



Ebey's Landing National Historic Reserve Amphibian Inventory 2002-2003

Natural Resource Technical Report NPS/NCCN/NRTR—2013/684



ON THE COVER

Ebey's Landing National Historic Reserve amphibian survey sites.

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Ebey's Landing National Historic Reserve Amphibian Inventory 2002-2003

Natural Resource Technical Report NPS/NCCN/NRTR—2013/684

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Executive Summary

This document details amphibian inventories conducted at Ebey's Landing National Historical Reserve (EBLA). These inventories were part of a larger effort to document amphibian 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 parks (EBLA, FOCL, FOVA, and SAJH) had incomplete 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 species listed as "expected" but not confirmed in the parks and to document, to the 90% verification level,¹ amphibian species found in these parks. Prior to this inventory, EBLA had no verified list of amphibians or reptiles occurring in the park, however additional searches of museum specimens and state records have not been completed.

Our primary goal for EBLA 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*); western toad (*Anaxyrus boreas*); northwestern salamander (*Ambystoma gracile*); long-toed salamander (*Ambystoma macrodactylum*); and rough-skinned newt (*Taricha granulosa*).

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 EBLA. The report describes the methods used, 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 distribution of amphibians in the park. The appendices include more details on information documented in the inventory. A Microsoft Access database that provides records documenting sampling events has been submitted to the NCCN data manager. ArcMap GIS themes depicting locations; slide photographs of sites surveyed; and digital (and slide) voucher photos for new species documented have been produced.

Voucher specimens were not collected for this project but photographs were taken to document species occurrence in each of the five parks. 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.

¹ 90% verification level means that 90% of the species expected to be present in the park have been documented.

Nineteen aquatic and 15 terrestrial surveys were conducted in 2002 and 2003, and an additional 10 incidental observations were recorded. A total area of 75,286 m² was searched in 4,013 minutes, over 14 days.

Although much of the Reserve is agricultural or urban, we documented six amphibian and two snake species (garter snakes). One turtle was observed but could not be identified to species. The forested areas, in particular, appear to have the most suitable habitat for amphibians. We did not find the western red-backed salamander. Although this species is common throughout Washington State, a State distribution map for red-backed salamander indicates no records for Whidbey Island (Hallock and McAllister 2005a).

We found no perennial streams within the Reserve; consequently, stream dwelling amphibians are absent. Most of the ephemeral streams are highly impacted by agricultural activities and urban development. One drainage east of the Ebey's Landing parking area was searched, but no amphibians were detected (site EL8).

Species names have been verified and updated as needed based on Crother (2008). 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 Inventory and Monitoring 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

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We thank Matt Grove and Brian Hasebe, for their field assistance. We thank Rob Harbour, the EBLA Reserve Manager, for his assistance in locating field sites. We thank Robert Hoffman and Mark Huff 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. 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 1995, Phillips 1990, Wyman 1990, Wake 1991).

In 1994, Mount Rainier National Park (MORA), North Cascades National Park (NOCA), and Olympic National Park (OLYM) identified the lack of information on amphibian species distributions and abundances as the highest priority issue to address cooperatively with the newly created U.S. Geological Survey Biological Resources Division (BRD). The National Park Service (NPS) and BRD began inventories of aquatic breeding amphibians in these parks in 1996. The inventories continued through 1999, and resulted in the first published parkwide survey of amphibians for MORA (Tyler et al. 2003), NOCA (Holmes and Glesne 1997, Holmes and Glesne 1998, Holmes and Glesne 1999, and Rawhouser et al. 2009), and for OLYM (Bury and Adams 2000). Subsequent Vital Signs workshops for several of the 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 objective of this inventory was to document amphibian species presence at Ebey’s Landing National Historical Reserve (EBLA) because the park’s lists of species’ presence are incomplete, with limited supporting data. Our primary goal was to document, to the 90% verification level, amphibian species found in EBLA to meet the NPS Inventory and Monitoring program goal for vertebrates, which prior to this inventory had no documentation of amphibians or reptiles in the Reserve. Incidental reptile species encountered were also documented. Table 1 lists the amphibian species expected to be encountered in EBLA. State and federal species documentation lists, published references and local expertise were used to determine which species are expected to occur in the Reserve.

Table 1. Amphibian species expected to occur in Ebey's Landing National Historic Reserve, and their special status designation.

Genus and Species	Common Name	Code	Special Status Species	Non-native Species
Terrestrial Breeding Species				
Caudata — salamanders				
Ensatinas				
<i>Ensatina eschscholtzii oregonensis</i>	Oregon Ensatina	ENES		
Woodland Salamanders				
<i>Plethodon vehiculum</i>	Western red-backed salamander	PLVE		
Aquatic Breeding Species				
Anurans				
Brown Frogs ²				
<i>Rana aurora</i>	Northern red-legged frog	RAAU	**	
<i>Rana pretiosa</i>	Oregon spotted frog	RAPR	**	
American Water Frogs				
<i>Lithobates catesbeianus</i> (formerly <i>Rana catesbeiana</i>) ³	American bullfrog	RACAT		#
Chorus Frogs				
<i>Pseudacris regilla</i>	Pacific treefrog	PSRE		
North American Toads				
<i>Anaxyrus boreas</i> ⁴	Western toad	BUBO	**	
Caudata — salamanders				
Mole Salamanders				
<i>Ambystoma gracile</i>	Northwestern salamander	AMGR		
<i>Ambystoma macrodactylum</i>	Long-toed salamander	AMMA		
Pacific Newts				
<i>Taricha granulosa</i>	Rough-skinned newt	TAGR		

** = federal or state listed species of concern; # = introduced species.

² Brown Frogs is used in Crother 2008

³ See ITIS (www.itis.gov) and Crother 2008

⁴ Olson 2009 reports 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

Ebey's Landing National Historical Reserve (EBLA) was established in 1978 to preserve and protect a historically significant, pastoral landscape on Whidbey Island. The historical landscape of the Reserve today looks much like it did a century ago – a mosaic of farms, forests, and century old buildings and homes. The Reserve encompasses 25 miles² (17,400 ac), and includes federal, state, county, and private property (Figure 1). A Volunteer Trust Board administers the area to protect the cultural landscape and historic essence of the site.

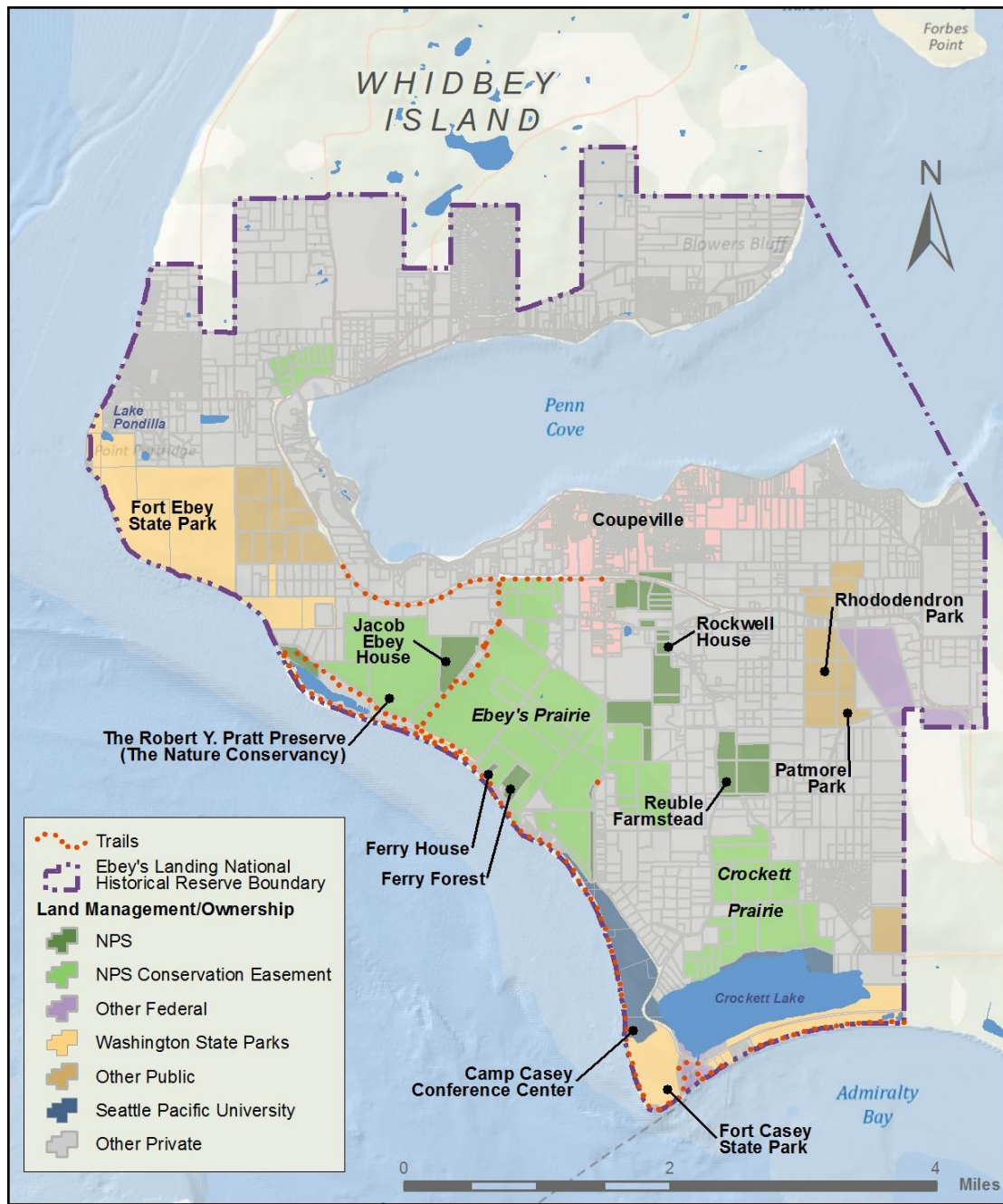


Figure 1. Ebey's Landing National Historical Reserve.

The Reserve is located on central Whidbey Island, approximately 45 miles north of Seattle, at the extreme northern end of Puget Sound (Figure 1). To the east are the North Cascades; north and south are miles of islands, coves, and bays; southwest lie the Olympic Mountains. Whidbey Island varies from one to ten miles in width and offers a rare combination of forests, prairies, and seascapes. A major force in the creation of this landscape was the Pleistocene glacial retreat about 13,000 years ago. The retreating ice left glacial moraines, gravel, sand, and clay, as well as kettle lakes and raised beaches. Natural forces continue to erode the beach bluffs and transport sand along the shore.

Outstanding natural features include miles of marine shoreline, 4000 ac Penn Cove, three large native prairies, multiple glacial kettles, the island's best farmland, high seaside bluffs, low rolling hills, shallow brackish lakes, and a long, narrow, rugged beach along Admiralty Inlet.

The Reserve is located in the Western Hemlock Forest Zone of western Washington. The unique climate, rain-shadow effect of the Olympic Mountains (18.6" of rain annually), productive agricultural soils, maritime influence, and geologic features result in an unusual diversity of plant and animal species, communities, and habitats, including several small populations of the federally listed (threatened) golden Indian paintbrush (*Castilleja levisecta*). Native flora are very diverse, ranging from small, scattered stands of old-growth Douglas-fir forest, flat-leaved cactus, and miles of hedgerows to dense rhododendron (*Rhododendron macrophyllum*) thickets, significant salt marsh communities and a recently discovered intact acre of original, pristine prairie. Numerous populations of invasive exotic flora exist within the Reserve.

The rich marine resources attract over 140 species of migratory and resident birds. Marine mammals are commonly observed in the waters mentioned above. Prior to this survey, little was known of amphibian and reptile species and populations within the Reserve. The EBLA Resource Management Plan (NPS 1998) reported only one amphibian and reptile species as occurring within the Reserve.

Threats to park resources include numerous vegetation management issues including control–eradication of exotic, invasive flora, loss of prairies, and forest health. Human population increase and associated land development are also of concern, especially with increased freshwater use. Other concerns include catastrophic events associated with human activities, such as coastal marine oil spills, landscape scale fires, climate change, warming, and rising sea level.

Potential aquatic breeding amphibian habitat within the reserve includes Lake Pondilla in Fort Ebey State Park, and several small wetlands (palustrine open water, emergent, shrub and forested) throughout the Park. Terrestrial breeding amphibian habitat exists within the Reserve, primarily within two large, densely wooded areas that comprise about 4500 ac and mostly comprised of second- and third-growth Douglas-fir (*Pseudotsuga menziesii*), western redcedar (*Thuja plicata*), red alder (*Alnus rubra*), salal (*Gaultheria shallon*), Oregon grape (*Berberis aquifolium*), and ferns. Remnant patches of old-growth forests occur along the bluffs above the Ebey's Landing site; within Rhododendron Park and the Seattle Pacific University's Camp Casey forest. There are also areas that have not been cut or burned since 1900 where mature Douglas-fir, grand fir (*Abies grandis*), and western hemlock (*Tsuga heterophylla*) occur (NPS 2006).

Methods

The focus of the surveys at EBLA was to inventory and confirm the presence of amphibian species, and to document reptiles incidental to amphibian surveys. Aquatic and terrestrial surveys were conducted. Incidental observations were also recorded.

National Wetland Inventory maps or hydrography data were used to identify all potential aquatic habitats. Land use maps and assistance from Rob Harbour, the Reserve Manager, were used to identify suitable and accessible habitat within the boundaries of EBLA. Surveys were conducted during the months of April and May 2002, and April 2003, during a narrow two to three week period. All suitable, accessible habitats were surveyed. See Figure 2 for a map of amphibian survey locations and Table 1 for a list of survey site locations and coordinates.

Table 2. Ebey's Landing National Historical Reserve survey site locations and associated Universal Transverse Mercator (UTM) coordinates.

Field Site ID	Location Description	Date	UTM E NAD27	UTM N NAD27	Elevation (m)
EL1A	Lake Pondilla	23-Apr-02	517442	5341396	5
EL1B	Lake Pondilla wetland	01-May-02	517335	5341396	5
EL1C	Lake Pondilla wetland, Night Survey	01-May-02	517335	5341396	5
EBI1	Nature Conservancy, Pratt Preserve	01-May-02	520735	5338335	240
EBI2	Fort Ebey State Park	02-May-02	518833	5339961	180
EBI3	Fort Ebey State Park	07-May-02	518097	5340820	160
EBI4	Nature Conservancy, Pratt Reserve	07-May-02	520415	5338654	240
EBI5	Drainage ditch on Zylstra Road, Just north of Hwy. 20	29-Apr-02	520058	5342224	15
EBI6	Wetland in northeast portion of EBLA, Monroe Landing Pond, Aural night survey	29-Apr-02	523703	5342925	10
EL2	Fort Ebey's State Park on south slope of glacial kettle	23-Apr-02	517619	5341123	80
EL3	Kettles State Park	01-May-02	519384	5340503	40
EL4	Wetland off of Zylstra Rd. Whidbey Is.	24-Apr-02	519932	5343460	49
EL6	Pond in Coupeville, off Terry Rd. between school and bowling alley	25-Apr-02	523759	5339074	39
EL7	South side of Hwy 20, approx. 5 mi. E of Main St. (Coupeville)	25-Apr-02	524267	5339592	60
EL8	East of Ebey's Landing Parking area	30-Apr-02	521931	5337364	15
EL9	Wilbur Bishop's Pond: E side of Ferry Forest	30-Apr-02	522675	5337042	52
EL10	Bishop's Woods	30-Apr-02	522525	5337032	68
EL11	Coniferous forest in Pratt Preserve, Nature Conservancy	01-May-02	520680	5338315	40
EL12	Coniferous forest in Pratt Preserve, Nature Conservancy	02-May-02	520951	5339300	80
EL13	Coniferous forest southeast of Fort Ebey's State Park	02-May-02	518996	5339791	80
EL14	Nature Conservancy, Pratt Preserve	07-May-02	518157	5340801	25
EL15	Nature Conservancy, Pratt Preserve	07-May-02	520267	5338641	60
EL16	North west of Crocket Lake	08-May-02	524130	5334907	18
EL17	Rhododendron Park	08-May-02	526230	5338269	61
EL18	Wetland east of Crocket Lake	15-Apr-03	527037	5334878	10

Table 2. Ebey's Landing National Historical Reserve survey site locations and associated Universal Transverse Mercator (UTM) coordinates (continued).

Field Site ID	Location Description	Date	UTM E	UTM N	Elevation (m)
EL19	Tiny pond off Wanamaker Rd.	15-Apr-03	526792	5335240	30
EL20	Coniferous forest near southeast boundary of EBLA	15-Apr-03	526827	5335410	80
EL21	East of Washington State Game Farm	15-Apr-03	527296	5340055	180
EL22	Retention pond behind Coupeville Post Office	15-Apr-03	523106	5340532	50
EL23	871 N. WEST BEACH	16-Apr-03	518326	5342948	270
EL24	152 N. OLSON RD., NW Corner of Reserve	16-Apr-03	519059	5344058	230
EL25	Pond behind Oak Harbor Airport	16-Apr-03	524043	5343952	140
EL26	Pond at junction of Monterey and Libbey Road	16-Apr-03	517696	5341924	40
EL27	Fort Casey State Park	17-Apr-03	523861	5334923	30
EL28	Fort Casey State Park	17-Apr-03	523705	5335056	40
EL29	MUZZAL POND 1 (off of Scenic Heights Rd, near Oak Harbor Air Park in northeast portion of EBLA on private lands)	22-Apr-03	524781	5343562	180
EL30	MUZZAL 2 (off of Scenic Heights Rd, near Oak Harbor Air Park in northeast portion of EBLA on private lands)	22-Apr-03	524798	5343683	200
EL31	MUZZAL 3 (off of Scenic Heights Rd, near Oak Harbor Air Park in northeast portion of EBLA on private lands)	22-Apr-03	524952	5343575	200
EL32	MUZZAL 4 (highly impacted cattle pond, located off of Scenic Heights Rd, near Oak Harbor Air Park in northeast portion of EBLA on private lands)	22-Apr-03	525265	5343819	No data
EL33	Bishop's Pond off Hill Road	22-Apr-03	522677	5337049	130
EL34	Bottom of large kettle, NW of the dump	23-Apr-03	525287	5339829	40
EL35	Pond near Coupeville	23-Apr-03	524790	5340016	200
EL36	Slough across from bowling alley	23-Apr-03	523703	5339185	100
EL37	Kettles Recreation Area	23-Apr-03	518735	5340730	35
EL38	Kettles Recreation Area	23-Apr-03	519715	5340759	20

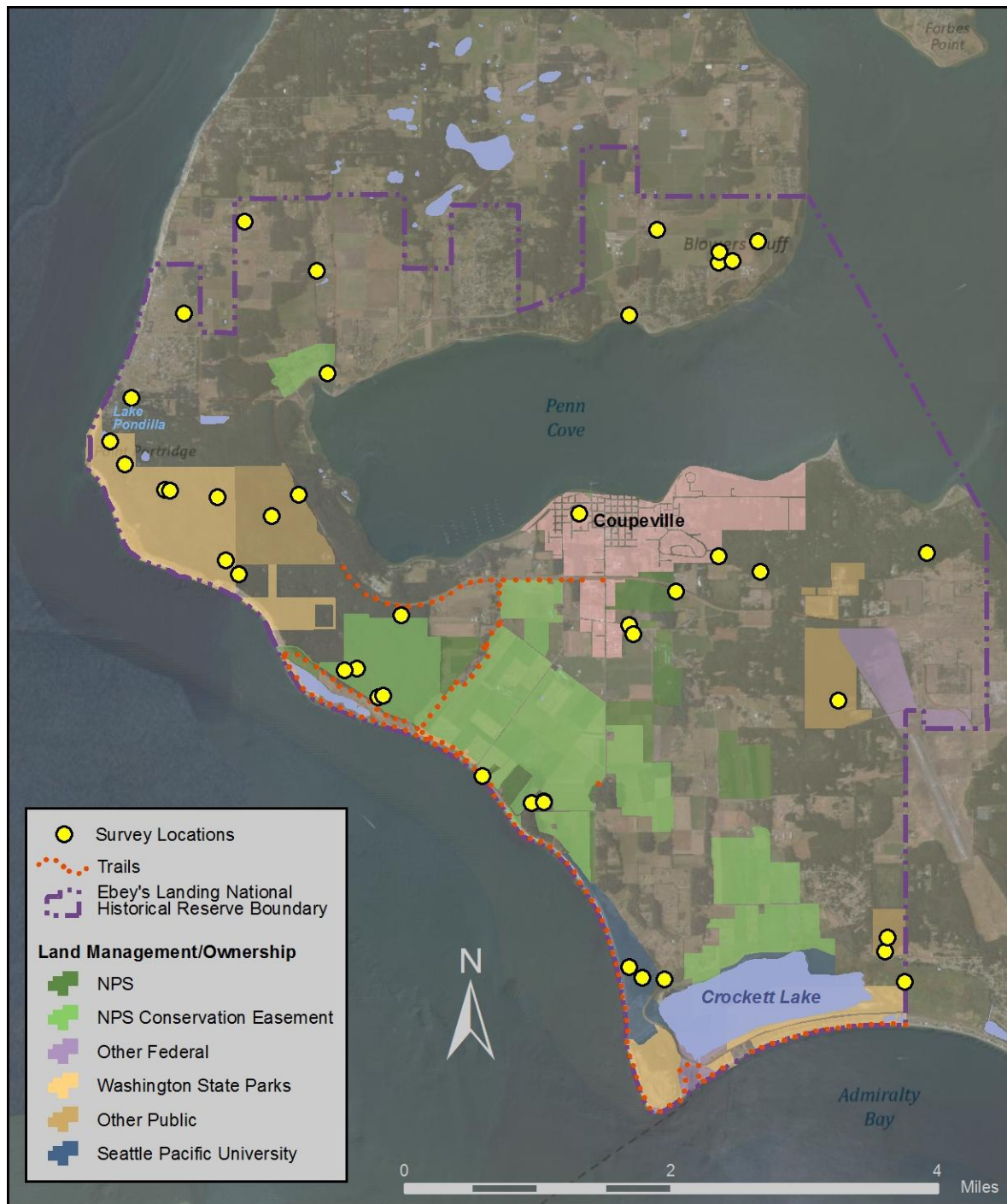


Figure 2. Amphibian survey site locations at Ebey's Landing National Historic Reserve.

Aquatic Surveys

Aquatic habitats included ponds, lakes, and wetland complexes. Aquatic habitats were described and surveyed with visual searches conducted according to modified protocols initially developed by Dr. Michael J. Adams, USGS-BRD (Appendix A), under the Amphibian Research and Monitoring Initiative (ARMI). Visual surveys were conducted by a minimum of two people. 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.

Only one flowing water (lotic) site was included in the EBLA surveys: a drainage from farm fields east of the Ebey's Landing parking area. The data collected at this site was recorded as an Incidental Search record (EL8). Aquatic habitat survey site characteristics are presented in Appendix B, Table B-1.

Fish Presence

Fish presence in aquatic breeding sites was documented to further characterize amphibian habitat. Lake and pond shallows, lake surfaces, and inlets and outlets were searched for fish presence and recorded on datasheets as present or not detected.

Water quality

Water quality of aquatic breeding sites was characterized at 18 sites (Appendix B, Table B-2). A Hach™ Sension 156 multi-parameter meter was used to measure pH, conductivity ($\mu\text{S}/\text{cm}$), and dissolved oxygen (mg/L). In addition, dissolved oxygen and conductivity were determined in the field at some sites using a YSI 57 Dissolved Oxygen meter and a self-calibrating Hach™ 44600 portable meter, respectively. All meters were calibrated before use. The pH meter was calibrated with prepared pH buffer and check solutions. Electrodes were triple-rinsed with de-ionized water between uses. Air and water temperatures were measured with an NIST stem thermometer.⁵ Air temperature was measured in the shade and one m above ground. Water temperature was measured in the sun and ten cm below the surface of the water. Further details on sample collection are provided in Appendix A.

Terrestrial Surveys

EBLA land ownership and wetland maps were searched for all suitable habitats for which a safe and legal access route could be found. Safety precluded sampling in areas that were located on slopes $>34^\circ$. For each area with suitable habitat, field surveyors established plots (with a radius of 30 m) based on the amount of existing habitat. Habitats that were most productive for detection were targeted and at least one plot was established in each habitat type within a geographic area. Where possible, the center of each plot was at least 75 m from any forest edge. Searches for amphibians were made within these plots for a minimum of 30 minutes. Search time was doubled or tripled in some cases if amphibian habitat was spatially complex.

Field habitat measurements were taken to aid in future amphibian studies at EBLA, but detailed analysis of these data was beyond the scope of this inventory. Field habitat measurements were recorded from the center of each plot and included: the primary forest association series; canopy cover to the nearest 20%; slope and aspect; presence of streams, seeps, or talus; the relative percent cover of each overstory species present and any deciduous trees present; size class categories for the percent of stems from each tree species; the absolute cover of understory

⁵ National Institute of Standards and Technology

components for the three most dominant species in each category using the six cover categories and the percent cover of grasses, mosses, and large organic debris (Appendix C, Table C-1). Course woody debris was recorded at 13 survey sites using four transects. The distance (cm) that a line was in contact with down wood was recorded along with the decay class for each object.

Each plot was searched for a minimum of 30 worker-minutes during daylight (>1 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.

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

Additional details on terrestrial survey protocols and examples of datasheets are provided in Appendix D.

Incidental surveys

When unmapped amphibian habitat was encountered, workers surveyed these areas and recorded: the area and amount of time the area was searched; general habitat description; location coordinates; general weather conditions; species encountered; life stage; and snout-vent length (Appendix C, Table C-3). Incidental surveys were also used in areas of thick brush such as Himalayan blackberry (*Rubus discolor*) and wild rose (*Rosa* spp.)

All amphibians encountered were recorded on data sheets. Photographs depicting key identification characteristics were taken for previously unconfirmed species. No voucher specimens were collected but voucher photographs were taken for all species observed.

Voucher Specimens

Amphibians and reptiles were not captured as voucher specimens in this project because it was intended as a low-impact inventory. Photographic vouchers were taken of species detected during this inventory. Color voucher photos were taken on slide film and provided to the NCCN data managers along with data sheets and the database associated with this study. Voucher slides were scanned into digital format and can be accessed through the NCCN Data Managers.

Results

Nineteen aquatic and 15 terrestrial surveys were conducted in 2002 and 2003, and an additional 11 incidental surveys were documented. A total area of 75,286 m² was searched in 4,013 minutes, over 14 days.

Amphibian observations are mapped in Figures 3 to 6. Results for all survey locations are summarized below (Table 2). Detailed results by species, life stage, and total count at each survey location are presented in Appendix E.

Six species, half of the number expected to inhabit EBLA, were observed: northwestern salamander; long-toed salamander; Oregon Ensatina (*Ensatina eschscholtzii oregonensis*); Pacific treefrog; northern red-legged frog; and rough-skinned newt. Several survey sites had more than one species present: two species were detected at nine sites (EL2, EL24, EL25, EL30, EL31, EL33, EL4, EL7, EL9); three species were detected at four sites (EL16, EL1B, EL26, EL35); and four species and one reptile were detected at one site (EL29, located between Oak Harbor airport and Penn Cove), a man-made pond with 80% cover of emergent vegetation.

Fish were present with Pacific treefrogs in two lakes; with long-toed salamanders in two lakes and with northern red-legged frogs in one lake.

Table 3. Survey sites description and location, and all species detected.

12	Site ID	Date	Area Surveyed (m ²)	Search Minutes	Survey Type	Location Description	HERP Species	Other Species Observed
	EL1A	4/23/2002	1800	360	Full ARMI Pond	Lake Pondilla	PSRE, turtle (species unknown)	
	EL1B	5/1/2002	500	120	Incidental Terrestrial	Lake Pondilla wetland	AMGR, PSRE, RAAU	
	EL1C	5/1/2002	500	120	Incidental (aural survey)	Lake Pondilla wetland	PSRE	
	EBI1	5/1/2002	5	40	Incidental Terrestrial	Nature Conservancy, Pratt Preserve	ENES	
	EBI2	5/2/2002	80	90	Incidental Terrestrial	Coniferous forest, Kettle	ENES	
	EBI3	5/7/2002	300	70	Incidental Terrestrial	Fort Ebey's State Park	ENES	
	EBI4	5/7/2002	100	40	Incidental Terrestrial	Nature Conservancy, Pratt Preserve	ENES	
	EBI5	4/29/2002	500	60	Incidental Terrestrial	Drainage ditch on Zylstra, just north of Hwy. 20	NONE	
	EBI6	4/29/2002	50	5	Incidental Terrestrial (aural survey only)	Wetland in northeast portion of EBLA, Monroe Landing Pond	PSRE	
	EL2	4/23/2002	2400	180	Incidental Terrestrial	Fort Ebey's State Park on south slope of Glacial Kettle	AMMA, ENES	
	EL3	4/1/2002	2827	60	Full NCCN Terrestrial	Kettles State Park	ENES	
	EL4	4/24/2002	2000	270	Full ARMI Pond	Wetland off of Zylstra Rd. Whidbey Is.	AMMA, PSRE	
	EL6	4/25/2002	500	140	Full ARMI Pond	Pond in Coupeville, off Terry Rd. between school and bowling alley	PSRE	
	EL7	4/25/2002	94	60	Full ARMI Pond	South side of Hwy 20, approx.5 mi. E of Main St. (Coupeville)	AMMA, PSRE	
	EL8	4/30/2002	250	180	Incidental	East of Ebey's Landing Parking area		

ENES = Oregon Ensatina; PSRE = Pacific treefrog; AMMA = long-toed salamander; RAAU = northern red-legged frog; TAGR = rough-skinned newt; THOR = northwestern garter snake; THIS = common garter snake

Table 3. Survey sites description and location, and all species detected (continued).

Site ID	Date	Area Surveyed (m ²)	Search Minutes	Survey Type	Location Description	HERP Species	Other Species Observed
EL9	4/30/2002	280	128	Full ARMI Pond	Wilbur Bishop's Pond: E side of Ferry Forest	PSRE, TAGR	Mollusk: crayfish
EL10	4/30/2002	2827	60	Full NCCN Terrestrial	Bishop's Woods	AMMA	
EL11	5/1/2002	2827	80	Full NCCN Terrestrial	Coniferous forest Pratt Preserve, Nature Conservancy	ENES	
EL12	5/2/2002	2827	160	Full NCCN Terrestrial	Coniferous forest Pratt Preserve, Nature Conservancy	ENES	
EL13	5/2/2002	2827	60	Full NCCN Terrestrial	Coniferous forest southeast of Fort Ebey's State Park	ENES	
EL14	5/7/2002	2827	90	Full NCCN Terrestrial	Nature Conservancy, Pratt Preserve	ENES	
EL15	5/7/2002	2827	90	Full NCCN Terrestrial	Nature Conservancy, Pratt Preserve	ENES	
EL16	5/8/2002	1750	100	Full ARMI Pond	North west of Crocket Lake-	AMMA, PSRE, RAAU	Fish, unknown family
EL17	5/8/2002	2827	60	Full NCCN Terrestrial	Rhododendron Park	ENES	
EL18	4/15/2003	20000	60	Full ARMI Pond	Wetland east of Crocket lake	NONE	
EL19	4/15/2003	40	60	Full ARMI Pond	Tiny pond off Wanamaker Rd.	NONE	
EL20	4/15/2003	2827	60	Full NCCN Terrestrial	Coniferous forest near southeast boundary of EBLA	ENES	
EL21	4/15/2003	2827	70	Full NCCN Terrestrial	East of Washington State Game Farm	ENES	
EL22	4/15/2003	160	60	Full ARMI Pond	Retention pond behind Coupeville Post Office	PSRE	
EL23	4/16/2003	200	60	Full ARMI Pond	871 N. WEST BEACH	PSRE	
EL24	4/16/2003	240	60	Full ARMI Pond	152 N. OLSON RD., NW Corner of Reserve	PSRE, TAGR, THSI	
EL25	4/16/2003	110	60	Full ARMI Pond	Pond behind Oak Harbor Airport	AMMA, PSRE	Fish: Stickleback
EL26	4/16/2003	100	90	Full ARMI Pond	Pond at junction of Monterey and Libbey Road	AMMA, PSRE, TAGR	

ENES = Oregon Ensatina; PSRE = Pacific treefrog; AMMA = long-toed salamander; RAAU = northern red-legged frog; TAGR = rough-skinned newt; THOR = northwestern garter snake; THIS = common garter snake

Table 3. Survey sites description and location, and all species detected (continued).

Site ID	Date	Area Surveyed (m ²)	Search Minutes	Survey Type	Location Description	HERP Species	Other Species Observed
EL27	4/17/2003	2827	60	Full NCCN Terrestrial	Fort Casey State Park	ENES	
EL28	4/17/2003	2827	60	Full NCCN Terrestrial	Fort Casey State Park	ENES	
EL29	4/22/2003	120	100	Full ARMI Pond	MUZZAL POND 1 (off of Scenic Heights Rd, near Oak Harbor Air Park in northeast portion of EBLA on private lands)	AMMA, PSRE, RAAU, TAGR, THOR	
EL30	4/22/2003	200	70	Full ARMI Pond; no incidental terrestrial detections	MUZZAL 2 (off of Scenic Heights Rd, near Oak Harbor Air Park in northeast portion of EBLA on private lands)	PSRE, RAAU	
EL31	4/22/2003	74	50	Full ARMI Pond,	MUZZAL 3 (off of Scenic Heights Rd, near Oak Harbor Air Park in northeast portion of EBLA on private lands)	AMMA, PSRE	
EL32	4/22/2003	10	20	Incidental Terrestrial	MUZZAL 4 (Highly impacted cattle pond, located off of Scenic Heights Rd, near Oak Harbor Air Park in northeast portion of EBLA on private lands)	PSRE	
EL33	4/22/2003	150	100	Full ARMI Pond	Bishop's Pond off Hill Road	PSRE, TAGR	
EL34	4/23/2003	2827	70	Full NCCN Terrestrial	Bottom of large kettle, NW of the dump	ENES	
EL35	4/23/2003	60	60	Full ARMI Pond	Pond near Coupeville	AMGR, PSRE, TAGR	
EL36	4/23/2003	308	90	Full ARMI Pond	Slough across from bowling alley	PSRE	Fish: Dace species
EL37	4/23/2003	2827	60	Full NCCN Terrestrial	Kettles Recreation Area	TAGR	
EL38	4/23/2003	2827	70	Full NCCN Terrestrial	Kettles Recreation Area	ENES	

ENES = Oregon Ensatina; PSRE = Pacific treefrog; AMMA = long-toed salamander; RAAU = northern red-legged frog; TAGR = rough-skinned newt; THOR = northwestern garter snake; THIS = common garter snake

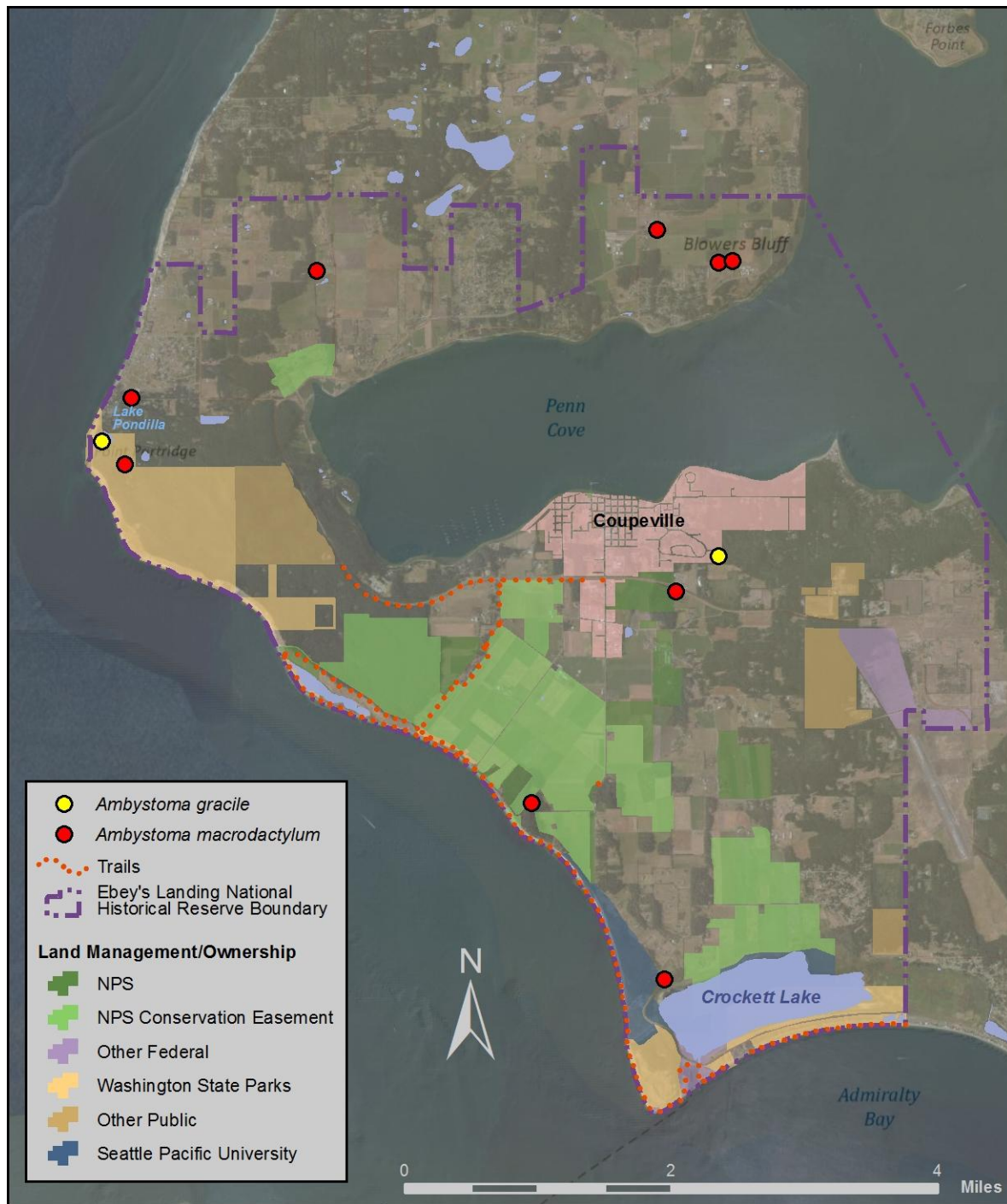


Figure 3. Observations of northwestern salamanders (*Ambystoma gracile*) and long-toed salamanders (*Ambystoma macrodactylum*) based on amphibian surveys conducted at Ebey's Landing National Historical Reserve, 2002 and 2003.



Figure 4. Observations of rough-skinned newts (*Taricha granulosa*) and Oregon Ensatina (*Ensatina eschscholtzii oregonensis*) based on amphibian surveys conducted at Ebey's Landing National Historical Reserve, 2002 and 2003.

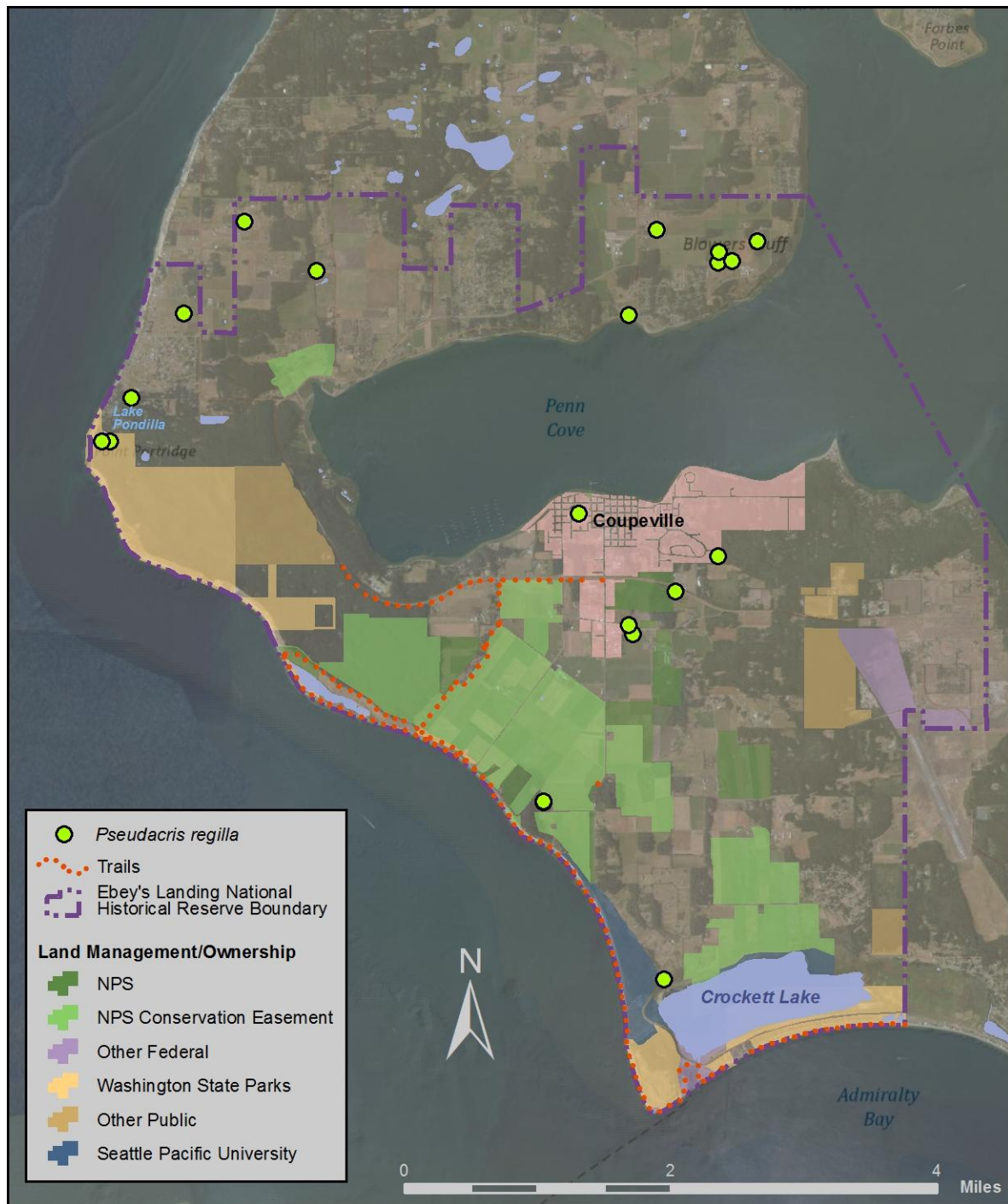


Figure 5. Observations of Pacific treefrogs (*Pseudacris regilla*) based on amphibian surveys conducted at Ebey's Landing National Historical Reserve, 2002 and 2003.

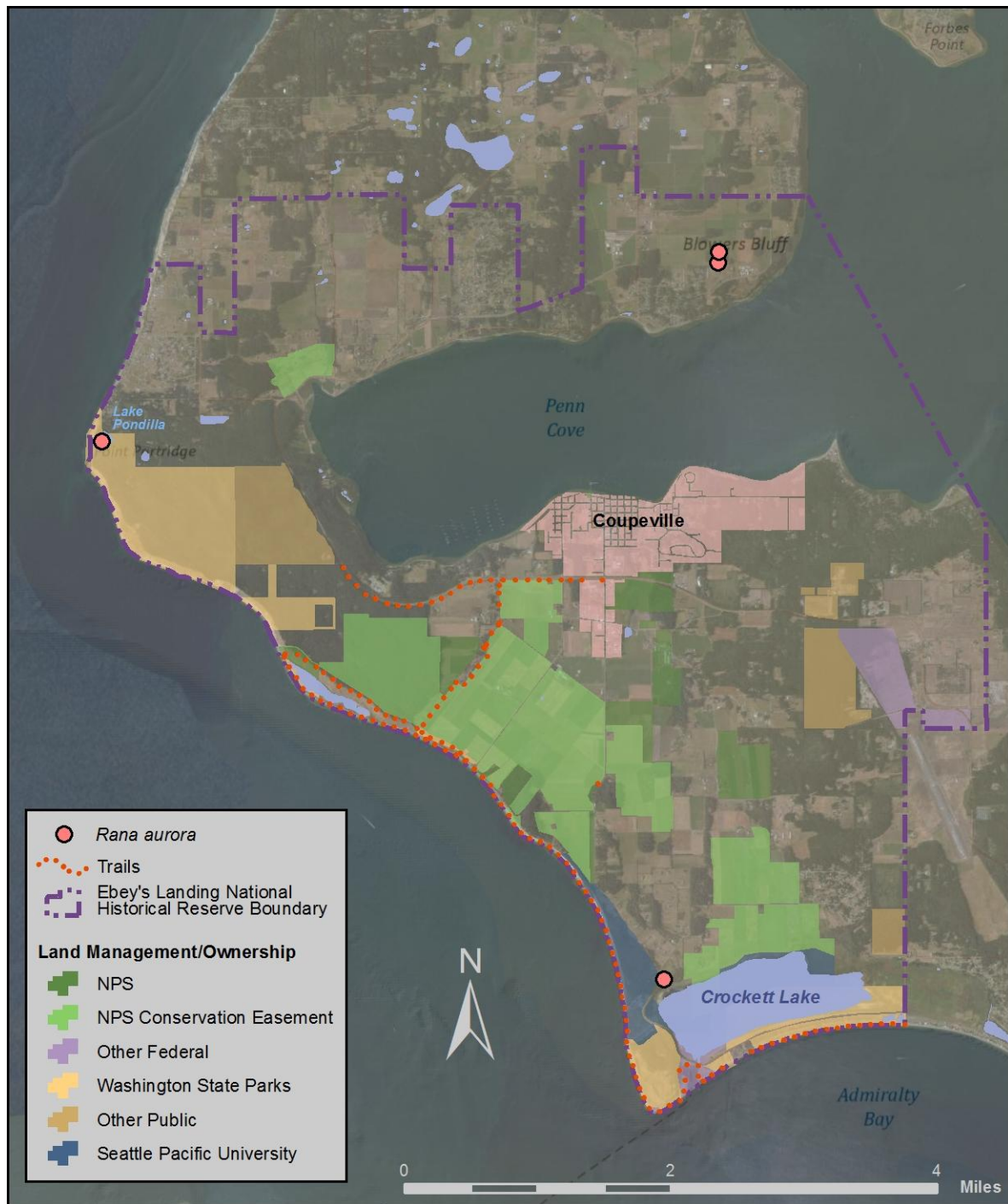


Figure 6. Observations of northern red-legged frogs (*Rana aurora*) based on amphibian surveys conducted at Ebey's Landing National Historical Reserve, 2002 and 2003.

Figure 7 summarizes the number of species present in habitat types at EBLA. The Pacific treefrog was the most abundant species found in aquatic surveys of both natural and man-made permanent ponds.⁶ Oregon Ensatina was the dominant terrestrial species detected and was found mostly in coniferous forests in decaying logs. Habitat information is presented in Appendix B, Table B-1 and Appendix C.

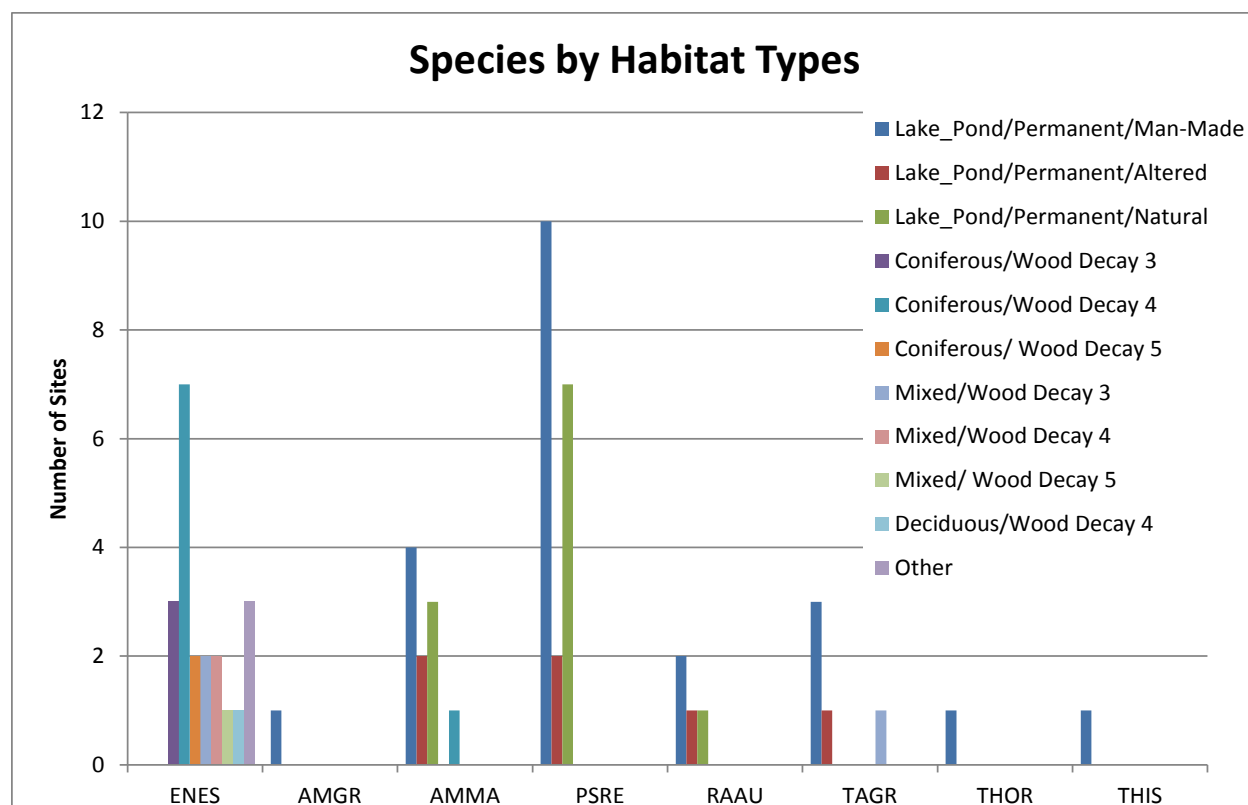


Figure 7. Species occurrence for various habitat types at Ebey's Landing National Historic Reserve. ENES = Oregon Ensatina; PSRE = Pacific treefrog; AMMA = long-toed salamander; RAAU = northern red-legged frog; TAGR = rough-skinned newt; THOR = northwestern garter snake; THIS = common garter snake.

Aquatic Surveys

Aquatic surveys covered 28,186 m² and 1,978 minutes of searching. Northwest Salamander egg masses were observed during one aquatic survey (Nancy Conard's Pond) and one incidental survey. Life stages and total counts for long-toed salamanders, Pacific treefrogs, red-legged frogs, and rough-skinned newts are presented in Figures 8 to 11. Pacific treefrog adults were the only species found at Lake Pondilla. Red-legged frogs were detected at only three sites, all man-made or altered ponds. Northwestern salamanders and red-legged frogs were detected in incidental surveys at wetlands adjacent to Lake Pondilla.

⁶ The origin of each site was noted as "natural," "altered," or "man-made." The origin of one site (EL6) was in question and field crews were uncertain as to whether this pond in Coupeville, off Terry Rd. between the school and bowling alley, was "natural."

General water quality measurements were taken at several sites to further describe aquatic breeding habitat. Water quality results are presented in Appendix B, Table B-2.

Water temperatures at survey sites ranged from 10 to 19°C. Measurements of pH ranged from 6.5 at EL9 to a high of 9.0 at EL 23 and EL24. Conductivity ranged from 100 µS/cm at EL9 to a high of 1188 µS/cm at EL6, a pond in Coupeville. Dissolved oxygen ranged from 5.75 mg/L at the slough (EL36) to 14.3 mg/L at Muzzal 2 pond (EL30).

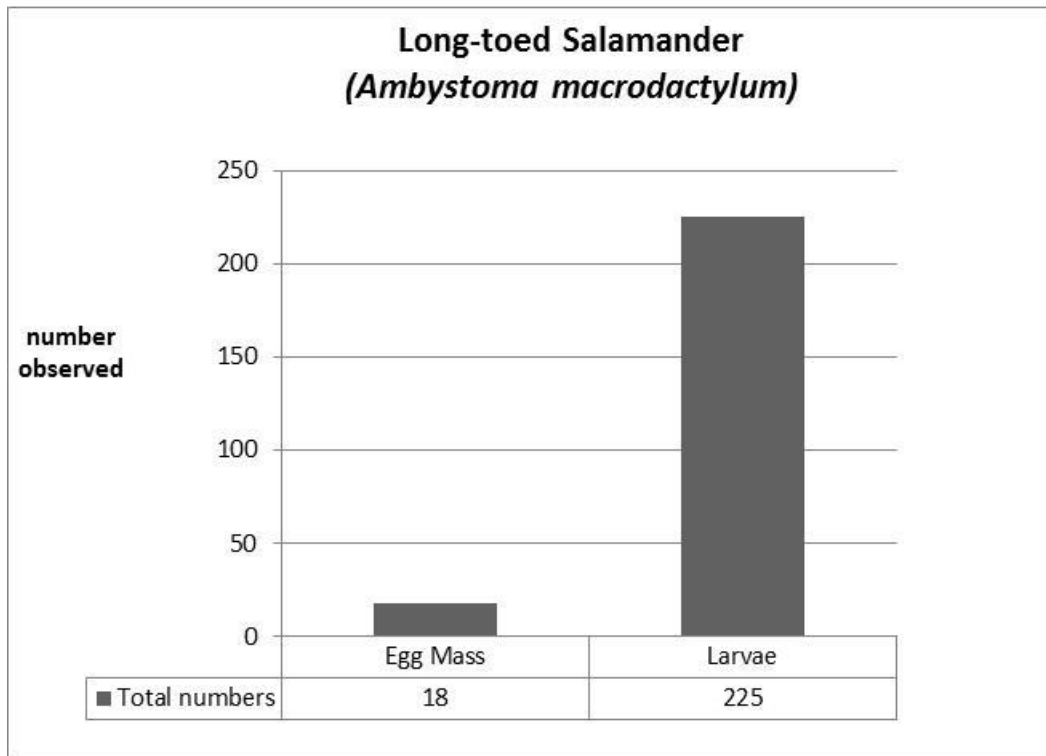


Figure 8. Long-toed salamander (*Ambystoma macrodactylum*) life stage and counts at Ebey's Landing National Historical Reserve (aquatic surveys).

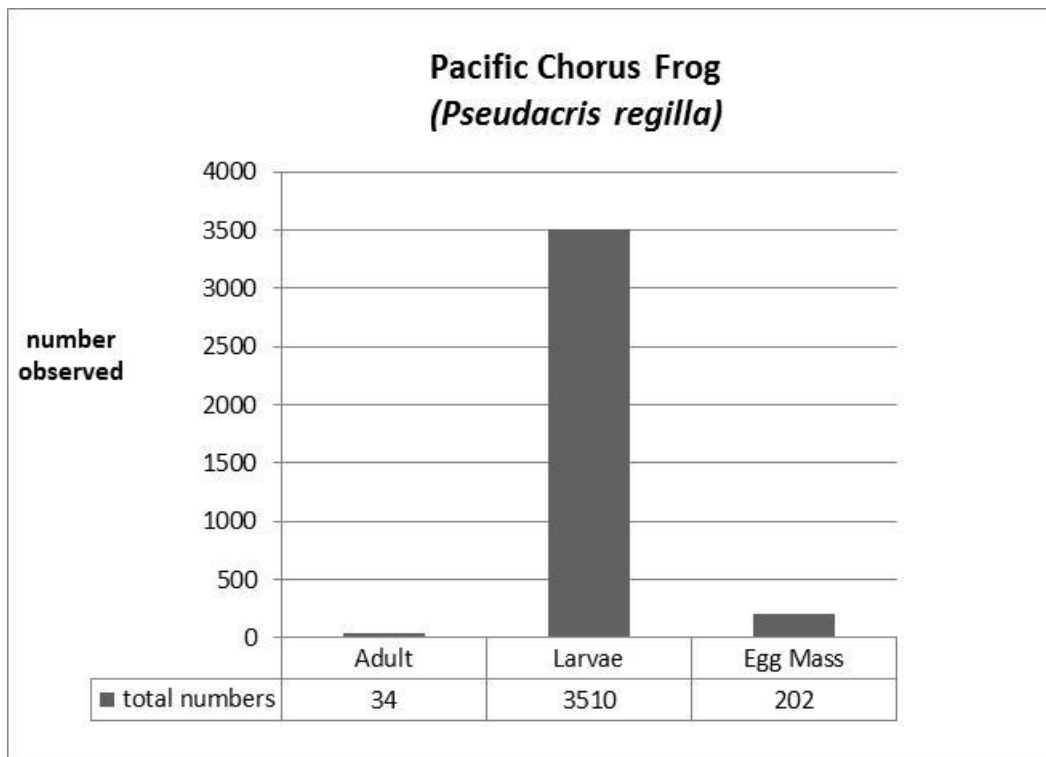


Figure 9. Pacific treefrog (*Pseudacris regilla*) life stage and counts at Ebey's Landing National Historic Reserve (aquatic surveys). Larval counts were estimated.

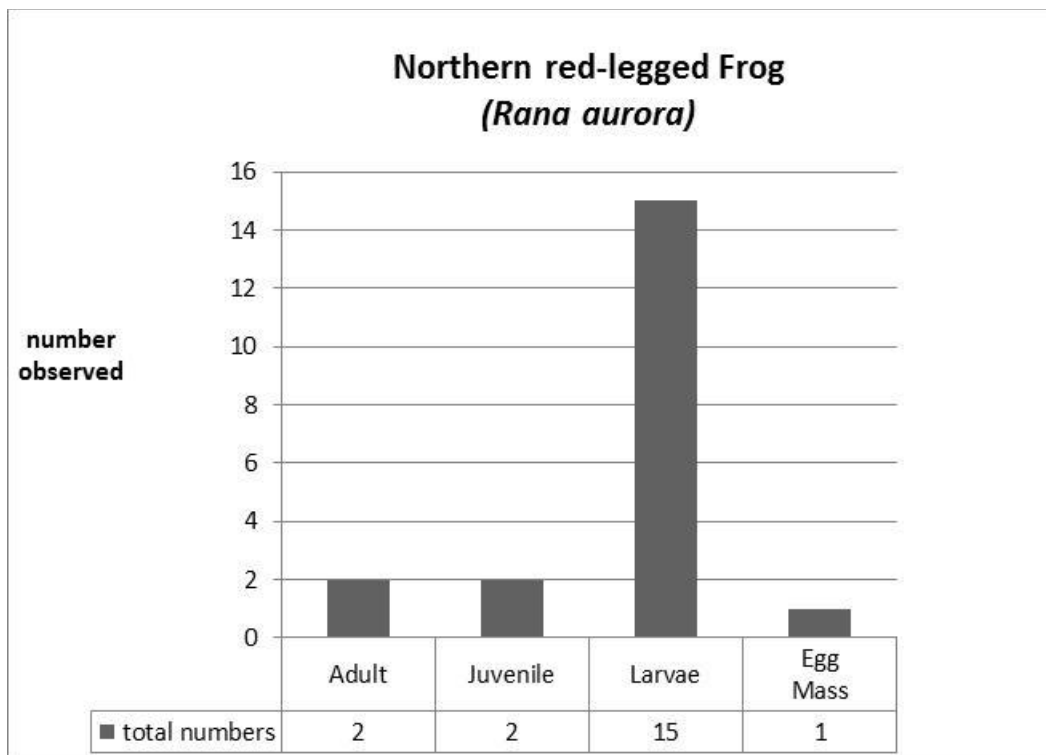


Figure 10. Northern red-legged frog (*Rana aurora*) life stage and counts at Ebey's Landing National Historic Reserve (aquatic surveys).

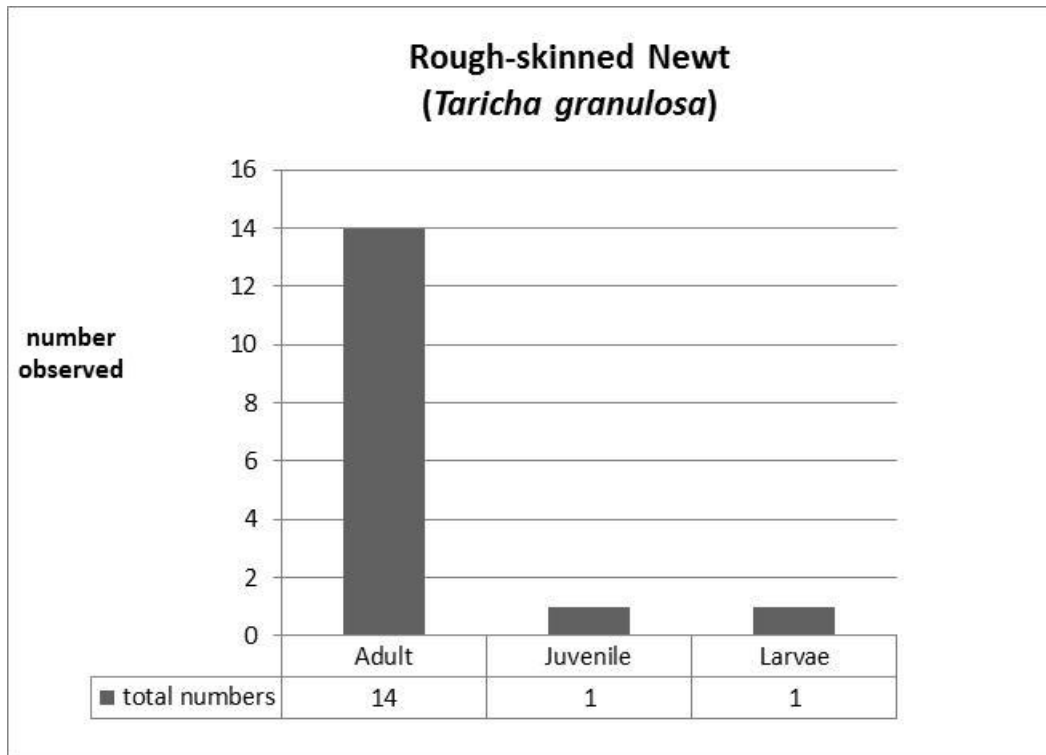


Figure 11. Rough-skinned newt (*Taricha granulosa*) life stage and counts at Ebey's' Landing National Historic Reserve (aquatic surveys).

Terrestrial Surveys

Terrestrial surveys covered 42,405 m² and 1,110 minutes of searches. Three species were observed during the terrestrial surveys: Long-toed salamander; Oregon Ensatina; and rough-skinned newt. Oregon Ensatina was the most abundant species observed. Observed habitat for rough-skinned newt adult, long-toed salamander adult, and Oregon Ensatina adults and juveniles are presented in Table 3. Amphibian species and life stages detected in terrestrial surveys are presented in Figure 12.

Table 4. Observed habitat for rough-skinned newt adult, long-toed salamander adult, Oregon Ensatina adults, and Oregon Ensatina juveniles.

Species	Habitat
Rough-skinned newt adult	mostly coniferous forest habitat with western hemlock, Douglas-fir, and red alder overstory; and an understory of sword fern (<i>Polystichum munitum</i>), rhododendron, ocean spray (<i>Holodiscus discolor</i>), red elderberry (<i>Sambucus racemosa</i>), and western hemlock
Long-toed salamander adult	coniferous overstory habitat with western hemlock and Douglas-fir, and an understory of sword fern, lady fern (<i>Athyrium filix-femina</i>), ocean spray, red huckleberry, red elderberry, red maple (<i>Acer rubrum</i>), Douglas-fir, and western hemlock
Oregon Ensatina adults	coniferous and mixed overstory habitat with grand fir, Douglas-fir, western redcedar, and red maple; and an understory of stinging nettle (<i>Urtica dioica</i>), sword fern, bracken fern (<i>Pteridium aquilinum</i>), lady fern (<i>Athyrium filix-femina</i>); salal, ocean spray, red huckleberry, rhododendron, salmonberry (<i>Rubus spectabilis</i>), red huckleberry, red elderberry, himalayan blackberry, and vine maple (<i>Acer circinatum</i>), Indian plum (<i>Oemleria cerasiformis</i>), western redcedar, and western hemlock
Oregon Ensatina juveniles	overstory of grand fir, Douglas-fir, western hemlock, western redcedar, and vine maple, with an understory of sword fern, spreading woodfern (<i>Dropteris expansa</i>), salal, ocean spray, red huckleberry, rhododendron, salmonberry, red huckleberry, vine maple, Indian plum, western redcedar, western hemlock, and red alder

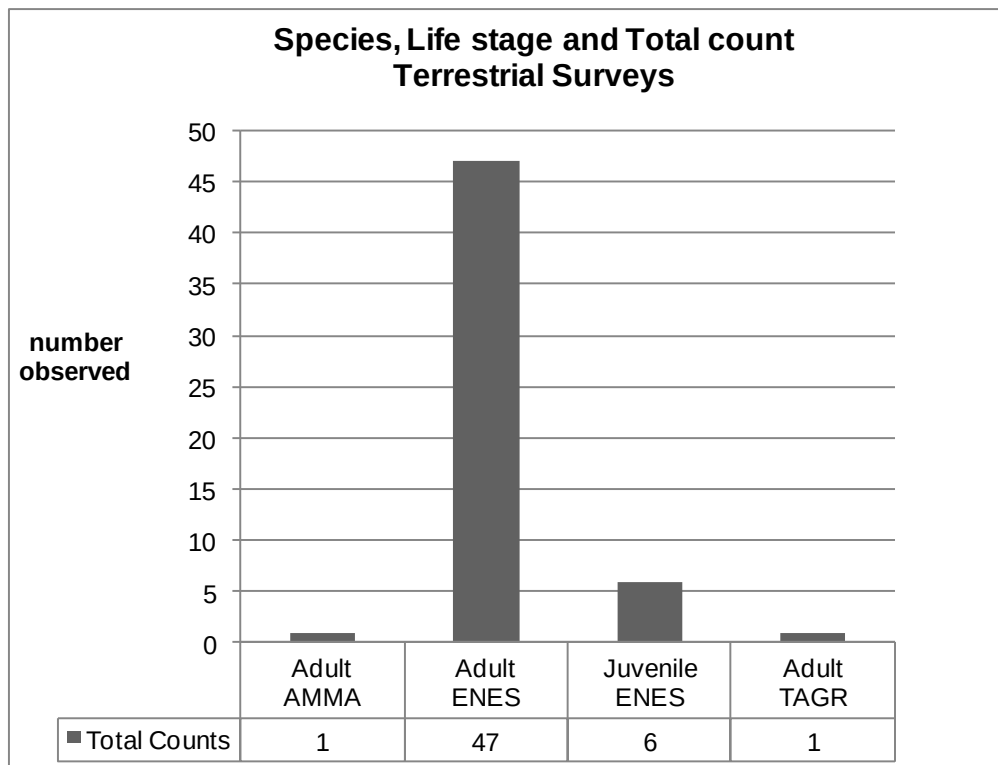


Figure 12. Life stage and counts for species detected in Ebey's Landing National Historic Reserve (terrestrial surveys). AMMA = long-toed salamander; ENES = Oregon Ensatina; TAGR = rough-skinned newt.

Incidental Surveys

Incidental terrestrial surveys covered 4695 m² and 925 minutes of searching. The surveys documented additional amphibian observations at the Nature Conservancy lands, Fort Ebey State Park, wetlands adjacent to Lake Pondilla, the Nature Conservancy Pratt Reserve, and other sites: long-toed salamanders; northwestern salamanders; Pacific treefrogs; northern red-legged frogs; Oregon Ensatina; and rough-skinned newts (Figure 13). Pacific treefrogs were also observed during two night surveys.

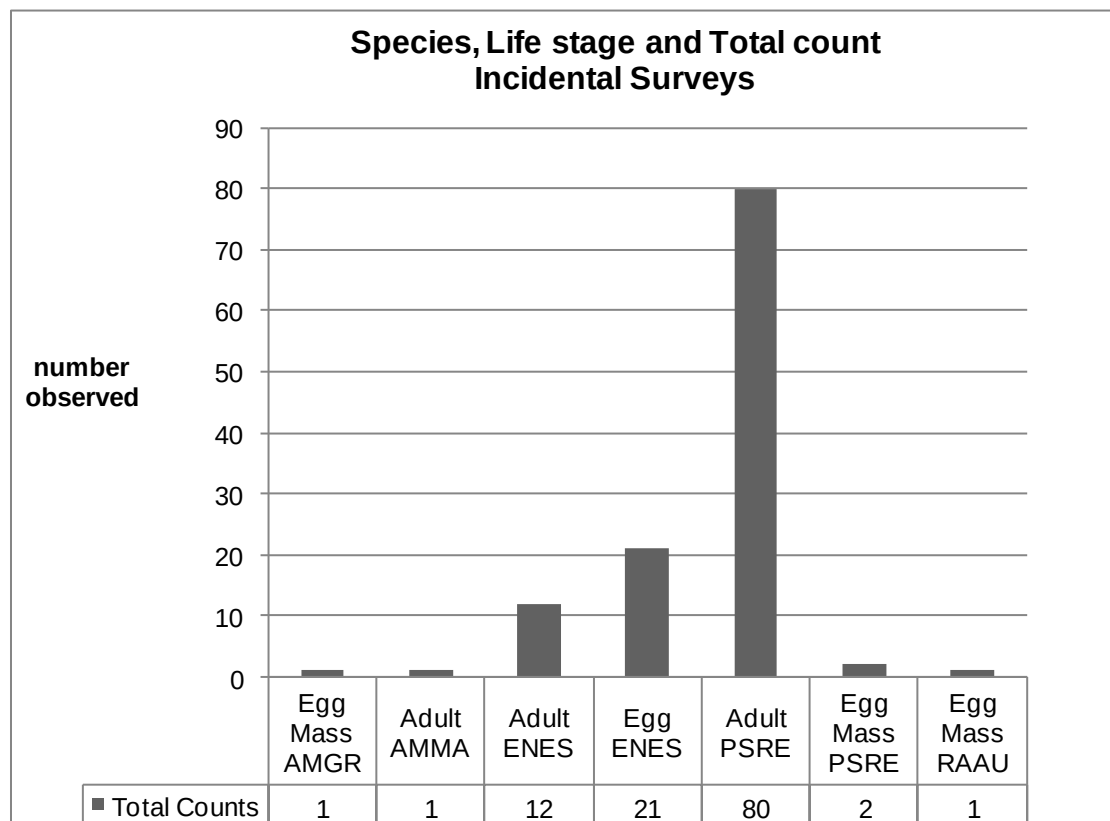


Figure 13. Life stage and counts for species detected at Ebey's Landing National Historic Reserve (incidental observations). AMGR = northwestern salamander; AMMA = long-toed salamander; ENES = Oregon Ensatina; TAGR = rough-skinned newt; RAAU = northern red-legged frog; PSRE = Pacific treefrog.

Two species of garter snake were detected during incidental surveys: northwestern garter snake (*Thamnophis ordinoides*); common garter snake (*T. sirtalis*). An unknown turtle species was detected near Lake Pondilla (Table 4 and Figure 14).

Table 5. Reptile species detected by ARMI visual encounter surveys at Ebey's Landing National Historic Reserve (A = adult).

DATE	SITE ID	UTM-N	UTM-E	Species	Stage	Count
22-Apr-03	EL29	5343562	524781	THOR	A	1
16-Apr-03	EL24	5344058	519059	THSI	A	1
23-Apr-02	EL1A	5341396	517442	Turtle sp.	A	1

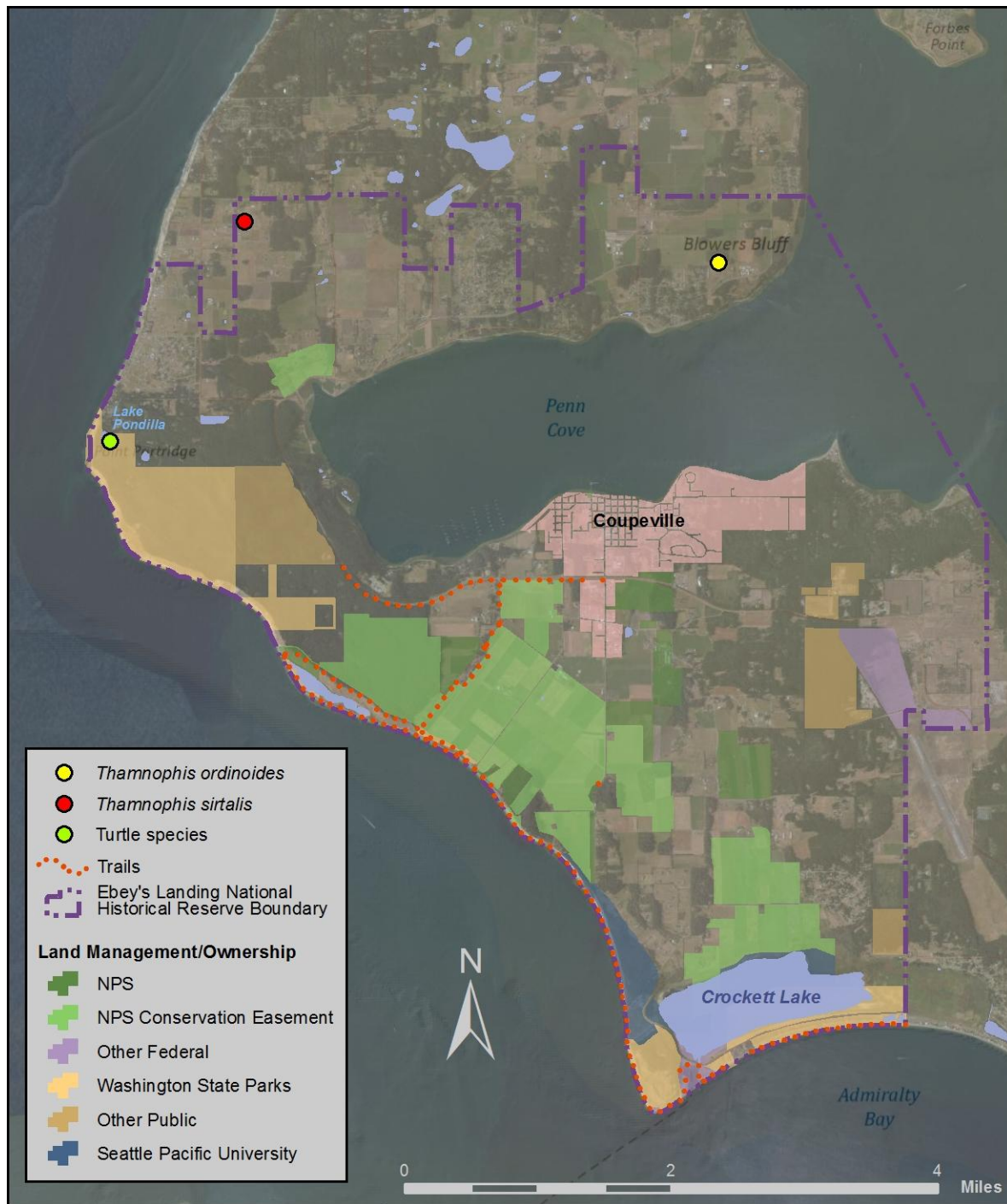


Figure 14. Observations of the northwestern garter snake (*Thamnophis ordinoides*), common garter snake (*Thamnophis sirtalis*), and an unknown turtle species based on amphibian surveys conducted at Ebey's Landing National Historical Reserve, 2002 and 2003.

Discussion

EBLA contains a diverse landscape that includes natural areas and human developments including woodlands, prairies, beaches, lakes and ponds, and fresh, brackish and saltwater wetlands. Lakes and ponds within the Reserve are limited but include: Lake Pondilla, a kettle pond located in a heavily glaciated area of the West Woodlands; Crockett Lake (brackish water); Perego's, Kennedy's, and Grasser's lagoons; and a number of shallow ponds in various areas of the Reserve. Wetlands occur within the kettles area at Fort Ebey State Park, around Crockett Lake, and near Prairie Center, as well as those associated with Kennedy's and Grasser's lagoons, and at Perego's Lagoon. Significant salt marsh areas are located at Crockett Lake, Perego's Lagoon, and Grasser's Lagoon.

Several human-constructed ponds were included in this inventory. Although many of these ponds were man-made or altered, the number of species found at some of these sites was high, especially at Muzzal Pond 1, near the Oak Harbor Air Park (EL29), where four amphibian and one reptile species were detected.

Although much of the park is agricultural or urban we documented six amphibian and two snake species. One turtle was observed but could not be identified to species. The forested areas, in particular, appear to have the most suitable habitat for amphibians. We did not find the western red-backed salamander, although this species is common throughout the State. A State of Washington distribution map for western red-backed salamanders indicates no records for Whidbey Island (Hallock and McAllister 2005a).

We found no perennial streams within the Reserve; consequently, stream dwelling amphibians are absent. Most of the ephemeral streams are highly impacted by agricultural activities and urban development. One drainage east of the Ebey's Landing parking area was searched, but no amphibians were detected (EL8).

Long-toed Salamander (*Ambystoma macrodactylum*)

Long-toed salamanders were found at the pond near Crockett Lake (EL16); several man-made ponds between Oak Harbor airport and Penn Cove (EL25, 29,31); a pond on the south side of Hwy 20, 0.5 mi east of Main St. in Coupeville (EL7); an adult found in a decaying log in a kettle south of Lake Pondilla (EL2) (Figure 15); an altered pond at the junction of Monterey and Libbey Rd. (EL 26); a natural wetland off Zylstra Rd, north of Grasser's Hill (EL4); and in a Douglas- fir–western hemlock forest at Bishop Woods, south of Ebey's Landing State Park (EL10). Ponds were <2 m deep, and emergent vegetation in the ponds ranged from 5% to 90%. Long-toed salamanders were found in association with northern red-legged frogs, Pacific treefrogs, rough-skinned newts and *Ensatina*.

Long-toed salamanders occur in low elevation wet coastal forests, and often breed in newly formed, temporary or recently disturbed pools of water, shallow lake edges, or very slow flowing streams (Corkran and Thoms 2006). This is the earliest breeding salamander in the Pacific Northwest, beginning breeding as early as January through April. Eggs hatch in two to three weeks and the length of the larval period is variable, depending on site conditions such as food and temperature (Hallock and McAllister 2005b). Adults spend most of their lives underground

except when migrating to and from breeding sites. They often seek refuge under decaying logs, loose bark, and rocks.

In addition to loss of breeding habitat, long-toed salamanders are also affected by the introduced fish (Hallock and McAllister 2005b, Liss et al. 1995). Loss of habitat such as the small isolated wetlands may also pose a threat to this species.

Slater (1955) reported this species on Whidbey Island in the 1950's. Surveys of known breeding sites should be repeated to verify the continued presence of this species within the Reserve.



Figure 15. Long-toed salamander (*Ambystoma macrodactylum*) found in a decaying log in a glacial kettle (site EL2). The dorsal stripe is blurred in this photograph.

Northwestern Salamander (*Ambystoma gracile*)

Northwestern salamander egg masses were found at two sites within the Reserve: Lake Pondilla wetland (EL1B) (Figure 16) and Nancy Conard's pond (EL35). Both sites were man-made ponds with muddy substrate and 10 to 15% emergent vegetation. Northwestern salamanders were found in association with rough-skinned newt, northern red-legged frogs and Pacific treefrogs. Adult northwestern salamanders live in partly wooded moist forests, and breed in permanent ponds or stream backwaters in early to mid-spring (Corkran and Thoms 2006), although breeding can begin as early as late January. Embryos take one to two months to develop and larvae may transform in their second year, or remain permanently aquatic as gilled adults (Hallock and McAllister 2005c). Land use activities that alter breeding habitat or access to breeding habitat can be detrimental to northwestern salamanders (e.g., tree removal, wetland drainage, land conversion, and the introduction of fish).

Slater (1955) reported this species present in Island County in the 1950's. Additional surveys should be conducted to search for this species, especially during the breeding season.



Figure 16. Northwestern salamander (*Ambystoma gracile*) egg mass found in a small wetland (EL1B) at Ebey's Landing National Historic Reserve.

Pacific Treefrog (*Pseudacris regilla*)

Pacific treefrogs were abundant and found throughout the park in man-made ($n = 10$), altered ($n = 2$), and natural lakes and ponds ($n = 7$) from <1 m to 2 m deep (Figure 17). This species is very common in the Reserve and throughout the region. Pacific treefrogs were found in association with rough-skinned newts, long-toed salamanders, and northern red-legged frogs. Slater (1955) reported this species in Coupeville and several other locations on Whidbey Island in the 1950's.

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 Thomas 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).

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

Threats to Pacific treefrogs include the introduction of fish to breeding areas, pollutants, and chemical contaminants. Hallock and McAllister (2005d) 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. We recommend that a public education program for land owners be developed to help address the effects of land use practices on amphibians within the Reserve.



Figure 17. Pacific treefrog (*Pseudacris regilla*) found at a small pond (EL25) at Ebey's Landing National Historic Reserve.

Rough-skinned Newt (*Taricha granulosa*)

Rough-skinned newts were found throughout the Reserve at seven survey sites (EL9, EL24, EL26, EL29, EL33, EL35, EL37) (Figure 4), in permanent, altered and man-made ponds mostly one to two meters deep. Rough-skinned newts were found in association with long-toed salamander, Pacific treefrog, and red-legged frog. Slater (1955) reported this species in Coupeville and several other locations on Whidbey Island in the 1950's.

Rough-skinned newts are found most commonly in mesic conifer or hardwood forests, but may also occur in open valleys and farmland (Nussbaum et al. 1983). Adults are active year round and can be found in a variety of habitats such as coniferous forests, oak-woodland, farmlands, and grassland. Terrestrial animals spend much of their time underground in burrows, and also may be found beneath cover objects such as logs, bark or boards (Nussbaum et al. 1983). Breeding habitats include lakes, ponds, roadside ditches, and slow-moving portions of streams. Breeding begins in March but can be as late as July at low elevations (Nussbaum et al. 1983). Eggs hatch in 20 to 26 days and larvae typically metamorphose late in their first summer; however, larvae may overwinter where growing seasons are short, and metamorphosis occurs in their second summer (Nussbaum et al. 1983). Road mortality may threaten local populations of species as they migrate to breeding ponds in large groups (Hallock and McAllister 2005e).



Figure 18. Rough-skinned newt (*Taricha granulosa*) adult found at a small pond (site EL24) at Ebey's Landing National Historic Reserve.

Northern Red-legged Frog (*Rana aurora*)

Since this survey was conducted, a change to the red-legged frog taxonomy was made to differentiate the two sub-species, northern red-legged frogs and California red-legged frogs due to biochemical, ecological and life-history differences (Crother 2008, Pearl 2009). Hallock and McAllister (2009a) report that genetically, northern red-legged frogs are more closely related to Cascades frogs than they are to California red-legged frogs.

Northern red-legged frogs were found at four sites (EL16, EL1B, EL29, and EL30) in man-made and altered ponds, less than one m deep (Fig. 19). One adult was found in a wetland near Lake Pondilla.

Northern red-legged frogs are found at lower elevations in moist forested habitats with access to suitable breeding sites that include vegetation suitable for egg mass attachment. They are uncommon or absent in sites with fish (Hallock and McAllister 2009a), and were found breeding only in sites without fish in the Reserve. 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 (Nussbaum et al. 1983). Eggs hatch in about 30 to 40 days and metamorphosis occurs in about 11 to 16 weeks. Juveniles often remain around edges of breeding ponds for days to weeks before dispersing (Pearl 2009). Juvenile habitat includes moist, densely vegetated riparian microhabitats during the summer.

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. In addition, according to Hallock and McAllister (2009a), experimental work has found no mortality attributable to increased levels of ultraviolet radiation, but negative sub-lethal effects may exist. They also 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 streambanks) 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 that northern red-legged frog breeding ponds be re-surveyed annually and that breeding habitat be monitored to ensure that suitable habitat is protected.



Figure 19. Northern red-legged frog (*Rana aurora*) found at a small pond (site EL30) at Ebey's Landing National Historical Reserve (left). Northern red-legged frog found at site EL29 (right).

Oregon Ensatina (*Ensatina eschscholtzii oregonensis*)

Oregon Ensatina, (Fig. 20), the most common species found in terrestrial surveys, was detected at 18 sites (EL2, EBI1, EBI2, EBI3, EBI4, EL11, EL12, EL13, EL14, EL15, EL17, EL20, EL21, EL27, EL28, EL3, EL34, EL38). They were found mostly in decaying logs in coniferous forests, suggesting the importance of coarse woody debris on forest floors (Appendix C, Table C-1). Oregon Ensatina are mainly found in forests and are active on the surface during spring and fall when temperatures are cooler and the ground is damp from rain or snow melt. During warmer and drier conditions they retreat underground (Nussbaum et al. 1983). In addition to decaying logs, Oregon Ensatina are found under leaf litter, bark, and rocks. Oregon Ensatina appear to be common and well distributed throughout their historic range in Washington (Hallock and McAllister 2005f).



Figure 20. Oregon Ensatina (*Ensatina eschscholtzii*) found in a coniferous forest (site EL11) at Ebey's Landing National Historic Reserve.

Crother (2008) reports that the taxonomy of *Ensatina* is complex; there are from two to 11 or more species recognized. Crother (2008) presently lists seven subspecies, and Nussbaum et al. (1983) report that the Oregon Ensatina (*E. e. oregonensis*) is the only subspecies that occurs in Washington.

Western Toad (*Anaxyrus boreas*)

Western toads were not detected in EBLA surveys, although suitable habitat appears to exist in the Reserve. They occur in a variety of terrestrial habitats including prairies, forests, and grasslands (Hallock and McAllister 2005g). 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 2005g). Slater (1955) reported western toads on the north end of Whidbey Island, in the vicinity of the Reserve. The Hallock and McAllister (2005g) distribution map for the western toad shows that this species was present on Whidbey Island in the vicinity of EBLA prior to 1984. The NPS species list reports western toad as present in the Reserve, but rare. The Ebey's Landing General Management Plan states that the western toad occurs within the Reserve, citing a 1979 reference (NPS 2006). One landowner mentioned to our field crews that in the 1930's and 1940's, when he first settled near EBLA, western toads were in high abundance at survey sites EL29 and EL30, but this species has not been seen at these sites for many years. We recommend additional searches for this species within suitable habitat in the Reserve. Winter habitat has not been described for the western toad, but searches could 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 EBLA area.

American Bullfrog (*Lithobates catesbeianus*)

The American bullfrog was not documented as being present at EBLA during this inventory. However, Slater (1955) reported this species from Cranberry Lake in Deception Pass State Park, just north of the Reserve. American bullfrog juveniles and adults are found in permanent wetlands, ponds, lakes, sloughs and streams. Hallock and McAllister (2009b) report that American bullfrogs occasionally move to terrestrial sites at night and they will disperse over land, *en mass*, on warm rainy nights. Juvenile bullfrogs have also been observed in road puddles at some distance from aquatic habitat; puddles and other sources of temporary standing water may be important habitat features for dispersing individuals (Hallock and McAllister 2009b). American bullfrog breeds in permanent ponds and lakes. American bullfrogs are native to the eastern United States and were introduced throughout the west in the early 1900s (Hallock and McAllister 2009b). They are now considered an invasive problematic species in Washington. Current Washington regulations prohibit transport of live adults or tadpoles without a Washington Department of Fish and Wildlife permit.

We recommend that surveys continue to verify the absence of this invasive species at EBLA.

Western Red-Backed Salamander (*Plethodon vehiculum*)

Western red-backed salamanders are the most commonly encountered *Plethodon* salamander in the State (Hallock and McAllister 2005a), and in the Pacific Northwest (Leonard et al. 1993). However, we did not detect western red-backed salamanders in this inventory. This species is terrestrial and inhabits forest stands of all ages and is commonly associated with rocky areas and edges of streams and seeps, finding shelter under rocks, forest litter, vegetation and woody debris on the forest floor. Western red-backed salamanders are primarily nocturnal (Jones et al. 2005), but this survey was conducted mostly during the day. Additional surveys should be conducted to confirm their presence or absence.

Oregon Spotted Frog (*Rana pretiosa*)

The Oregon spotted frog (*Rana pretiosa*) is quite rare today. Over the past half-century this species has declined to the point where it is now in jeopardy over most of its range (Jones et al. 2005). The Oregon spotted frog was once found from southwest British Columbia through western Washington, Oregon, and California but only a few populations exist in British Columbia, four in Washington State, and about 30 in Oregon. This species is generally found in association with wetlands and is rarely found away from water (Hallock and McAllister 2005i). Breeding occurs in shallow, emergent wetlands in spring (Jones et al. 2005). Oregon spotted frog occur on the mainland areas near Whidbey Island but no documented sites have been found in Island County.

Turtles

Field crews observed a turtle at Lake Pondilla (EL1A) and speculated that it could have been a western pond turtle (*Clemmys marmorata*). Hallock and McAllister (2005h), however, report no observations of this species on Whidbey Island. Western pond turtles utilize both lentic and lotic ecosystems. In Washington, there are only two native populations of this species. Two introduced populations also exist and are part of a recovery program for this species which is listed as a federal Species of Concern and a State of Washington endangered species. The other native turtle in Washington is the western painted turtle (*Chrysemys picta bellii*), which ranges from the Columbia Gorge eastward, being most abundant in the Columbia River Basin (Storm

and Leonard 1995). This species, however, was also introduced in the Puget Trough as early as 1958. One introduced turtle species, the red-eared slider (*Trachemys scripta elegans*) native to the southern United States, is the most common turtle sold in pet stores and released by pet owners into the wild. This species is now considered to be common and widespread in the Pacific Northwest (Storm and Leonard 1995). In fact, many species of released and escaped pet turtles are observed regularly in Washington and some can be easily confused with native turtles and the red-eared slider. Box turtles, snapping turtles, mud turtles, as well as Asian and South American turtles have been found in Washington. Additional surveys, including snorkel surveys, should be conducted to verify the presence and specific identity of the individual observed in Lake Pondilla.

Northwestern Garter Snake (*Thamnophis ordinoides*)

A northwestern garter snake was found at one site, EL29 (Muzzal Pond), near the Oak Harbor Air Park. This was a man-made pond with 80% coverage of emergent vegetation. Long-toed salamanders, Pacific treefrogs, red-legged frogs, and rough-skinned newts were also present at this site. Northwestern garter snake habitat includes meadows and coniferous forest edges, as well as thick brushy areas (Nussbaum et al. 1983). They are also common near water bodies (Hallock and McAllister 2009c). Their prey primarily on slugs but also eat earthworms and salamanders (Nussbaum et al. 1983). Hallock and McAllister (2009c) report that threats to this species include: over-hunting or collecting; wanton killing; destruction of overwintering sites; and road mortality (in areas where snakes must cross roads to access overwintering or foraging habitat).

Common Garter Snake (*Thamnophis sirtalis*)

A common garter snake was found at one site (EL24), a man-made pond located in the northwest portion of the Reserve. Rough-skinned newts and Pacific treefrogs were also present at the site. Common garter snakes are most commonly found near water but also inhabit open valleys and coniferous forests (Nussbaum et al. 1983). Hallock and McAllister (2009d) report that typical habitats for this species in Washington include: wetlands; bogs; ponds; lakes; springs; creeks and rivers, and sunny areas such as meadows, forest openings, and shrubby areas near water. Common garter snakes are good swimmers and can hunt on and below the water surface. Juveniles have been observed hunting newly metamorphosing Pacific treefrogs in shallow, seasonal, water bodies (Hallock and McAllister 2009d).

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 such as within EBLA, 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 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 luteiventris*) 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, Schotthoefer 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 EBLA 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 from 13 freshwater fish species from 129 sites. PCBs, DDT, PBDE, Chlordane, and mercury were found in fish from lakes throughout the State (Seiders et al. 2007). 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 their susceptibility to predation (Bridges 1999a) and their ability to compete and reproduce (Bridges 1999b, Relyea and Mills 2001, Boone and Semlitsch 2002). Chemical contaminants may also affect the 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). Water quality monitoring programs conducted in EBLA 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 1000 m 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 many 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

This inventory confirmed the presence of six species of amphibians and two reptile species at EBLA. However, because of the size and diversity of habitat within the Reserve, more thorough surveys should be conducted in the future. We learned that breeding for many of the amphibian species occurs earlier in the spring than when our surveys were conducted. We recommend that future surveys begin as early as February for some species. The NPS species list for EBLA lists

Western toad as occurring in the park. We were, however, unable to document their presence during this inventory. Additional searches for western toads should be a priority to confirm their presence. If breeding sites are found, we recommend long-term monitoring of these sites to track their presence in the Reserve. In addition, continued searches for the introduced Bullfrog should be conducted.

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 Reserve. Amphibian and reptile surveys could be suitable citizen science projects for the park to coordinate. Given that much of the land within the Reserve is subject to disturbance, we 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

Six out of 10 amphibian species expected to be present at EBLA were observed (Table 5). Only one terrestrial species (Ensatina) was detected. Although suitable habitat exists for the other terrestrial species expected to be present, red-backed salamanders, none were detected. The previously documented western toad and bullfrog were not detected in the Reserve. The rare Oregon spotted frog was not detected. Given the limited time involved in conducting this inventory and diversity and amount of amphibian habitat existing within the Reserve, additional species could be present and future surveys should be conducted.

Table 6. Amphibian species documented at Ebey's Landing National Historic Reserve, and their status.

Genus and Species	Common Name	Code	Special Status Species	Present in Reserve
Terrestrial breeding species				
Caudata — salamanders				
Woodland Salamanders (Family Plethodontidae)				
<i>Plethodon vehiculum</i>	Western red-backed salamander	PLVE		No
Ensatinas				
<i>Ensatina eschscholtzii</i>	Ensatina	ENES		Yes
Aquatic breeding species				
Anurans				
Brown frogs (Family Ranidae)				
<i>Rana aurora</i>	Northern red-legged frog	RAAU	**	Yes
<i>Rana pretiosa</i>	Oregon spotted frog	RAPR	**	No
American Water Frogs				
<i>Lithobates catesbeianus</i> (formerly <i>Rana catesbeiana</i>) ⁷	American bullfrog	RACAT		No
Chorus Frogs				
<i>Pseudacris regilla</i>	Northern Pacific treefrog	PSRE		Yes
North American toads (Family Bufonidae)				
<i>Anaxyrus boreas</i> ⁸	Western toad	BUBO	**	No

** = federal or state listed species of concern; # = introduced species.

⁷ See IT IS (www.itis.gov) and Crother 2008

⁸ Olson 2009 reports 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.

Table 6. Amphibian species documented at Ebey's Landing National Historic Reserve, and their status (continued).

Genus and Species	Common Name	Code	Special Status Species	Present in Reserve
Aquatic breeding species				
Caudata — salamanders				
Mole salamanders (Family Ambystomatidae)				
<i>Ambystoma gracile</i>	Northwestern salamander	AMGR		Yes
<i>Ambystoma macrodactylum</i>	Long-toed salamander	AMMA		Yes
Pacific newts (Family Salamandridae)				
<i>Taricha granulosa</i>	Rough-skinned newt	TAGR		Yes

** = federal or state listed species of concern; # = introduced species.

Two garter snakes were observed incidental to this survey (Table 6) and are reported here to assist in verification of reptiles present in the Reserve.

Table 7. Reptile species documented at Ebey's Landing National Historic Reserve, and their status.

Reptile Species	Common Name	Special Status Species	Present in Reserve
<i>Thamnophis ordinoides</i>	Northwestern garter snake		Yes
<i>Thamnophis sirtalis</i>	Common garter snake		Yes
Unknown turtle species			

Literature Cited

- AmphibiaWeb: Information on amphibian biology and conservation. [web application]. 2009. AmphibiaWeb, Berkeley, California. Available at: <http://amphibiaweb.org/> (accessed 1 February 2010).
- Beebee, T. J. C. 1995. Amphibian Breeding and Climate. *Nature* 374:219-220.
- Berger, L., R. Speare, P. Dazsak, D. E. Green, A. A. Cunningham, C. L. Goggin, R. Slocombe, M. A. Ragan, A. D. Hyatt, K. R. McDonald, and others. 1998. Chytridiomycosis causes amphibian mortality associated with population declines in the rain forests of Australia and Central America. *Proceedings of the National Academy of Sciences of the United States of America* 95:9031-9036.
- Blaustein, A. R., D. G. Hokit, R. K. O'Hara, and R. A. Holt. 1994. Pathogenic fungus contributes to amphibian losses in the Pacific Northwest. *Biological Conservation* 67:251-254.
- Blaustein, A. R., and P. T. J. Johnson. 2003. The complexity of deformed amphibians. *Frontiers in Ecology and the Environment* 2(1):87-94.
- Blaustein, A. R., J. M. Romansic, J. M. Kiesecker, and A. C. Hatch. 2003. Ultraviolet radiation, toxic chemicals and amphibian population declines. *Diversity and distributions* 9:123-140.
- Blaustein, A. R., and D. B. Wake. 1995. The puzzle of declining amphibian populations. *Scientific American* April 1995:52-57.
- Boone, M. D., and R. D. Semlitsch. 2002. Interactions of an insecticide with competition and pond drying in amphibian communities. *Ecological Applications* 12:307-316.
- Bridges, C. M. 1997. Tadpole swimming performance and activity affected by acute exposure to sublethal levels of carbaryl. *Environmental Toxicology & Chemistry* 16:1935-1939.
- Bridges, C. M. 1999a. Effects of a pesticide on tadpole activity and predator avoidance behavior. *Journal of Herpetology* 33:303-306.
- Bridges, C. M. 1999b. Predator-prey interactions between two amphibian species: Effects of insecticide exposure. *Aquatic Ecology* 33:205-211.
- Bridges, C. M. 2000. Long-term effects of pesticide exposure at various life stages of the southern leopard frog (*Rana sphenoccephala*). *Archives of Environmental Contamination and Toxicology* 39:91-96.
- Briggs, C. J., R. A. Knapp, and V. T. Vredenburg. 2010. Enzootic and epizootic dynamics of the chytrid fungal pathogen of amphibians. *Proceedings of the National Academy of Sciences* 107(21):9695-9700.
- Burton, T. M. and G. E. Likens. 1975. Salamander populations and biomass in Hubbard Brook Experimental Forest, New Hampshire. *Copeia* 1975:541-546.

- Bury, R. B. 1988. Habitat relationships and ecological importance of amphibians and reptiles. Pages 61-67 in K. J. Raedke (ed.). *Streamside management: Riparian and forestry interactions*. Contribution 59, Institute of Forest Resources, University of Washington, Seattle, Washington.
- Bury, R. B. 1999. A historical perspective and critique of the declining amphibian crisis. *Wildlife Society Bulletin* 27:1064–1068.
- Bury, R. B., C. K. Dodd, Jr., and G. M. Fellers. 1980. Conservation of the Amphibia of the United States: A review. Resource Publication 134. U.S. Fish and Wildlife Service, Washington, D.C.
- Bury, R. B., and M. J. Adams. 2000. Inventory and monitoring of amphibians in North Cascades and Olympic National Parks, 1995-1998. Final report. USGS Forest and Rangeland Ecosystem Science Center in cooperation with Olympic National Park, Corvallis, Oregon.
- Carey, C., and M. A. Alexander. 2003. Climate change and amphibian declines: Is there a link? *Diversity and Distributions* 9:111-121.
- Christin, M. S., A. D. Gendron, P. Brousseau, L. Menard, D. J. Marcogliese, D. Cyr, S. Ruby, and M. Fournier. 2003. Effects of agricultural pesticides on the immune system of *Rana pipiens* and on its resistance to parasitic infection. *Environmental Toxicology and Chemistry* 22:1127-1133.
- Corn, P. S., and R. B. Bury. 1990. Sampling methods for terrestrial amphibians and reptiles. In: *Wildlife-habitat relationships: Sampling procedures for Pacific Northwest vertebrates*. General Technical Report PNW-GTR-256. Pacific Northwest Research Station, USDA Forest Service, Portland, Oregon.
- Corkran, C. C., and C. Thoms. 2006. Amphibians of Oregon, Washington and British Columbia. A field identification guide. Revised and updated. Lone Pine Publishing, Auburn, Washington.
- Crother, B. I. (ed.). 2008. Scientific and standard English names of amphibians and reptiles of North America north of Mexico, with comments regarding confidence in our understanding. Circular 37. 6th Edition. Society for the Study of Amphibians and Reptiles Herpetological, Shoreview, Minnesota.
- Daszak, P., A. A. Cunningham, and A. D. Hyatt. 2003. Infectious disease and amphibian population declines. *Diversity and Distributions* 9:141-150.
- Eigenbrod, F., S. J. Hecnar, and L. Fahrig. 2009. Quantifying the road-effect zone: threshold effects of a motorway on anuran populations in Ontario, Canada. *Ecology and Society* 14:24.
- Fahrig, L., and T. Rytwinski. 2009. Effects of roads on animal abundance: an empirical review and synthesis. *Ecology and Society* 14: 21.

- Fellers, G. M., and C. A. Drost. 1993. Disappearance of the Cascades frog, *Rana cascadae*, at the southern end of its range, California, USA. *Biological Conservation* 65:177–181.
- Fisher, M.C., T.W.J. Garner, and S.F. Walker. 2009. Global emergence of *Batrachochytrium dendrobatidis* and amphibian chytridiomycosis in space, time, and host. *Annual Review of Microbiology* 63:291–310.
- Galvan, S. K., M. J. Adams, B. Samora, R. E. Holmes, S. Stonum, P. J. Happe, R. S. Glesne, and A. Rawhouser. 2005. North Coast and Cascades Network consolidated amphibian database and mapping project. U.S. Geological Survey in Cooperation with the National Park Service. Forest and Rangeland Ecosystem Science Center, Corvallis, Oregon.
- Gendron, A. D., D. J. Marcogliese, S. Barbeau, M. S. Christin, P. Brousseau, S. Ruby, D. Cyr, and M. Fournier. 2003. Exposure of leopard frogs to a pesticide mixture affects life history characteristics of the lungworm *Rhabdias ranae*. *Oecologia* 135:469–476.
- Gray, M. J., D. L. Miller, and J. T. Hoverman. 2009. Ecology and pathology of amphibian ranaviruses. *Diseases of Aquatic Organisms*. Vol. 87: 243–266, 2009.
- Hallock, L. A., and K. R. McAllister. 2005a. Western red-backed salamander. Washington herp atlas. Available from <http://www1.dnr.wa.gov/nhp/refdesk/herp/> (accessed 05 May 2010)
- Hallock, L. A., and K. R. McAllister. 2005b. Long-toed salamander. Washington herp atlas. Available from <http://www1.dnr.wa.gov/nhp/refdesk/herp/> (accessed 10 May 2010).
- Hallock, L. A., and K. R. McAllister. 2005c. Northwestern salamander. Washington herp atlas. Available from <http://www1.dnr.wa.gov/nhp/refdesk/herp/> (accessed 05 May 2010).
- Hallock, L. A., and K. R. McAllister. 2005d. Pacific treefrog. Washington herp atlas. Available from <http://www1.dnr.wa.gov/nhp/refdesk/herp/> (accessed 01 May 2010).
- Hallock, L. A., and K. R. McAllister. 2005e. Rough-skinned newt. Washington herp atlas. Available from <http://www1.dnr.wa.gov/nhp/refdesk/herp/> (accessed 20 May 2010).
- Hallock, L. A., and K. R. McAllister. 2005f. Ensatina. Washington herp atlas. Available from <http://www1.dnr.wa.gov/nhp/refdesk/herp/> (accessed 01 May 2010).
- Hallock, L. A., and K. R. McAllister. 2005g. Western toad. Washington herp atlas. Available from <http://www1.dnr.wa.gov/nhp/refdesk/herp/> (accessed 01 May 2010).
- Hallock, L. A., and K. R. McAllister. 2005h. Western pond turtle. Washington herp atlas. Available from <http://www1.dnr.wa.gov/nhp/refdesk/herp/> (accessed 01 May 2010).
- Hallock, L. A., and K. R. McAllister. 2005i. Oregon spotted frog. Washington herp atlas. <http://www1.dnr.wa.gov/nhp/refdesk/herp/> (accessed 01 May 2010).
- Hallock, L. A., and K. R. McAllister. 2009a. Northern red-legged frog. Washington herp atlas. Available from <http://www1.dnr.wa.gov/nhp/refdesk/herp/> (accessed 20 May 2010).

- Hallock, L. A., and K. R. McAllister. 2009b. American bullfrog. Washington herp atlas. Available from <http://www1.dnr.wa.gov/nhp/refdesk/herp/> (accessed 10 May 2010).
- Hallock, L. A., and K. R. McAllister. 2009c. Northwestern garter snake. Washington herp atlas. Available from <http://www1.dnr.wa.gov/nhp/refdesk/herp/> (accessed 01 May 2010).
- Hallock, L. A., and K. R. McAllister. 2009d. Common garter snake. Washington herp atlas. Available from <http://www1.dnr.wa.gov/nhp/refdesk/herp/> (accessed 01 May 2010).
- Hayes, T. B., P. Falso, S. Gallipeau, and M. Stice. 2010. The cause of global amphibian declines: a developmental endocrinologist's perspective. *The Journal of Experimental Biology* 213:921-933.
- Holmes R. E., and R. S. Glesne. 1997. NOCA NRPP Amphibian inventory Big Beaver Watershed 1996 – progress report. North Cascades National Park, Sedro-Woolley, Washington.
- Holmes R. E., and R. S. Glesne. 1998. NOCA NRPP Amphibian inventory Bridge Creek Watershed 1997 – progress report. North Cascades National Park, Sedro-Woolley, Washington.
- Holmes R. E., and R. S. Glesne. 1999. NOCA NRPP Amphibian inventory North Cascades National Park Service Complex 1998 – progress report. North Cascades National Park, Sedro-Woolley, Washington.
- ICUN. 2005. Amphibian conservation action plan. Proceedings IUCN/SCC Amphibian Conservation Summit. The World Conservation Union, Gland, Switzerland.
- Johnson, P. T. J., K. B. Lunde, E. G. Ritchie, and A. E. Launer. 1999. The effect of trematode infection on amphibian limb development and survivorship. *Science* 284(5415):802-804.
- Johnson, P. T. J., K. B. Lunde, E. M. Thurman, E. G. Ritchie, S. N. Wray, D. R. Sutherland, J. M. Kapfer, T. J. Frest, J. Bowerman, and A. R. Blaustein. 2002. Parasite (*Ribeiroia ondatrae*) infection linked to amphibian malformations in the western United States. *Ecological Monographs* 72: 151.168.
- Johnson, P. T. J., E. R. Preu, D. R. Sutherland, J. M. Romansic, B. Han, and A. R. Blaustein. 2006. Adding infection to injury: Synergistic effects of predation and parasitism on amphibian malformations. *Ecology* 87:2227-2235.
- Kiesecker, J. M., A. R. Blaustein, and L. K. Belden. 2001a. Complex causes of amphibian population declines. *Nature* 410:681-684.
- Kiesecker, J. M., A. R. Blaustein, and C. L. Miller. 2001b. Transfer of a pathogen from fish to amphibians. *Conservation Biology* 15:1064-1070.
- Lannoo, M. (ed.). 2005. Amphibian declines: The conservation status of United States species. University of California Press, Berkeley, California.

- Lawler, J. J., and M. Mathias. 2007. Climate change and the future of biodiversity in Washington. Report prepared for the State of Washington Biodiversity Council. College of Forest Resources, University of Washington, Seattle, Washington.
- Lind, A. 2008. Amphibians and reptiles and climate change. Climate Change Research Center, United States Forest Service. Available from: <http://www.fs.fed.us/ccrc/topics/amphibians-reptiles.shtml>. (Accessed 10 October 2010).
- Liss, W. J., G. L. Larson, E. K. Deimling, L. Ganio, R. Gresswell, R. Hoffman, M. Kiss, G. Lomnický, C. D. McIntire, R. Truitt, and T. Tyler. 1995. Ecological effects of stocked trout in naturally fishless high mountain lakes, North Cascades National Park Service Complex, WA, USA. Technical Report NPS/PNROSU/NRTR-95-03. U.S. National Park Service, Pacific Northwest Region Science and Technology, Seattle, Washington. Available from <http://www.nps.gov/archive/noca/Trout/trout1.htm> (accessed 01 Jan. 2010).
- National Park Service and Ebey's Landing NHR Trust Board (NPS). 1998. Resources management Plan Ebey's Landing National Historical Reserve (updated from 1995). National Park Service, Seattle, Washington.
- National Park Service (NPS). 2006. Ebey's Landing National Historical Reserve Final General Management Plan and Environmental Impact Statement. Pacific West Region – Seattle Office, National Park Service, Department of the Interior, Seattle, Washington.
- National Park Service (NPS). 2009. Ranavirus confirmed in a population of Long-Toed Salamanders (*Ambystoma macrodactylum*) in Lassen Volcanic National Park. Klamath I&M Resource Brief. Available at http://science.nature.nps.gov/im/units/klmn/Monitoring/vs/Lakes/Documents/Resource%20Briefs/Ranavirus_RB_2009.pdf.
- Nussbaum, R. A., E. D. Brodie, Jr., and R. M. Storm. 1983. Amphibians and reptiles of the Pacific Northwest. University of Idaho Press, Moscow, Idaho.
- Olson, D. H. (ed.). 2009. Herpetological conservation in northwestern North America. *Northwestern Naturalist* 90:61–96.
- Olson, D. H., and W. P. Leonard. 1997. Amphibian inventory and monitoring, a standardized approach for the Pacific Northwest. Pages 1-21 in D. H. Olson, W. P. Leonard, and R. B. Bury. Sampling amphibians in lentic habitats: methods and approaches for the PNW. *Northwest Fauna* 4:1-21. *Society for Northwest Vertebrate Biology*, Olympia, Washington.
- Pearl, C. A. USGS. In AmphibiaWeb: Information on amphibian biology and conservation. [web application]. 2011. AmphibiaWeb, Berkeley, California. Available from <http://amphibiaweb.org/>. (Accessed 29 March 2009).
- Phillips, K. 1990. Where have all the frogs and toads gone? *BioScience* 40:422-424.
- Pounds, J. A., M. R. Bustamante, L. A. Coloma, J. A. Consuegra, M. P. L. Fogden, P. N. Foster, E. La Marca, K. L. Masters, A. Merino-Viteri, R. Puschendorf, and others. 2006. Widespread

- amphibian extinctions from epidemic disease driven by global warming. *Nature* 439:161–167.
- Rawhouser, A. K., R. E. Holmes and R. S. Glesne. 2009. A survey of stream amphibian species composition and distribution in the North Cascades National Park Service Complex, Washington State (2005). Natural Resource Technical Report NPS/NCCN/NRTR—2009/169. National Park Service, Fort Collins, Colorado.
- Relyea, R. A., and N. Mills. 2001. Predator-induced stress makes the pesticide carbaryl more deadly to gray treefrog tadpoles (*Hyla versicolor*). *Proceedings of the National Academy of Sciences of the United States of America* 98:2491-2496.
- Richards, R. H., and A. D. Pickering. 1978. Frequency and distribution patterns of *Saprolegia* infection in wild and hatchery-reared brown trout *Salmo trutta* and char *Salvelinus alpinus*. *Journal of Fish Diseases* 1:69-82.
- Schothoeffer, A. M., A. V. Koehler, C. U. Meteyer, and R. A. Cole. 2003. Influence of *Ribeiroia ondatrae* (Trematoda: Digenea) infection on limb development and survival of northern leopard frogs (*Rana pipiens*): Effects of host stage and parasite-exposure level. *Canadian Journal of Zoology* 81(7):1144-1153.
- Seiders, K., and C. Deligeannis. 2008. Washington state toxics monitoring program: Freshwater fish tissue component, 2008. Environmental Assessment Program, Washington State Department of Ecology, Olympia, Washington.
- Seiders, K., C. Deligeannis, and P. Sandvik. 2007. Washington state toxics monitoring program: Contaminants in fish tissue from freshwater environments in 2004 and 2005. Environmental Assessment Program, Washington State Department of Ecology, Olympia, Washington.
- Sessions, S. K., and S. B. Ruth. 1990. Explanation for naturally occurring supernumerary limbs in amphibians. *The Journal of Experimental Zoology* (254)1:38–47.
- Skerratt, L. F., L. Berger, R. Speare, S. Cashins, K. R. McDonald, A. Phillott, H. Hines, and N. Kenyon. 2007. Spread of chytridiomycosis has caused the rapid global decline and extinction of frogs. *EcoHealth* 4:125-134.
- Slater, J. R. 1955. Distribution of Washington amphibians. College of Puget Sound, Occasional Papers 16:122–154.
- Storm, R. M., and W. P. Leonard (eds.). 1995. Reptiles of Washington and Oregon. Seattle Audubon Society, Seattle, Washington.
- Tyler, T. J., C. D. McIntire, B. Samora, R. L. Hoffman, and G. L. Larson. 2003. Inventory of aquatic breeding amphibians. Mount Rainier National Park, 1994-1999. Forest and Rangeland Ecosystem Science center in Cooperation with Mount Rainier National Park. U.S. Geological Survey. U.S. Department of the Interior.

- U.S. Geological Survey (USGS). 2011. Amphibian disease. Available from http://www.fort.usgs.gov/RARMI/rarmi_amphibdisease.asp (Accessed 19 September 2011).
- Wake, D. B. 1991. Declining amphibian populations. *Science* 253:860.
- Wood, S. E., and L. G. Willoughby. 1986. Ecological observations on the fungal colonization of fish by Saprolegniaceae in Windermere. *Journal of Applied Ecology* 23:737-740.
- Wyman, R. L. 1990. What's happening to the amphibians? *Conservation Biology* 4:350-352.

Appendix A. NCCN Aquatic Amphibian Survey Protocols and Datasheets.

NCCN Amphibian Inventory Standard Operating Procedure for Aquatic Amphibian Surveys 2001

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

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 generally are 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 collected data, the conditions at that site, how difficult it was to get to that site, etc.
3. Think of the notes as a journal to 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 the survey began, not the arrival time 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 area surveyed is more than 1 km of a creek, stream, or river, 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 using a GPS or from the center of the water body if 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 using a GPS unit to get UTM coordinates, 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 estimated or C if all the larvae or egg masses were actually counted. 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 size classes can be clearly distinguished, record a count for each size-class. If the number of egg masses can be counted then do so and record as EM, #, C. If the egg masses cannot be separated then 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 able to identify.

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 uncertain, 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 **one** 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 the entire pond from the shore cannot be seen (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

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		Conductivity		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).

NOTES:

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

Table B-1. Aquatic habitat measurements and descriptors.

Date	Site ID	Length (m)	Width (m)	Max Depth (m)	% Shallow Area (<0.5m)	Color of water	Turbidity	Emergent Vegetation Cover %	% of Site Edge Searched	Wetland Type	Permanence	Site Origin
23-Apr-02	EL1A	300	150	>2	20	Stained	Clear	5	100	Lake/Pond	Permanent	Natural
24-Apr-02	EL4	40	50	<1	60	Stained	Clear	70	100	Lake/Pond	Permanent	Natural
25-Apr-02	EL6	100	5	<1	80	Clear	Clear	95	80	Lake/Pond	Permanent	Natural
25-Apr-02	EL7	20	10	1-2	30	Clear	Clear	5	100	Lake/Pond	Permanent	Man-Made
30-Apr-02	EL9	80	60	1-2	30	Stained	Clear	50	30	Lake/Pond	Permanent	Natural
8-May-02	EL16	50	35	<1	85	Stained	Clear	70	80	Lake/Pond	Permanent	Altered
15-Apr-03	EL18	200	100	<1	100	Stained	Clear	100	30	Meadow/ Wetland	Seasonal	Altered
15-Apr-03	EL 19	8	5	<1	100	Clear	Clear	100	100	Lake/Pond	Seasonal	Man-Made
16-Apr-03	EL22	60	20	1-2	80	Clear	Clear	30	100	Lake/Pond	Permanent	Man-Made
16-Apr-03	EL23	60	40	1-2	15	Stained	Cloudy	20	100	Lake/Pond	Permanent	Man-Made
16-Apr-03	EL24	60	60	1-2	75	Stained	Cloudy	0	100	Lake/Pond	Permanent	Man-Made
16-Apr-03	EL25	35	20	1-2	30	Stained	Clear	30	100	Lake/Pond	Permanent	Man-Made
16-Apr-03	EL26	40	15	1-2	60	Stained	Clear	90	100	Lake/Pond	Permanent	Altered
22-Apr-03	EL29	12	10	<1	100	Clear	Clear	80	100	Lake/Pond	Permanent	Man-Made
22-Apr-03	EL30	20	10	<1	50	Clear	Clear	40	100	Lake/Pond	Permanent	Man-Made
22-Apr-03	EL31	12	25	1-2	75	Clear	Cloudy	70	100	Lake/Pond	Permanent	Man-Made
22-Apr-03	EL33	50	25	1-2	60	Clear	Clear	60	100	Lake/Pond	Permanent	Natural
23-Apr-03	EL35	20	10	1-2	30	Stained	Clear	10	100	Lake/Pond	Permanent	Man-Made
23-Apr-03	EL36	150	4	1-2	50	Stained	Clear	25	100	Lake/Pond	Permanent	Man-Made

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

Site ID	Location Description	Date	Weather	Wind	Air Temp (°C)	Water Temp (°C)	pH	Conductivity (µS/cm)	DO (mg/L)	ANC (µeq/L)	Species Present	Egg Fungus Presence	Fish Presence
EL1A	Lake Pondilla	23-Apr-02	Clear	Calm	9	10	7.26	2410 ⁸		5079.4	PSRE	FALSE	TRUE
EL4	Wetland off of Zylstra Rd. Whidbey Is.	24-Apr-02	Overcast	Calm	16	15	7.07	421		2058.6	AMMA, PSRE	FALSE	FALSE
EL6	Pond In Coupeville, Off Terry Rd. Between School And Bowling Alley	25-Apr-02	Clear	Calm	14	10	7.5	1188		4712.7	PSRE	FALSE	FALSE
EL7	South Side Of Hwy 20, Approx.5 Mi. E Of Main St. (Coupeville)	25-Apr-02	Clear	Light	15	17	7.11	236		1153.67	AMMA, PSRE	FALSE	FALSE
EL9	Wilbur Bishop's Pond: E Side Of Ferry Forest	30-Apr-02	Clear	Light	12	13	6.5	192		764.6	PSRE, TAGR	FALSE	FALSE
EL16	Crocket Lake-NW Pond	8-May-02	Clear	Calm	9.5	12		520		1987.98	AMMA, PSRE, RAAU	FALSE	FALSE
EL18	Wetland East Of Crocket Lake	15-Apr-03	Overcast	Gusty	14	14	7.09	880	7.87		NONE	FALSE	FALSE
EL19	Tiny pond off Wanamaker Rd.	15-Apr-03	Overcast	Light	16	12	8.32	780	9.43		NONE	FALSE	FALSE
EL22	Retention Pond Behind Coupeville Post Office	15-Apr-03	Overcast	Gusty	13	19	8.68	200	9.12		PSRE	FALSE	FALSE
EL23	871 N. West Beach	16-Apr-03	Overcast	Gusty	13	11	9	820	8.42		PSRE	FALSE	FALSE
EL24	152 N. Olson Rd., NW Corner Of Reserve	16-Apr-03	Overcast	Gusty	15	11.5	9	880	10.8		PSRE, TAGR, THIS	FALSE	FALSE
EL25	Pond Behind Oak Harbor Airport	16-Apr-03	Overcast	Gusty	14	14	8.77	120	10.83		AMMA, PSRE	FALSE	FALSE
EL26	Pond At Junction of Monterey & Libbey Road	16-Apr-03	Rain	Calm	9	11	8.17	580	7.9		AMMA, PSRE, TAGR	FALSE	FALSE

⁸ Questionable data

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

Site ID	Location Description	Date	Weather	Wind	Air Temp (°C)	Water Temp (°C)	pH	Conductivity (µS/cm)	DO (mg/L)	ANC (µeq/L)	Species Present	Egg Fungus Presence	Fish Presence
EL29	Muzzal Pond 1	22-Apr-03	Overcast	Light	12	10	7.16	130	10.75		AMMA, PSRE, RAAU, TAGR, THOR	FALSE	FALSE
EL30	Muzzal 2	22-Apr-03	Overcast	Light	14	15	6.52	180	14.3		PSRE, RAAU	FALSE	FALSE
EL31	Muzzal 3	22-Apr-03	Overcast	Calm	14	13	6.52	950	10.74		AMMA, PSRE	FALSE	FALSE
EL33	Bishop's Pond Off Hill Road	22-Apr-03	Overcast	Light	16	13	6.51	140	10.26		PSRE, TAGR	FALSE	FALSE
EL35	Pond near Coupeville	23-Apr-03	Rain	Gusty	9	10	6.93	100	9.12		AMGR, PSRE, TAGR	FALSE	FALSE
EL36	Slough Across From Bowling Alley	23-Apr-03	Rain	Gusty	9	11	7.05	820	5.75		PSRE	FALSE	FALSE

Appendix C. Terrestrial and Incidental Habitat Characteristics.

Table C-1. Terrestrial habitat characteristics associated with species detection. Dominant forest type, soil temp, aspect and slope recorded at center of plot. *See Table C-2 for description of habitat classes.

Survey date	Field Site ID	Species Code	Stage	SVL (mm)	Habitat at Detection*	Seep, Stream, or Talus	Dominant Forest Type	Soil Temp (°C)	Aspect	Slope (%)
5/1/2002	EL3	ENES	A	45	D4	N	Coniferous	16	NA	20
5/1/2002	EL3	ENES	A	53	D5	N	Coniferous	16	NA	20
5/1/2002	EL3	ENES	A	53	D5	N	Coniferous	16	NA	20
5/1/2002	EL3	ENES	J	31	D4	N	Coniferous	16	NA	20
4/30/2002	EL10	AMMA	A	58	D4	N	Coniferous	13	90	7
5/1/2002	EL11	ENES	A	55	D4	N	Coniferous	8	90	20
5/2/2002	EL12	ENES	A	45	D4	N	Coniferous	8	NA	NA
5/2/2002	EL12	ENES	A	47	D3	N	Coniferous	8	NA	NA
5/2/2002	EL12	ENES	A	49	D4	N	Coniferous	8	NA	NA
5/2/2002	EL12	ENES	A	50	D4	N	Coniferous	8	NA	NA
5/2/2002	EL12	ENES	A	51	D4	N	Coniferous	8	NA	NA
5/2/2002	EL12	ENES	A	51	D4	N	Coniferous	8	NA	NA
5/2/2002	EL12	ENES	A	52	D4	N	Coniferous	8	NA	NA
5/2/2002	EL12	ENES	A	53	D4	N	Coniferous	8	NA	NA
5/2/2002	EL12	ENES	A	53	D4	N	Coniferous	8	NA	NA
5/2/2002	EL12	ENES	A	54	D4	N	Coniferous	8	NA	NA
5/2/2002	EL12	ENES	A	55	D4	N	Coniferous	8	NA	NA
5/2/2002	EL12	ENES	A	48	O (under moss)	N	Coniferous	8	NA	NA
5/2/2002	EL13	ENES	A	34	D4	N	Coniferous	8	270	15
5/2/2002	EL13	ENES	A	50	D4	N	Coniferous	8	270	15
5/2/2002	EL13	ENES	A	52	D4	N	Coniferous	8	270	15
5/7/2002	EL14	ENES	A	42	D4	N	Mixed	6	NA	0
5/7/2002	EL14	ENES	A	44	D3	N	Mixed	6	NA	0
5/7/2002	EL14	ENES	A	50	D3	N	Mixed	6	NA	0
5/7/2002	EL14	ENES	A	41	O (leaf litter)	N	Mixed	6	NA	0

Table C-1. Terrestrial habitat characteristics associated with species detection. Dominant forest type, soil temp, aspect and slope recorded at center of plot. *See Table C-2 for description of habitat classes (continued).

Survey date	Field Site ID	Species Code	Stage	SVL (mm)	Habitat at Detection*	Seep, Stream, or Talus	Dominant Forest Type	Soil Temp (°C)	Aspect	Slope (%)
5/7/2002	EL14	ENES	A	43	O (leaf litter)	N	Mixed	6	NA	0
5/7/2002	EL14	ENES	A	43	O (leaf litter)	N	Mixed	6	NA	0
5/7/2002	EL14	ENES	J	33	D4	N	Mixed	6	NA	0
5/7/2002	EL14	ENES	J	34	D4	N	Mixed	6	NA	0
5/7/2002	EL15	ENES	A	46	D4	N	Mixed	7	360	5
5/7/2002	EL15	ENES	A	48	D4	N	Mixed	7	360	5
5/7/2002	EL15	ENES	A	51	D5	N	Mixed	7	360	5
5/7/2002	EL15	ENES	A	53	D3	N	Mixed	7	360	5
5/7/2002	EL15	ENES	A	56	D4	N	Mixed	7	360	5
5/7/2002	EL15	ENES	J	38	D4	N	Mixed	7	360	5
5/8/2002	EL17	ENES	A	48	D3	N	Coniferous	7	NA	NA
4/15/2003	EL20	ENES	A	42	D4	N	Coniferous	11	NA	10
4/15/2003	EL21	ENES	A	43	D3	N	Coniferous	10	NA	5
4/15/2003	EL21	ENES	A	54	D3	N	Coniferous	10	NA	5
4/15/2003	EL21	ENES	A	55	O	N	Coniferous	10	NA	5
4/17/2003	EL27	ENES	A	48	D4	N	Coniferous	10	NA	10
4/17/2003	EL27	ENES	A	55	D4	N	Coniferous	10	NA	10
4/17/2003	EL27	ENES	A	55	D4	N	Coniferous	10	NA	10
4/17/2003	EL27	ENES	A	57	D4	N	Coniferous	10	NA	10
4/17/2003	EL27	ENES	J	35	D4	N	Coniferous	10	NA	10
4/17/2003	EL28	ENES	A	45	D4	N	Coniferous	10	NA	5
4/17/2003	EL28	ENES	A	48	D5	N	Coniferous	10	NA	5
4/17/2003	EL28	ENES	A	52	D4	N	Coniferous	10	NA	5
4/17/2003	EL28	ENES	A	55	D4	N	Coniferous	10	NA	5
4/17/2003	EL28	ENES	J	15	D4	N	Coniferous	10	NA	5
4/23/2003	EL34	ENES	A	43	D4	N	Deciduous	10	NA	NA
4/23/2003	EL37	TAGR	A	50	D3	N	Mixed	10	NA	NA
4/23/2003	EL38	ENES	A	37	D4	N	Mixed	9	NA	NA

Table C-2. 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 o ground

Table C-3. Incidental habitat characteristics associated with species detection. *See Table C-2 for description of habitat classes.

Survey Date	Field Site ID	Species Code	Habitat at Detection*	Slope	SVL	Aspect
5/1/2002	EBI1	ENES	D4	1	57	360
5/1/2002	EBI1	ENES	D4	1	58	360
5/1/2002	EBI1	ENES	D4	1	NA	360
5/1/2002	EBI1	ENES	D4	1	60	360
5/2/2002	EBI2	ENES	D4	30	43	360
5/2/2002	EBI2	ENES	D4	30	39	360
5/7/2002	EBI3	ENES	D4	NA	59	NA
5/7/2002	EBI3	ENES	D4	57 with 10 eggs	NA	NA
5/7/2002	EBI3	ENES	D4	NA	58	NA
5/7/2002	EBI3	ENES	D4	NA	50	NA
5/7/2002	EBI3	ENES	D4	NA	53	NA
5/7/2002	EBI3	ENES	D4	NA	47	NA
5/7/2002	EBI4	ENES	D4	10	49	45
5/7/2002	EBI4	ENES	D4	10	54	45
5/7/2002	EBI4	ENES	D3	10	58	45
4/23/2002	EL2	AMMA	D5	20	45	270
4/23/2002	EL2	ENES	D4	20	48	270

Appendix D. NCCN Terrestrial Survey Protocols and Datasheets.

NCCN Amphibian Inventory Standard Operating Procedure for Amphibian Terrestrial Surveys

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. NWI maps in ArcView files are available at:

X:\ArcGIS\Data\Shapefiles\Network\wetlands

Boundaries of the NCCN parks are located at:

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
- 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

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 for each object (Figure 1).

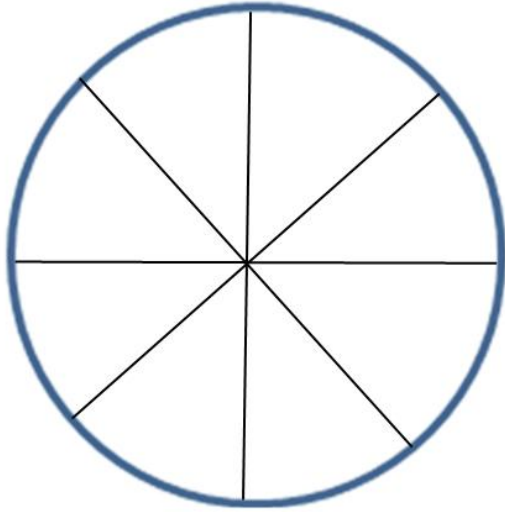


Figure 1. 30m plot with 8 transects for recording coarse woody debris. *(Note: Data recorded for only 4 transects in this study as CWD data collection was time consuming and limited the amount of time available for amphibian searches).*

Field Amphibian Surveys

Each plot will be searched for 30 worker-minutes during daylight (>1 hr after sunrise and before sunset). Search time was doubled or tripled in some cases if amphibian habitat was spatially complex. 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 D-1. Terrestrial amphibian inventory data sheets.

[illegible]

Notes:

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

Appendix E. Amphibian Survey Results for All Sites by Species, Life Stage, and Total Count.

Table E-1. Amphibian species detected by aquatic visual encounter surveys.

SITE ID	DATE	UTM-N	UTM-E	SPECIES	STAGE	COUNT
EL1A	4/23/2002	5341396	517442	PSRE	A	1
EL4	4/24/2002	5343460	519932	AMMA	L	3
				PSRE	A	4
				PSRE	L	1000
				PSRE	A	2
EL6	4/25/2002	5339074	523759	PSRE	A	2
EL7	4/25/2002	5339592	524267	AMMA	E	5
				AMMA	L	100
				PSRE	E	20
				PSRE	L	1000
EL9	4/30/2002	5337042	522675	AMMA	E	5
				AMMA	L	100
				PSRE	E	20
				PSRE	L	1000
EL16	5/8/2002	5334907	524130	AMMA	L	1
				AMMA	L	11
				PSRE	L	100
				RAAU	L	1
EL22	4/15/2003	5340532	523106	PSRE	A	1
				PSRE	EM	100
				PSRE	L	300
EL23	4/16/2003	5342948	518326	PSRE	EM	15
EL24	4/16/2003	5344058	519059	PSRE	EM	7
				TAGR	A	1
EL25	4/16/2003	5343952	524043	AMMA	L	2
				AMMA	EM	7
				PSRE	A	3
				PSRE	EM	4
EL26	4/16/2003	5341924	517696	AMMA	L	5
				PSRE	EM	3
				PSRE	L	25
				TAGR	L	1
EL29	4/22/2003	5343562	524781	AMMA	E	1
				AMMA	L	1
				PSRE	EM	1
				PSRE	A	2
				RAAU	A	1
				RAAU	EM	1
				RAAU	J	2
				RAAU	L	10
EL30	4/22/2003	5343683	524798	TAGR	J	1
				PSRE	A	3
				PSRE	EM	14
				PSRE	L	80
				RAAU	A	1
				RAAU	L	4

Table E-1. Amphibian species detected by aquatic visual encounter surveys (continued).

SITE ID	DATE	UTM-N	UTM-E	SPECIES	STAGE	COUNT
EL31	4/22/2003	5343575	524952	AMMA	L	2
				PSRE	A	1
				PSRE	L	5
EL33	4/22/2003	5337049	522677	PSRE	EM	2
				PSRE	A	12
				TAGR	A	12
EL35	4/23/2003	5340016	524790	AMGR	EM	1
				PSRE	A	4
				PSRE	EM	16
				TAGR	A	1
EL36	4/23/2003	5339185	523703	PSRE	A	1

Table E-2. Amphibian species detected by terrestrial surveys at EBLA.

DATE	SITE ID	UTM-N	UTM-E	SPECIES	STAGE	COUNT
4/24/2002	EL3	5340503	519384	ENES	A	3
				ENES	J	1
4/30/2002	EL10	5337032	522525	AMMA	A	1
5/1/2002	EL11	5338315	520680	ENES	A	3
5/2/2002	EL12	5339300	520951	ENES	A	12
5/2/2002	EL13	5339791	518996	ENES	A	3
5/7/2002	EL14	5340801	518157	ENES	A	6
				ENES	J	2
5/7/2002	EL15	5338641	520267	ENES	A	5
				ENES	J	2
5/8/2002	EL17	5338269	526230	ENES	A	1
4/15/2003	EL20	5335410	526827	ENES	A	1
4/15/2003	EL21	5340055	527296	ENES	A	3
4/17/2003	EL27	5334923	523861	ENES	A	4
				ENES	J	1
4/17/2003	EL28	5335056	523705	ENES	A	4
				ENES	J	1
4/23/2003	EL34	5339829	525287	ENES	A	1
4/23/2003	EL37	5340730	518735	TAGR	A	1
4/23/2003	EL38	5340759	519715	ENES	A	1

Table E-3. Amphibian species detected by incidental surveys.

DATE	SITE ID	UTM-N	UTM-E	SPECIES	STAGE	COUNT
5/1/2002	EBI1	5338335	520735	ENES	A	1
				ENES	E	13
5/2/2002	EBI2	5339961	518833	ENES	A	1
5/7/2002	EBI3	5340820	518097	ENES	A	6
				ENES	E	10
5/7/2002	EBI4	5338654	520415	ENES	A	3
4/29/2002	EBI6	5342925	523703	PSRE	A	20
5/1/2002	EL1B	5341396	517335	AMGR	EM	1
				PSRE	A	1
				RAAU	EM	1
5/1/2002	EL1C	5341396	517335	PSRE	A	50
4/23/2002	EL2	5341123	517619	AMMA	A	1
				ENES	A	1
4/22/2003	EL32	5343819	525265	PSRE	A	9
				PSRE	EM	2

Table E-4. Reptile species detected during amphibian surveys.

DATE	SITE ID	UTM-N	UTM-E	SPECIES	STAGE	COUNT
4/16/2003	EL24	5344058	519059	THSI	A	1
4/22/2003	EL29	5343562	524781	THOR	A	1
4/23/2002	EL1A	5341396	517442	Turtle sp.	A	1

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