Tree	red alder	*Alnus rubra*
ALVI	Shrub	Sitka alder	*Alnus viridis*
AMAL	Shrub	serviceberry	*Amelanchier alnifolia*
ANLY	Groundcover	Lyall's anemone	*Anemone lyllii*
ANMA	Groundcover	pearly everlasting	*Anaphalis margaritacea*
ARLU	Forb	western wormwood	*Artemisia ludoviciana*
ARMA	Groundcover	bigleaf landwort	*Arenaria macrophylla*
ARME	Tree	madrone	*Arbutus menziesii*
ARUV	Groundcover	kinnikinnick	*Arctostaphylos uva-ursi*
ARUV	Shrub	kinnikinnick	*Arctostaphylos uva-ursi*
ATFI	Fern	lady fern	*Athyrium filix-femnina*
BENE	Groundcover	Oregon grape	*Berberis nervosa*
BLSP	Fern	deer fern	*Blechnum spicant*
BOEL	Groundcover	coast boykinia	*Boykinia elata*
BRVU	Groundcover	Columbia brome	*Bromus vulgaris*
CADE	Groundcover	Dewey's sedge	*Carex dewayana*
CAME	Forb	Merten's mountain heather	*Cassiope mertensiana*
CARO	Groundcover	rodd sedge	*Carex rossii*
CASC	Groundcover	Scouler's harebell	*Campanula scouleri*
CHGL	Groundcover	western golden carpet	*Chrysosplenium glechomaefolium*
CHME	Groundcover	little prince's pine	*Chimaphila menziesii*
CHNO	Tree	yellow cedar	*Chamaecyparis nootkatensis*
CHUM	Groundcover	prince's pine	*Chimaphila umbellata*
CIAL	Groundcover	enchanter's nightshade	*Circaea alpina*
CLSI	Forb	Siberian miner's lettuce	*Claytonia sibirica*
CLUN	Groundcover	queen's cup	*Clintonia uniflora*
COCA	Groundcover	bunchberry dogwood	*Cornus canadensis*
COCA	Shrub	hazelnut	*Corylus cornuta*
COLA	Groundcover	cut-leaved goldthread	*Coptis laciniata*
CONU	Tree	Pacific dogwood	*Cornus nuttalli*
COSC	Groundcover	Scouler's corydalis	*Corydalis scouleri*

Table B-8. Plant species codes (continued).

Code	Type	Common Name	Scientific Name
COST	Shrub	red-osier dogwood	*Cornus stolinifera*
CRAC	Fern	American parsley fern	*Cryptogramma acrostichoides*
CRDO	Shrub	black hawthorn	*Crataegus douglasii*
DIHO	Groundcover	Hooker's fairybell	*Disporum hookeri*
DRAU	Fern	wood fern	*Dryopteris austiniae*
ELGL	Groundcover	blue wildrye	*Elmus glaucus*
ELHI	Groundcover	hairy wildrye	*Elymus hirsutus*
EPAN	Groundcover	fireweed	*Epilobium augustfolium*
ERGR	forb	yellow glacier lily	*Erythronium grandiflorum*
ERGR	Forb	glacier lily	*Erythronium grandiflorum*
ERLA	Groundcover	woolly sunflower	*Eriophyllum lanatum*
ERMO	Forb	avalanche lily	*Erythronium montanum*
FEOC	Groundcover	western fescue	*Festuca occidentalis*
FERN	Fern	fern species	
FRVE	Groundcover	woods strawberry	*Fragaria vesca*
GAAP	Groundcover	cleavers	*Galium aparine*
GASH	Groundcover	salal	*Gaultheria shallon*
GASH	Shrub	salal	*Gaultheria shallon*
GATR	Groundcover	fragrant bedstraw	*Galium triflorum*
GOOB	Groundcover	rattlesnake-plantain	*Goodyera oblongifolia*
GRASS	Groundcover	grass species	
GYDR	Fern	oak fern	*Gymnocarpium dryopteris*
HELA	forb	cow-parsnip	*Heracleum lanatum*
HIAL	Groundcover	white hawkweed	*Hieracium albiflorum*
HODI	Shrub	oceanspray	*Holodiscus discolor*
HYTE	Groundcover	Pacific waterleaf	*Hydrophyllum tenuipes*
ILAN	Shrub	English holly	*Ilex angustifolium*
JUCO	Shrub	common juniper	*Juniperus scopulorum*
JUSC	Tree	Rocky Mountain juniper	*Juniperus scopulorum*
LANE	Groundcover	Nuttall's peavine	*Lathyrus nevadensis*
LASA	Forb	edible lettuce	*Lactuca sativia*
LIBO	Groundcover	twinflower	*Linnaea borealis*
LICA	Forb	western twayblade	*Listera caurina*
LICO	Groundcover	heartleaf twayblade	*Listera cordata*
LOCI	Groundcover	orange honeysuckle	*Lonicera ciliosa*
LOIN	Shrub	black twinberry	*Lonicera involucrata*
LOMA	Groundcover	Martindale's lomatium	*Lomatium martindalei*
LOUT	Groundcover	Utah honeysuckle	*Lonicera utahensis*
LULA	Groundcover	subalpine lupine	*Lupinus latifoilus*
LUPA	Groundcover	small-flowered woodrush	*Luzula parviflora*
LYAM	Groundcover	skunkcabbage	*Lysichitum americanum*
MADI	Groundcover	false lily-of-the-valley	*Maianthemum dilatum*
MEFE	Shrub	false azalea	*Menziesia ferunginea*
MOPA	Groundcover	streambank spring-beauty	*Montia parvifolia*

Table B-8. Plant species codes (continued).

Code	Type	Common Name	Scientific Name
MOSI	Groundcover	candyflower	*Montia sibirica*
MOSS	Groundcover	moss species	
NONE	Groundcover	woodland beardtongue	*Nothochelone nemorosa*
OECE	Shrub	Indian-plum	*Oemleria cerasiformis*
OPHO	Shrub	devil's club	*Oplopanax horridum*
OSCH	Groundcover	sweet cicely	*Osmorhiza chilensis*
OXOR	Groundcover	oxalis	*Oxalis oregana*
PAMY	Shrub	Oregon boxwood	*Pachistima myrsinites*
PHCA	Shrub	Pacific ninebark	*Physocarpus capitalus*
PHEM	Forb	red mountain-heather	*Phyllodoce empetriformis*
PICO	Tree	lodgepole pine	*Pinus contorta*
PIMO	Tree	western white pine	*Pinus monticola*
PISI	Tree	Sitka spruce	*Picea sitchensis*
POBA	Tree	black cottonwood	*Populus balsamifera*
POGL	Fern	licorice fern	*Polypodium glycyrrhiza*
POMU	Fern	sword fern	*Polystichum munitum*
PSME	Tree	Douglas fir	*Pseudotsuga menziesii*
PTAQ	Fern	bracken fern	*Pteridium aquilinum*
PYFU	Tree	western crabapple	*Pyrus fusca*
PYSE	Groundcover	sidebells pyrola	*Pyrola secunda*
PYUN	Groundcover	woodnymph	*Pyrola uniflora*
QUGA	Tree	Garry oak	*Quercus garryana*
RANU	Groundcover	buttercup species	*Ranunculus species*
RHAL	Shrub	white azalea	*Rhododendron albifloru*
RHMA	Shrub	rhododendron	*Rhododendron macrophyllum*
RHPU	Tree	cascara	*Rhamnus purshiana*
RHPU	Shrub	cascara	*Rhamnus purshiana*
RIBR	Groundcover	stink currant	*Ribes bracteosum*
RILA	Shrub	black gooseberry	*Ribes lacustre*
RISA	Shrub	red-flowering currant	*Ribes sanguineum*
ROGY	Shrub	baldhip rose	*Rosa gymnocarpa*
RONU	Shrub	Nootka rose	*Rosa nutkana*
ROSP	shrub	rose species	*Rosa spp.*
RUPA	Shrub	thimbleberry	*Rubus parviflorus*
RUPE	Groundcover	five-leaved bramble	*Rubus pedatus*
RUSH	Groundcover	rush species	
RUSP	Shrub	salmonberry	*Rubus spectabilis*
RUUR	Groundcover	trailing blackberry	*Rubus ursinus*
SALI	Shrub	willow species	*Salix species*
SARA	Shrub	red elderberry	*Sambucus racemosa*
SASC	Shrub	Scouler's willow	*Salix scouleriana*
SEDGE	Groundcover	sedge species	
SEOR	Groundcover	Oregon selaginella	*Selaginella oregana*
SHRUB	Shrub	unknown shrub	

Table B-8. Plant species codes (continued).

Code	Type	Common Name	Scientific Name
SMST	Groundcover	star-flowered Solomon's seal	*Smilicina stellata*
SOSC	shrub	western mountain ash	*Sorbus scopulina*
SOSI	Shrub	Sitka mountain-ash	*Sorbus sitchensis*
STME	Groundcover	Mexican betony	*Stachys mexicana*
SYAL	Shrub	common snowberry	*Symphoricarpus albus*
SYMO	Groundcover	creeping snowberry	*Symphoricarpos mollis*
TABR	Tree	Pacific yew	*Taxus brevifolia*
THPL	Tree	western redcedar	*Thuja plicata*
TITR	Groundcover	three-leafed foamflower	*Tiarella trifoliata*
TOME	Groundcover	piggyback plant	*Tolmia menziesii*
TRCA	Groundcover	tall trisetum	*Trisetum canescens*
TRCE	Groundcover	nodding trisetum	*Trisetum cernuum*
TRLA	Groundcover	starflower	*Trientalis latifolia*
TROV	Groundcover	trillium	*Trillium ovatum*
TSHE	Tree	western hemlock	*Tsuga heterophylla*
TSME	Tree	mountain hemlock	*Tsuga mertensiana*
URDI	Forb	stinging nettle	*Urtica dioica*
VAAL	Shrub	Alaska huckleberry	*Vaccinium Alaskense*
VACC	Shrub	vaccinium species	*Vaccinium species*
VADE	Forb	blue-leaf huckleberry	*Vaccinium deliciosum*
VAME	Shrub	huckleberry	*Vaccinium membranaceae*
VAOV	Shrub	evergreen huckleberry	*Vaccinium ovatum*
VAPA	Shrub	red huckleberry	*Vaccinium parvifolium*
VASC	Forb	Scouler’s valerian	*Valerian scouleri*
VASP	Shrub	huckleberry	*Vaccinium species*
VEVI	Forb	false hellebore	*Veratrum viride*
VIAM	Groundcover	American vetch	*Vicia americanum*
VIGL	Groundcover	pioneer violet	*Viola glabella*
VISE	Groundcover	evergreen violet	*Viola sempervirens*
XETE	Groundcover	beargrass	*Xerophyllum tenax*

Table B-9. Terrestrial survey woody debris transects (see Table 4 for Decay Class descriptions).

Location	Transect #	cm	class
AC2	1	250	3
AC2	1	260	4
AC2	1	920	3
AC2	1	1210	3
AC2	1	1480	3
AC2	1	1750	5
AC2	1	1900	3
AC2	1	2020	4
AC2	1	2300	1
AC2	1	2450	1
AC2	1	2740	1
AC2	1	2800	1
AC2	1	2900	2
AC2	2	260	4
AC2	2	770	4
AC2	2	1030	2
AC2	2	1140	2
AC2	2	1600	5
AC2	2	2360	3
AC2	2	2580	5
AC2	2	2640	2
AC2	2	2730	2
AC2	2	2900	3
AC2	2	2940	3
AC2	3	400	4
AC2	3	530	2
AC2	3	670	3
AC2	3	900	4
AC2	3	1200	5
AC2	3	1440	5
AC2	3	1550	5
AC2	3	2150	1
AC2	3	2800	2
AC2	4	290	4
AC2	4	600	2
AC2	4	970	3
AC2	4	1100	5
AC2	4	1240	5
AC2	4	1910	5
AC2	4	2110	5

Location	Transect #	cm	class
AC2	4	2870	4
AC2	5	400	4
AC2	5	600	4
AC2	5	860	3
AC2	5	960	3
AC2	5	1150	4
AC2	5	1260	3
AC2	5	1400	4
AC2	5	1760	4
AC2	5	1930	3
AC2	5	2150	3
AC2	6	200	3
AC2	6	630	3
AC2	6	810	4
AC2	6	1170	3
AC2	6	1250	2
AC2	6	1470	5
AC2	6	1770	3
AC2	6	2400	2
AC2	6	2510	5
AC2	6	2700	5
AC2	6	2810	5
AC2	6	2870	4
AC2	6	2900	4
AC2	7	540	3
AC2	7	650	3
AC2	7	800	3
AC2	7	1100	3
AC2	7	1230	4
AC2	7	2730	4
AC2	8	290	3
AC2	8	370	4
AC2	8	550	4
AC2	8	660	4
AC2	8	790	3
AC2	8	970	5
AC2	8	1140	5
AC2	8	1590	4
AC2	8	1720	4
AC2	8	1880	5

Location	Transect #	cm	class
AC2	8	2140	2
AC3	1	1370	4
AC3	1	1840	3
AC3	1	1860	3
AC3	1	1980	3
AC3	1	2170	4
AC3	2	2740	4
AC3	3	240	4
AC3	3	1380	3
AC3	3	1800	4
AC3	3	2880	2
AC3	4	520	4
AC3	4	630	1
AC3	4	770	4
AC3	4	930	5
AC3	4	1640	4
AC3	4	1810	3
AC3	4	2250	4
AC3	4	2790	4
AC3	4	2920	3
AC3	5	180	4
AC3	5	1290	4
AC3	5	1990	4
AC3	6	300	4
AC3	6	1520	4
AC3	6	1670	3
AC3	6	1710	3
AC3	7	150	4
AC3	7	650	4
AC3	7	1210	4
AC3	7	1570	2
AC3	7	1930	4
AC3	7	2330	2
AC3	7	2400	2
AC3	7	2700	2
AC3	8	1430	3
AC3	8	1500	3
AC3	8	2180	3
AC3	8	2460	3
AC3	8	2530	5
AC3	8	2630	3
AC5	1	260	3

Location	Transect #	cm	class
AC5	1	360	3
AC5	1	660	2
AC5	1	730	2
AC5	1	830	3
AC5	1	1500	4
AC5	1	2110	1
AC5	1	2330	4
AC5	1	2450	3
AC5	1	2640	2
AC5	2	810	5
AC5	2	1460	2
AC5	2	1530	5
AC5	2	1670	3
AC5	2	1870	4
AC5	2	2410	4
AC5	2	2790	4
AC5	2	2890	5
AC5	3	290	4
AC5	3	660	4
AC5	3	1380	4
AC5	3	1480	4
AC5	3	1920	3
AC5	3	2390	5
AC5	3	2810	3
AC5	4	110	4
AC5	4	340	4
AC5	4	410	4
AC5	4	420	2
AC5	4	530	2
AC5	4	1120	2
AC5	4	1150	4
AC5	4	1550	4
AC5	4	1670	4
AC5	4	1830	3
AC5	4	2050	4
AC5	4	2130	4
AC5	4	2350	2
AC5	4	2390	3
AC5	4	2490	1
AC5	4	2800	3
AC5	4	2920	4
AC5	5	110	5

Location	Transect #	cm	class
AC5	5	370	2
AC5	5	460	4
AC5	5	480	3
AC5	5	580	4
AC5	5	650	4
AC5	5	760	4
AC5	5	820	5
AC5	5	970	3
AC5	5	1410	3
AC5	5	1680	3
AC5	5	1810	2
AC5	5	1990	2
AC5	5	2440	5
AC5	5	2540	4
AC5	5	2580	1
AC5	5	2840	2
AC5	5	2990	2
AC5	5	3000	2
AC5	6	140	4
AC5	6	290	5
AC5	6	470	2
AC5	6	910	5
AC5	6	1210	5
AC5	6	1490	2
AC5	6	1520	2
AC5	6	1560	3
AC5	6	1740	3
AC5	6	1900	2
AC5	6	2190	3
AC5	6	2360	3
AC5	6	2390	3
AC5	6	2450	3
AC5	6	2700	3
AC5	6	2810	3
AC5	6	2950	3
AC5	7	340	1
AC5	7	380	1
AC5	7	440	4
AC5	7	540	5
AC5	7	1240	3
AC5	7	1350	3
AC5	7	1540	3

Location	Transect #	cm	class
AC5	7	1800	1
AC5	7	1990	3
AC5	7	2050	3
AC5	7	2080	2
AC5	7	2490	1
AC5	7	2600	1
AC5	8	340	3
AC5	8	440	1
AC5	8	510	3
AC5	8	1320	3
AC5	8	1630	2
AC5	8	1690	4
AC5	8	1750	5
AC5	8	1860	4
AC5	8	1890	2
AC5	8	2050	4
AC5	8	2370	5
AC5	8	2490	2
AC5	8	2630	1
AC5	8	2840	1
AC5	8	2930	3
AC6	1	570	5
AC6	1	740	5
AC6	1	950	5
AC6	1	1350	3
AC6	1	1730	3
AC6	2	1450	1
AC6	2	2050	5
AC6	2	2250	5
AC6	2	2470	4
AC6	3	960	5
AC6	3	1060	2
AC6	3	1300	5
AC6	3	1480	5
AC6	3	1500	5
AC6	3	1850	5
AC6	3	2380	5
AC6	3	2510	3
AC6	3	2640	1
AC6	4	180	4
AC6	4	370	4
AC6	4	630	4

Location	Transect #	cm	class
AC6	4	710	4
AC6	4	1030	4
AC6	4	1100	5
AC6	4	1180	4
AC6	4	1250	1
AC6	4	1300	1
AC6	4	1310	1
AC6	4	1330	1
AC6	4	2150	4
AC6	4	2400	4
AC6	4	2600	4
AC6	4	2700	4
AC6	4	2850	5
AC6	5	170	5
AC6	5	700	5
AC6	5	1100	5
AC6	5	2600	3
AC6	5	2730	4
AC6	5	2820	5
AC6	6	940	4
AC6	6	1100	5
AC6	6	1670	2
AC6	6	2220	1
AC6	6	2400	1
AC6	7	520	4
AC6	7	670	4
AC6	7	730	5
AC6	7	900	4
AC6	7	1750	4
AC6	7	2000	3
AC6	7	2080	2
AC6	7	2340	3
AC6	8	520	4
AC6	8	1130	4
AC6	8	1270	4
AC6	8	1320	3
AC6	8	1380	2
AC6	8	1570	4
AC6	8	1690	4
AC6	8	1750	5
AC6	8	1770	3
AC6	8	2330	4

Location	Transect #	cm	class
AC6	8	2600	5
BC1	1	180	1
BC1	1	550	3
BC1	1	1010	3
BC1	1	1030	3
BC1	1	1290	2
BC1	1	1450	1
BC1	1	2000	5
BC1	1	1300	5
BC1	1	2520	4
BC1	1	2940	2
BC1	2	1580	1
BC1	2	2250	1
BC1	2	2680	2
BC1	3	760	3
BC1	3	1110	2
BC1	3	1200	3
BC1	3	1400	1
BC1	3	1730	5
BC1	3	1960	5
BC1	3	2070	5
BC1	3	2660	5
BC1	4	1050	3
BC1	4	1250	4
BC1	4	1470	2
BC1	4	1510	2
BC1	4	1630	1
BC1	4	1760	2
BC1	4	1910	2
BC1	4	2320	2
BC2	1	90	1
BC2	1	330	2
BC2	1	930	5
BC2	1	1060	2
BC2	1	1250	2
BC2	1	1270	5
BC2	1	1910	4
BC2	1	2150	3
BC2	1	2230	3
BC2	1	2690	2
BC2	1	2810	4
BC2	2	810	5

Location	Transect #	cm	class
BC2	2	1200	2
BC2	2	1430	5
BC2	2	1560	5
BC2	2	1840	4
BC2	2	1880	5
BC2	2	2060	3
BC2	2	2300	2
BC2	2	2600	3
BC2	2	2910	3
BC2	3	420	5
BC2	3	540	5
BC2	3	700	5
BC2	3	1370	5
BC2	3	1560	3
BC2	3	2010	2
BC2	3	2290	5
BC2	3	2750	1
BC2	4	330	4
BC2	4	1370	2
BC2	4	1990	3
BC2	4	2340	5
BC2	4	2430	3
BC2	4	2770	5
BC3	1	480	5
BC3	1	760	4
BC3	1	870	4
BC3	1	1090	3
BC3	1	1890	3
BC3	1	2170	1
BC3	1	2270	3
BC3	1	2280	3
BC3	1	2350	2
BC3	1	2730	1
BC3	1	2840	4
BC3	2	70	3
BC3	2	120	3
BC3	2	900	3
BC3	2	1180	2
BC3	2	1370	4
BC3	2	1480	2
BC3	2	1560	3

Location	Transect #	cm	class
BC3	2	1580	3
BC3	2	1590	3
BC3	2	1810	3
BC3	2	2140	4
BC3	2	2540	4
BC3	2	2740	2
BC3	2	3000	5
BC3	3	110	3
BC3	3	140	3
BC3	3	450	5
BC3	3	580	3
BC3	3	1090	3
BC3	3	1320	4
BC3	3	1410	4
BC3	3	2300	5
BC3	3	2410	4
BC3	3	2830	2
BC3	4	380	4
BC3	4	450	5
BC3	4	510	1
BC3	4	940	3
BC3	4	1000	3
BC3	4	1150	3
BC3	4	1240	4
BC3	4	1360	4
BC3	4	1370	5
BC3	4	1440	3
BC3	4	1620	3
BC3	4	1930	5
BC3	4	2030	1
BC3	4	2750	2
BC4	1	140	1
BC4	1	620	3
BC4	1	650	5
BC4	1	810	4
BC4	1	1640	3
BC4	1	1830	3
BC4	1	1940	3
BC4	1	2140	3
BC4	1	2660	4
BC4	1	2800	4

Location	Transect #	cm	class
BC4	1	2930	4
BC4	2	140	1
BC4	2	210	1
BC4	2	870	4
BC4	2	1070	1
BC4	2	1230	1
BC4	2	1360	1
BC4	2	1380	1
BC4	2	1560	2
BC4	2	1810	4
BC4	2	2960	4
BC4	3	380	1
BC4	3	530	1
BC4	3	820	1
BC4	3	1040	1
BC4	3	1270	1
BC4	3	1400	2
BC4	3	1430	2
BC4	3	1520	2
BC4	3	1850	2
BC4	3	2190	2
BC4	3	2330	2
BC4	3	2490	2
BC4	3	2580	3
BC4	3	2670	2
BC4	3	2840	2
BC4	3	2960	2
BC4	4	460	1
BC4	4	890	2
BC4	4	1050	2
BC4	4	1110	2
BC4	4	1380	2
BC4	4	1400	2
BC4	4	1420	2
BC4	4	1560	3
BC4	4	1630	3
BC4	4	1870	3
BC4	4	1880	3
BC4	4	1920	3
BC4	4	1980	3
BC5	1	10	5

Location	Transect #	cm	class
BC5	1	270	2
BC5	1	460	2
BC5	1	740	3
BC5	1	750	3
BC5	1	1000	3
BC5	1	1340	4
BC5	1	1410	3
BC5	1	1690	4
BC5	1	1810	3
BC5	1	2020	2
BC5	1	2080	4
BC5	1	2660	4
BC5	1	2840	4
BC5	1	2850	4
BC5	2	10	5
BC5	2	290	2
BC5	2	440	2
BC5	2	850	3
BC5	2	870	3
BC5	2	1030	2
BC5	2	1060	2
BC5	2	1420	3
BC5	2	1570	3
BC5	2	1610	3
BC5	2	1800	4
BC5	2	1960	4
BC5	2	2080	2
BC5	2	2160	3
BC5	2	2460	3
BC5	2	2570	4
BC5	2	3000	5
BC5	3	10	5
BC5	3	350	4
BC5	3	1010	2
BC5	3	1280	2
BC5	3	1370	2
BC5	3	1410	2
BC5	3	1440	2
BC5	3	1580	2
BC5	3	1690	3
BC5	3	1750	3

Location	Transect #	cm	class
BC5	3	1880	2
BC5	3	2010	2
BC5	3	2240	2
BC5	3	2860	4
BC5	4	10	5
BC5	4	690	2
BC5	4	1030	4
BC5	4	1280	3
BC5	4	1300	3
BC5	4	1390	3
BC5	4	1470	4
BC5	4	1900	3
BC5	4	2030	3
BC5	4	2130	3
BC5	4	2270	3
BC5	4	3000	5
BC6	1	370	4
BC6	1	390	4
BC6	1	420	4
BC6	1	470	4
BC6	1	610	5
BC6	1	840	5
BC6	1	2520	3
BC6	1	2780	3
BC6	1	2980	2
BC6	2	250	5
BC6	2	480	4
BC6	2	510	3
BC6	2	600	4
BC6	2	2060	4
BC6	2	2160	4
BC6	2	2440	3
BC6	2	2550	4
BC6	2	2590	4
BC6	3	210	4
BC6	3	350	5
BC6	3	450	5
BC6	3	530	4
BC6	3	700	3
BC6	3	1000	3
BC6	3	1190	4

Location	Transect #	cm	class
BC6	3	1400	3
BC6	3	3000	5
BC6	4	250	4
BC6	4	330	5
BC6	4	380	4
BC6	4	580	3
BC6	4	1520	3
BC6	4	2060	4
BC6	4	2250	3
BC6	4	2660	3
BC7	1	170	4
BC7	1	280	5
BC7	1	430	4
BC7	1	630	4
BC7	1	1250	4
BC7	1	1560	3
BC7	1	1910	2
BC7	2	150	5
BC7	2	580	3
BC7	2	640	5
BC7	2	870	4
BC7	2	1180	3
BC7	2	1740	2
BC7	2	2120	4
BC7	2	2350	4
BC7	2	2450	5
BC7	2	2490	4
BC7	3	120	5
BC7	3	600	4
BC7	3	770	2
BC7	3	1130	3
BC7	3	1320	4
BC7	3	1430	4
BC7	3	1740	5
BC7	3	1880	3
BC7	3	2090	5
BC7	3	2400	4
BC7	3	2730	4
BC7	3	2800	4
BC7	4	100	5
BC7	4	270	5

Location	Transect #	cm	class
BC7	4	1040	4
BC7	4	1070	4
BC7	4	1360	2
BC7	4	1500	2
BC7	4	1540	2
BC7	4	1800	1
BC7	4	2050	2
BC7	4	2250	4
BC7	4	2600	1
BC8	1	4	4
BC8	1	300	4
BC8	1	330	4
BC8	1	740	5
BC8	1	1840	4
BC8	1	2770	5
BC8	1	2870	4
BC8	2	650	4
BC8	2	850	3
BC8	2	1130	3
BC8	2	1140	1
BC8	2	1410	2
BC8	2	1700	3
BC8	2	1920	4
BC8	2	2000	3
BC8	2	2740	5
BC8	3	830	4
BC8	3	990	4
BC8	3	1200	2
BC8	3	1410	2
BC8	3	1630	2
BC8	3	1710	2
BC8	3	2020	3
BC8	3	2180	4
BC8	3	2400	2
BC8	3	2900	3
BC8	4	340	3
BC8	4	800	5
BC8	4	1400	1
BC8	4	1750	3
BC8	4	2000	4
BC8	4	2110	1

Location	Transect #	cm	class
BC8	4	2180	2
BC8	4	2310	4
BC8	4	2710	2
BC8	4	2940	2
BC9	1	70	1
BC9	1	200	4
BC9	1	330	5
BC9	1	380	3
BC9	1	460	3
BC9	1	1030	1
BC9	1	2270	3
BC9	1	2400	3
BC9	1	2450	3
BC9	1	2910	4
BC9	2	70	3
BC9	2	180	4
BC9	2	340	3
BC9	2	350	4
BC9	2	400	3
BC9	2	500	3
BC9	2	630	3
BC9	2	840	3
BC9	2	930	5
BC9	2	1360	5
BC9	2	1380	5
BC9	2	1410	5
BC9	2	1720	5
BC9	2	1990	3
BC9	2	2290	5
BC9	2	2380	4
BC9	2	2570	3
BC9	3	100	5
BC9	3	140	1
BC9	3	340	4
BC9	3	570	3
BC9	3	630	3
BC9	3	1120	3
BC9	3	1680	2
BC9	3	2500	5
BC9	3	2980	5
BC9	4	70	5

Location	Transect #	cm	class
BC9	4	120	5
BC9	4	150	3
BC9	4	330	5
BC9	4	650	3
BC9	4	1130	4
BC9	4	1660	4

Location	Transect #	cm	class
BC9	4	1890	3
BC9	4	2120	4
BC9	4	2300	3
BC9	4	2490	4
BC9	4	2520	3
BC9	4	1800	5

Appendix C: NCCN terrestrial survey protocols and datasheets.

NCCN Amphibian Inventory
Standard Operating Procedure for Amphibian Terrestrial Surveys
Michael J. Adams, prepared in 2001[2]

Site Selection

We will survey all appropriate habitat for which a safe and legal access route can be found. National Wetland Inventory maps, USGS topographical maps, and Vegetation or Forest Inventory maps will be used to locate appropriate habitat. Availability of maps varies for each park. You can find the NWI maps in ArcView files at:
X:\ArcGIS\Data\Shapefiles\Network\wetlands

Boundaries of the NCCN parks are in
X:\ArcGIS\Data\Shapefiles\Network\boundaries

Safety precludes sampling areas that are located on slopes >34 degrees.

On a topographic map or aerial photo of the study area, determine the number of 30 minute searches (plots) to use in appropriate habitat, assuming a 30m radius for each plot. The center of each 30 min. search plot should be at least 75 m from any forest edge (if possible). Also determine the path to follow between searches, with compass headings and approximate distances. Record the outlines of the plots on the air photo or map overlay.

Field Habitat Measurements

The following measurements are to be recorded from the plot center:

- Primary forest association series (see table B-8 for codes)
- Canopy cover to the nearest 20%
- Slope (%)
- Aspect
- Presence of streams, seeps, or talus
- Record the relative cover of each overstory species present – these numbers add to 100%. Include any deciduous trees present
- For each of the size class categories record the percent of stems from each tree species. Should sum to 100% going across columns
- Record the absolute cover of understory components for the 3 most important (dominant) species in each category using the 6 cover categories listed
- Record the percent cover of grasses, mosses, and L.O. debris (large organic debris)

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[2] U.S. Geological Survey, Biological Resources Division, Forest and Rangeland Ecosystem Science Center, 3200 SW Jefferson Way Corvallis, OR 97331

CWD: For each 30m plot, mark 4 evenly distributed lines, radiating from the plot center to the plot edge. Record the distance (cm) that the line is in contact with down wood and record the decay class (Table B-9) for each object (Figure 1).

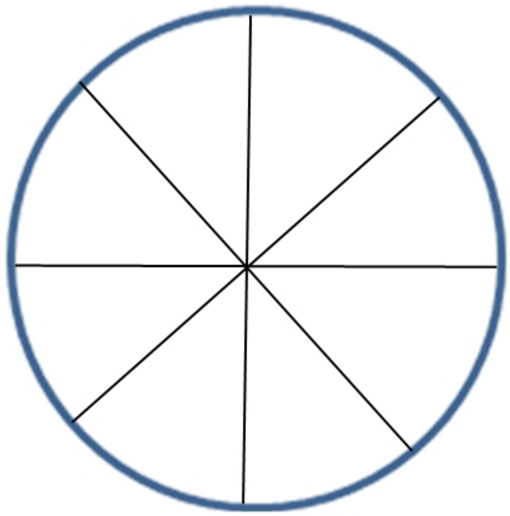

Figure 1. 30m plot with 8 transects for recording coarse woody debris. (Note: Data recorded for only 4 transects in this study for all but 4 sites. Reduction of the number of transects was necessary as CWD data collection was extremely time consuming, limiting the amount of time available for amphibian searches).

Field Herp Surveys

Each plot will be searched for 30 worker-minutes during daylight (>1 hr after sunrise and before sunset). A search consists of workers methodically visually searching for amphibians over the entire area of the plot and looking under as much loose wood, bark, or rock that can be lifted and restored to a condition similar to its original state. Workers should not tear apart decayed logs or completely dig up talus or piles of decaying wood. For example, a worker encountering a heavily decayed log that is still largely intact should attempt to move and replace pieces of decayed wood. It is permissible to break apart a small portion of the log (up to 10%) in this process.

Night time surveys, using a spotlight, should be conducted to verify absence of species expected that were not observed during daytime searches of sites.

Field Quality Assurance

After each survey, the field leader will review the data forms for completeness and accuracy and then initial the top of the form in the space provided.

Field QA: ______________ Entered by: ______________ Survey ID#: ______________

Page 1

Cluster #		Stand		Drainage	
Crew			Verification Plot?	Y N	
PDOP		Date			

Uncorrected UTM Coord.		File	Corrected UTM Coord.	
N	E		N	E

Forest					
Tot. Cov. (near. 20%)		Slope:		Aspect:	
Stream:	Y N	Seep:	Y N	Talus:	Y N

Canopy cover and stem density by size class.

Species	%Cov	1(0-23)	2(23-53)	3(53-81)	4(81-122)	5(>122)
All Stems						

Record absolute cover of understory components for the 3 most important species in each category. Use cover classes of <1, 1-5, 6-25, 26-50, 51-75, 76-100%.

Category	Sp1	%Cov	Sp2	%Cov	Sp3	%Cov
Ust. Conifer						
Ust. Decid.						
Shrubs						
Ferns						
Forbs						
Total Cover of	Grasses:		Mosses:		L.O.Debris:	

Figure C-1. Terrestrial amphibian inventory data sheets.

CWD Transect Data							
1		2		3		4	
cm	class	cm	class	cm	class	cm	class

Start				**End**			
Air Temp (^{0}C)	**Soil Temp (^{0}C)**	**Rel. Humid**	**Time**	**Air Temp (^{0}C)**	**Soil Temp (^{0}C)**	**Rel. Humid**	**Time**

Precipitation	**D F M LR HR SL SN**	**Wind**	**C LB MB W G**
D=dry, F=fog, M=mist, LR=light rain, HR=hard rain, SL=sleet, SN=snow		*C=calm, LB=light breeze, MB=mod. breeze, W=windy, G=gusty*	

Herp Sp.	**Sex**	**Stage**	**SVL(mm)**	**UL**	**LL**	**MB**	**Hab**
	M F U	**E L J A P U**					
	M F U	**E L J A P U**					
	M F U	**E L J A P U**					
	M F U	**E L J A P U**					
	M F U	**E L J A P U**					
	M F U	**E L J A P U**					
Habitats: D1-5 = Wood of decay classes 1-5; R=Rock; S=Stream/seep; O=other.							

Notes:

Figure C-1. Terrestrial amphibian inventory data sheets (continued).

Herp Sp.	Sex	Stage	SVL(mm)	UL	LL	MB	Hab
	M F U	E L J A P U					
	M F U	E L J A P U					
	M F U	E L J A P U					
	M F U	E L J A P U					
	M F U	E L J A P U					
	M F U	E L J A P U					
	M F U	E L J A P U					
	M F U	E L J A P U					
	M F U	E L J A P U					
	M F U	E L J A P U					
	M F U	E L J A P U					
	M F U	E L J A P U					
	M F U	E L J A P U					
	M F U	E L J A P U					
	M F U	E L J A P U					
	M F U	E L J A P U					
	M F U	E L J A P U					
	M F U	E L J A P U					
Habitats: D1-3 = Wood of decay classes 1-3; R=Rock; S=Stream/seep; O=other.							

Figure C-1. Terrestrial amphibian inventory data sheets (continued).

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