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In cooperation with Olympic National Park

Olympic National Park Amphibian and Reptile Inventory, with Emphasis Upon Terrestrial Herpetofauna (1999-2001).

Final Report

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Executive Summary

Olympic National Park (ONP) comprises 370,000 ha of land on the Olympic Peninsula in Washington State, and includes the Olympic Mountains as well as a 100 km strip of Pacific coastline. The Olympic Mountains are isolated from other mountain ranges and are characterized by glaciated peaks and steep elevational gradients (0-2000 m). ONP is almost entirely roadless and trails are mostly confined to valley bottoms and some steep ascents up to ridges and glacial basins. Access off of established trails to the steep terrain is difficult, potentially dangerous, and labor-intensive. High elevations consist of alpine meadow, rock, and glacier; the remainder of the park is mostly old-growth forest.

We conducted park-wide surveys of terrestrial habitats at 478 different sites in 2000 and 2001. Our surveys were designed to document the occurrence, distribution, relative abundance, and habitat associations of terrestrial amphibians and reptiles in ONP. They also provided ancillary data for aquatic breeding species. Survey methods included one probabilistic design and two non-random designs.

For each species detected during the terrestrial surveys, we provided a dot map of its distribution in ONP in Appendix H. We failed to document any new species during these surveys. Because we used three different survey methods, we were able to examine the effectiveness of each method on a species-by-species basis. Based on our data, reptiles and most anurans were detected more often by opportunistic surveys while at least one salamander species was better detected by probabilistic sampling. Multiple visits to four verification sites within seasons indicated that salamanders were active and detectable throughout the spring and summer at ONP.

Counts of ensatina (*Ensatina eschscholtzii*) and western red-backed salamander (*Plethodon vehiculum*), the two most common terrestrial amphibians in ONP, were positively associated with high canopy cover, high moss cover, and high relative humidity during the survey. Ensatina and western red-backed salamanders were negatively associated with elevation and slope. Both species were more abundant at sites with unconsolidated substrate; the presence of talus or water did not result in significantly higher capture rates for either species. Ensatina captures did not differ significantly among decay classes of downed wood, but western red-backed salamanders were associated with sites having relatively large amounts of moderately decayed logs.

We also conducted surveys of gravel bar pools, ponds, and streams and seeps in 1999 to supplement similar studies from previous years. The tailed frog (*Ascaphus truei*), Olympic torrent salamander (*Rhyacotriton olympicus*) and western red-backed salamander were detected by stream and seep surveys conducted in the Duckabush and Elwha drainages. We did not detect Cope's giant salamander (*Dicamptodon copei*) in these drainages despite seemingly favorable habitat conditions.

The western toad, *Bufo boreas*, is a species of interest due to its decline at high elevations in other parts of its range. We surveyed 55 gravel bar pools and observed a total of 14 populations in the Queets and Quinault drainages. No western toads were found in the Skokomish drainage; the only other drainage where gravel bar surveys were conducted.

Finally, we conducted pond surveys in 10 drainages to supplement similar surveys from previous years. The Cascade frog (*Rana cascadae*) remained the most common and the western toad was the least common amphibian species detected

All of the terrestrial species that were the primary focus of this project were detected at least once but most were too rare for a detailed analysis. Despite appropriate methodology, western fence lizards and sharp-tailed snakes were not detected but were unlikely to occur in

ONP. The two species with enough data for a habitat analysis, ensatina and western red-backed salamander, occupied a wide range of habitats within ONP and did not exhibit tight habitat linkages. This generalist habit is consistent with the broad distribution of these species in the Pacific Northwest.

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Inventory, Sampling, and Habitat Associations of Herpetofauna in Olympic National Park

Introduction

The first stage of the National Park Service's inventory and monitoring program is to determine which members of the regional fauna are present within park boundaries and to quantify the distribution and relative abundance of priority species. Olympic National Park possesses a rich herpetofauna and provides a unique opportunity to study these animals in an environment relatively free of anthropogenic disturbance.

Olympic National Park encompasses 370,000 ha on the Olympic Peninsula in Washington State, including the Olympic Mountains and 84 km of the Pacific coastline. The Olympic Mountains are isolated from other mountain ranges and are characterized by glaciated peaks and steep elevational gradients that range from sea level to over 2000 meters. The Olympic Mountains can, is some ways, be viewed as a biogeographic island. The Olympic Peninsula is surrounded on three sides by water (Pacific Ocean to the west, Strait of Juan de Fuca to the north, and Hood Canal to the east). ONP itself is surrounded by managed forest, wilderness areas, and a few moderate urban areas. Olympic National Park is almost entirely roadless, and trails generally parallel river valleys (Figure 1). These river valleys radiate outward from Mt. Olympus (2430 m) at the park's center. Alpine meadows, rock, and glaciers dominate the landscape at high elevations; the remainder of the park is heavily forested. The Olympic mountains create a prominent rain shadow in the northeast portion of the park. Annual rainfall ranges from 6000 mm on the southwest side of the park to 450 mm in the rain shadow.

Olympic National Park formed a list of species that could potentially occur in the park by querying field guides, museum records, and anecdotal accounts. This list was meant to error on the side of inclusiveness and thus included some species that were unlikely to occur in the park's habitats but whose ranges approached the park's boundary. This list included nine species of salamander, 6 species of anuran, 5 species of snake, and 2 species of lizard (Table 1). Most of these species had been previously documented in the park but distribution and relative abundance data were sparse.

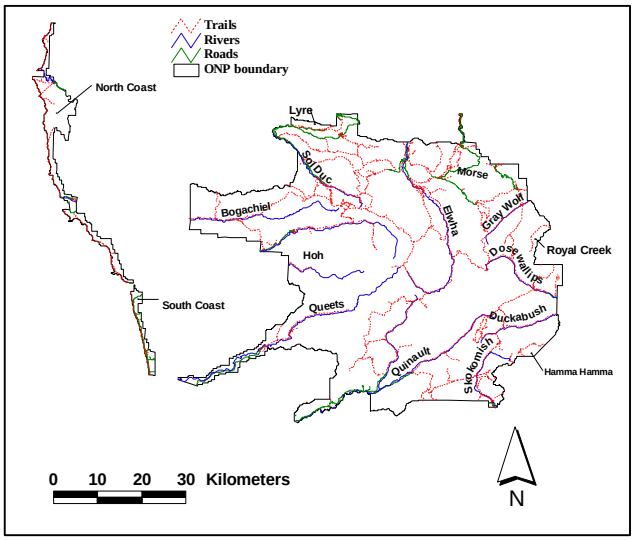

Figure 1. The trails, roads, and river drainages of Olympic National Park.

Pond- and stream-breeding amphibians were inventoried in ONP during a previous effort (Bury and Adams, 2000; Adams *et al.*, 2001; Adams and Bury, 2002) but a complete inventory of terrestrial amphibians and reptiles had not been conducted. The habitat associations of terrestrial-breeding amphibians in the Pacific Northwest were examined by several workers (Welsh and Lind, 1988; Aubry and Hall, 1991; Bury *et al.*, 1991; Corn and Bury,

Table 1. Known and anticipated herpetofauna of Olympic National Park. These species were listed as potentially occurring in Olympic National Park during an early planning phase in the NPS Inventory and Monitoring Program. Capture and detection data are from the current study and include FIA, IF and Incidental surveys; habitat descriptions are from Stebbins (1985), Corkran and Thoms (1996), and St. John (2002). An asterisk indicates species not detected by our surveys.

Scientific Name	Common Name	Breeding Habitat	Non-breeding Habitat	Total Captures	Total Detections
Frogs and Toads					
Ascaphus truei	tailed frog	streams	streams, forests	74	44
Bufo boreas	western toad	ponds	marshes, forest, grassy areas	63	24
Pseudacris regilla	Pacific treefrog	ponds	marshes, forest, grassy areas	18	15
Rana aurora	red-legged frog	ponds	marshes, shallow ponds	64	36
Rana cascadae	Cascades frog	ponds	marshes, small streams	114	53
*Rana catesbeiana**	bullfrog	ponds	ponds, marshes	0	0
Salamanders					
Ambystoma gracile	northwestern salamander	ponds	forest and logs	37	14
Ambystoma macrodactylum	long-toed salamander	ponds	grass and shrub	17	11
Dicamptodon copei	Cope's giant salamander	streams	Streams	8	6
*Dicamptodon tenebrosus**	Pacific giant salamander	streams	streams, forests (if metamorphic)	0	0
Ensatina eschscholtzii	ensatina	terrestrial	forest and logs, talus	131	61
Rhyacotriton olympicus	Olympic torrent salamander	streams or seeps	Streamside	80	33
Plethodon vandykei	Van Dyke's salamander	streamside/terrestrial	streamside, moist talus	30	15
Plethodon vehiculum	western red-backed salamander	terrestrial	forest and logs, talus	879	173
Taricha granulosa	rough-skinned newt	ponds	marsh, forest and logs	25	15
Snakes					
Charina bottae	rubber boa	terrestrial	Forests	7	1
*Contia tenuis**	sharp-tailed snake	terrestrial	forests, chaparral, savannahs	0	0
*Thamnophis elegans**	western terrestrial garter snake	terrestrial	forests, chaparral, savannahs	0	0
Thamnophis ordinoides	northwestern garter snake	terrestrial	damp forests	95	44
Thamnophis sirtalis	common garter snake	terrestrial	moist forests and meadows	45	39
Lizards					
Elgaria coerulea	northern alligator lizard	terrestrial	coniferous forests	7	7
*Sceloporus occidentalis**	western fence lizard	terrestrial	oak woodlands, open fields	0	0
		Total:		**1694**	**591**

1991; Gilbert and Allwine, 1991; Dupuis *et al.*, 1995; Aubry, 2000) but most of these studies focused on a relatively narrow range of environmental conditions and none occurred in ONP.

Ensatina (*Ensatina eschscholtzii)* and the western red-backed salamander (*Plethodon vehiculum)* are abundant, providing us with an opportunity to study their habitat associations. Olympic National Park's marked environmental and elevational gradients across a large, contiguous area provide a unique opportunity to examine a wide spectrum of possible habitats for terrestrial amphibians.

Determining appropriate and effective sampling methods for terrestrial amphibians in an area such as ONP is challenging. Ninety-six percent of ONP is designated as wilderness, and access to remote areas can be difficult, dangerous, and time-consuming. As much as possible, the National Park Service generally wants distribution and relative abundance data for whole parks, but the desire to gain broad inference must be balanced with the limited time and resources available. Probabilistic sampling is advantageous because it provides a well-defined range of inference (*e.g.*, Olympic National Park) and common species are readily detected. Opportunistic surveys (or deliberately chosen survey sites) lack a defined range of inference, but are effective for sampling rare or patchily distributed species that may be overlooked by a more structured sampling frame. Either method would partially fulfill the goal of generating inventory, distribution and relative abundance records. Conversely, neither method solely encompasses the attributes necessary to comprehensively document herpetofauna within ONP's complex envi-

ronmental matrix, which argues for a multi-method approach.

Our objectives for the terrestrial inventory were 1) to document the presence, distribution, and relative abundance of terrestrial herpetofauna in Olympic National Park; 2) to determine whether terrestrial amphibians remain detectable throughout the summer; and 3) to describe the habitat associations of two species of terrestrial salamander common in ONP.

Methods

We used two types of sampling in this study: 1) a grid-based probabilistic design for broad inference to the accessible portions of the park; and 2) non-random surveys of convenient locations (to increase sample size) and rare habitats. Our sampling frame for the probabilistic survey was the U.S. Forest Service's Forest Inventory and Analysis (FIA) grid system. The FIA grid was originally created to facilitate an interagency vegetation monitoring program, and our use of the grid enables us to co-locate herpetofaunal data with the vegetation data. FIA points are spaced ca. 5.5 km apart and at a density of one point per 2,430 ha. The grid is oriented in north/south and east/west directions. ONP contains 123 FIA points, and we surveyed 63 of these. We eliminated 60 points from our sampling pool because they fell on unsuitable habitat (*e.g.*, glaciers, large bodies of water), were unsafe (terrain with slopes > 37° or dangerous river crossings), or were inaccessible (based on judgments of crews or >1 day's travel from water). We visited each FIA point once within the two-year study, surveying 31 points in 2000 and 29 points in 2001. Sixteen drainages in ONP had FIA surveys.

At each FIA point, we searched 1- 4 (depending on time and access) circular plots with a 60-meter diameter (2827 m^2) for reptiles and amphibians. We refer to these groupings of 1-4 plots as "sites". We spaced plot centers 200 meters apart in a square design around each FIA point (Figure 2). Environmental, habitat, and vegetation data were collected at each plot. We divided each plot into equal quarters and assigned two surveyors to search each quarter for 15 minutes for a total of two worker-hours per plot. Surveyors visually searched the entire area of the plot by turning logs, rocks, duff, moss, and bark. Included in the surveys were seeps or small streams present on the plot. Crews used a "light touch" approach, restoring displaced material to a condition similar to its original state. They did not disturb soil, vegetation, or logs to an extent that they could not be restored to their approximate original condition. However, the surveyors would often detach pieces of decayed wood or bark during surveys. Captured animals were held in plastic bags with moist substrate (*e.g.*, moss, leaf litter) until crews completed searching each plot quarter (*i.e.*, no more than 15 minutes), after which the animals were identified, measured, and released at the point of capture. Each animal had its species, age class, sex, and snout-vent length recorded.

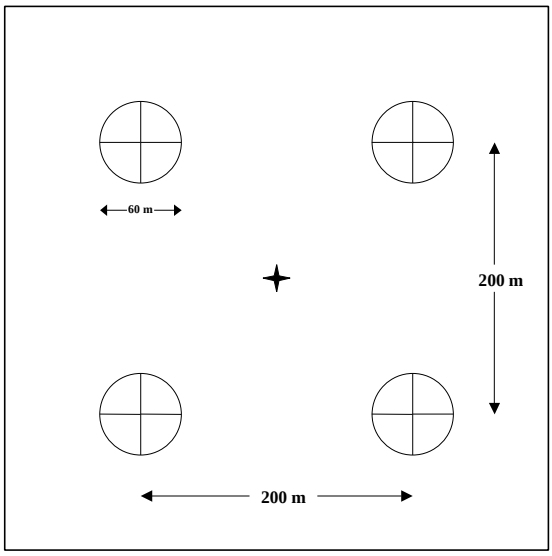

Figure 2. FIA and IF survey diagram. Four-pointed star represents FIA coordinate or IF survey center.

We added two types of non-probabilistic survey to the study to supplement distribution and relative abundance records obtained by the FIA surveys. Crews conducted these surveys at non-random sites chosen for unique habitat or convenient location. The first type of non-probabilistic survey, Informal FIA surveys (hereafter "IF" surveys), had an identical sampling protocol to the FIA surveys. On occasion, access to FIA points was deemed unattainable after we had already ventured into the field. Conducting IF surveys along access routes enabled us to collect valuable data on what would have otherwise been wasted trips. Crews considered an area appropriate for an IF survey if it fell within the safety guidelines and was large enough to accommodate the survey sampling scheme. Nine drainages throughout ONP received IF surveys.

The second type of non-probabilistic survey, Incidental surveys, targeted rare and patchy microhabitats that were unlikely to be sampled by the probabilistic surveys. Incidental surveys were done wherever we deemed conditions or habitat to be favorable for herpetofauna. We often focused on habitats of rare species, and occasionally these habitats included stream banks, seeps, splash zones, and gravel bars. Other areas, such as south-facing, rocky slopes, were routinely searched for reptiles. The amount of time and area searched during Incidental surveys varied, depending on the time available for a thorough search and the size of the targeted microhabitat. Crews collected a subset of habitat data during the Incidental surveys, which included a coarse habitat description, air temperature, and precipitation and wind conditions. Each amphibian or reptile captured had its species, age class, sex, snout-vent length, and, for garter snakes, labial and mid-body scale counts recorded. Encountering an animal while hiking was recorded as an Incidental survey even if crews did not thoroughly search the immediate area. This was noted on the data form by writing zero for search time. Fifteen drainages throughout ONP received Incidental surveys. A gear checklist is provided in Appendix B, and data forms are provided in Appendix C and Appendix D. We surveyed from April to September in 2000 and 2001.

To measure seasonal changes in species detectability and relative abundance, we selected four non-random "verification" sites. We selected these verification sites for high amphibian abundance, convenient location, and contrasting habitats. During both years of the study, crews sampled these sites approximately every two months throughout the spring and summer. Verification site surveys followed the same protocol as the FIA and IF surveys. We calculated seasonal coefficients of variation for ensatina and western red-backed salamanders from the average captures per plot for each verification site visit.

Habitat Analysis. The original intention of this study was to follow a probabilistic sampling design so that we could make broad inferences about ONP as well as set the stage for future monitoring efforts. Because we had great difficulty reaching FIA points and because many of the points that we originally included in the sampling pool were not reached, we were left with a somewhat compromised range of inference. Thus, we did not attempt to analyze habitat relationships for the FIA plots alone, but instead lumped these data with the IF data for the habitat analysis.

Data from plots were averaged within sites, and site values were used for statistical analysis. Predictor variables were comprised of nine continuous (elevation, slope, aspect, percent canopy cover, coarse woody debris, percent moss cover, percent grass cover, air temperature, relative humidity) and seven categorical (surface geology, understory, streams, seeps, talus, precipitation, wind) variables (Table 2). The

Table 2. Environmental and habitat variables collected at FIA and IF sites in Olympic National Park.

Name	Description
Elevation	From a USGS digital elevation map with 30m resolution (equivalent to 7.5', 1:24000 quad map). Range: 35m-1927m.
Slope	Recorded in degrees. Range: 0°-40°.
Aspect	Degrees from north that the survey site faced. Range: 5°-177°.
Surface geology	From USGS geological map (1:125000, NAD27) digitized by the Olympic National Forest (1993). Categories consolidated into four classes ranging from the most consolidated (1, *e.g.*, basalt, breccia) to the least consolidated (4, *e.g.*, alluvial and landslide deposits).
% Canopy cover	Visual estimation of the percentage of sky blocked by vegetation (to the nearest 20%). Range: 0%-80%.
Canopy species	The canopy species occurring at each survey.
% Canopy species cover	Relative percent cover of each canopy species (to the nearest 5%).
Understory species	The three most dominant understory coniferous, understory deciduous, shrub, fern, and forb species.
Understory species cover	The percentage of each plot covered by the three dominant species in each understory category (<1%, 1-5%, 6-25%, 26-50%, 51-75%, 76-100%).
Coarse woody debris	Coarse woody debris available as habitat was estimated by recording length (cm) and decay class (I = bark still intact, little decay; II = moderate decay, bark loose and falling off; III = major decay, no bark, mushy) of wood that occurred along transects within each plot. In each plot, 30 m of twine was extended from the center to the edge of the plot in the four opposing directions. The middle 10m of each 30 m line was used to assess the density of coarse woody debris. We recorded the distance along the twine that each piece of wood lay under (or over) and scored the decay class of each piece. We then totaled the lengths for each plot and averaged within sites. Ranges of average length (cm) per plot: 0-390cm (I); 0-620cm (II); and 0-783cm (III).
Stream	Presence or absence of a stream on a plot. Sites were designated as containing a stream if one occurred on any given plot within a site. Streams occurred at 15 sites.
Seep	Presence or absence of a seep on a plot. Sites were designated as containing a seep if one occurred on any given plot within a site. Seeps occurred at 38 sites.
Talus	Presence or absence of talus (defined as loose, rocky substrate) on a plot. Sites were designated as containing talus if it occurred at any given plot within a site. Talus occurred at 30 sites.
% Moss cover	Percentage of moss covering each plot. Estimated visually from the center of the plot. Range: 0%-83%.
% Grass cover	Percentage of grass covering each plot. Estimated visually from the center of the plot. Range: 0%-60%.
Air temperature	Average air temperature (°C) during each survey. Measured 1 m off the ground at the beginning and end of surveying each plot. Range: 6°-24°.
Relative humidity	Average relative humidity (%) during each survey. Measured 1 m off the ground at the beginning and end of surveying each plot. Range: 32%-93%.
Precipitation	Precipitation data were recorded only for the duration of each survey, and did not include precipitation events occurring in the days prior to sampling. Data were grouped into "wet" (rain, sleet, or snow occurring during survey) and "dry" categories. We categorized 16 surveys as wet and 80 sites as dry.
Wind	Wind conditions were recorded only for the duration of the survey. Data were grouped into "wind" (which included all wind speeds) and "calm" categories. We categorized 46 surveys as calm and 50 surveys as windy.

response variables were average captures per plot for each salamander species.

Vegetation Analysis. We used NCSS to perform a *k*-means cluster analysis to characterize vegetation associations for comparison with amphibian counts (Hintze, 1998). Canopy cover was recorded in percentages and understory cover was recorded in percentage classes. To make the two data sets comparable, we took the mid-value of the percentage class assigned to each understory species (*i.e.*, a species in the 26-50% cover class was given a value of 38%). We then combined the canopy and understory coverage into one table with a row for each site for the cluster analysis. Based upon the relative distances between cluster centers, we decided that eight clusters provided the best minimization of variation within clusters and maximization of variation among clusters. The cluster analysis assigned each site to a vegetation association. We then treated vegetation association as a categorical predictor variable and the average salamander captures per plot as a response variable.

The relationships between salamander counts and predictor variables were

examined through univariate analyses using generalized linear modeling in S-Plus 2000 with a log link and Poisson error. Capture data approximated a Poisson distribution, but were overdispersed. Overdispersion was compensated for by using an F-test instead of a chi-square test (Crawley, 1993) and significance was set at a = 0.05.

Results

Inventory and Sampling

We conducted 63 FIA and 33 IF surveys in 16 drainages and 382 Incidental surveys in 15 drainages throughout ONP (Figure 3). The distribution of survey sites among drainages is outlined in Figure 4, and the distribution of sampling effort per

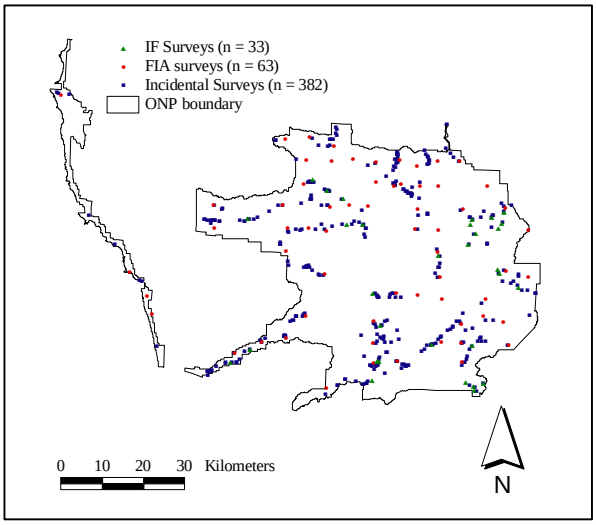

Figure 3. Olympic National Park 2000-2001 terrestrial survey sites.

hectare within drainages is provided in Figure 5. We captured a total of 1694 individuals, comprising 13 species of amphibians and four species of reptiles (Table 1; Appendix E; Appendix F; Appendix G). Amphibians constituted 91% of individuals observed, including five species of anuran and eight species of salamander. We captured the western redbacked salamander (*Plethodon vehiculum*) more often than any other amphibian. Our surveys also detected three species of snake and one species of lizard. Species detections for all terrestrial surveys are shown in dot maps in Appendix H.

FIA surveys documented 12 amphibian and two reptile species, IF surveys documented ten amphibian and one reptile species, and Incidental surveys documented 13 amphibian and four reptile species. FIA and IF surveys accounted for 16% of total anuran captures and 57% of total salamander captures. We found wide variation in both the distribution of species detections among drainages (Figure 6) and the proportion of species detected by each survey type (Figure 7). We considered a species "detected" if it was captured at least once during a survey. Incidental surveys accounted for 84% of all anuran detections, IF surveys for 4%, and FIA surveys for 12%. Incidental surveys also encompassed the majority of salamander detections (66%), with 23% occurring in FIA surveys and 11% occurring in IF surveys. Jennifer Jones and Amanda Heffner detected one Van Dyke's salamander in the Sol Duc drainage at an elevation of ~1,253m (UTM E 44215, N 5307662). A comparison of locality records from the Washington Gap Analysis project suggests that this capture represents a new drainage record for Van Dyke's salamander in ONP. Amanda and Jennifer were less experienced with identifying amphibians than other members of our crew but had seen multiple VanDyke's salamanders and felt certain of their identification of this particular specimen. Their voucher photograph taken to document the specimen is too blurry for positive identification.

The vast majority of reptile detections occurred during Incidental surveys (96%), with the remaining 4% of detections split equally between FIA and IF surveys. We detected rubber boa and northern alligator lizards (*Elgaria coerulea*) only during Incidental surveys. The rubber boa site was

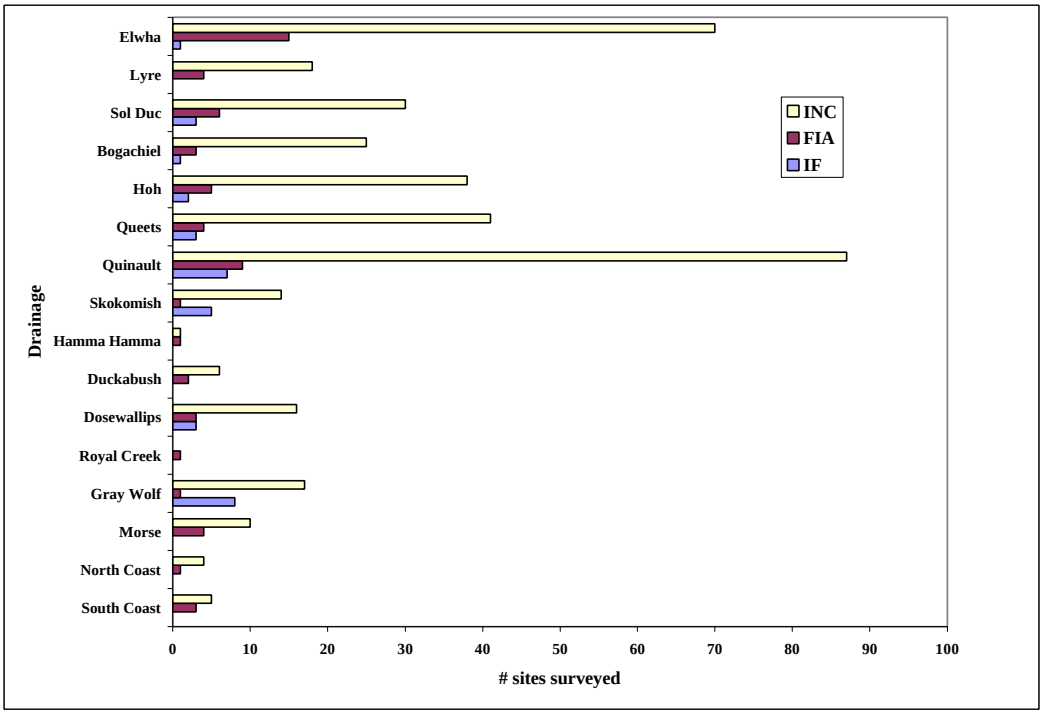

Figure 4. Distribution of Incidental (n = 382), FIA (n = 63), and IF (n = 33) survey sites among ONP drainages, 2000-2001. Drainages are listed in a counterclockwise fashion, beginning at the north/center of ONP and moving to the northwest. We divided the coastal strip of ONP geographically (into two segments at the Hoh Indian Reservation) and not based upon major river drainages.

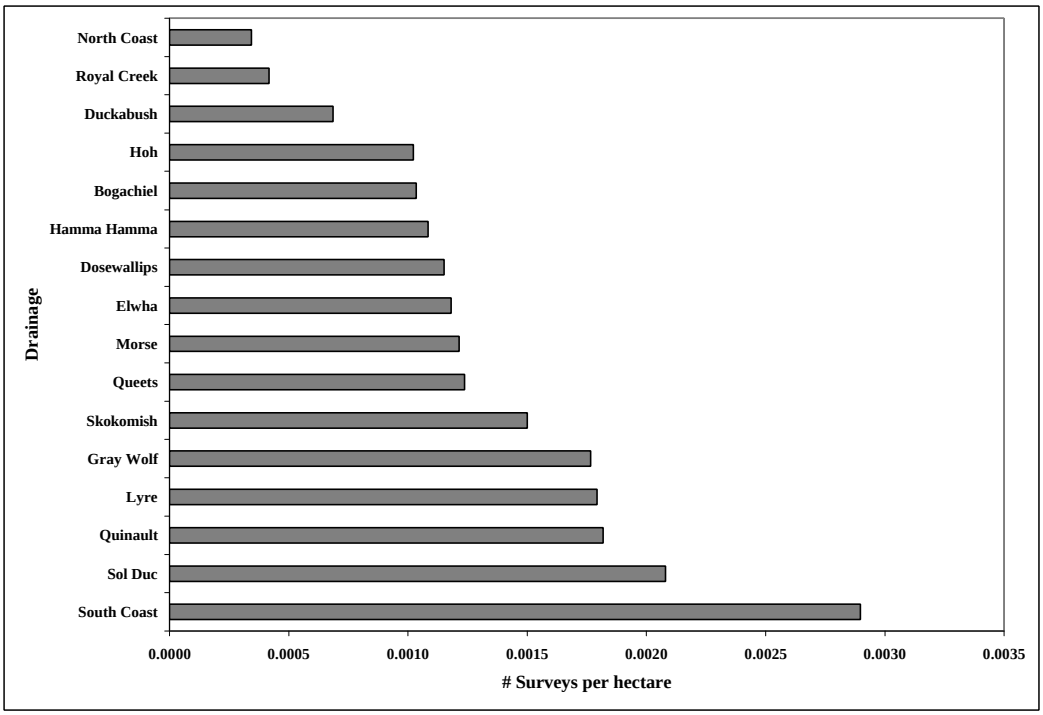

Figure 5. Distribution of sampling effort among major drainages in ONP. We divided the coastal strip of ONP geographically (into two segments at the Hoh Indian Reservation) and not based upon major river drainages.

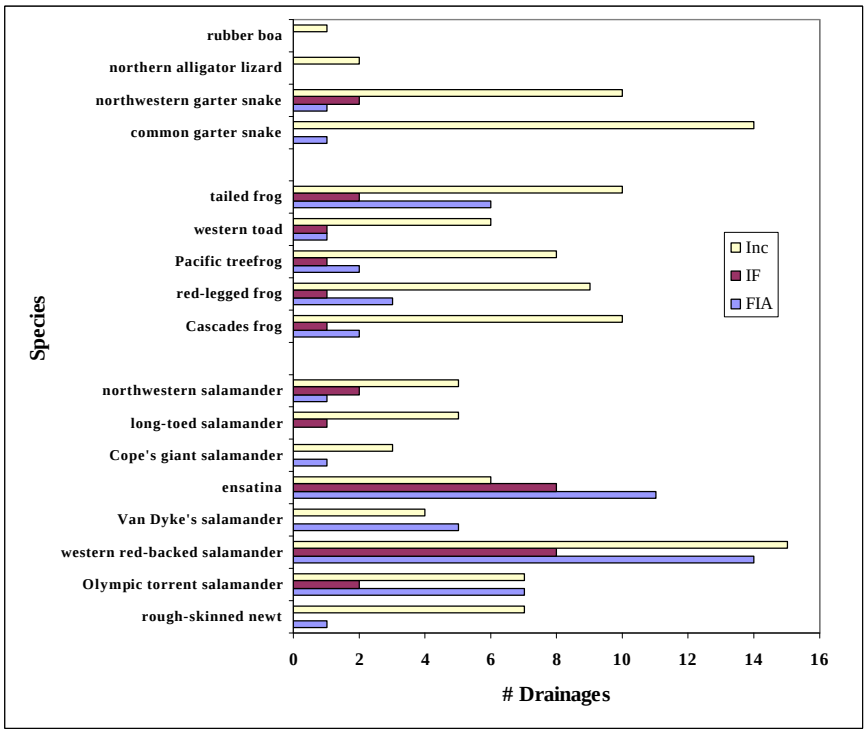

Figure 6. Number of drainages in which each survey type detected each species.

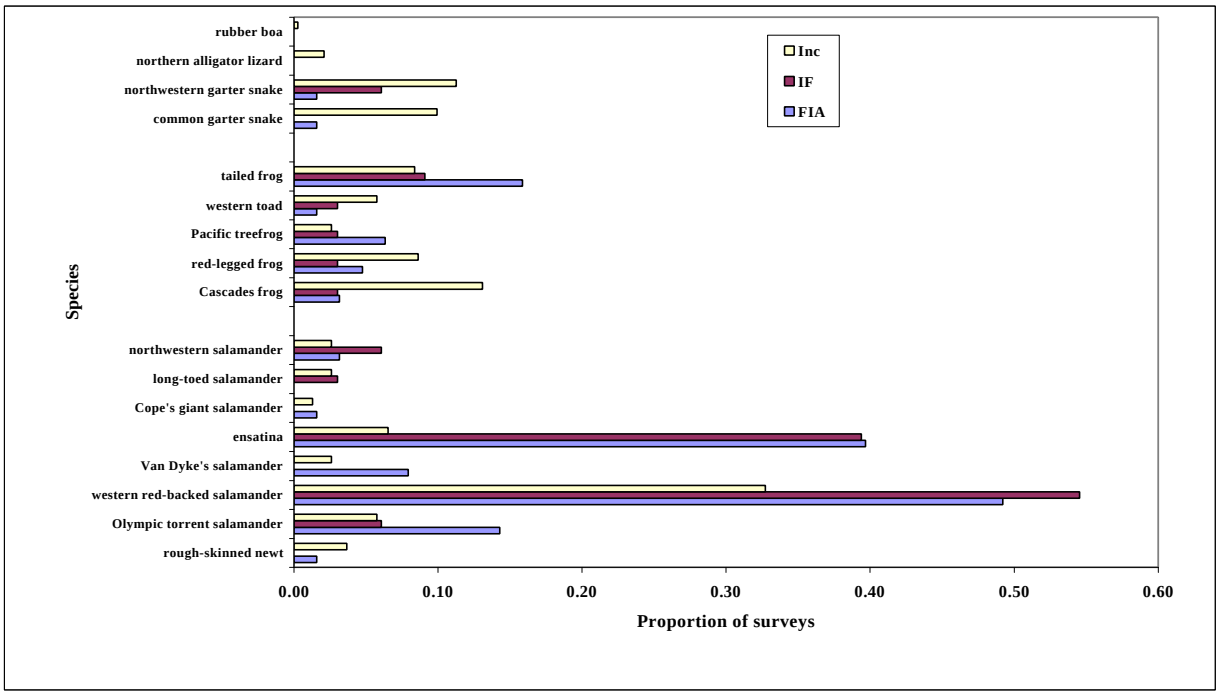

Figure 7. Proportion of surveys in which each species was detected. Incidental: n = 382; FIA: n = 63; IF: n = 33.

found by our crew after a tip from a different crew that found several snakes under a rock in the Elwha drainage. A rubber boa was previously found by one of us (PJH) on the Spruce RR trail on the north shore of Lake Crescent but repeated searches during the current project failed to produce additional animals. FIA surveys detected the common garter snake (*Thamnophis sirtalis*) and northwestern garter snake (*T. ordinoides*), but IF surveys detected only the latter.

Captures of many of the species sampled on FIA and IF sites had higher within-site variation than among-site variation (Table 3). All of these species, with the exception of the common and northwestern garter snakes, are aquatic-breeding amphibians. While some of these amphibians are fully terrestrial outside of the breeding season, most continue to be associated with water throughout the year. It follows that microhabitat features (*e.g.*, presence of water on a plot) are more important to these species than larger-scale habitat features.

The capture rates for ensatina at verification sites showed no pattern beyond random variation for both sampling seasons. Capture rates for the western red-backed salamander at the same sites increased in late summer during the 2000 surveys, and showed no trend in 2001 (Figure 8). The mean coefficients of variation for ensatina were 76.2% for 2000 and 115% for 2001, indicating that capture rates fluctuated considerably across the sampling season. Values for western red-backed salamanders were similar, with coefficients of variation

Table 3. Summary data for FIA and IF surveys. "Sites" refer to groupings of 1-4 circular plots that occurred at either 1) locations corresponding to FIA points ("FIA" surveys, N = 63); or 2) non-random locations selected by field crews ("IF" surveys, N = 33). The sampling protocols for FIA and IF surveys were identical. "Plots" refer to the 1-4 circular sub-sampling areas within each site. N = number of sites where each species was detected. Ranges, means, and standard deviations are based upon the average number of captures per circular plot (2827 m^2). "NA" indicates no captures of the species by that particular survey type.

	FIA					IF				
				Standard Deviation					Standard Deviation	
Scientific Name	**N**	**Range**	**Mean**	***Among sites***	***Plots w/in sites***	**N**	**Range**	**Mean**	***Among sites***	***Plots w/in sites***
northwestern salamander	2	0-2.50	0.07	4.024382	0.7071068	2	0-1.00	0.05	1.1997475	0.70710678
long-toed salamander	0	NA	0.00	NA	NA	1	0-2.00	0.06	1.9847907	0.00000000
tailed frog	10	0-2.00	0.13	4.659859	4.8989795	3	0-1.67	0.08	3.1127791	2.02072586
western toad	1	0-0.25	0.00	0.49375	0.8660254	1	0-0.33	0.01	0.5640761	0.81649660
Cope's giant salamander	1	0-1.00	0.02	1.405402	0.0000000	0	NA	0.00	NA	NA
ensatina	25	0-3.00	0.47	9.745148	6.6957673	13	0-8.00	0.58	8.7381955	4.69929037
Van Dyke's salamander	5	0-3.00	0.08	4.421035	1.9578892	0	NA	0.00	NA	NA
western red-backed salamander	31	0-8.00	2.07	34.27498	25.2603048	18	0-15.00	3.38	31.3233379	13.18458570
Pacific treefrog	4	0-0.67	0.03	1.691074	2.2173559	1	0-0.50	0.02	0.6963106	0.70710678
red-legged frog	3	0-0.50	0.02	1.316797	2.0412415	1	0-1.00	0.03	0.9923953	0.00000000
Cascades frog	2	0-1.50	0.03	2.175765	2.2730304	1	0-4.00	0.12	3.9695818	0.00000000
Olympic torrent salamander	9	0-3.50	0.19	7.993916	10.0166511	2	0-1.50	0.09	3.5032456	5.61248608
rough-skinned newt	1	0-0.25	0.00	0.49375	0.8660254	0	NA	0.00	NA	NA
northwestern garter snake	1	0-0.25	0.00	0.49375	0.8660254	2	0-0.50	0.03	0.9692233	1.00000000
common garter snake	1	0-0.33	0.01	0.571946	0.8164966	0	NA	0.00	NA	NA

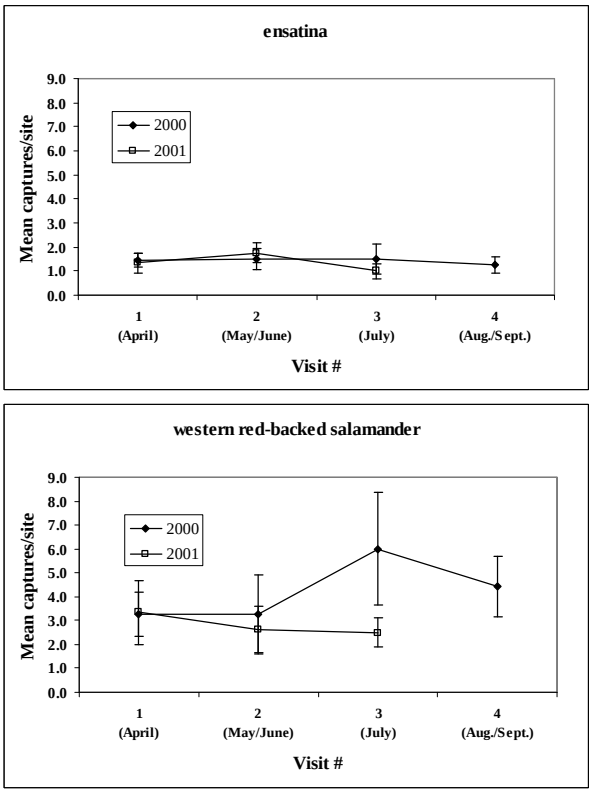

Figure 8. Seasonal trends in capture rates for ensatina and western red-backed salamanders. Error bars are SEM.

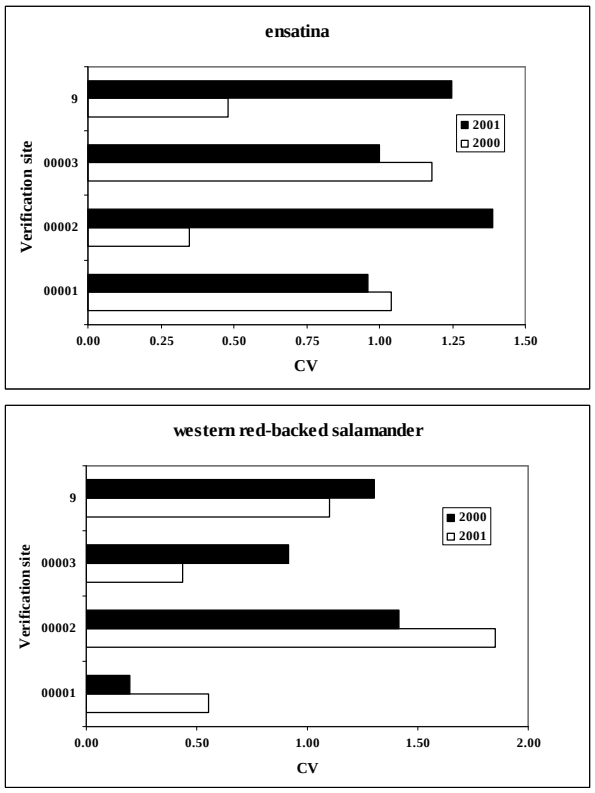

Figure 9. Coefficients of variation (CV) for ensatina and western red-backed salamanders from verification sites. The CV represents seasonal variation in average captures per plot.

of 98.5% for 2000 and 95.8% for 2001. The mean CV for ensatina for both sampling years was 95.6% compared to 97.1% for western red-backed salamanders. The mean CV for both species over all surveys and sample years was 96.4% (Figure 9). See Appendix A for an evaluation of monitoring prospects for terrestrial salamanders.

Habitat Associations

We conducted 63 FIA and 33 IF surveys in 16 drainages throughout ONP during two sampling seasons. The two most common species were the western red-backed salamander ($\bar{x}$ = 2.52 individuals/plot, or 1.26 individuals/worker-hour) and the ensatina ($\bar{x}$ = 0.51 individuals/plot, or 0.26 individuals/worker-hour). Mean captures of western red-backed salamanders ranged from 0-15 individuals per plot, with most captures occurring in the west half of the park (Figure 10). Ensatina salamanders occurred at lower densities (mean captures ranged from 0-8 individuals/plot) than western red-backed salamanders, but were more evenly distributed throughout ONP (Figure 11). Van Dyke's salamander (*Plethodon vandykei*) is also terrestrial ($\bar{x}$ = 0.05 individuals/plot, or 0.25 individuals/worker-hour) but we were unable to analyze the habitat associations of this species because we only found it at a few sites.

Capture rates for both western red-backed salamanders ($F_{7,88} = 5.616$, $p < 0.001$) and ensatina ($F_{7,88} = 2.957$, $p = 0.008$) differed among the vegetation

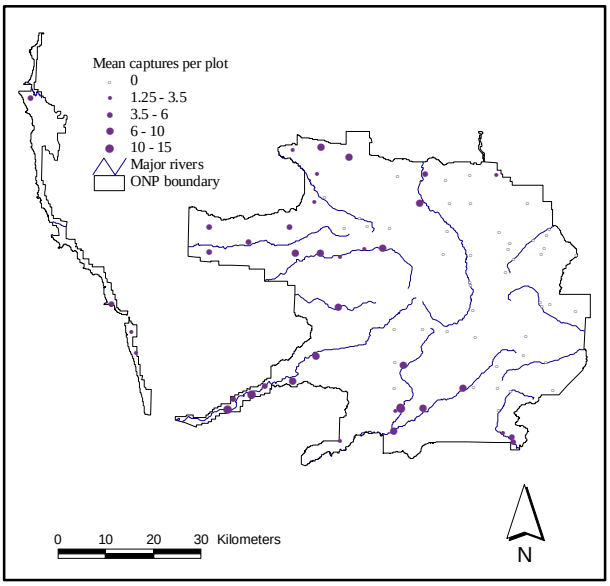

Figure 10. Relative abundance of western red-backed salamanders in ONP represented by mean captures per plot during FIA and IF surveys.

categories that resulted from the cluster analysis (Figure 12). Ensatina abundance was highest in clusters four ($\bar{x}$ = 1.15 captures/cluster, ± 0.25 S.E.) and six ($\bar{x}$ = 1.25 captures/cluster, ± 0.31 S.E.). Both of these clusters were dominated in the canopy by Douglas-fir (*Pseudotsuga menziesii*), western hemlock (*Tsuga heterophylla*), and western red cedar (*Thuja plicata*). Understory species in cluster four were sword fern (*Polystichum munitum*), salal (*Gaultheria shallon*), and Oregon grape (*Berberis nervosa*); cluster six had salal, deer fern (*Blechnum spicant*), and *Vaccinium* spp. Western red-backed salamander abundance was highest in clusters five ($\bar{x}$ = 4.51 captures/cluster, ± 0.71 S.E.) and seven ($\bar{x}$ = 5.65 captures/cluster, ± 1.180 S.E.). Cluster five was composed of western hemlock, Douglas-fir, and western red cedar in the canopy, and sword fern, oxalis (*Oxalis oregana*), and salmonberry (*Rubus spectabilis*) in the understory. The dominant canopy species in cluster seven were Sitka spruce (*Picea sitchensis*), western hemlock, and red alder (*Alnus rubra*); the understory was dominated by oxalis, sword fern, and *Vaccinium* spp. We did not capture either salamander species during surveys conducted in clusters one and three. The dominant vegetation in cluster one was composed of western hemlock, Douglas-fir, and red alder in the canopy, and vanilla leaf (*Achlys triphylla*), lady fern (*Athyrium filix-femnina*), and twinflower (*Linnaea borealis*) in the understory. The dominant canopy species in cluster three were Pacific silver fir (*Abies amabilis*), Douglas-fir, and western red cedar, and the dominant understory species were *Vaccinium* spp., Pacific silver fir, and western red cedar.

The relative abundance of both western red-backed salamanders and ensatina were associated with topographical variables (elevation, slope, and geology). Capture rates of both salamanders were negatively associated with elevation (western red-backed salamander: $F_{1,94} = 141.570$, $p < 0.001$; ensatina: $F_{1,94} = 23.499$, $p < 0.001$; Figure 13). We detected ensatina at elevations from 35 to 1345 m, and western red-backed salamanders between 35 and 1235 m. Both were also negatively associated

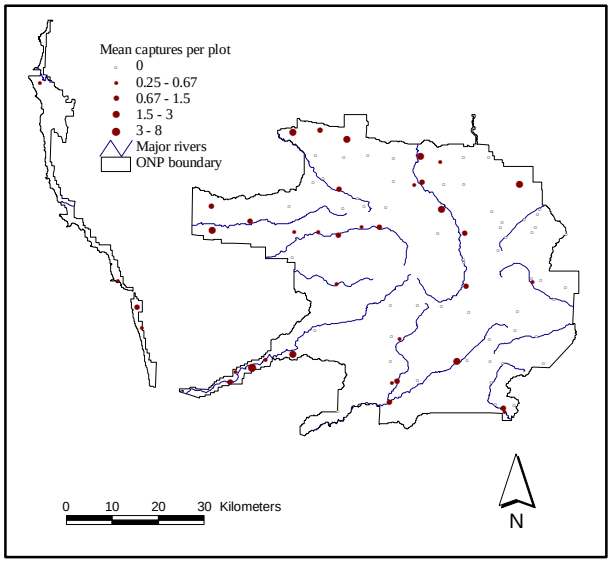

Figure 11. Relative abundance of ensatina salamanders in ONP represented by mean captures per plot during FIA and IF surveys.

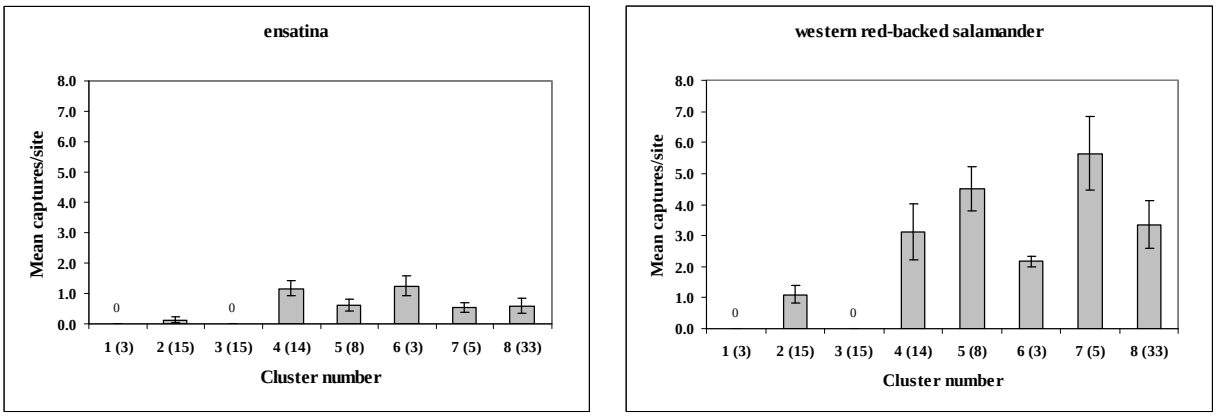

Figure 12. Relationship of mean salamander captures to vegetation clusters. Numbers in parentheses on the x-axes indicate the number of surveys in each vegetation cluster. Error bars are SEM. Plant species associated with each cluster are detailed in Table 4.

Table 4. Dominant plant species associated with vegetation cluster analysis.

Cluster	Dominance	Canopy	Understory
1	1	*Tsuga heterophylla* (western hemlock)	*Achlys triphylla* (vanilla leaf)
	2	*Pseudotsuga menziesii* (Douglas-fir)	*Athyrium filix-femnina* (lady fern)
	3	*Alnus rubra* (red alder)	*Linnaea borealis* (twinflower)
2	1	*Abies amabilis* (Pacific silver fir)	*Vaccinium* spp.
	2	*Tsuga heterophylla* (western hemlock)	*Abies amabilis* (Pacific silver fir)
	3	*Pseudotsuga menziesii* (Douglas-fir)	*Tsuga heterophylla* (western hemlock)
3	1	*Abies amabilis* (Pacific silver fir)	*Vaccinium* spp.
	2	*Pseudotsuga menziesii* (Douglas-fir)	*Abies amabilis* (Pacific silver fir)
	3	*Thuja plicata* (western red cedar)	*Thuja plicata* (western red cedar)
4	1	*Pseudotsuga menziesii* (Douglas-fir)	*Polystichum munitum* (sword fern)
	2	*Tsuga heterophylla* (western hemlock)	*Gaultheria shallon* (salal)
	3	*Thuja plicata* (western red cedar)	*Berberis nervosa* (Oregon grape)
5	1	*Tsuga heterophylla* (western hemlock)	*Polystichum munitum* (sword fern)
	2	*Pseudotsuga menziesii* (Douglas-fir)	*Oxalis oregana* (oxalis)
	3	*Thuja plicata* (western red cedar)	*Rubus spectabilis* (salmonberry)
6	1	*Tsuga heterophylla* (western hemlock)	*Gaultheria shallon* (salal)
	2	*Thuja plicata* (western red cedar)	*Vaccinium* spp.
	3	*Pseudotsuga menziesii* (Douglas-fir)	*Blechnum spicant* (deer fern)
7	1	*Picea sitchensis* (Sitka spruce)	*Oxalis oregana* (oxalis)
	2	*Tsuga heterophylla* (western hemlock)	*Polystichum munitum* (sword fern)
	3	*Alnus rubra* (red alder)	*Vaccinium* spp.
8	1	*Tsuga heterophylla* (western hemlock)	*Vaccinium* spp
	2	*Pseudotsuga menziesii* (Douglas-fir)	*Gaultheria shallon* (salal)
	3	*Thuja plicata* (western red cedar)	*Tsuga heterophylla* (western hemlock)

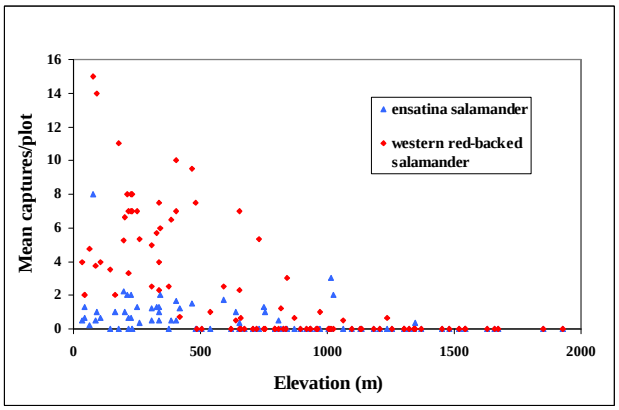

Figure 13. Relationship between mean salamander captures per plot and elevation (m). These data include FIA and IF sites.

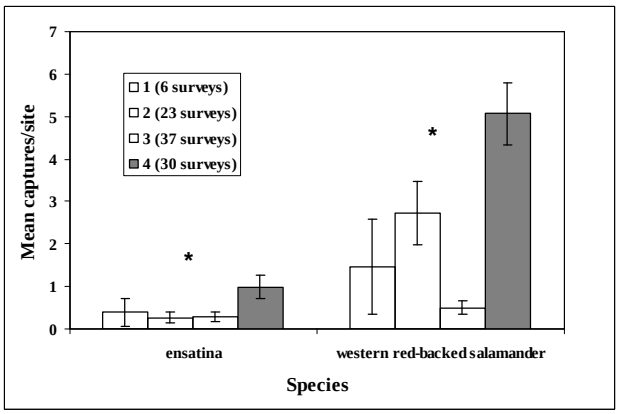

Figure 15. Relationship between mean salamander captures and surface geology at FIA and IF sites. Sites were ranked on a scale of 1-4, with "1" being the most consolidated (e.g., basalt, breccia) and "4" being the least consolidated (e.g., alluvial and landslide deposits). Error bars are SEM; an asterisk indicates $p < 0.05$ comparing mean captures among surface geology categories within species.

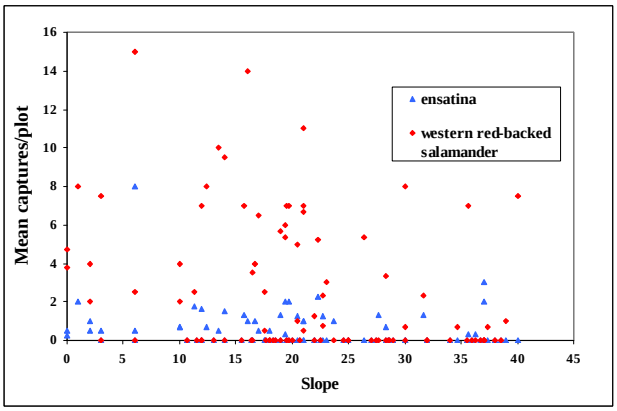

Figure 14. Relationship between mean salamander captures per plot and percent slope. These data include FIA and IF sites.

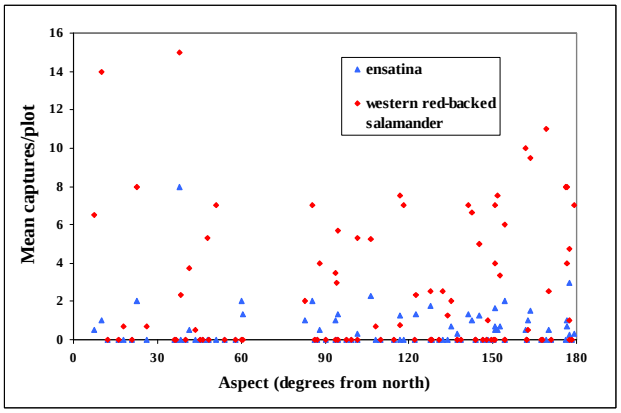

Figure 16. Relationship between mean salamander captures per plot and aspect (degrees deviance from north). Data are from FIA and IF sites.

with slope (western red-backed salamander: $F_{1,93} = 9.344$, $p = 0.003$; ensatina: $F_{1,93} = 4.546$, $p = 0.036$; Figure 14). Differences in surface geology (*i.e.*, the degree of consolidation of the substrate) appear to be important to both western red-backed salamanders ($F_{3,92} = 17.445$, $p < 0.001$) and ensatina ($F_{3,92} = 2.903$, $p = 0.039$; Figure 15). Both species were captured at higher rates in areas with less consolidated substrates. Capture rates for both species were unrelated to aspect (western red-backed salamander: $F_{1,93} = 0.462$, $p = 0.499$; ensatina: $F_{1,93} = 0.202$, $p = 0.654$; Figure 16), indicating that in ONP, salamanders exhibited no tendency towards either warmer, south-facing slopes or cooler, north-facing slopes.

The relative abundance of western red-backed salamanders was positively associated with the amount of coarse woody debris in decay classes I and II ($F_{1,94} = 6.271$, $p = 0.014$; $F_{1,94} = 6.696$, $p = 0.011$, respectively; Figure 17), but we did not find an association with coarse woody debris in decay class III ($F_{1,94} = 3.680$, $p = 0.058$). We were unable to find a relationship between the relative abundance of ensatina with downed wood in any decay class (I: $F_{1,94} = 0.480$, $p = 0.505$; II: $F_{1,94} = 1.022$, $p = 0.315$; III: $F_{1,94} = 2.436$, $p = 0.122$) .

Average captures of both ensatina and western red-backed salamanders were higher at sites with a high percentage of canopy cover (western red-backed salamander: $F_{1,94} = 11.623$, $p < 0.001$; ensatina: $F_{1,94} = 7.708$, $p = 0.006$; Figure 18). We did not find an association between the relative abundances of either species with grass cover (western red-backed salamander: $F_{1,94} = 0.226$, $p = 0.635$; ensatina: $F_{1,94} = 2.670$, $p = 0.106$; Figure 19). However, both species were positively associated with moss cover (western red-backed salamander: $F_{1,94} = 18.591$, $p < 0.001$; ensatina: $F_{1,94} = 5.474$, $p = 0.021$; Figure 20).

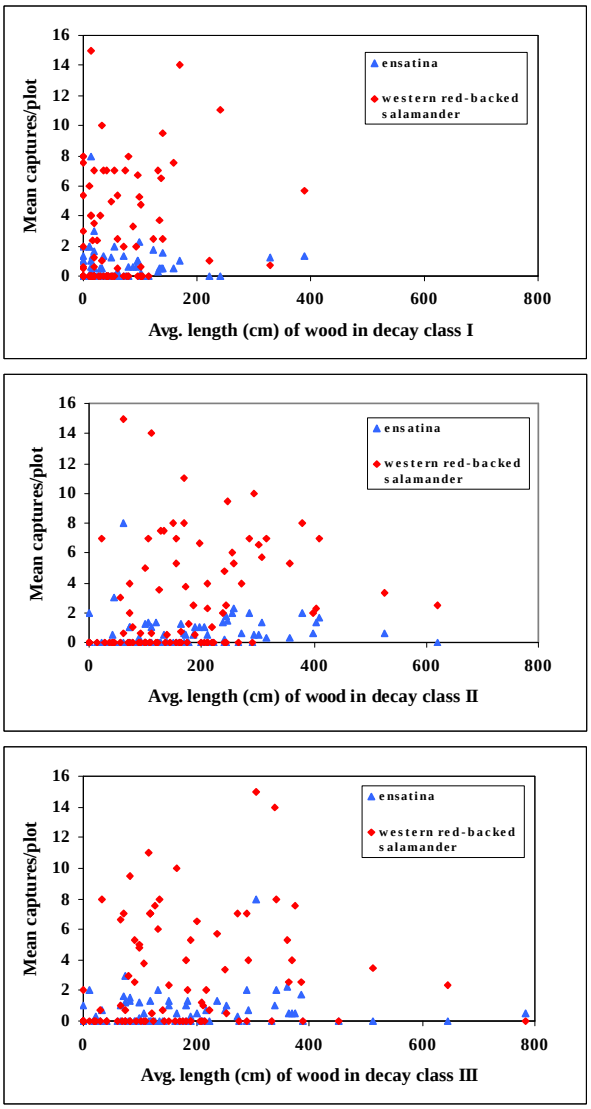

Figure 17. Relationship between mean salamander captures and the average length (cm) of coarse woody debris per plot at FIA and IF sites. Coarse woody debris was partitioned into three decay classes (I = bark still intact, little decay; II = moderate decay, bark loose and falling off; III = major decay, no bark, mushy). Length is the total distance that four 10 m transects overlapped downed wood greater than 10 cm in diameter.

Mean captures did not vary significantly between sites with and without talus for both ensatina ($F_{1,94} = 0.196$, $p = 0.659$) and western red-backed salamanders ($F_{1,94} = 0.853$, $p = 0.358$; Figure 21). We did not find a relationship between the relative abundance of ensatina ($F_{1,94} = 0.035$, $p =$

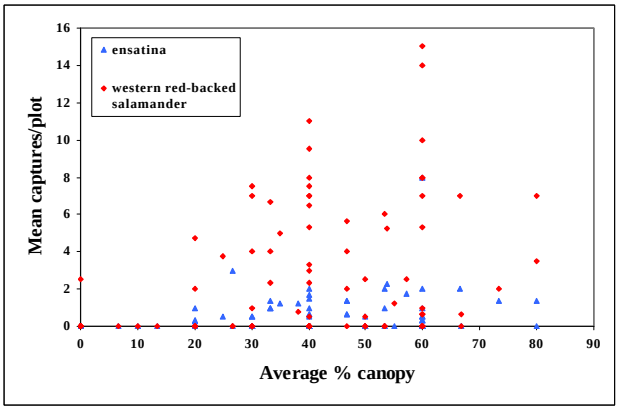

Figure 18. Relationship between mean salamander captures and average percent canopy cover per plot at FIA and IF sites.

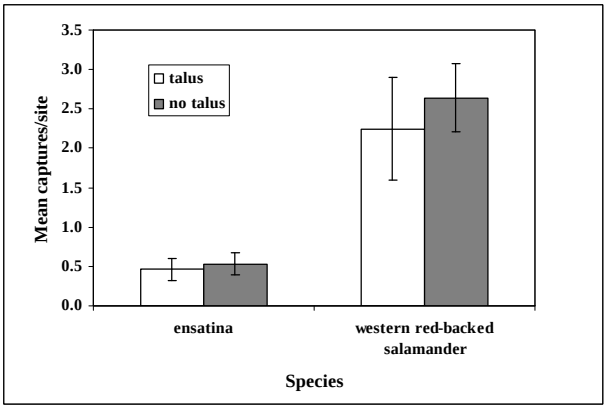

Figure 21. Relationship between average salamander captures and the presence of talus at FIA and IF sites. Error bars are SEM.

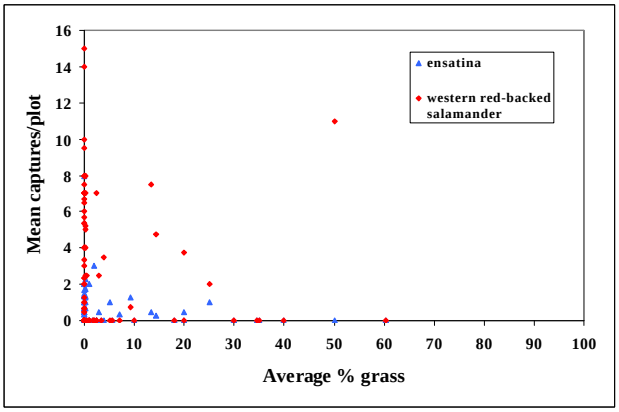

Figure 19. Relationship between mean salamander captures and average percent grass cover per plot at FIA and IF sites.

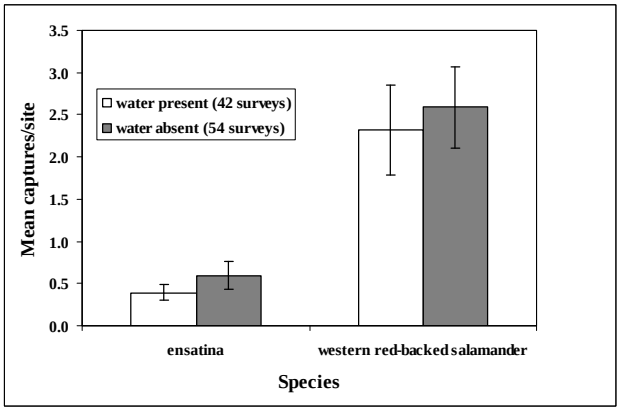

Figure 22. Relationship between mean salamander captures and the presence of water at FIA and IF sites. Error bars are SEM.

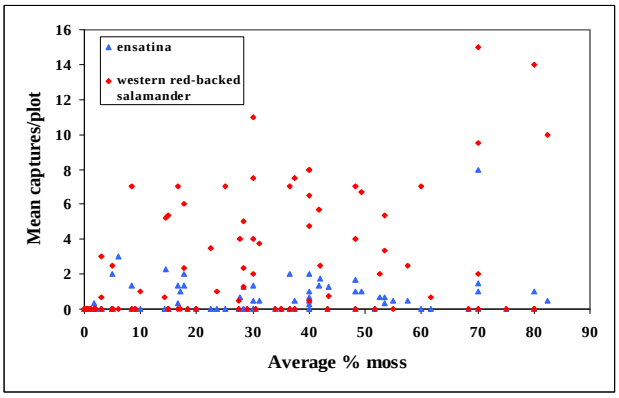

Figure 20. Relationship between mean salamander captures and increasing presence of moss within a plot. Data are from FIA and IF sites.

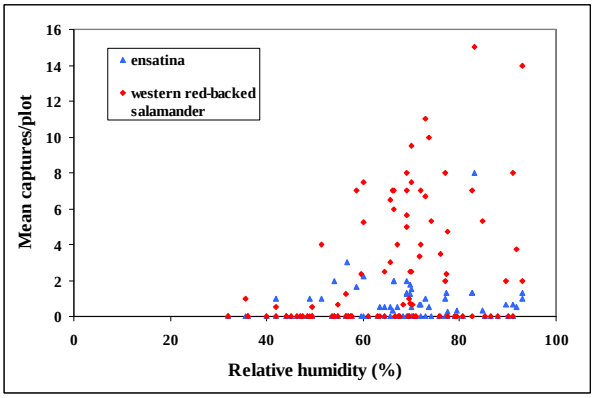

Figure 23. Relationship between relative humidity and mean salamander captures during surveys of FIA and IF sites.

0.852) or western red-backed salamanders ($F_{1,94}$ = 0.200, p = 0.656; Figure 22) with the presence of water within a site.

Ensatina and western red-backed salamander captures were positively associated with relative humidity ($F_{1,93}$ = 4.132, p = 0.045; $F_{1,93}$ = 17.824, p < 0.001, respectively; Figure 23) but showed no association with air temperature ($F_{1,93}$ = 3.168, p = 0.078; $F_{1,93}$ = 3.878, p = 0.052, respectively; Figure 24). Ensatina were more abundant during precipitation events ($F_{1,94}$ = 5.368, p = 0.023), while capture rates of western red-backed salamanders did not differ between categories ($F_{1,94}$ = 2.738, p = 0.101; Figure 25). Wind conditions did not affect mean salamander captures (western red-backed salamander: $F_{1,94}$ = 2.667, p = 0.105; ensatina: $F_{1,94}$ = 0.667, p = 0.413; Figure 26).

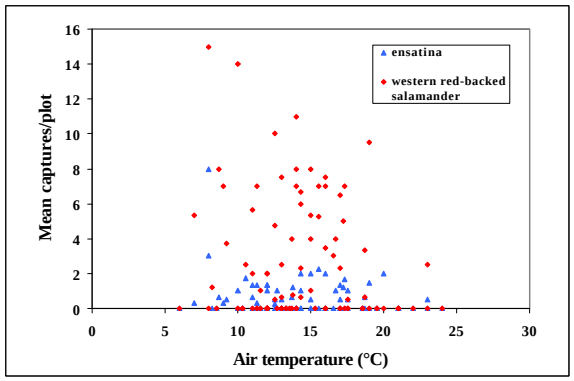

Figure 24. Relationship between mean salamander captures and air temperature (°C) during surveys of FIA and IF sites.

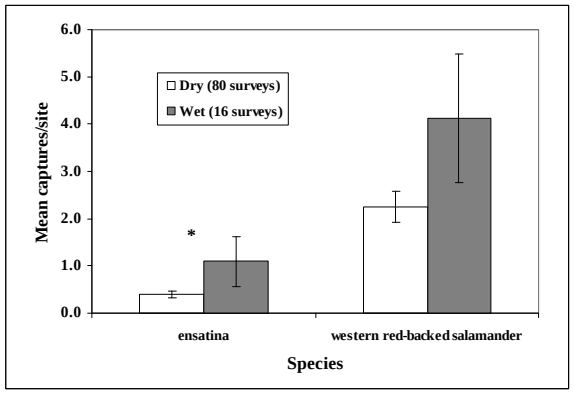

Figure 25. Relationship between mean salamander captures and precipitation during surveys of FIA and IF sites. Error bars are SEM, an asterisk indicates p < 0.05.

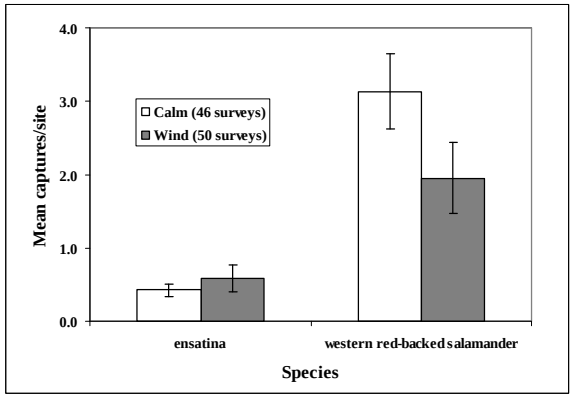

Figure 26. Relationship between mean salamander captures and wind conditions during FIA and IF surveys. Error bars are SEM.

Discussion

Inventory

We detected four out of the seven reptiles that were listed by the NPS as potentially occurring in Olympic National Park (Table 1). The northwestern and common garter snakes were frequently detected during Incidental surveys where specific habitat could be targeted. A single record exists for the western terrestrial garter snake (*T. elegans*) on the Olympic Peninsula outside of the ONP boundary (McAllister, 1995), but this species was not detected during our surveys. A single unconfirmed sighting of *T. elegans* was reported during an unrelated survey inside the park in 2001. Garter snakes can be difficult to identify and even concrete features like scale counts can overlap among species. Because of the paucity of good records, we consider it unlikely that *T. elegans* occurs in ONP. We also did not detect sharp-tailed snakes (*Contia tenuis*) or western fence lizards (*Sceloporus occidentalis*). Sharp-tailed snakes are only patchily distributed in the extreme northwest United States and southwest Canada, with the nearest population to ONP occurring at the southern end of Vancouver Island and a pos-

sibly extirpated population recorded in the Tacoma area (St. John, 2002). Western fence lizards are currently only known in Washington from beaches around the Puget Sound. Because of this narrow habitat association, western fence lizards were an unlikely candidate for occurrence in the park. Despite this, we speculated that they might find appropriate habitat around gravel bars on rivers. Repeated searches of such habitats failed to detect this species and we conclude that it is highly unlikely that they occur in the park.

We detected 13 out of 15 amphibians that were listed by the NPS as potentially occurring in Olympic National Park (Table 1). The only species missing were the bullfrog (*Rana catesbeiana*) and the Pacific giant salamander (*Dicamptodon tenebrosus*). Giant salamanders in this region are split into two genetically and morphologically distinct species (*D. copei* and *D. tenebrosus*). These species are only known to be sympatric in northwestern Oregon and southwestern Washington (Good, 1989). Cope's giant salamanders inhabit the Olympic Peninsula and southwestern Washington (including the southern Washington Cascades and the Willapa Hills), while Pacific giant salamanders occupy a much greater range to the east and south of ONP. We see no reason why *D. tenebrosus* could not occur in ONP but numerous surveys of stream habitats inside and outside the park have failed to detect them on the Olympic Peninsula (Bury and Adams, 2000; Adams and Bury, 2002; Raphael *et al.*, 2002). Non-native bullfrogs are one of the warmest adapted ranids in North America. A few scattered populations are found on the west, south, and east margins of the Olympic Peninsula, but none have been found in the park by this or other surveys (Bury and Adams, 2000; Adams *et al.*, 2001). Bullfrogs are generally restricted to warmer, lower elevation ponds, but their occupancy of colder, higher elevation ponds is not unheard of (Corkran and Thoms, 1996). The coastal strip of ONP and rare low elevation ponds (ca. < 600m) are candidates for bullfrog invasion, but our surveys did not detect them.

Our detections of Van Dyke's salamanders were infrequent. Van Dyke's salamanders exist in small, isolated populations (Leonard *et al.*, 1993) and tend to be habitat specialists, dwelling in and around rocky seeps or stream banks and sometimes in dry streambeds. They are technically terrestrial breeders, and thus a focus of our surveys, but are thought be closely tied to water and are frequently sampled in association with stream and seep surveys. We anticipated that we would detect Van Dyke's salamanders more often during the Incidental surveys focused on these specific habitats. Contrary to our expectations, we detected them more during FIA surveys than during Incidental surveys. However, approximately 75% of the captures were on FIA sites possessing streams or seeps. All captures of Van Dyke's salamanders occurred in the moisture-rich area of the park to the west and/or south of the Olympic range within in the Sol Duc, Bogachiel, Hoh, and Quinault river drainages.

Sampling

This study was not designed to compare sampling designs. However, our use of both a probabilistic design and a more opportunistic approach allows a rough comparison of their effectiveness. The reason we used a probabilistic sampling frame (the FIA sites) was to have a known range of inference. This goal was compromised by the fact that we were unable to get to many of the sites we had originally hoped to sample. Despite this shortcoming, the surveys of FIA points still provide data that are only biased by hard-to-define access constraints. In other words, these data are much better than the data we collected in a more directed

fashion at characterizing the relative abundance of amphibians and reptiles in the park. A shortcoming that may be more important than the compromised range of inference is that these surveys missed some rare species. For example, three species were only detected by Incidental and IF surveys. The Incidental surveys were especially good at sampling rare species or habitats. However, they are not at all representative of the relative abundance of amphibians and reptiles in the park. Overall, terrestrial salamanders were effectively detected by FIA surveys. However, Incidental surveys were more effective than FIA surveys for detecting reptiles and some amphibians in ONP. This is consistent with our expectations because two of the three terrestrial salamanders are abundant and widespread while reptiles are rare.

Studies for non-game species are perpetually under-funded and under-staffed, and are often confined to relatively short sampling seasons. We were interested in whether or not salamanders would be active enough to be detectable during hot, dry conditions, and if it would be cost-effective to survey when conditions were not optimal. Terrestrial amphibians are prone to desiccation in hot, dry conditions, and limit their surface activity when conditions are unfavorable (Shoemaker *et al.,* 1992). In addition, time spent on the surface (*e.g.*, foraging) increases a salamander's chance of being detected by predators. Feder (1983) proposed that hydroregulation was the main factor influencing the foraging strategy of plethodontids, and that the primary factors in determining the duration of foraging (and therefore detection) are body mass, air temperature, relative humidity and wind speed. It stands to reason that the availability of moisture, whether in the form of humidity, precipitation, or other water sources would affect our counts of terrestrial salamanders. We found that the mean captures of ensatina and western red-backed salamanders did not significantly differ across temperature and wind gradients, but counts of both species were positively associated with relative humidity. However, contrary to our expectations, capture rates at our verification sites showed no trend throughout the spring and summer. We hypothesize that ONP's dense, moist forests with abundant coarse woody debris may allow terrestrial salamanders to remain active longer than they do in forests managed for timber production.

Habitat Associations

The two most common species found at the FIA/IF sites were the ensatina and the western red-backed salamander. Western red-backed salamanders are wide-ranging and are the most abundant of plethodontid in the Pacific Northwest (Leonard *et al.,* 1993). They range from Vancouver Island, British Columbia to southwestern Oregon (Nussbaum *et al.,* 1983). Ensatina have a similar distribution ranging from Vancouver Island into northern California. Both species occupy a wide range of forest habitats.

Many studies have focused on stand age and moisture gradients as indicators of terrestrial amphibian abundance in Pacific Northwest forests. Olympic National Park is relatively pristine, and contains large-scale, contiguous stands of old forests that encompass a wide spectrum of forest ages, moisture regimes, and elevations. However, the relative cover of early seral stands is very low. The steep elevational gradients of ONP make it possible to sample amphibians under a diverse range of environmental conditions. Ensatina and western red-backed salamanders are generally thought to prefer upland habitats on steep slopes at low- to mid-elevations (Aubry and Hall, 1991; Bury *et al.,* 1991; Corn and Bury, 1991; Gilbert and Allwine, 1991; McComb *et al.,* 1993b). In our study, both species were negatively

associated with increasing slope. Because of ONP's dramatic and abrupt topography, slope is closely tied to elevation (r = 0.45) and our result may be an artifact of that correlation. Captures of both species did not differ with aspect, suggesting that the heat and moisture stress prevalent on south-facing slopes in drier or more exposed landscapes is not present in ONP.

Relative abundance of ensatina is usually lower in high-moisture sites (Bury *et al.,* 1991; Gilbert and Allwine, 1991; McComb *et al.,* 1993b; Gomez and Anthony, 1996), particularly those with standing water present (Aubry and Hall, 1991). While there have been some occurrences of western red-backed salamanders occupying habitat around seeps and springs (Leonard, 1996; Wilkins and Peterson, 2000), they tend to be more associated with drier environments (Nussbaum *et al.,* 1983; Stebbins, 1985). We did not find capture rates of either species to be statistically different between sites with and without standing or flowing water. Precipitation events during surveys resulted in significantly higher mean capture rates for ensatina salamanders but did not affect the mean capture rates for western red-backed salamanders. This result should be taken with caution due to the disparity between the number of dry (no precipitation during survey, n = 80) and wet (precipitation during survey, n = 16) surveys.

A key microhabitat feature of many herpetofaunal communities is talus or loose, rocky substrate. Talus is utilized in many ways, including thermoregulation, refuge, and reproduction (Herrington, 1988). In general, terrestrial salamanders tend to be observed in higher numbers in areas containing loose rock (Herrington, 1988; Bury *et al.,* 1991; Corn and Bury, 1991), although in some instances they may actually be negatively associated with exposed rock (Aubry, 2000). Our findings did not reveal a strong association between counts of either salamander and rocky substrate in ONP. Talus is usually considered to be hard (*e.g*., basaltic), exposed rock rubble (Herrington, 1988), although we included any loose, rocky areas as talus. Mean captures of both ensatina and western red-backed salamanders were higher in ONP on sites with less consolidated substrate. It is possible that marginally subsurface talus was present and not detected by our crews, and that we underestimated the association of plethodontids with talus in ONP.

High canopy cover (Welsh and Lind, 1991) and moss (Ovaska and Gregory, 1989) appear to be indicators of favorable salamander habitat. Canopy cover keeps forest temperatures cooler and more stable. Moss, the presence of which generally indicates a relatively moist climate (Pojar and MacKinnon, 1994), serves to retain moisture and facilitates salamander dispersal (Dupuis, *et al.*, 1995). Both ensatina and western red-backed salamanders were strongly associated with increased percentages of canopy and moss coverage. A high percentage of grass cover suggests a more open overstory, resulting in greater penetration of sunlight, lower moisture retention and higher temperature fluctuations. Despite these seemingly unfavorable conditions, ensatina and western red-backed salamanders did not show a negative association with increasing grass cover.

The composition of the overstory species in the vegetation clusters that we produced was generally quite similar. Most clusters were dominated by Douglas-fir (*Psuedotsuga menziesii*) and western hemlock (*Tsuga heterophylla*). The understory species were more varied with sword fern (*Polystichum munitum*) and salal (*Gaultheria shallon*) as common but not dominant species. We found ensatina to be abundant in clusters with ferns (similar to Butts and McComb, 2000) and berry-producing

shrubs. Besides ferns and berry-producing shrubs, western red-backed salamanders were most abundant in clusters containing oxalis (*Oxalis oregana*). We did not detect either species in clusters whose understory was dominated by coniferous seedlings. The more structurally complex vegetation may provide more cover, retain more moisture, or generate more leaf litter, all of which are components of favorable plethodontid salamander habitat (Nussbaum *et al.,* 1983).

Old-growth forests are characterized by large loads of downed wood, sometimes covering as much as 25% of the forest floor (Harmon and Chen, 1991). Coarse woody debris is considered one of the most important structural elements of Pacific Northwest forests (Marra and Edmonds, 1994), and many studies have shown a positive association between terrestrial amphibians and coarse woody debris (Aubry *et al.,* 1988; Aubry and Hall, 1991; Corn and Bury, 1991; Welsh and Lind, 1991). Western red-backed salamanders are thought to use downed wood in most states of decomposition (Aubry *et al.,* 1988; Corkran and Thoms, 1996), which generally corresponds to what we found in ONP. However, we did not find ensatina to be significantly associated with downed wood of any type, supporting Aubry (2000) but contrary to Aubry, *et al.*, (1988), Corn and Bury (1991), and Welsh and Lind (1991), which all report associations with well-decayed wood. That we did not find an association between ensatina and well-decayed wood could be attributed to a number of factors. It is possible that the amount of coarse woody debris available in ONP (discussed below) is high enough that the association of ensatina with downed wood is not as obligatory compared to other areas where downed wood is scarce. It is also possible that ensatina occupying large, well-decayed logs were under-sampled due to our practice of non-destructive sampling.

Densities of terrestrial salamanders vary across forest age (Aubry *et al.,* 1988; Welsh and Lind, 1988; Bury *et al.,* 1991; Corn and Bury, 1991; Dupuis *et al.,* 1995; Dupuis and Bunnell, 1999; Aubry, 2000), moisture gradient (Aubry *et al.,* 1988; Welsh and Lind, 1988), and forest management practices (Cole *et al.,* 1997; Grialou *et al.,* 2000; Vesely and McComb, 2002). However, comparing the densities of terrestrial salamanders in ONP to other studies is problematic for a number of reasons. Most studies of terrestrial salamanders in the Pacific Northwest are dominated by pitfall trapping methods (Bury *et al.,* 1991; Corn and Bury, 1991; McComb *et al.,* 1993a; McComb *et al.,* 1993b; Gomez and Anthony, 1996; Cole *et al.,* 1997; Aubry, 2000; Grialou *et al.,* 2000), making direct comparisons of salamander densities impossible. In the few studies that employ time- or area-constrained searches similar to our methods (Dupuis *et al.,* 1995; Dupuis and Bunnell, 1999; Butts and McComb, 2000; Vesely and McComb, 2002), search effort is disparate enough to allow only coarse comparisons. For example, Dupuis *et al.,* (1995) conducted searches on Vancouver Island on $90m^2$ plots for ~5 hours, reporting mean captures of western red-backed salamanders of ~1459 individuals/ha in old-growth forest. Our surveys covered $2827m^2$ plots for 2 hours, resulting in a mean captures of 8.85 western red-backed salamanders/ha (the mean density for ensatina salamanders was 1.95 individuals/ha). We would need to extend our search effort to 157 hours to mirror the prior study.

To further illustrate this point, we compared our search efforts with the aforementioned studies by estimating catch per unit effort (individuals captured/ha) and catch per unit time (individuals captured/worker-hour) based upon the data reported. We then calculated an index of search intensity, which we define as the time

Table 5. Comparison of density estimates among area-constrained surveys of terrestrial salamanders in the Pacific Northwest. Data presented are estimates and/or averages of values reported. The unit of measure for catch per unit area (CPUA) is individuals captured per hectare, and the unit of measure for catch per unit time (CPUT) is individuals captured per worker-hour. The intensity index represents the amount of time spent (in worker-hours) per unit area (hectare).

		Managed/Logged			***Unmanaged/Unlogged***		
Author	**Salamander**	**CPUA**	**CPUT**	**Intensity Index**	**CPUA**	**CPUT**	**Intensity Index**
Dupuis, *et al.* (1995)	western red-backed	260	0.468	725	1459	2.63	775
Dupuis & Bunnell (1999)	western red-backed	251	0.346	725	1433	1.85	775
Butts & McComb (2000)	ensatina	130	0.99	133	NA	NA	NA
Vesely & McComb (2002)	western red-backed	184	3.68	50	280	5.6	50
ONP FIA/IF surveys	western red-backed	NA	NA	NA	8.85	1.26	7.07
	ensatina	NA	NA	NA	1.95	0.26	7.07

spent searching per unit area (worker-hours/ha) (Table 5). In unmanaged/unlogged stands, the number of individuals captured per hectare rose proportionately to the intensity index (*i.e.*, increasing the time spent searching a particular area resulted in an increased number of individuals captured). More telling in terms of cost-effectiveness is the comparison between the number of individuals captured per worker-hour and the intensity index. The number of individuals captured per worker-hour does not increase proportionately to the intensity of the search effort; past a certain threshold, spending more time searching does not appear to increase the number of animals captured.

Comparing salamander densities between our surveys and others is further complicated by the environmental heterogeneity of ONP relative to other study sites. Dupuis *et al.,* (1995) acknowledge that old-growth forests can be structurally complex and inherently difficult to accurately sample terrestrial salamanders. The amount of downed wood in ONP, combined with a non-destructive sampling protocol, may have affected our ability to thoroughly sample terrestrial salamanders. In a wide-ranging study across multiple habitat and forest types, Ohmann and Waddell (2002) examined regional patterns of dead wood across Oregon and Washington. For coarse woody debris ≥ 12.5cm in diameter, they found the mean percent cover to be from 0.2% in early-stage western juniper forests to 5.6% in late-stage conifer and Sitka spruce/western hemlock forests. We found downed wood covering an average of 8.3% (range 0-23%) of our survey sites in ONP. Our data represent downed wood ≥ 10cm in diameter (and therefore include more wood than Ohmann and Waddell) so the degree to which coarse woody debris in ONP exceeds

amounts elsewhere may be overstated by this comparison. However, our data suggest ONP has amounts of coarse woody debris approaching the high end of the range for the Pacific Northwest. We feel that this structural complexity, combined with the non-destructive and low-intensity methodology that we used, may explain the unexpectedly low densities of western red-backed and ensatina salamanders in ONP.

Despite the steep environmental gradients in ONP, ensatina and western red-backed salamanders were widely distributed and only were limited by high elevations. We did find associations with other environmental variables, but none exhibited strong controls on distribution and abundance. The strongest of these were percent canopy and moss cover but, consistent with previous studies, we conclude that these species are habitat generalists in the forests of the western Pacific Northwest.

Pond, Stream, and Seep Surveys

Introduction

From 1995-1998, we conducted an inventory of pond-, stream-, and seep-breeding amphibians (Bury and Adams, 2000). In that effort, there were some drainages that we were either unable to sample, or were under-sampled. In 1999, we conducted additional surveys to complete the earlier effort. For details on study design and methodology, please see the earlier report (Bury and Adams, 2000).

Our first objective was to survey the gravel bar pools of the Quinault, Queets, and Skokomish rivers on the west side of ONP for the presence of breeding populations of the western toad (*Bufo boreas*). We choose these drainages because of their wide valley floors and easily accessible gravel bars. In the Pacific Northwest, the western toad breeds in habitats ranging from sea level dune ponds to the shallows of lakes and ponds in high mountainous areas. Our previous surveys of high elevation ponds and lakes revealed few toad populations. This is a cause for concern as toads are declining in many parts of their range (Corn *et al.,* 1989). We had not previously surveyed gravel bar habitats but had heard that they can host toads (Peterson pers. comm.). Our second objective was to continue pond amphibian surveys throughout ONP. Only a few scattered drainages had been previously surveyed. Our third objective was to survey streams and seeps in the Duckabush, the last major drainage to remain unsurveyed in the park. We also continued stream monitoring in the Elwha to increase our knowledge of seasonal variability. These data, together with data from previous years, provide baseline information on the distribution of pond, stream, and seep breeding amphibians in the park.

Methods

Gravel Bar Surveys

We chose sections of the Quinault, Queets, and Skokomish rivers with large gravel bars containing pools suitable for western toad breeding habitat. The selection process was based on prior knowledge of accessible gravel bar habitats, although we also searched for additional gravel bars some distance (depending on accessibility and how much time we had) up and down stream from the gravel bars that we targeted. We visually surveyed individual pools within gravel bars for presence of amphibians, insects, and fish, and determined the positions of each pool and gravel bar with a GPS receiver. For each pool, we visually estimated the dominant substrate and average percent cover of emergent and overhanging vegetation, as well as pool length, width, and depth.

Pond Amphibian Surveys

We chose additional ponds to survey to increase our coverage of ONP. We tried to get even coverage of ONP and to choose ponds along routes where we could maximize the number of ponds surveyed. We did not use any form of randomization. We used USGS 7.5' Topographic and National Wetlands Inventory maps to locate water bodies prior to the each trip. We surveyed mapped ponds that were accessible and unmapped ponds that fell within 100 meters of a mapped pond or that were encountered in route to a mapped pond. To maximize detectability, we visited each wetland at least once during the summer months of 1999 when aquatic life stages of native amphibians were likely to be present and active. We sampled each wetland for amphibians using Visual Encounter Surveys (Thoms, *et al.*,

1997) and measured a variety of habitat variables.

Stream and Seep Amphibian Surveys

Our sampling methods followed the same protocol as described for NRPP stream surveys (Bury and Adams, 2000). The Duckabush drainage, located in the central-east side of ONP, was surveyed in 1999 for the first time. We also re-surveyed Mule Creek, which is located near the Elwha Ranger Station south of Griff Creek (Elevation: 400 m; UTM N 5317920, E 456240, NRPP Site #: 96243).

Results and Discussion

Gravel Bar Surveys

We surveyed 55 gravel bar pools in the Queets, Quinault, and Skokomish drainages in the southwestern and southeastern corners of ONP. We found three pools with western toads out of 13 pools in the Quinault and 11 with toads out of 28 pools in the Queets. Our surveys of the Skokomish drainage did not detect any toads in 14 pools surveyed (Table 6; Appendix I). We detected Pacific treefrogs (*Pseudacris regilla*) and red-legged frogs (*Rana aurora*) at 11 and 12 pools each in the Queets drainage.

Our surveys indicate that, while western toads are rare at high elevation ponds, they are more common along rivers in the southwest area of the park. We do not know the occurrence of toads in drainages around the northeast side of the park. Our data provide evidence that breeding populations of western toads (and other amphibian species) are present in gravel bar pools in the low elevation rivers of ONP. We do not know how common the western toads were historically in ONP, or whether their rarity at high elevation ponds represents a decline. Their use of gravel bar pools has not been previously described in the literature, but it appears to be an important habitat in ONP and further research is recommended.

Pond Amphibian Surveys

We surveyed 77 ponds at least once, and three ponds twice. For each species identified, we noted evidence of breeding (Figure 27; Appendix J). Our surveys covered ten drainages, and detected amphibians in each one (Table 7). We found western toads to be the least common and the Cascades frog (*Rana cascadae*) to be the most common species. Ponds with muddy substrate appeared to be the most likely to host amphibians but we detected Cascades frogs and northwest salamanders in ponds of with gravel and cobble substrate as well (Table 8). Site location maps are provided in Appendix K. Our 1999 surveys appear consistent with the previous findings that Cascade frogs are less likely to occur when exotic fish (introduced trout) were present. Further, long-toed salamanders (*Ambystoma macrodactylum*) never co-occurred with exotic fish. Ponds located in the low elevation, coastal strip of ONP had red-legged frogs, Pacific treefrogs, western toads, and northwestern salamanders (*Ambystoma gracile*) present during surveys.

Table 6. Number of pools with western toads present from surveys of gravel bars.

DRAINAGE	# OF GRAVEL BARS	# OF POOLS	# POOLS WITH TOADS
Quinault	2	13	3
Queets	4	28	11
Skokomish	4	14	0
Total	10	55	14

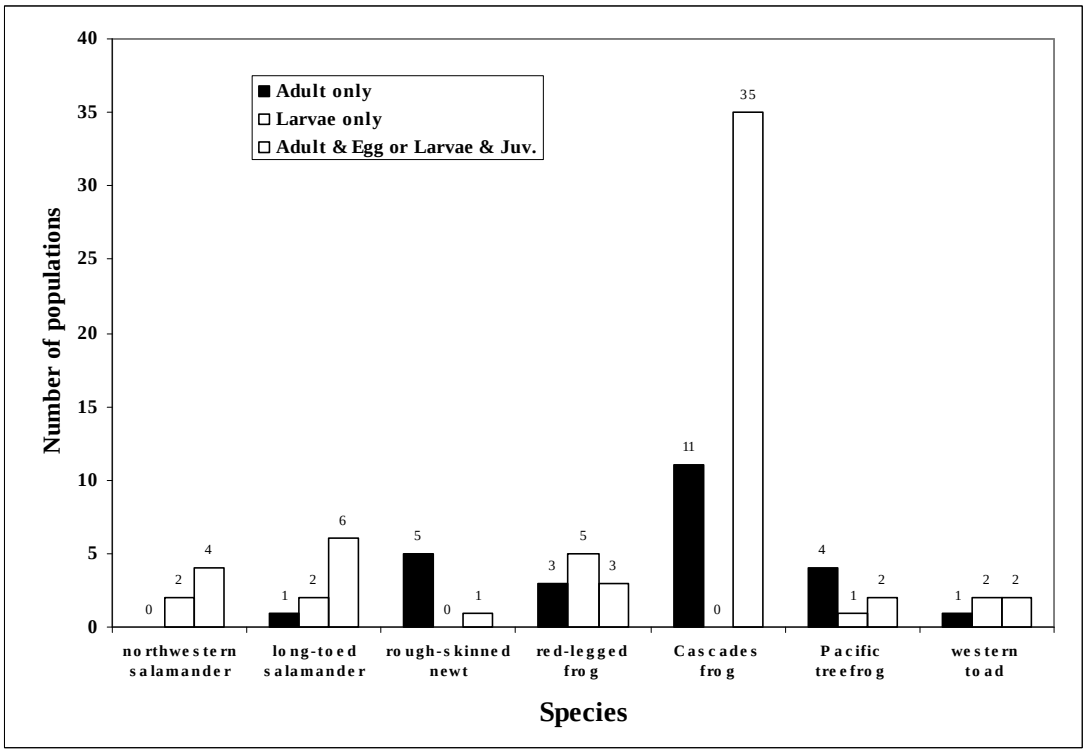

Figure 27. Number of amphibian populations detected by life stage during pond surveys, 1999.

Stream and Seep Amphibian Surveys

We conducted stream and seep surveys in the Elwha and Duckabush drainages. We had not previously surveyed the Duckabush drainage and found two amphibian species (Table 9). Out of 11 streams and seeps surveyed in the Duckabush, five had tailed frogs (*Ascaphus truei*) and one had Olympic torrent salamanders (*Rhyacotriton olympicus*). We did not detect any Cope's giant salamanders (*Dicamptodon copei*) at any of our survey sites in the Duckabush drainage.

Our surveys of Mule Creek (in the Elwha drainage) in 1999 supplemented previous surveys conducted in 1996 and 1998 (Table 10). Tailed frog abundance was higher in 1999 and only our 1999 survey detected a western red-backed salamander (one adult) and an Olympic torrent salamander (one larva, Table 10). Site location maps are provided in Appendix K.

Streams and seeps in the Duckabush and Elwha drainages appear to have abundant populations of tailed frogs, but we did not detect Cope's giant salamander in either drainage. Surveys from previous years failed to find Cope's giant salamanders from the Lyre River drainage (on the northwest corner of ONP) around the northeast side of the park to the Duckabush drainage on the southeast corner (Adams and Bury, 2002). However, it should be noted that the number of streams surveyed in the Duckabush and Morse drainages was low (five and six, respectively). The habitats in these drainages appear suitable for Cope's giant salamanders, and the potential causes for its absence should be investigated.

Table 7. Number of pond-breeding amphibian populations detected by drainage.

Drainage (# of surveys)	*Northwestern salamander*	*Long-toed salamander*	*Western toad*	*Pacific treefrog*	*Red-legged frog*	*Cascades frog*	*Rough-skinned newt*
Grey wolf (18)	0	10	0	0	0	14	0
Hoh (5)	3	0	0	3	5	0	1
Lyre (6)	3	1	1	3	1	5	3
Morse Creek (3)	0	1	1	1	0	3	1
North Fork Quinault (1)	1	0	1	1	1	0	1
Ozette (3)	2	0	1	1	3	0	0
Quinault (4)	2	0	0	0	0	2	0
Skokomish (29)	6	10	0	0	0	18	0
Sol Duc (4)	3	0	2	3	1	2	1
Wynoochee (7)	2	4	0	0	0	7	0
Total # of populations	22	26	6	12	11	51	7

Table 8. Proportion of ponds where each species of pond-breeding amphibian was detected during pond surveys. Numbers in parentheses indicate the number of ponds surveyed.

Species	Mud (50)	Gravel (16)	Cobble (6)	Other (2)	Total # detections
northwestern salamander	0.73	0.23	0.05	0.00	22
long-toed salamander	0.69	0.31	0.00	0.00	26
western toad	0.80	0.00	0.00	0.20	5
Pacific treefrog	1.00	0.00	0.00	0.00	7
red-legged frog	1.00	0.00	0.00	0.00	8
Cascades frog	0.74	0.16	0.10	0.00	31
rough-skinned newt	1.00	0.00	0.00	0.00	6

Table 9. Amphibian captures from 1999 stream/seep surveys in the Duckabush River drainage. Data represent larvae and adults.

SITE #	DRAINAGE	CLASS	UTM-N	UTM-E	ELEV (M)	*tailed frog*	*Cope's giant salamander*	*Olympic torrent salamander*	*western red-backed salamander*
99001	Duckabush	Stream	5282140	489660	1300	0	0	0	0
99002	Duckabush	Stream	5282120	489240	1350	13	0	0	0
99003	Duckabush	Stream	5282160	489060	1440	2	0	0	0
99004	Duckabush	Stream	5282000	488700	1440	0	0	0	0
99005	Duckabush	Stream	5281860	488660	1350	2	0	0	0
99102	Duckabush	Seep	5280650	486220	440	0	0	0	0
99104	Duckabush	Seep	5280600	486040	440	0	0	0	0
99114	Duckabush	Seep	5280020	484700	1520	0	0	0	0
99116	Duckabush	Seep	5279680	483980	1760	1	0	0	0
99118	Duckabush	Seep	5279710	483700	1800	1	0	0	0
99119	Duckabush	Seep	5279710	483600	1800	0	0	5	0

Table 10. Amphibian captures at Mule Creek survey site. Data represent larvae, metamorphs, and adults.

SITE #	DRAINAGE	YEAR	UTM-N	UTM-E	ELEV (M)	*tailed frog*	*Cope's giant Salamander*	*Olympic torrent Salamander*	*western red-backed salamander*
96243	Elwha	1996	5317920	456240	400	15	0	0	0
		1998				16	0	0	0
		1999				28	0	1	1

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Appendix A. Designing a Monitoring Plan for Terrestrial Salamanders

Introduction

Inventory data can be used to assist in the design of a long-term monitoring plan for terrestrial salamanders. Here, we demonstrate how data collected on terrestrial salamanders in Olympic National Park can be used to address issues of power and sample size in a monitoring program.

There are 3 primary factors that can affect the power of a terrestrial salamander monitoring program: 1) the number of plots to sample each field season; 2) the time interval between each sampling season; and 3) the number of times a plot will be sampled within each season. We will focus on the effects of varying the number of plots sampled on the power to detect negative population trends over a 20-year period. This section is meant to provide a guide for evaluating survey designs with the program MONITOR using data collected in the terrestrial amphibian inventory and is not intended to be an exhaustive evaluation of the possible sampling designs. Numerous designs can be examined in the program MONITOR by changing the input variables.

Methods

We used the program MONITOR (Gibbs 1995; freeware available at http://www.mp2-pwrc.usgs.gov/powcase/) to assess the effect of sample size on a 20-year monitoring program for ensatina (*Ensatina eschscholtzii*) and western red-backed salamanders (*Plethodon vehiculum*). To reduce the risk of biasing parameters we only used data collected from randomly selected plots to estimate the parameters needed by MONITOR. Detailed information about MONITOR can be found in the program manual (Gibbs 1995).

Plots

Number Monitored: This field specifies the total number of plots monitored. In our simulations we used 5, 10 and 15 as the number of 2827m^2 plots (same as the circular plots in our surveys) monitored.

Counts/Plot/Survey: This field specifies the number of times each plot is surveyed during each sampling period. We assumed that each plot would only be surveyed once during each sampling season, so we used a value of 1.

Initial Values: This field consists of three required value for each plot monitored: Plot Counts, Plot Variance, and Plot Weights.

> *Plot counts:* This field specifies the initial counts on each plot. It is typical to use the mean of the observed counts on a plot. In this simulation we did not have a specific set of sites we wanted to monitor. Instead, we generated random numbers from a Poisson distribution with a mean equal to the mean of the counts we observed on plots in our inventory. For western red-backed salamanders the mean of plot counts was 1.94 and for ensatina the mean of plot counts was 0.377.

Plot Variances: This field specifies the variation in counts on each plot and is input as the standard deviation of the counts per plot. This value is best calculated by taking repeated counts on the same plots within or between seasons. Repeated count data was unavailable at randomly selected plots, so we calculated the coefficient of variation (CV) for each aggregation of two or more plots, averaged these values and multiplied by the mean of plot counts to get the standard deviation. Sites with one plot were dropped from the CV calculation, because their variance and standard deviation is undefined. For western red-backed salamanders the standard deviation was 1.47 and for ensatina the standard deviation was 0.404.

Plot Weights: Plots can be weighted to give greater or lesser influence to specific plots. We did not use plot weighting, so all of the weights were set to 1.

Surveys

Number Conducted: This field specifies the total number of surveys to be performed on each plot. We used 1 survey every 5 years over a 20-year period, so we set this field to 4.

Occasions: This field specifies the interval between each survey. The first sample must occur at time zero and subsequent samples do not need to be evenly spaced. We used values of 0, 4, 9, 14, and 19 to represent one sample every 5 years for 20 years.

Trends

Type: This field specifies the type of trend expected in the data. Exponential trends were examined, because count data are usually log-normally distributed and trends in the data are expected to be multiplicative rather than linear.

Significance Level: This field specifies the significance level used to test trend significance. A significance level of 0.05 was used in all simulations.

Number of Tails: This field specifies whether a one or two-tailed t-test will be used to test for trend significance. We used a two-tailed test, because the direction of future population changes is not known in advance.

Trend Variation: This field specifies the amount that population trends vary among plots. This parameter was not measured, so we used the default value of 0.

Rounding: This field specifies if integers or decimal values are used in calculations. We chose whole number rounding as opposed to decimal values, because the values are population counts.

Trend Coverage: This field specifies trend magnitudes to be analyzed. We used the complete option to analyze 21 trends. The trends analyzed ranged from a –10% to a +10% change in population size per year with an increment size of one percentage point, but we focused on declines in our results and discussion.

Replications: This field specifies the number of iterations MONITOR will use to assess the power. To maximize precision this parameter was set to 10,000.

Results

The default output on MONITOR is the power to detect a population trend based on the percent change in the population per year. The power calculations were simulated over a 20-year span, so we converted the percent yearly population change to the percent change over a 20-year span. The conversions of annual population losses to 20-year population losses are shown in Table 11. The calculations in Table 11 assume that the annual population loss was constant throughout the 20-year period.

As one would expect, the power to detect trends increased with the number of sites surveyed and with increases in the magnitude of population declines (Figure 28 and Figure 29). For ensatina and western red-backed salamanders the power remained below 0.90 for sample sizes of 5 and 10 even though the population declined by 88% over the 20-year period. In both species the power exceeded 0.9 when the sample size was 15 and population losses of 60% or greater occurred.

Table 11. Relationship between percent annual population loss and percent loss after 20 years.

% population loss per year	% population loss after 20 years
0	0.00
1	18.21
2	33.24
3	45.62
4	55.80
5	64.15
6	70.99
7	76.58
8	81.13
9	84.84
10	87.84

Discussion

The number of plots surveyed greatly affects the power to detect population losses. With 15 plots surveyed, the power only begins to reach acceptable levels with population losses of 50% or more for both species. This analysis demonstrates that sample sizes will need to be relatively large to detect even large population trends.

The method we used to calculate plot variance was not ideal because repeated measurements on randomly selected sites were not available. Calculating the plot variance from the average CV of sites with multiple plots provides a reasonable estimate of this value, but the effect of varying population sizes between plots could potentially bias this estimate. Differing population sizes between plots will cause the site variance to represent variation in population size between plots rather than the variation due to sampling. The plots at each site were close together, so we assume the population size between plots did not vary too greatly.

We did not simulate the effects of trend variation on power and if present this can reduce the power to detect trends (Gibbs, 1995). We would expect population trends to vary across a region as the weather patterns, presence of stressors, and community structure changes. The presence of trend variation would require a larger sample size than a set of populations without trend variation to detect a trend of the same magnitude. If information on the source of the variation is available, analyzing clusters of similar populations separately could reduce the required sample size.

The data indicate that substantial differences in power to detect the same size trend can occur between species when using the same sample size. For ensatina and western red-backed salamanders the disparity in the power to detect equal magnitude population losses declined as the sample size increased. These data suggests the importance of performing power calculations for each species being monitored to ensure that the monitoring design is sufficient to detect trends in all species. We have provided general details on how to perform such an analysis if a monitoring plan will be initiated. There are numerous parameters that can be altered and we suggest examining the effects of altering each parameter before finalizing any monitoring design. Perhaps the greatest problem with monitoring terrestrial salamanders is that it is not clear what the counts represent. A substantial portion of the population may be unobservable during the survey and the proportion unobservable may be affected by numerous factors like temperature, humidity, and density of coarse woody debris. Thus, potential changes in the capture probability make count data difficult to interpret. Despite this problem, some authors recommend terrestrial salamanders for long term monitoring (Welsh and Droege, 2001).

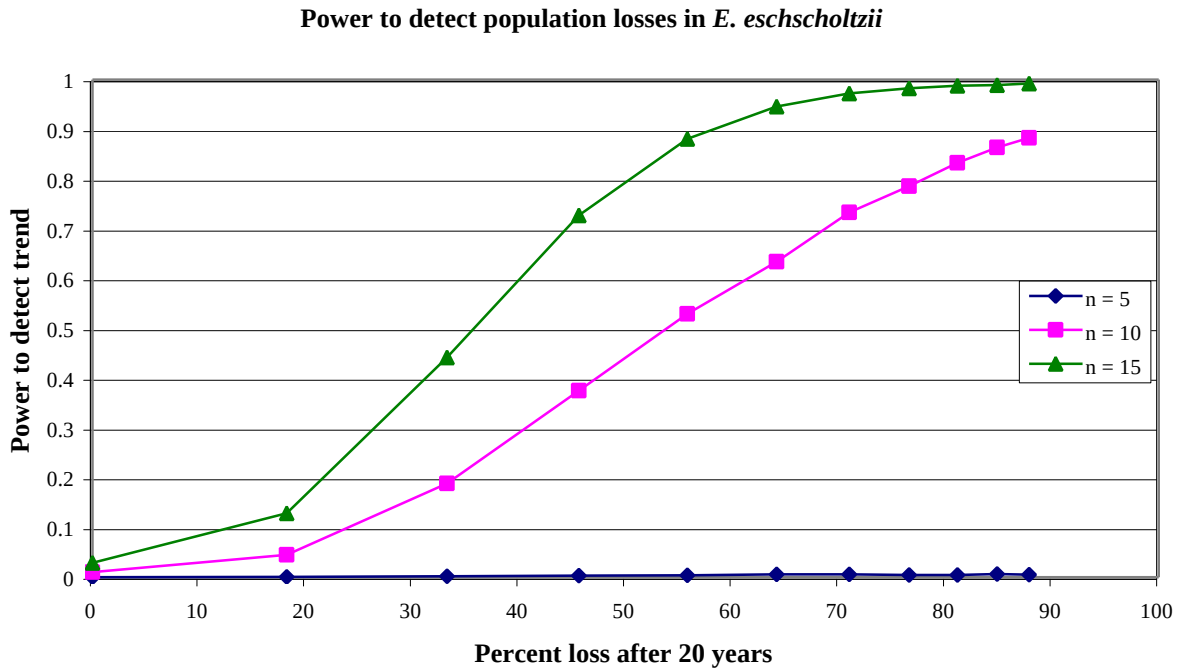


Figure 28. Power to detect 20-year population trends in ensatina at the a = 0.05 significance level. Calculations are based on sampling once every 5 years for 20 years.

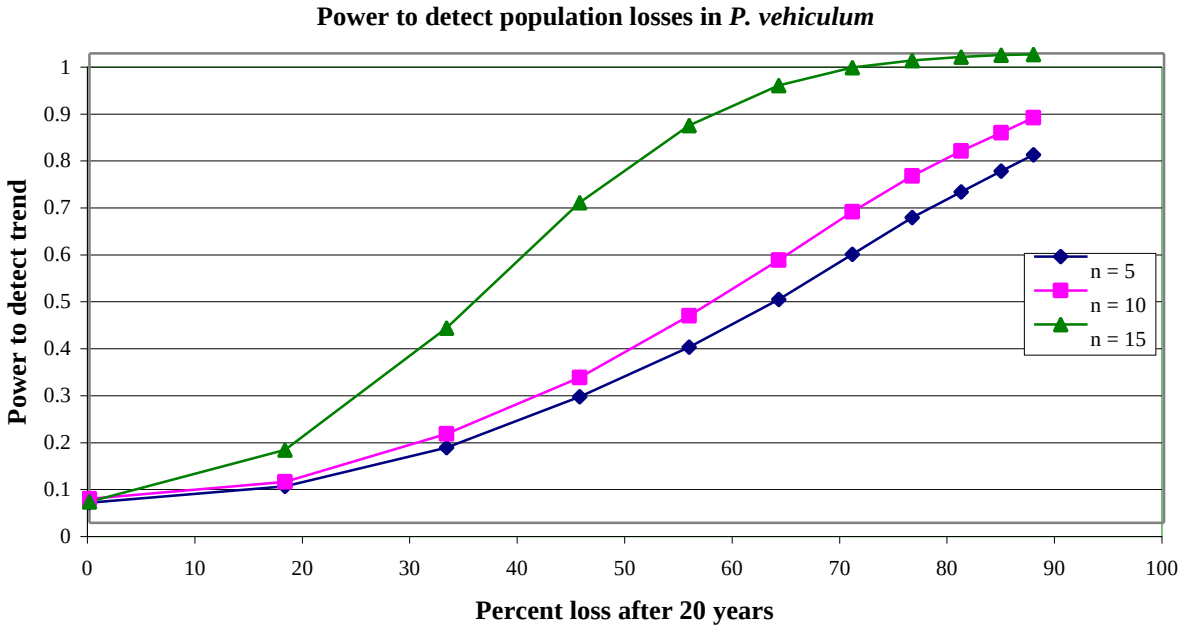


Figure 29. Power to detect 20-year population trends in western red-backed salamanders at the a = 0.05 significance level. Calculations are based on sampling once every 5 years for 20 years.

Appendix B. Gear checklist for terrestrial herpetofauna surveys.

Survey equipment:

Compass (each person)
Altimeter (1 per team)
Topographic maps with survey sites (1 per team) and general area (1 per person)
GPS unit and at least 4 extra AA batteries (1 per team)
Radio and extra battery (1 per team)
Data forms (1 notebook with datasheets per team)
Pencil, Rite-In-Rain pen, Sharpie marker (1 each per person)
Rake (1 per person)
Plant identification book (minimum 1 per team)
Hygrometer-thermometer and humidity gauge (1 per team)
Plot measuring strings, 30 m long (3 per team)
Ruler, 6 in, to measure amphibians (1 per person)
Paper clips to use for snake sexing probe (few per team)
Ziploc bags (~ 10 per person)
Flagging (1 per team)

Personal equipment:

Headlamp (1 per person)
First aid kit (1 per team)
Warm clothes and rain suit, gators
Water filter
Stove, pots, fuel bottle
Rope and bag for hanging food if needed
Bear canister
Tent
Sleeping bag
Sleeping pad

Appendix C. Terrestrial herpetofauna survey data sheet for FIA and IF surveys.

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

OLYMPIC TERRESTRIAL HERP SURVEY 2000

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:	

(Continued on next page)

Transect Data (first 5 to 15 m along each quadrant line)							
1		2		3		4	
Cm	class	cm	class	cm	class	cm	Class

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

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

Herp Sp.	Sex	Stage	SVL(mm)	UL	LL	MB	Hab
	M F U	E L J A P U					
	M F U	E L J A P U					
	M F U	E L J A P U					
	M F U	E L J A P U					
	M F U	E L J A P U					
	M F U	E L J A P U					

Habitats: D1-3 = Wood of decay classes 1-3; R=Rock; S=Stream/seep; O=other.

Notes:

Appendix D. Terrestrial herpetofauna survey data sheet for Incidental surveys.

Incidental Herp Observation Form

Date:		Drainage:		Start Time:	
Observer(s):		Slope:		Aspect:	
Elapsed Time (minutes):		*Area (m^2):*		*Habitat Descrip.:*	

Uncorrected UTM Coord.		**PDOP:**	**Corrected UTM Coord.**	
N	**E**	**File**	**N**	**E**

Location:		**Air Temp (C)**	
Precipitation	**D F M LR HR SL SN**	**Wind**	**C LB MB W G**

D=dry, F=fog, M=mist, LR=light rain, HR=hard rain, SL=sleet, SN=snow

C=calm, LB=light breeze, MB=mod. breeze, W=windy, G=gusty

Herp Sp.	Sex	Stage	SVL(mm)	UL	LL	MB	Hab
	M F U	E L J A P U					
	M F U	E L J A P U					
	M F U	E L J A P U					

Date:		Drainage:		Start Time:	
Observer(s):		Slope:		Aspect:	
Elapsed Time (minutes):		*Area (m^2):*		*Habitat Descrip.:*	

Uncorrected UTM Coord.		**PDOP:**	**Corrected UTM Coord.**	
N	**E**	**File**	**N**	**E**

Location:		**Air Temp (C)**	
Precipitation	**D F M LR HR SL SN**	**Wind**	**C LB MB W G**

D=dry, F=fog, M=mist, LR=light rain, HR=hard rain, SL=sleet, SN=snow

C=calm, LB=light breeze, MB=mod. breeze, W=windy, G=gusty

Herp Sp.	Sex	Stage	SVL(mm)	UL	LL	MB	Hab
	M F U	E L J A P U					
	M F U	E L J A P U					
	M F U	E L J A P U					

Habitats: D1-3 = Wood of decay classes 1-3; R=Rock; S=Stream/seep; O=other.

Appendix E. Total captures of all species by all terrestrial survey types in ONP drainages surveyed. Drainages have been subdivided in some instances to provide finer resolution of capture locations. We divided the coastal strip of ONP geographically (into two segments at the Hoh Indian Reservation) and not based upon major river drainages.

AMGR = *Ambystoma gracile* (northwestern salamander), AMMA = *Ambystoma macrodactylum* (long-toed salamander), ASTR = *Ascaphus truei* (tailed frog), BUBO = *Bufo boreas* (western toad), CHBO = *Charina bottae* (rubber boa), DICO = *Dicamptodon copei* (Cope's giant salamander), ELCO = *Elgaria coerulea* (northern alligator lizard), ENES = *Ensatina eschscholtzii* (ensatina), PLVA = *Plethodon vandykei* (Van Dyke's salamander), PLVE = *Plethodon vehiculum* (red-backed salamander), PSRE = *Pseudacris regilla* (Pacific treefrog), RAAU = *Rana aurora* (red-legged frog), RACAS = *Rana cascadae* (Cascades frog), RHOL = *Rhyacotriton olympicus* (Olympic torrent salamander), TAGR = *Taricha granulosa* (rough-skinned newt), THOR = *Thamnophis ordinoides* (northwestern garter snake), THSI = *Thamnophis sirtalis* (common garter snake)

Drainage	AMGR	AMMA	ASTR	BUBO	CHBO	DICO	ELCO	ENES	PLVA	PLVE	PSRE	RAAU	RACAS	RHOL	TAGR	THOR	THSI
Bogachiel	0	0	7	4	0	1	0	9	11	69	2	4	0	21	3	5	2
Dosewallips	0	0	10	0	0	0	0	2	0	6	1	0	4	0	4	4	1
Duckabush	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	1	4
EF Quinault	0	0	7	0	0	3	0	5	8	101	0	3	4	2	0	1	3
Elwha	0	7	9	28	7	0	5	24	0	35	4	3	18	10	1	25	10
Gray Wolf	0	4	14	0	0	0	0	0	0	1	0	0	15	0	0	1	2
Hamma Hamma	0	0	2	0	0	0	1	0	0	0	0	0	0	0	0	0	0
Hoh	0	1	2	8	0	0	0	2	2	56	1	2	6	12	0	14	5
Lake Quinault	0	0	0	0	0	0	0	0	0	10	0	0	0	0	0	0	0
Lyre	0	0	2	0	0	0	2	16	0	104	0	0	0	2	9	1	0
Morse	0	0	1	0	0	0	0	11	0	15	0	0	0	0	1	1	0
North Coast	0	0	0	2	0	0	0	2	0	16	0	0	0	0	0	0	1
NF Quinault	8	0	6	4	0	4	0	3	8	79	1	15	19	7	0	4	3
NF Sol Duc	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0
Queets	3	4	0	16	0	0	0	3	0	68	4	19	12	21	5	18	3
Royal Creek	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Skokomish	4	0	3	0	0	0	0	4	0	20	0	0	4	0	2	0	3
Sol Duc	18	1	4	1	0	0	0	10	1	27	3	3	28	3	0	22	4
South Coast	0	0	0	0	0	0	0	2	0	12	0	6	0	0	0	0	1
SF Hoh	2	0	0	0	0	0	0	1	0	42	1	11	0	1	0	0	2
WF Dosewallips	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1

Appendix F. Average number of captures per plot for FIA and IF surveys. UTM coordinates are NAD1927.

Sites with "*" indicate verification surveys. AMGR = *Ambystoma gracile* (northwestern salamander), AMMA = *Ambystoma macrodactylum* (long-toed salamander), ASTR = *Ascaphus truei* (tailed frog), BUBO = *Bufo boreas* (western toad), DICO = *Dicamptodon copei* (Cope's giant salamander), ENES = *Ensatina eschscholtzii* (ensatina), PLVA = *Plethodon vandykei* (Van Dyke's salamander), PLVE = *Plethodon vehiculum* (red-backed salamander), PSRE = *Pseudacris regilla* (Pacific treefrog), RAAU = *Rana aurora* (red-legged frog), RACAS = *Rana cascadae* (Cascades frog), RHOL = *Rhyacotriton olympicus* (Olympic torrent salamander), TAGR = *Taricha granulosa* (rough-skinned newt), THOR = *Thamnophis ordinoides* (northwestern garter snake), THSI = *Thamnophis sirtalis* (common garter snake).

ID #	UTM North	UTM East	AMGR	AMMA	ASTR	BUBO	DICO	ENES	PLVA	PLVE	PSRE	RAAU	RACAS	RHOL	TAGR	THOR	THSI
1	5334295	373643	0.0	0.0	0.0	0.0	0.0	0.5	0.0	4.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3	5324147	434585	0.0	0.0	0.0	0.0	0.0	1.3	0.0	7.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
5	5318509	433731	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
6	5318269	439929	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
7	5318821	445143	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0
8	5318104	450686	0.0	0.0	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
10	5317183	460833	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
11	5318258	465832	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
12	5318187	471312	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0
13	5312628	433104	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0
16	5312991	450674	0.0	0.0	2.0	0.0	0.0	0.0	0.0	0.7	0.0	0.0	0.0	1.0	0.0	0.0	0.0
17	5312232	455194	0.0	0.0	0.0	0.0	0.0	0.5	0.0	6.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0
18	5312320	461602	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
19	5312334	466029	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
21	5312396	477976	0.0	0.0	0.0	0.0	0.0	3.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
22	5307463	411075	0.0	0.0	0.0	0.0	0.0	1.3	0.0	5.7	0.0	0.0	0.0	0.3	0.0	0.0	0.0
25	5307466	427956	0.0	0.0	0.0	0.0	0.0	0.0	0.0	5.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0
27	5307156	439549	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0
28	5307662	444215	0.0	0.0	0.0	0.0	0.0	0.0	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
29	5307290	448904	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
31	5306676	461074	0.0	0.0	0.0	0.0	0.0	2.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
33	5306520	472048	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
35	5306920	482468	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
36	5302144	411142	0.0	0.0	1.0	0.0	0.0	2.0	0.3	6.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
39	5301838	429089	0.0	0.0	0.7	0.0	0.0	0.3	0.0	7.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
40	5301809	434300	0.0	0.0	0.0	0.0	0.0	0.7	0.0	8.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
41	5301271	438619	0.0	0.0	0.0	0.0	0.0	1.3	0.3	2.3	0.0	0.0	0.0	3.0	0.0	0.0	0.0

ID #	UTM North	UTM East	AMGR	AMMA	ASTR	BUBO	DICO	ENES	PLVA	PLVE	PSRE	RAAU	RACAS	RHOL	TAGR	THOR	THSI
45	5301681	460269	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
46	5301552	466052	0.0	0.0	0.0	0.0	0.0	1.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0
50	5301492	488110	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
51	5296475	428648	0.0	0.0	0.7	0.0	0.0	0.0	0.0	0.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0
58	5296101	465806	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.7	0.0	0.0	0.0	0.0	0.0	0.0
62	5291283	390559	0.0	0.0	0.0	0.0	0.0	0.7	0.0	4.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3
64	5290614	438287	0.0	0.0	0.0	0.0	0.0	0.5	0.0	7.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0
69	5290067	466449	0.0	0.0	0.0	0.0	0.0	1.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
72	5291503	482622	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
73	5289943	488002	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
74	5285518	394815	0.0	0.0	0.0	0.0	0.0	1.3	0.0	2.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
79	5286030	455852	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
80	5285685	461047	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
81	5284517	466975	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5	0.0	1.5	0.0	0.0	0.0	0.0
83	5284720	477573	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
86	5280992	395872	0.0	0.0	0.0	0.0	0.0	0.7	0.0	2.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
88	5280459	433499	0.0	0.0	0.0	0.0	0.0	0.0	0.0	7.0	0.0	0.5	0.0	3.5	0.0	0.0	0.0
91	5279250	450160	2.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
95	5278573	471529	0.0	0.0	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
96	5280704	477074	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
97	5279199	481867	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
99	5271472	416152	0.0	0.0	0.0	0.0	0.0	0.3	0.0	4.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0
100	5274129	422723	0.0	0.0	0.0	0.0	0.0	0.5	0.0	3.8	0.0	0.0	0.0	0.0	0.3	0.0	0.0
101	5275213	428693	0.0	0.0	0.0	0.0	0.0	2.0	0.0	8.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
105	5273891	450042	2.5	0.0	0.0	0.0	0.0	0.0	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
108	5274037	466683	0.0	0.0	1.0	0.0	1.0	0.0	3.0	0.0	0.0	0.0	0.0	1.0	0.0	0.0	0.0
109	5273822	471634	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
111	5273453	483257	0.0	0.0	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
113	5269001	450243	0.0	0.0	0.0	0.0	0.0	0.7	0.0	3.3	0.0	0.3	0.0	0.0	0.0	0.0	0.0
114	5269591	455913	0.0	0.0	0.0	0.0	0.0	0.0	0.0	7.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0
117	5269345	471791	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
118	5262880	438531	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0
IF1	5269194	415053	1.0	0.0	0.0	0.0	0.0	1.0	0.0	14.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
IF2	5272370	419992	0.0	0.0	0.0	0.0	0.0	8.0	0.0	15.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
IF3	5262555	474849	0.0	0.0	0.0	0.0	0.0	0.3	0.0	5.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0

ID #	UTM North	UTM East	AMGR	AMMA	ASTR	BUBO	DICO	ENES	PLVA	PLVE	PSRE	RAAU	RACAS	RHOL	TAGR	THOR	THSI
IF4	5263548	474529	0.0	0.0	0.0	0.0	0.0	1.0	0.0	4.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
IF5	5264439	472795	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0
IF6	5273363	474303	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
IF7	5264156	476981	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0
IF8	5311208	438847	0.0	0.0	0.0	0.0	0.0	1.0	0.0	0.5	0.5	0.0	0.0	0.0	0.0	0.0	0.0
IF9	5273715	464363	0.0	0.0	0.0	0.0	0.0	1.7	0.0	7.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
IF10	5295334	465973	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
IF11	5313719	435309	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
IF12	5304276	419459	0.0	0.0	0.0	0.0	0.0	1.3	0.0	5.0	0.0	0.0	0.0	1.5	0.0	0.0	0.0
IF13	5278443	451898	0.0	0.0	0.0	0.0	0.0	0.5	0.0	10.0	0.0	0.0	0.0	1.5	0.0	0.0	0.0
IF14	5286095	449971	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
IF15	5309303	442668	0.0	0.0	0.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
IF16	5287486	485545	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
IF17	5291822	480604	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5	0.0
IF18	5290893	480897	0.0	0.0	0.0	0.0	0.0	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
IF19	5302926	443699	0.0	0.0	0.0	0.0	0.0	0.5	0.0	2.5	0.0	0.0	0.0	0.0	0.0	0.5	0.0
IF20	5302943	447557	0.0	0.0	0.0	0.0	0.0	1.5	0.0	9.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0
IF21	5303125	481483	0.0	0.0	1.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
IF22	5301830	480850	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
IF23	5304082	474283	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
IF24	5302884	473830	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.0	0.0	0.0	0.0	0.0
IF25	5298027	473324	0.0	2.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
IF26	5300672	475111	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
IF27	5304718	479169	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
IF28	5264766	449776	0.0	0.0	0.0	0.0	0.0	1.0	0.0	6.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0
IF29	5269598	451398	0.0	0.0	0.0	0.0	0.0	0.0	0.0	11.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
IF30	5269685	451253	0.0	0.0	0.0	0.0	0.0	0.0	0.0	7.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
IF31	5269592	451150	0.0	0.0	0.0	0.0	0.0	0.0	0.0	8.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
IF32	5269449	451426	0.0	0.0	0.0	0.0	0.0	1.0	0.0	2.0	0.0	1.0	0.0	0.0	0.0	0.0	0.0
IF33	5305802	482013	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
00001*	5321968	440479	0.0	0.0	0.5	0.0	0.0	2.0	0.0	7.0	0.0	0.0	0.0	1.8	0.0	0.0	0.0
00002*	5312693	456831	0.0	0.0	0.0	0.3	0.0	1.3	0.0	0.8	0.0	0.0	0.0	0.0	0.0	0.3	0.0
00003*	5323603	428611	0.0	0.0	0.0	0.0	0.0	1.8	0.0	2.5	0.5	0.5	0.0	0.5	0.0	0.0	0.0
9*	5318379	456431	0.0	0.0	0.0	0.0	0.0	2.3	0.0	5.3	0.3	0.0	0.0	0.3	0.0	0.0	0.0

Appendix G. Capture data for Incidental surveys (counts of individuals per Incidental survey site). UTM coordinates are NAD1927.

AMGR = *Ambystoma gracile* (northwestern salamander), AMMA = *Ambystoma macrodactylum* (long-toed salamander), ASTR = *Ascaphus truei* (tailed frog), BUBO = *Bufo boreas* (western toad), CHBO = *Charina bottae* (rubber boa), DICO = *Dicamptodon copei* (Cope's giant salamander), ELCO = *Elgaria coerulea* (northern alligator lizard), ENES = *Ensatina eschscholtzii* (ensatina), PLVA = *Plethodon vandykei* (Van Dyke's salamander), PLVE = *Plethodon vehiculum* (red-backed salamander), PSRE = *Pseudacris regilla* (Pacific treefrog), RAAU = *Rana aurora* (red-legged frog), RACAS = *Rana cascadae* (Cascades frog), RHOL = *Rhyacotriton olympicus* (Olympic torrent salamander), TAGR = *Taricha granulosa* (rough-skinned newt), THOR = *Thamnophis ordinoides* (northwestern garter snake), THSI = *Thamnophis sirtalis* (common garter snake).

ID #	UTM East	UTM North	AMGR	AMMA	ASTR	BUBO	CHBO	DICO	ELCO	ENES	PLVA	PLVE	PSRE	RAAU	RACAS	RHOL	TAGR	THOR	THSI
1	457428	5311548	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
2	468100	5327200	0	0	0	0	0	0	0	0	0	5	0	0	0	0	0	0	0
4	455080	5316240	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
5	436800	5322190	0	0	0	0	0	0	0	0	0	5	0	0	0	0	0	0	0
6	439630	5322250	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0
7	441000	5326440	0	0	0	0	0	0	0	0	0	5	0	0	0	0	0	0	0
9	429250	5301270	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0
10	431250	5301624	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11	432359	5301493	0	0	0	7	0	0	0	0	0	0	0	0	0	0	0	0	0
12	432588	5301768	0	0	0	0	0	0	0	0	0	7	0	0	0	0	0	0	0
13	435979	5301655	0	0	0	0	0	0	0	0	0	5	0	0	0	0	0	0	0
14	397280	5273090	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
15	409810	5266070	0	0	0	0	0	0	0	0	0	1	0	0	0	9	0	0	0
16	411750	5268250	0	0	0	0	0	0	0	0	0	6	0	0	0	0	0	0	0
17	415440	5269310	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0
18	416810	5269500	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0
19	418650	5272000	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
20	423750	5275220	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
21	414000	5269080	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
22	410500	5267250	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
23	438288	5311341	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
25	439440	5311014	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0

ID #	UTM East	UTM North	AMGR	AMMA	ASTR	BUBO	CHBO	DICO	ELCO	ENES	PLVA	PLVE	PSRE	RAAU	RACAS	RHOL	TAGR	THOR	THSI
26	439621	5323726	0	0	0	0	0	0	0	1	0	1	0	0	0	0	1	0	0
27	440253	5323685	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0
29	375817	5334508	0	0	0	0	0	0	0	1	0	4	0	0	0	0	0	0	0
30	373182	5334852	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
31	372718	5334995	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
32	393464	5289205	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	2
34	393008	5289292	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	1
35	428760	5325000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
36	465192	5290965	0	0	0	0	0	0	0	0	0	1	0	0	0	2	0	0	0
38	463490	5305390	0	0	0	0	0	0	0	1	0	2	0	0	0	0	0	0	0
39	466430	5293520	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0
40	465920	5290030	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
41	466156	5292568	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
43	463490	5305460	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
45	456050	5320550	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0
46	461280	5309300	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
47	463380	5305640	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
53	447706	5264019	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0
54	467950	5321400	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
55	459550	5309760	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0
56	455792	5313500	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
59	434120	5313196	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
60	434564	5313421	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8	3
62	455209	5312860	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0
63	455046	5312779	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
64	455340	5312540	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
65	455400	5312540	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
66	455460	5312540	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
68	456020	5318800	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
69	434795	5313291	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	1

ID #	UTM East	UTM North	AMGR	AMMA	ASTR	BUBO	CHBO	DICO	ELCO	ENES	PLVA	PLVE	PSRE	RAAU	RACAS	RHOL	TAGR	THOR	THSI
73	459255	5310655	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
74	459399	5310467	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1	0
76	441011	5325010	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
77	447600	5264000	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
78	448435	5264186	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
79	448435	5264186	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
80	448885	5264763	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	1
81	445962	5264626	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
83	438355	5261561	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
84	441440	5263920	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
85	450400	5268960	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0
86	450320	5267700	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
87	451558	5270251	0	0	0	0	0	1	0	0	1	10	0	1	0	1	0	0	0
88	451689	5270549	0	0	1	0	0	0	0	0	1	4	0	0	0	0	0	0	0
89	453590	5271900	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
90	453400	5271800	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0
91	450825	5273976	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0
93	452640	5274840	0	0	0	0	0	0	0	0	4	3	0	0	0	0	0	0	0
94	454400	5274220	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0
95	451080	5274450	2	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0
96	450220	5278900	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0
97	452200	5275160	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
99	450500	5278550	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
100	451179	5276201	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0
101	451808	5275486	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0
102	452780	5275660	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
103	456013	5319966	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1	0
104	456020	5320494	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	0
109	460904	5301632	0	0	0	0	0	0	0	0	0	0	0	0	6	0	0	0	0
110	461223	5305299	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1

ID #	UTM East	UTM North	AMGR	AMMA	ASTR	BUBO	CHBO	DICO	ELCO	ENES	PLVA	PLVE	PSRE	RAAU	RACAS	RHOL	TAGR	THOR	THSI
112	448906	5317347	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
113	450500	5317670	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
117	439800	5323750	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1	0
118	453327	5314498	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	3
120	461546	5313322	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
121	485459	5287983	0	0	7	0	0	0	0	0	0	0	0	0	0	0	0	0	0
125	438779	5307548	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
126	439079	5307401	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
127	469700	5319240	0	0	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0
128	470970	5318360	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0
129	474441	5304173	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
130	476553	5304741	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
131	438540	5311140	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
132	427348	5298213	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
133	427450	5297974	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
134	438160	5301640	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
136	386968	5298132	0	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0
137	380581	5305061	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
138	435660	5313240	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
139	435200	5323840	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0
140	473780	5304750	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
142	456082	5319409	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
144	455602	5316784	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0
145	408777	5304140	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
146	412597	5303766	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
147	413243	5306893	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
148	412999	5306653	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0
149	411215	5307418	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0
150	409002	5304157	0	0	0	0	0	0	0	0	0	3	0	0	0	0	1	0	0
153	437500	5307400	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0

ID #	UTM East	UTM North	AMGR	AMMA	ASTR	BUBO	CHBO	DICO	ELCO	ENES	PLVA	PLVE	PSRE	RAAU	RACAS	RHOL	TAGR	THOR	THSI
154	457600	5311503	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0
156	434264	5292928	0	0	0	0	0	0	0	0	0	8	0	0	0	0	0	0	0
157	433724	5292635	0	0	0	0	0	0	0	0	0	0	1	5	0	0	0	0	0
158	433842	5292702	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
159	433892	5292752	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
160	436800	5290600	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
161	437782	5290537	1	0	0	0	0	0	0	0	0	0	0	5	0	0	0	0	0
162	436975	5290568	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
163	435340	5291867	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
164	433950	5292800	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0
165	433300	5292550	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
166	416020	5271500	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
167	422723	5274000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
168	420032	5272370	1	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0
169	417300	5269950	0	0	0	0	0	0	0	0	0	7	0	0	0	3	0	0	0
170	434527	5292592	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0
171	429380	5293760	0	0	0	0	0	0	0	0	0	9	0	0	0	0	0	0	0
172	429520	5292840	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0
173	448000	5270740	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0
174	475411	5262368	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
175	477030	5264247	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
176	474900	5263084	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
177	473729	5263741	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
178	489836	5286026	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
179	489800	5286026	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1
181	487787	5286999	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
182	471811	5268637	0	0	0	0	0	0	0	3	0	3	0	0	0	0	0	0	0
183	472520	5269500	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
184	473141	5270712	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
185	472935	5270206	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

ID #	UTM East	UTM North	AMGR	AMMA	ASTR	BUBO	CHBO	DICO	ELCO	ENES	PLVA	PLVE	PSRE	RAAU	RACAS	RHOL	TAGR	THOR	THSI
186	473745	5272460	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
187	466110	5274750	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
188	462749	5272361	0	0	0	0	0	0	0	0	1	5	0	0	0	0	0	0	0
189	464785	5273796	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
190	464630	5273759	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
191	464408	5273650	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
192	465480	5273990	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
193	462664	5320903	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
194	462959	5320118	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
195	463716	5317889	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0
196	463460	5317620	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
197	463430	5317545	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0
198	463375	5319642	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0
199	463518	5319296	0	0	0	0	0	0	0	0	0	2	0	0	0	0	1	0	0
200	463843	5318723	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
201	463882	5318598	0	0	0	0	0	0	0	0	0	5	0	0	0	0	0	0	0
202	453057	5266602	0	0	0	0	0	0	0	0	0	16	0	0	0	0	0	0	0
203	481518	5308199	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
205	482000	5307330	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
206	482043	5306066	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
208	439133	5311152	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
209	439264	5311096	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
210	439384	5311000	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
212	426272	5323485	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
213	426087	5323498	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
214	456100	5318000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
215	455980	5318640	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
216	456060	5319980	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	4	0
218	479400	5279550	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
219	477630	5279420	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1

ID #	UTM East	UTM North	AMGR	AMMA	ASTR	BUBO	CHBO	DICO	ELCO	ENES	PLVA	PLVE	PSRE	RAAU	RACAS	RHOL	TAGR	THOR	THSI
220	488375	5280880	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
221	476727	5283673	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
222	466059	5292340	0	0	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0
223	466480	5295136	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
224	434857	5313271	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	9	0
225	455982	5319996	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1	0
226	410421	5303199	0	0	0	1	0	0	0	0	0	0	1	0	0	0	0	0	0
227	410385	5303900	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
228	457966	5311069	0	0	0	0	7	0	0	0	0	0	0	0	0	0	0	2	0
229	409625	5303923	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
230	410567	5303849	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0
231	411116	5303843	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
232	411320	5303928	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
233	411387	5303887	0	0	0	1	0	0	0	0	0	0	1	1	0	0	0	0	0
234	412494	5303731	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	2
235	417502	5303902	0	0	0	0	0	0	0	0	0	5	0	0	0	0	0	0	0
236	418673	5303798	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0
237	418673	5303798	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
238	419626	5304161	0	0	0	0	0	0	0	0	0	10	0	0	0	4	0	0	0
239	419822	5304294	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
240	420992	5304302	0	0	0	0	0	0	0	0	1	2	0	0	0	0	0	0	0
241	421910	5304625	0	0	0	0	0	0	0	0	0	5	0	0	0	2	0	0	0
242	424728	5306232	0	0	1	0	0	1	0	0	5	1	0	0	0	2	0	0	0
243	426931	5307481	0	0	0	0	0	0	0	0	3	1	0	0	0	1	0	0	0
244	428035	5307571	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0
245	428550	5275920	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
246	428640	5275680	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0
247	428278	5275805	0	0	0	4	0	0	0	0	0	0	2	1	0	0	0	0	0
248	428334	5275982	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
249	428480	5275789	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0

ID #	UTM East	UTM North	AMGR	AMMA	ASTR	BUBO	CHBO	DICO	ELCO	ENES	PLVA	PLVE	PSRE	RAAU	RACAS	RHOL	TAGR	THOR	THSI
250	430512	5279709	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
251	433334	5281287	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
252	433035	5281068	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
253	432847	5280601	0	0	0	1	0	0	0	0	0	0	0	2	0	0	0	0	0
254	431274	5280528	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0
255	431274	5280390	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
256	431082	5280387	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0
257	429863	5279236	0	0	0	0	0	0	0	0	0	5	0	0	0	0	0	0	0
258	430405	5279600	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	1	0
259	422500	5274600	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
260	416707	5269514	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
261	434900	5309360	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
262	434800	5309830	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
263	432437	5308015	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
264	434750	5308960	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
265	434800	5308930	0	1	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0
266	455993	5320010	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0
267	455184	5317168	0	0	0	0	0	0	0	2	0	2	0	0	0	0	0	0	0
268	455728	5317726	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
269	471521	5306305	0	4	0	0	0	0	0	0	0	0	0	0	7	0	0	0	1
271	483042	5273478	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
272	486625	5287000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
273	441322	5326099	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8	0	0
274	441138	5324543	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
275	455842	5269653	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
276	455983	5269529	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
277	463316	5273543	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
278	466642	5275394	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
279	468992	5277397	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
280	470555	5279253	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0

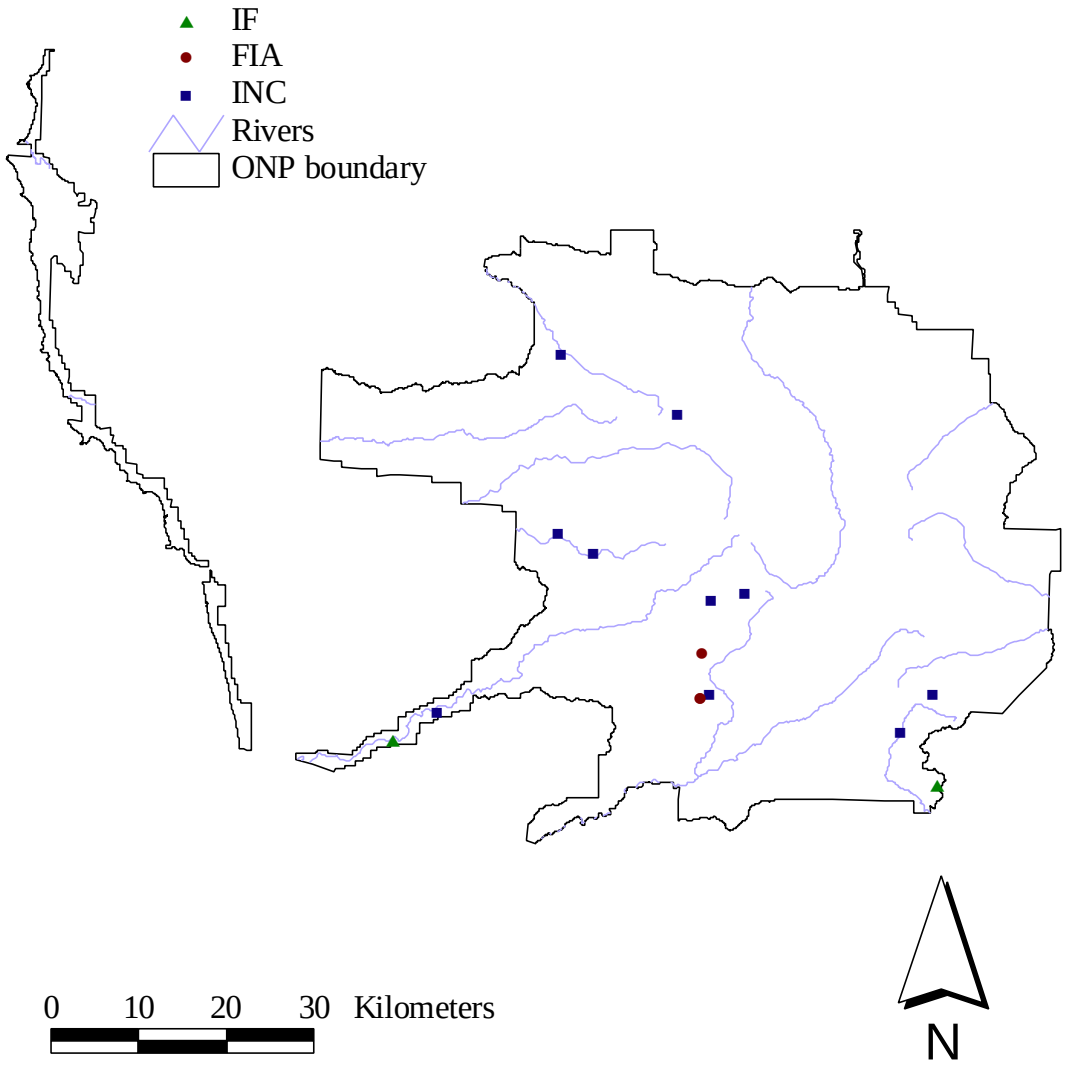
ID #	UTM East	UTM North	AMGR	AMMA	ASTR	BUBO	CHBO	DICO	ELCO	ENES	PLVA	PLVE	PSRE	RAAU	RACAS	RHOL	TAGR	THOR	THSI
281	471200	5279300	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
282	471450	5279000	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
284	472086	5281311	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1
285	469630	5278215	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0
286	469497	5277907	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
287	468200	5277300	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
288	466750	5275770	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
289	464243	5273509	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
290	464243	5273510	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
291	461999	5272030	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
292	457050	5268000	0	0	0	0	0	0	0	0	0	6	0	0	0	0	0	0	0
293	457301	5268927	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0
294	457611	5268822	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0
295	457882	5268569	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0
296	458052	5268346	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0
297	458216	5268349	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0
298	458515	5268461	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0
299	458674	5268640	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0
300	453594	5279500	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
301	456880	5285020	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
302	455600	5285240	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0
303	455120	5286050	1	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0
304	452002	5278367	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
305	452222	5278367	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
306	454800	5285950	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
307	454250	5285850	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
308	454050	5285090	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0
309	451020	5285730	0	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
310	451020	5285500	0	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
311	450570	5286000	0	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0

ID #	UTM East	UTM North	AMGR	AMMA	ASTR	BUBO	CHBO	DICO	ELCO	ENES	PLVA	PLVE	PSRE	RAAU	RACAS	RHOL	TAGR	THOR	THSI
312	451270	5285100	1	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0
313	451450	5285020	0	1	0	0	0	0	0	0	0	0	0	0	7	0	0	0	0
314	428640	5275680	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0
315	428334	5275789	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
316	452910	5279250	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
317	452935	5274188	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
318	456030	5277000	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
319	456315	5275063	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0
320	447250	5275940	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
324	477151	5306102	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0
325	447397	5306372	17	0	0	0	0	0	0	0	0	0	0	0	13	0	0	0	0
326	442303	5309234	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
327	459650	5311880	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
328	474289	5273122	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
329	476400	5275300	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
330	476573	5274490	2	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0
331	477650	5274384	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
332	472792	5277188	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	1
333	471752	5273964	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0
334	471756	5274094	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0
335	472226	5274292	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0
336	474450	5277600	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
337	476300	5275150	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
338	475800	5274550	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
340	484440	5289118	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
341	485556	5290263	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0
342	485649	5290708	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0
343	482054	5291544	0	0	0	0	0	0	0	0	0	0	1	0	0	0	4	0	0
344	480780	5291010	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
345	481603	5289222	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0

ID #	UTM East	UTM North	AMGR	AMMA	ASTR	BUBO	CHBO	DICO	ELCO	ENES	PLVA	PLVE	PSRE	RAAU	RACAS	RHOL	TAGR	THOR	THSI
346	483745	5288710	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
347	429576	5301019	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0
348	427460	5298606	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	1
349	440076	5302469	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
350	442600	5303000	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
351	444886	5302926	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
352	445493	5303743	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0
353	446624	5303402	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
354	447636	5302802	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
355	447817	5302898	0	0	0	0	0	0	0	0	0	1	0	0	0	2	0	0	0
356	448398	5302035	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0
357	448399	5301823	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
358	448000	5300500	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0
359	448202	5299765	0	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0	0
360	437511	5303078	0	0	0	0	0	0	0	0	0	6	0	0	0	0	0	0	0
361	479306	5304965	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
362	479441	5305168	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
363	479100	5304725	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0
364	473596	5304633	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0
365	478990	5302205	0	2	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
366	474821	5300654	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
367	473459	5298034	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0
368	481600	5303380	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
369	478018	5298289	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0
370	478000	5298000	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0
371	483890	5307700	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
372	469028	5320238	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0
373	431282	5318855	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
376	439008	5322005	0	0	0	0	0	0	0	0	0	9	0	0	0	0	0	0	0
380	455424	5318857	0	0	2	0	0	0	0	0	0	4	0	0	0	0	0	0	1

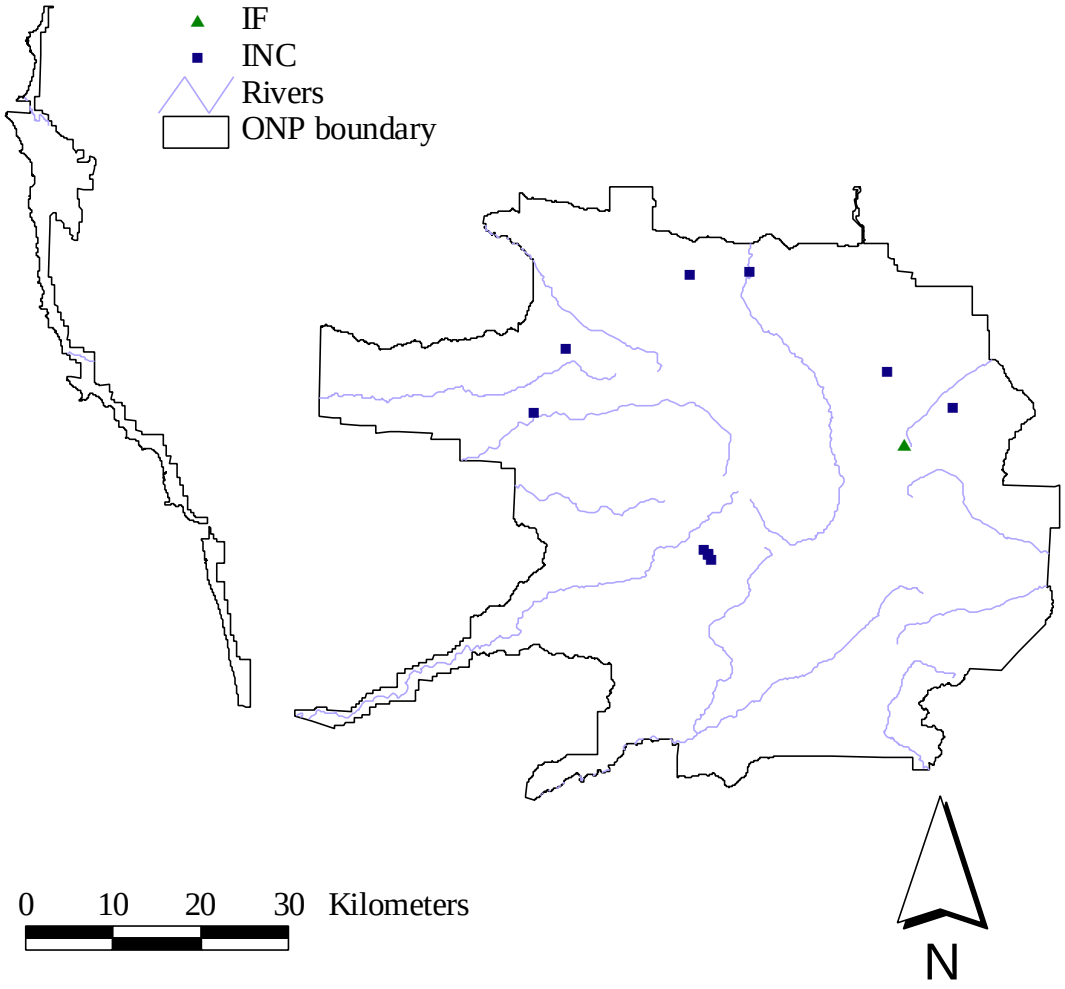
ID #	UTM East	UTM North	AMGR	AMMA	ASTR	BUBO	CHBO	DICO	ELCO	ENES	PLVA	PLVE	PSRE	RAAU	RACAS	RHOL	TAGR	THOR	THSI
381	410417	5267338	0	0	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0
382	450678	5268354	0	0	0	2	0	0	0	0	0	4	0	0	0	0	0	0	0
383	449734	5268281	0	0	0	0	0	0	0	0	0	1	1	2	0	0	0	0	0
384	449343	5268623	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
385	449411	5268423	0	0	0	0	0	0	0	0	0	2	0	2	0	0	0	0	0
386	459671	5310294	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
387	459502	5310190	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
388	458568	5310437	0	0	0	24	0	0	0	0	0	0	0	1	0	0	0	0	0
389	458436	5310986	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1
390	409514	5267052	0	0	0	2	0	0	0	0	0	0	0	2	0	0	0	0	0
391	409526	5266915	0	0	0	0	0	0	0	0	0	3	0	0	0	2	0	0	0
393	410677	5267408	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8	0
394	413931	5269174	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0
395	451362	5269138	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
396	443209	5265346	0	0	0	0	0	2	0	0	0	7	0	0	0	1	0	0	0
397	443339	5265164	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
398	441383	5263923	0	0	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0
399	451257	5268565	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0

Appendix H. Dot maps showing species detections during terrestrial surveys (including FIA, IF, and Incidental surveys) in Olympic National Park. A map of all survey locations is shown in Figure 3.



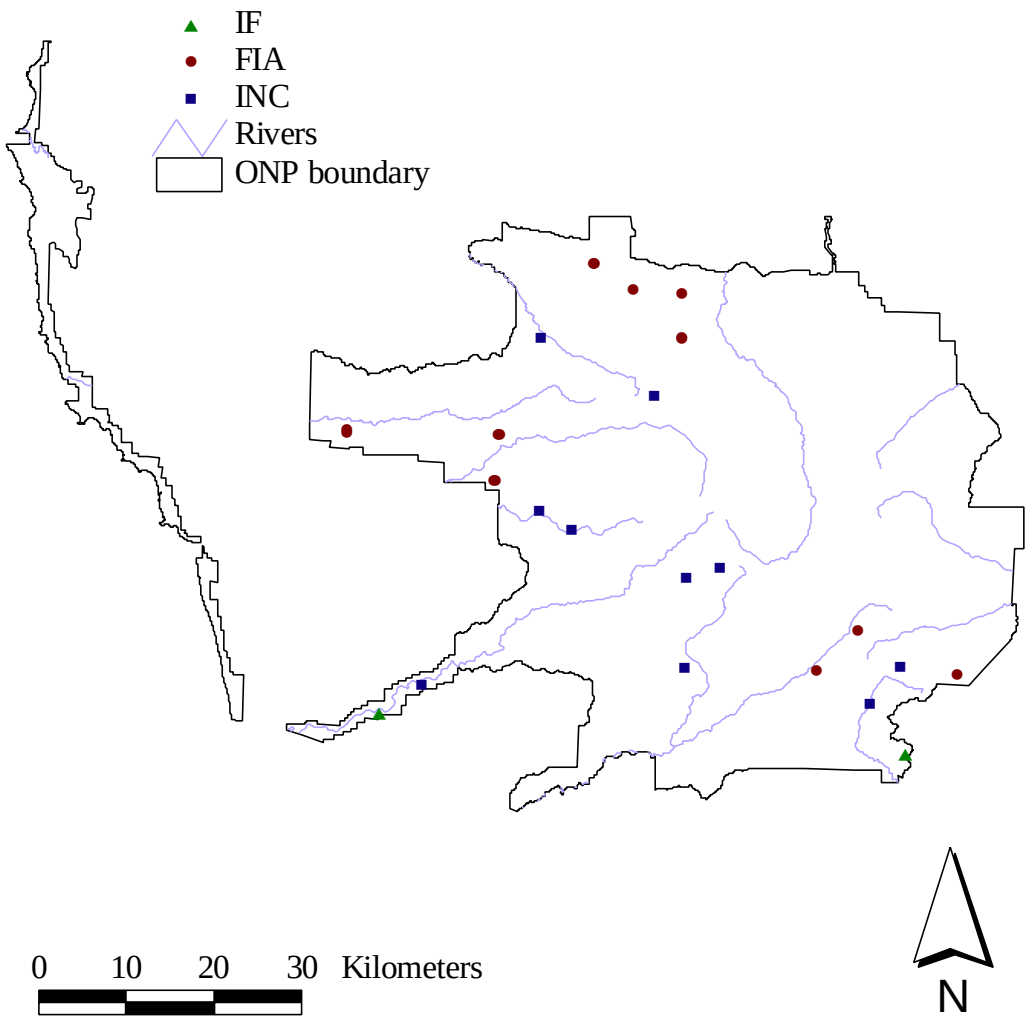
Northwestern salamander

(Ambystoma gracile)

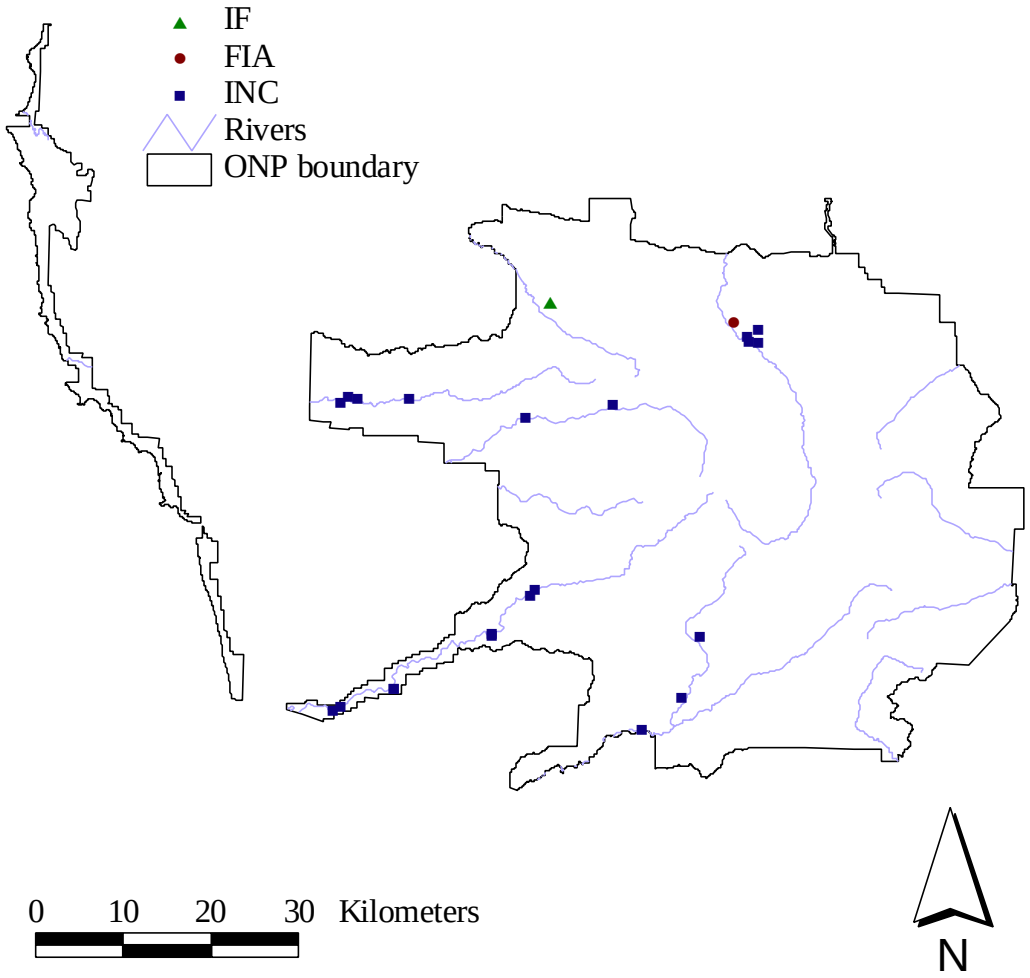


Long-toed salamander

(Ambystoma macrodactylum)

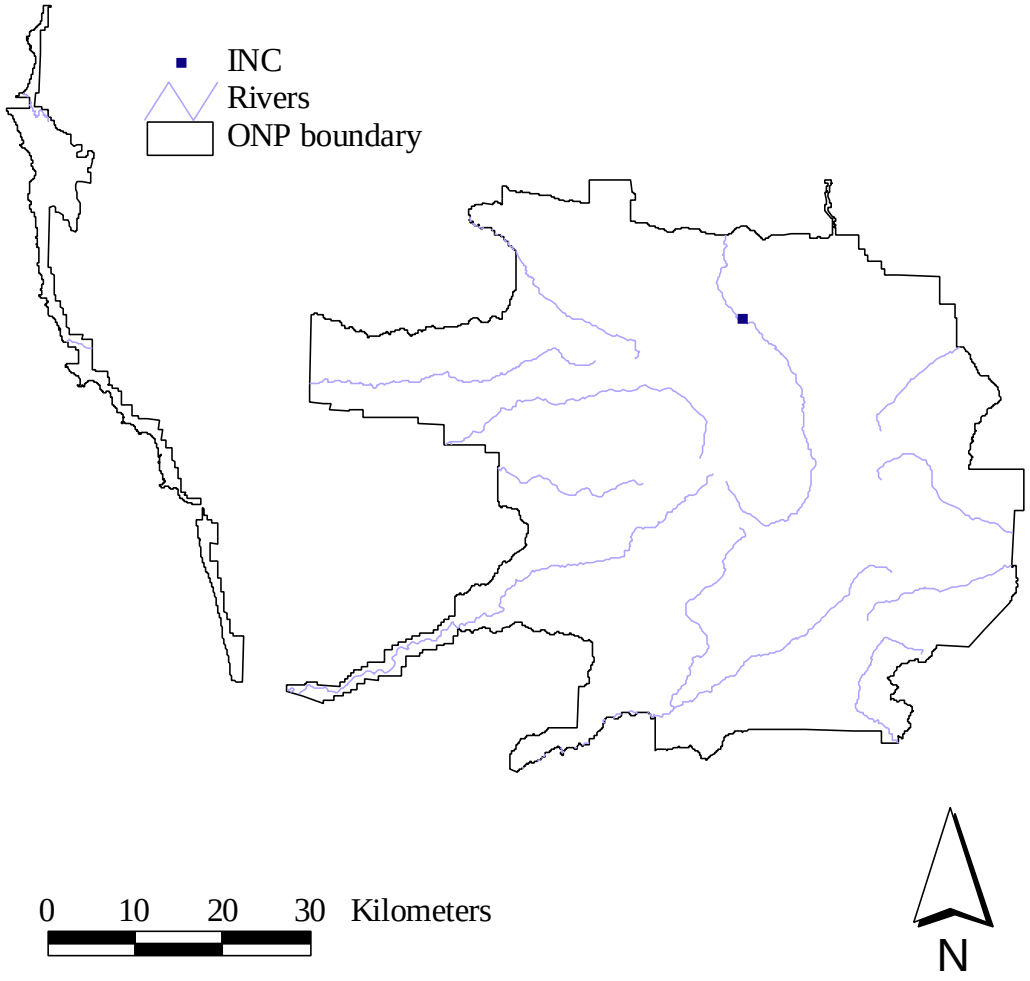


Tailed frog
(Ascaphus truei)



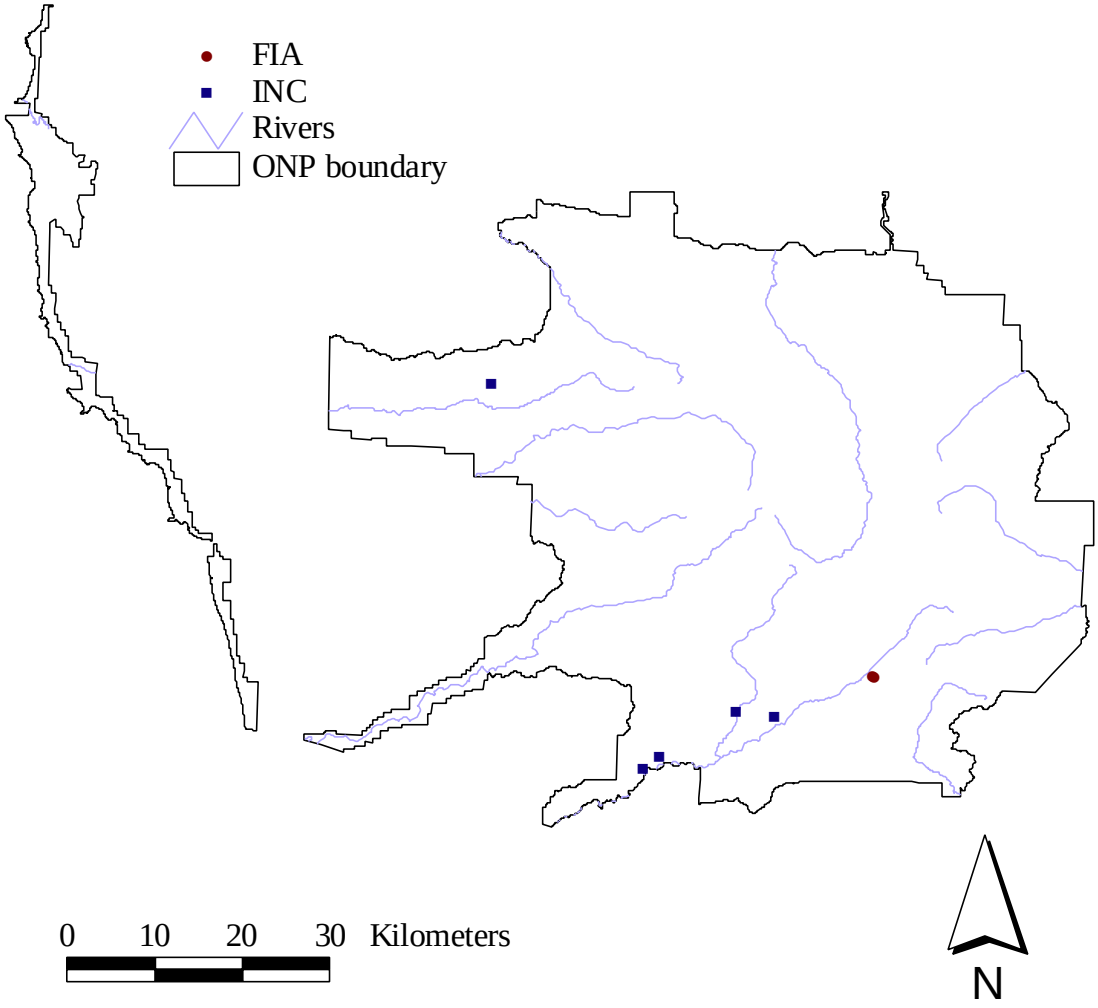
Western toad

(Bufo boreas)

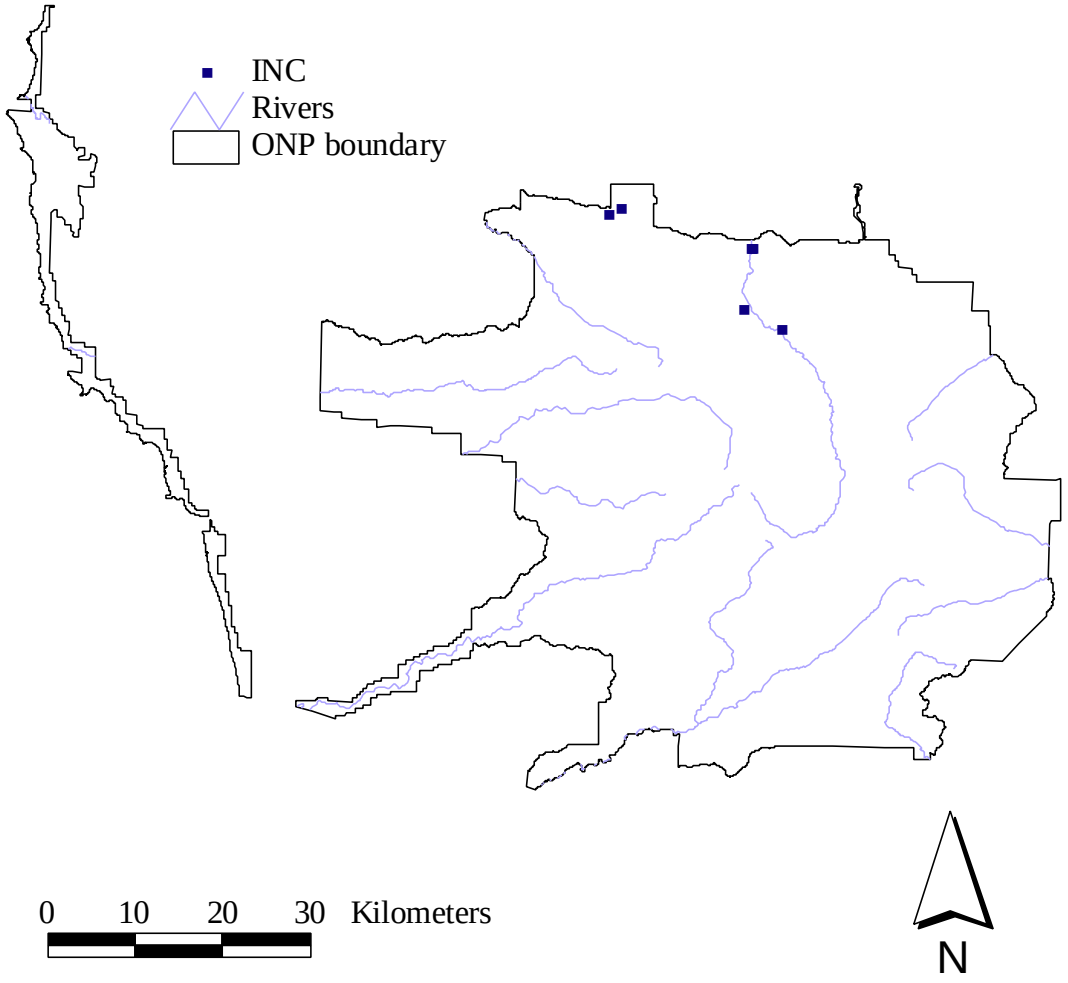


Rubber boa

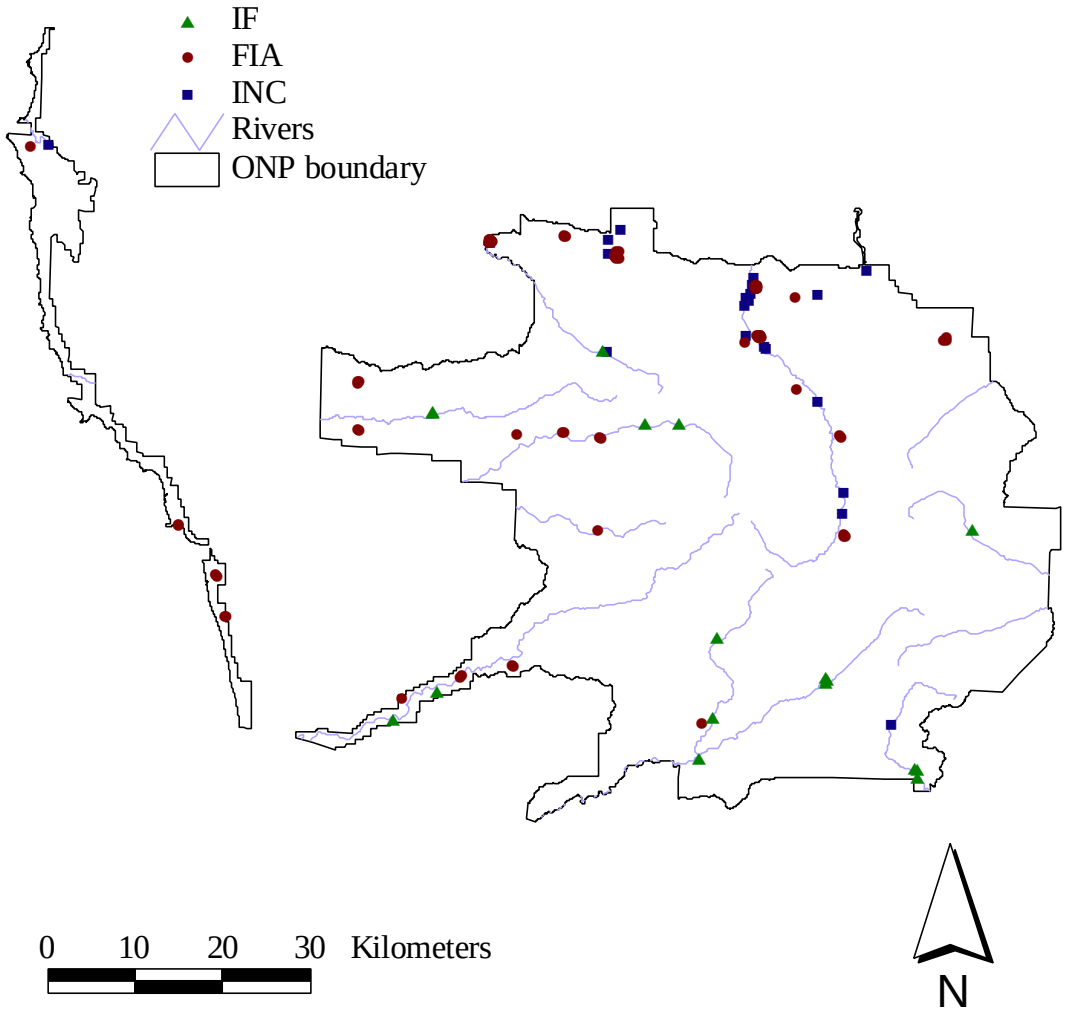
(Charina bottae)



Cope's giant salamander
(Dicamptodon copei)

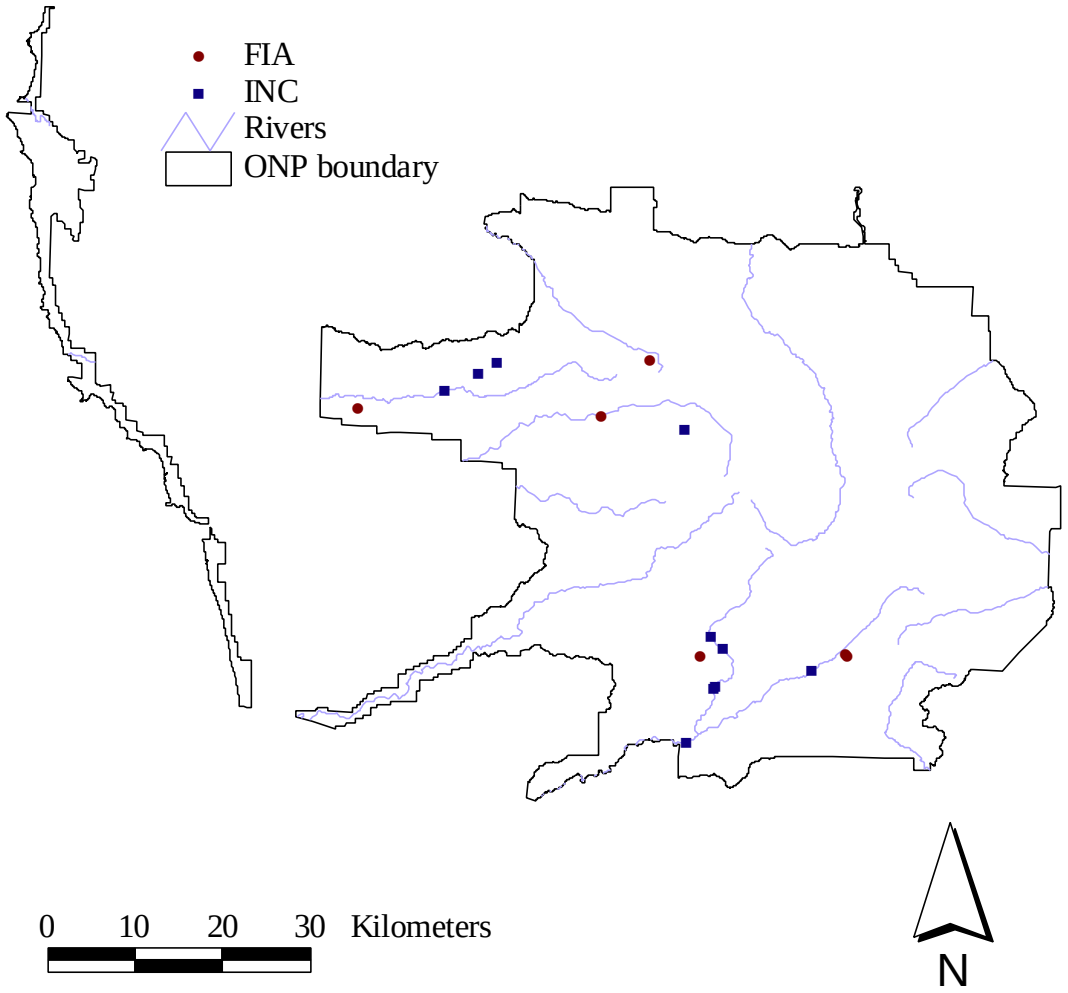


Northern alligator lizard
(Elgaria coerulea)



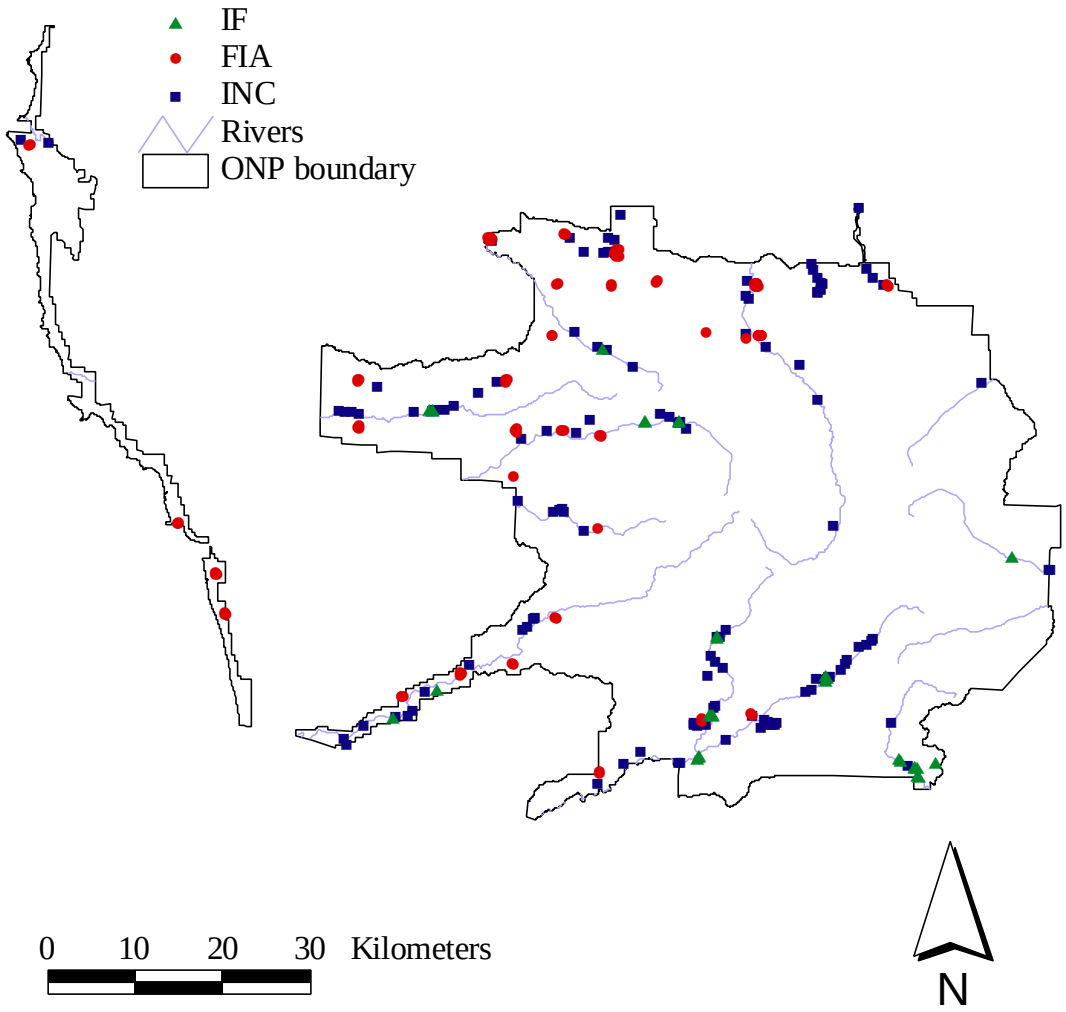
Ensatina

(Ensatina eschscholtzii)



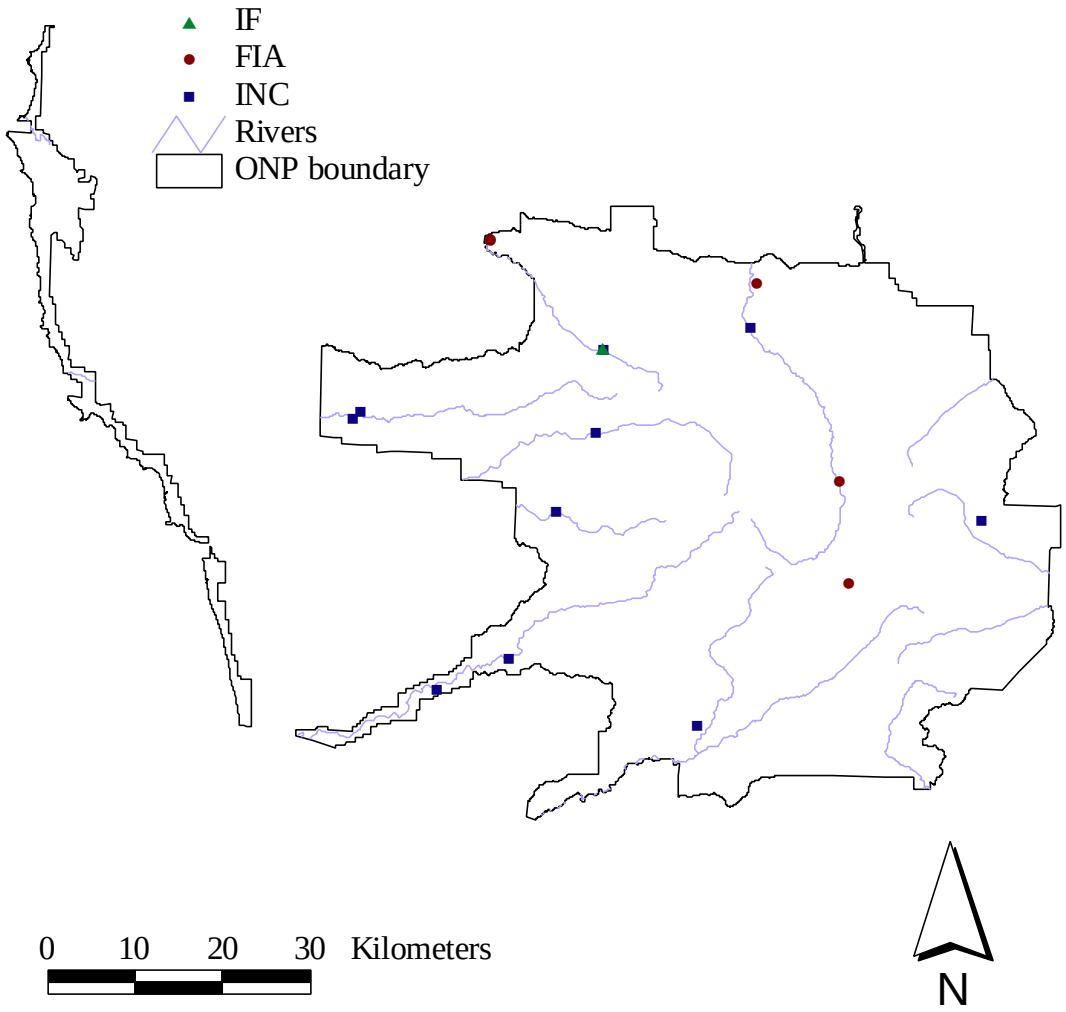
Van Dyke's salamander

(Plethodon vandykei)



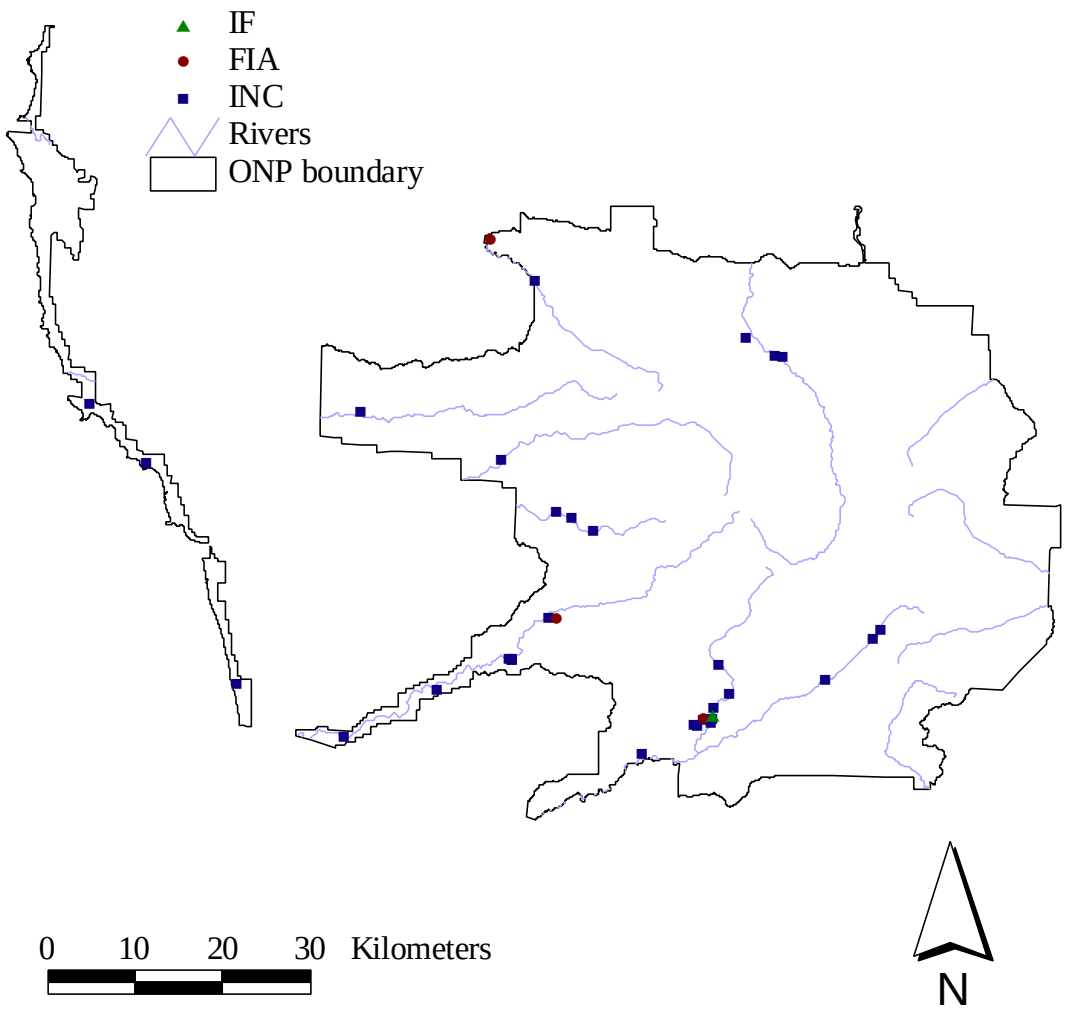
Western red-backed salamander

(Plethodon vehiculum)



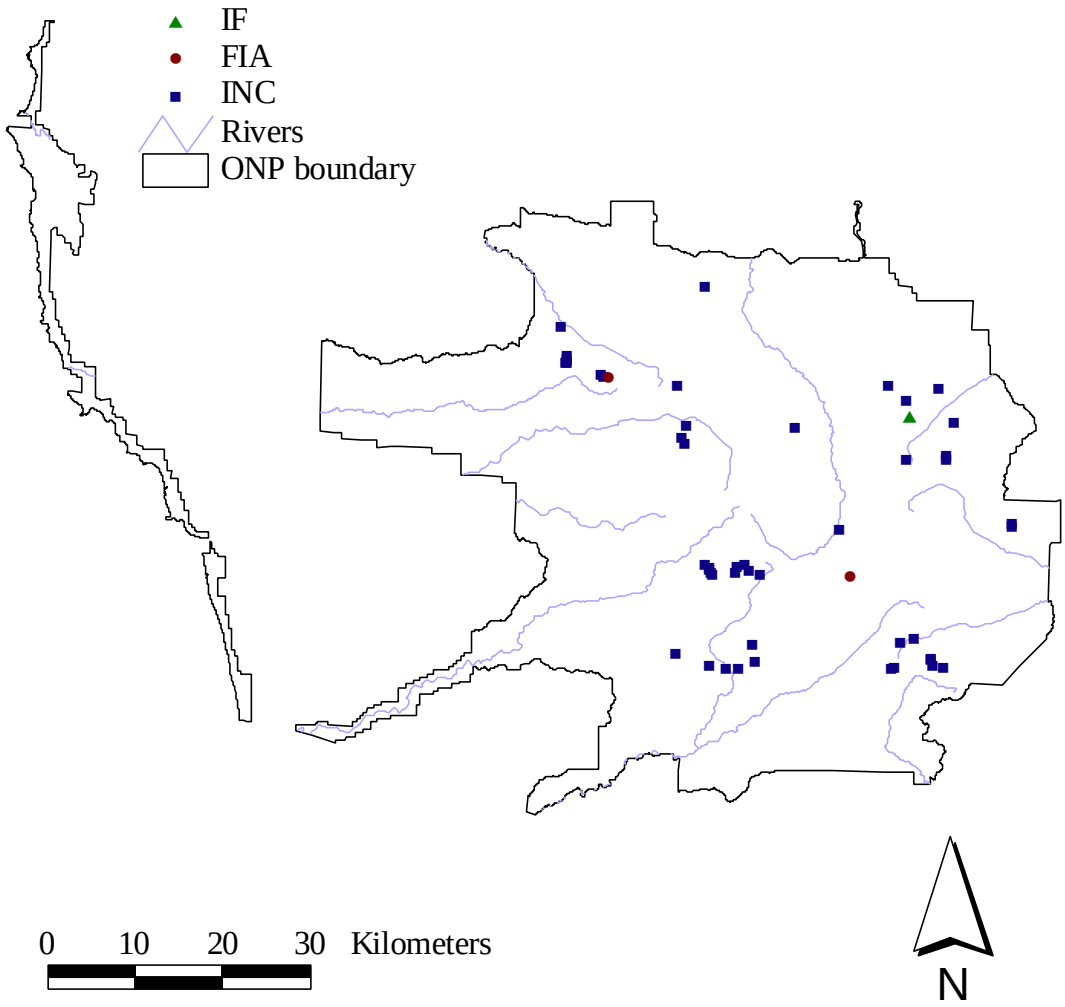
Pacific treefrog

(Pseudacris regilla)



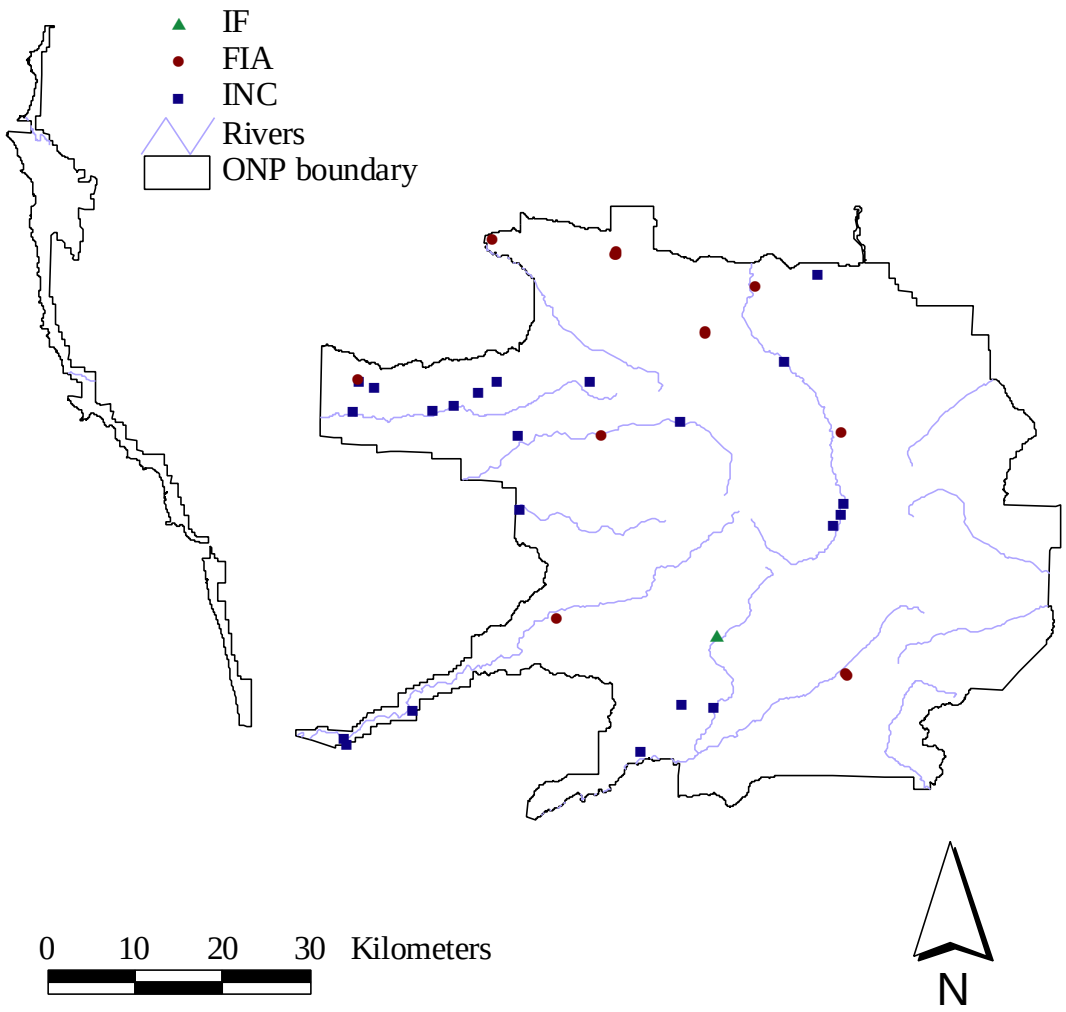
Red-legged frog

(Rana aurora)



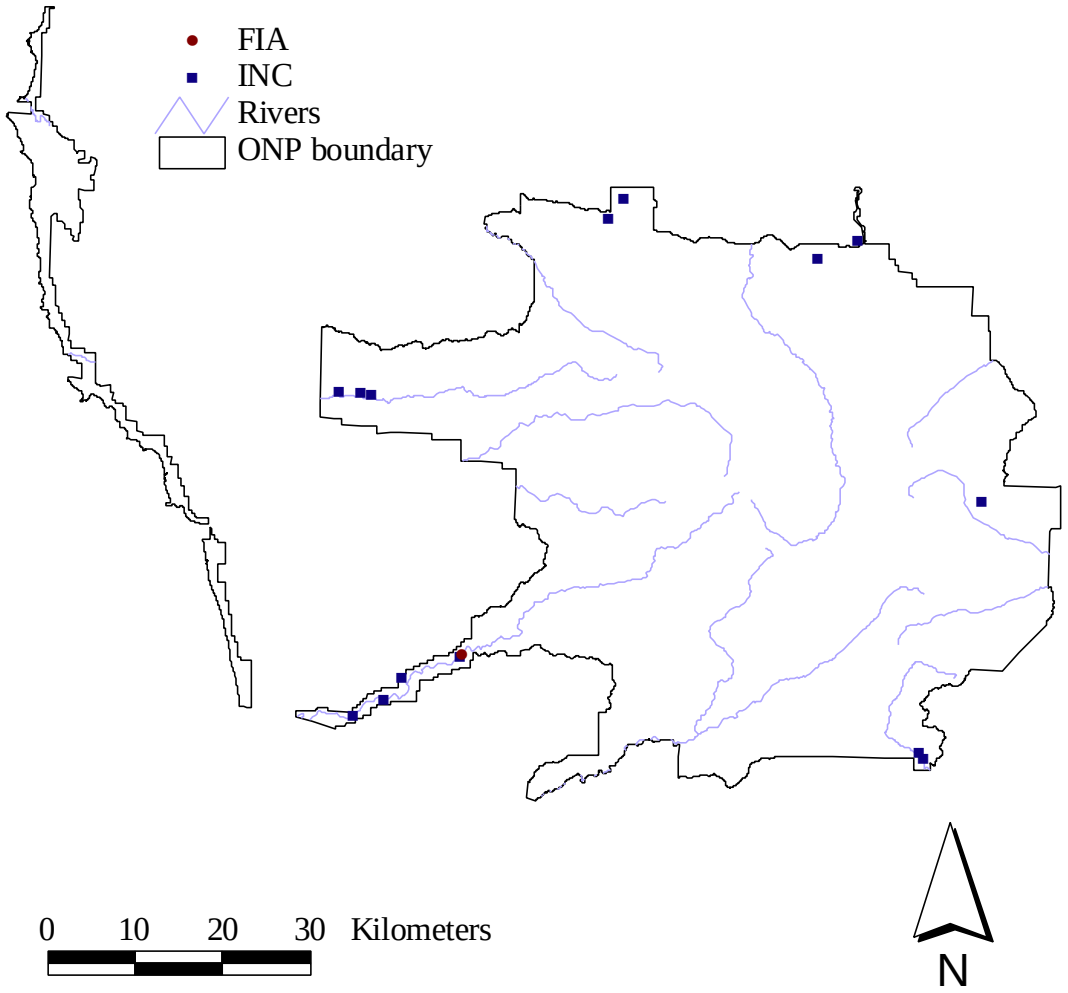
Cascades frog

(Rana cascadae)



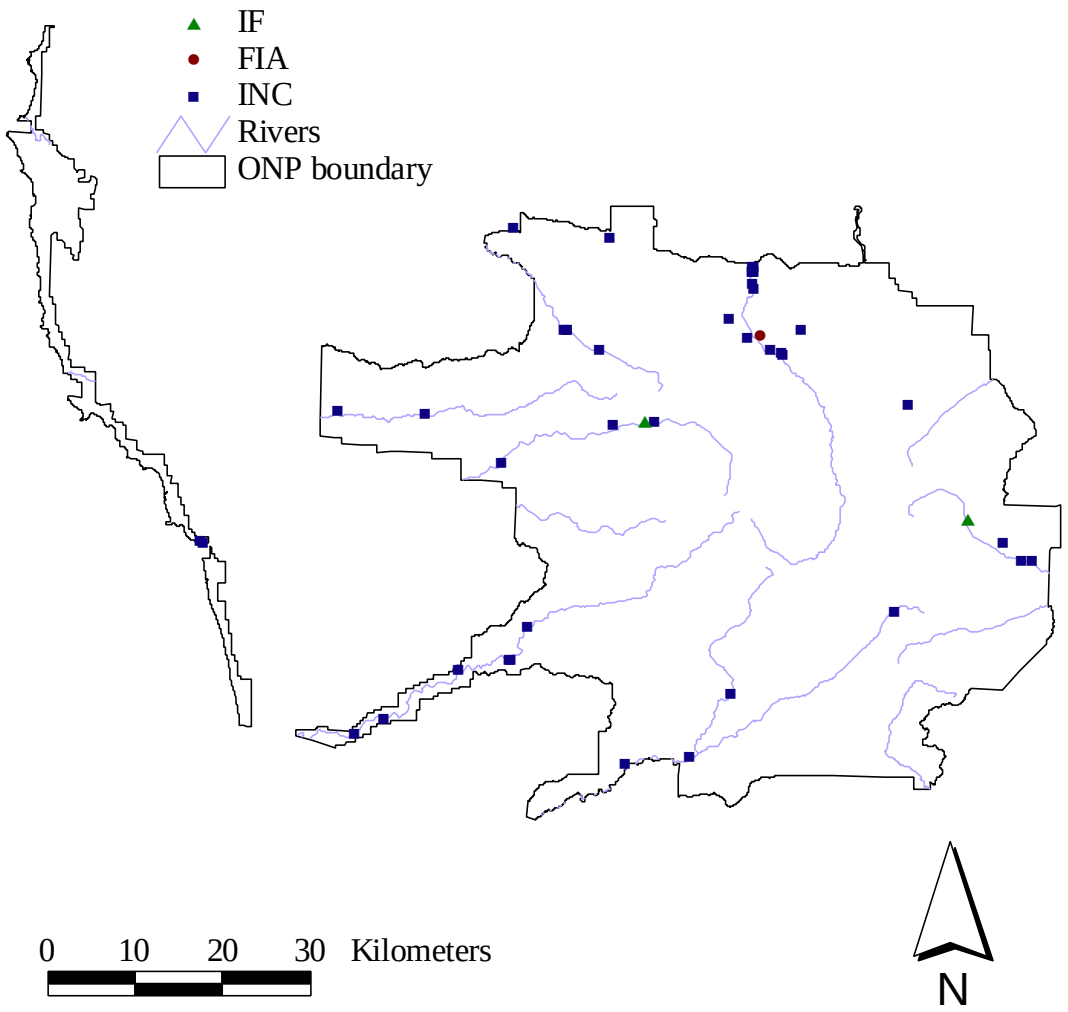
Olympic torrent salamander

(Rhyacotriton olympicus)



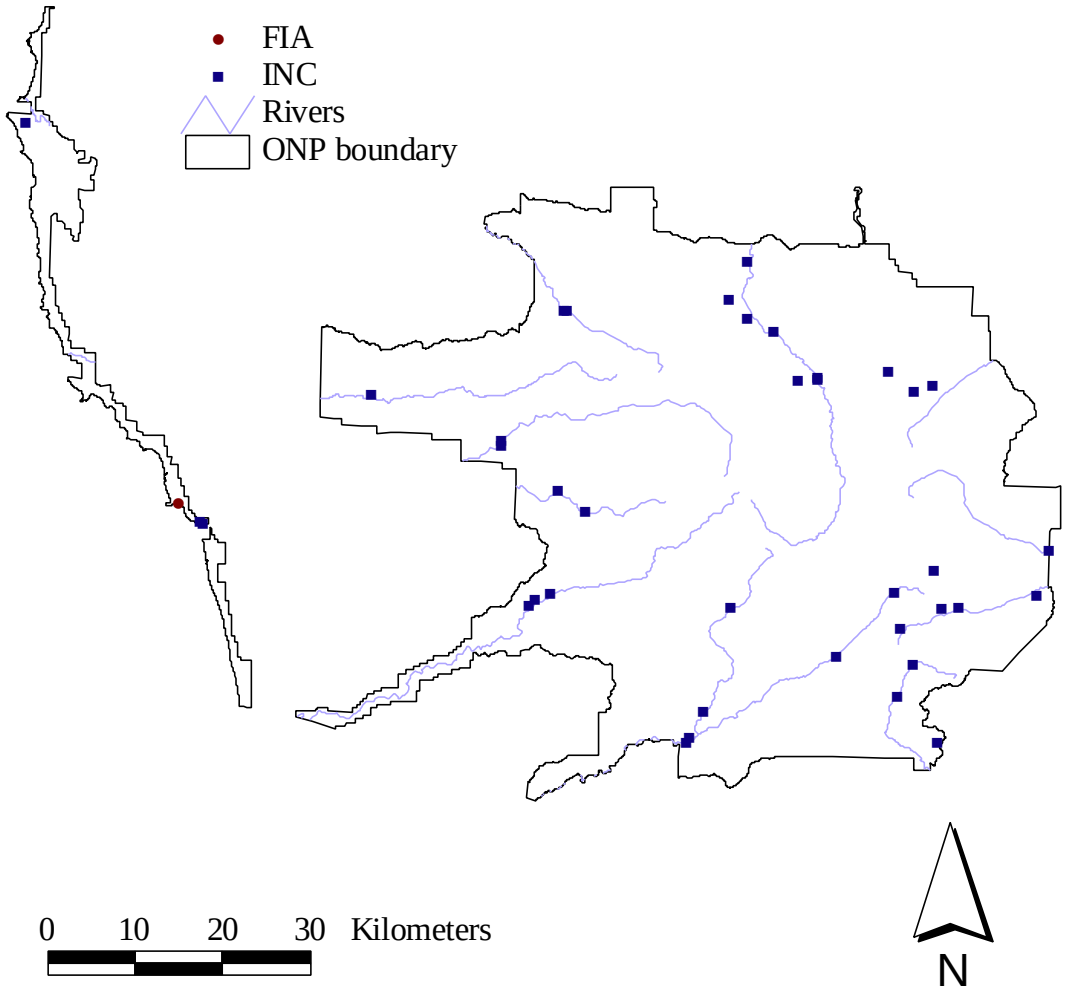
Rough-skinned newt

(Taricha granulosa)



Northwestern garter snake

(Thamnophis ordinoides)



Common garter snake

(Thamnophis sirtalis)

Appendix I. Site locations for gravel bar surveys. Data are number of Western toad (*Bufo boreas)* individuals recorded.

Drainage	Gravel Bar #	Pool #	UTM East	UTM North	Egg	Larvae	Juvenile	Adult
QUEETS	10	37	416738	5270830	0	0	0	0
QUEETS	10	38	416966	5270734	0	1	0	0
QUEETS	10	39	416848	5270633	0	0	0	0
QUEETS	10	40	416910	5270550	0	0	0	0
QUEETS	10	41	416917	5270120	0	0	0	0
QUEETS	10	42	416913	5270107	0	0	0	0
QUEETS	10	43	416903	5270103	0	0	0	0
QUEETS	10	44	416885	5270069	0	1	0	0
QUEETS	10	45	416845	5269964	0	0	0	0
QUEETS	10	46	416743	5269978	0	1	0	0
QUEETS	10	47	416745	5269991	0	0	0	0
QUEETS	10	48	416762	5270039	0	0	0	0
QUEETS	10	49	416774	5269900	0	1	0	0
QUEETS	11	50	423528	5275271	0	1	0	0
QUEETS	11	51	423504	5275246	0	0	0	0
QUEETS	12	52	422276	5273986	0	0	0	0
QUEETS	12	53	422353	5273798	0	1	0	0
QUEETS	13	54	421585	5273566	0	1	0	0
QUEETS	13	55	421554	5273578	0	0	0	0
QUEETS	13	56	421531	5273582	0	0	0	0
QUEETS	13	57	421432	5273578	0	1	0	0
QUEETS	13	58	421489	5273510	0	1	1	0
QUEETS	13	59	421450	5273469	0	1	0	0
QUEETS	13	60	421446	5273477	0	0	0	0
QUEETS	13	61	421453	5273479	0	0	0	0
QUEETS	13	62	421378	5273443	0	0	0	0
QUEETS	13	63	421356	5273447	0	1	0	0
QUEETS	13	64	421157	5273311	0	0	0	0
QUINAULT	8	24	448775	5264337	0	0	0	0
QUINAULT	8	25	448793	5264347	0	0	0	0
QUINAULT	8	26	448726	5264357	1	1	0	0
QUINAULT	8	27	448543	5264413	0	0	0	0
QUINAULT	8	28	448521	5264427	0	0	0	0
QUINAULT	9	29	449375	5264770	0	0	0	0
QUINAULT	9	30	449450	5264890	0	1	0	0
QUINAULT	9	31	449474	5264883	0	0	0	0
QUINAULT	9	32	449484	5264927	0	0	0	0
QUINAULT	9	33	449512	5264948	0	1	0	0
QUINAULT	9	34	449524	5265028	0	0	0	0
QUINAULT	9	35	449460	5265022	0	0	0	0
QUINAULT	9	36	449409	5264980	0	0	0	0
SKOKOMISH	1	9	475748	5261321	0	0	0	0
SKOKOMISH	1	11	475775	5261265	0	0	0	0

Drainage	Gravel Bar #	Pool #	UTM East	UTM North	Egg	Larvae	Juvenile	Adult
SKOKOMISH	5	12	473301	5263709	0	0	0	0
SKOKOMISH	5	13	473324	5263740	0	0	0	0
SKOKOMISH	5	14	473298	5263745	0	0	0	0
SKOKOMISH	5	15	473308	5263780	0	0	0	0
SKOKOMISH	5	16	473366	5263783	0	0	0	0
SKOKOMISH	5	17	473330	5263695	0	0	0	0
SKOKOMISH	5	18	473349	5263676	0	0	0	0
SKOKOMISH	5	19	473263	5263688	0	0	0	0
SKOKOMISH	6	20	473773	5263687	0	0	0	0
SKOKOMISH	6	21	473775	5263657	0	0	0	0
SKOKOMISH	7	22	473553	5263607	0	0	0	0
SKOKOMISH	7	23	473472	5263628	0	0	0	0

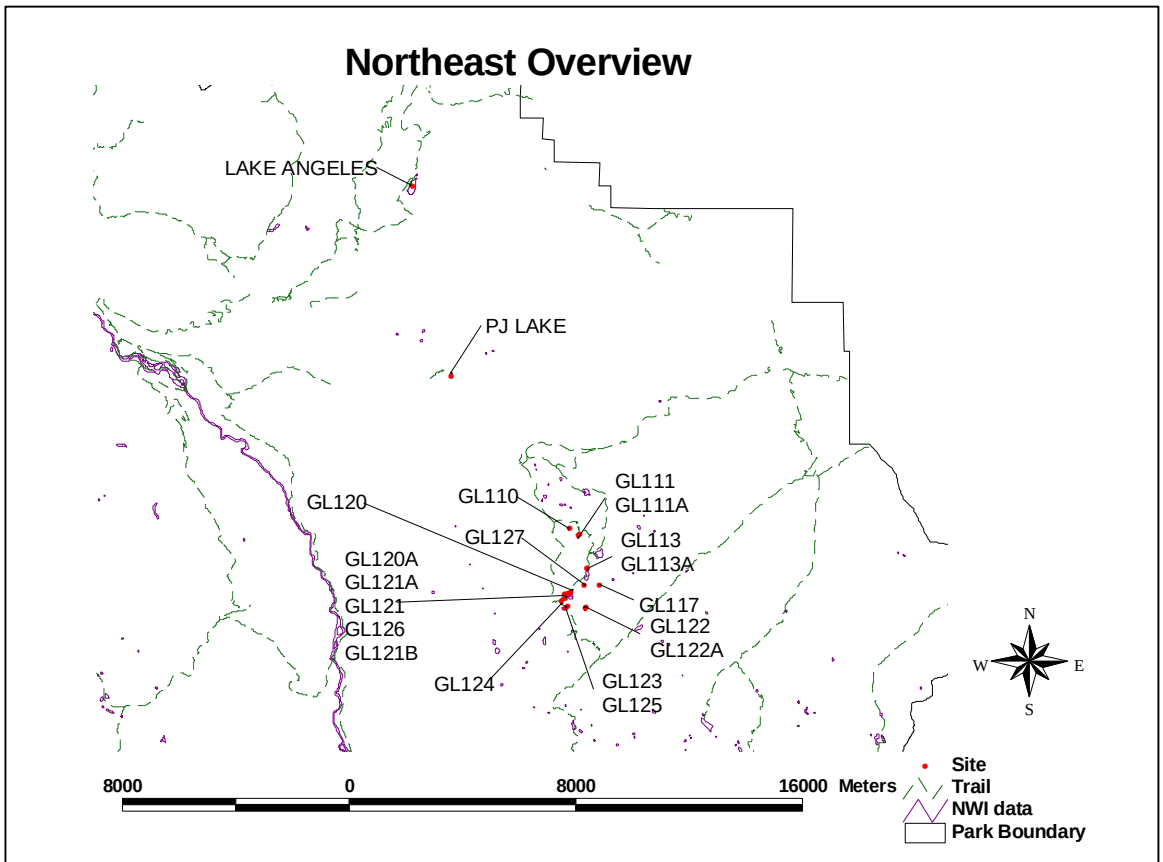
Appendix J. Inventory and monitoring site locations for pond and lake surveys. Data code: 0 = not present; 1 = adult, juvenile; 2 = egg, larvae.

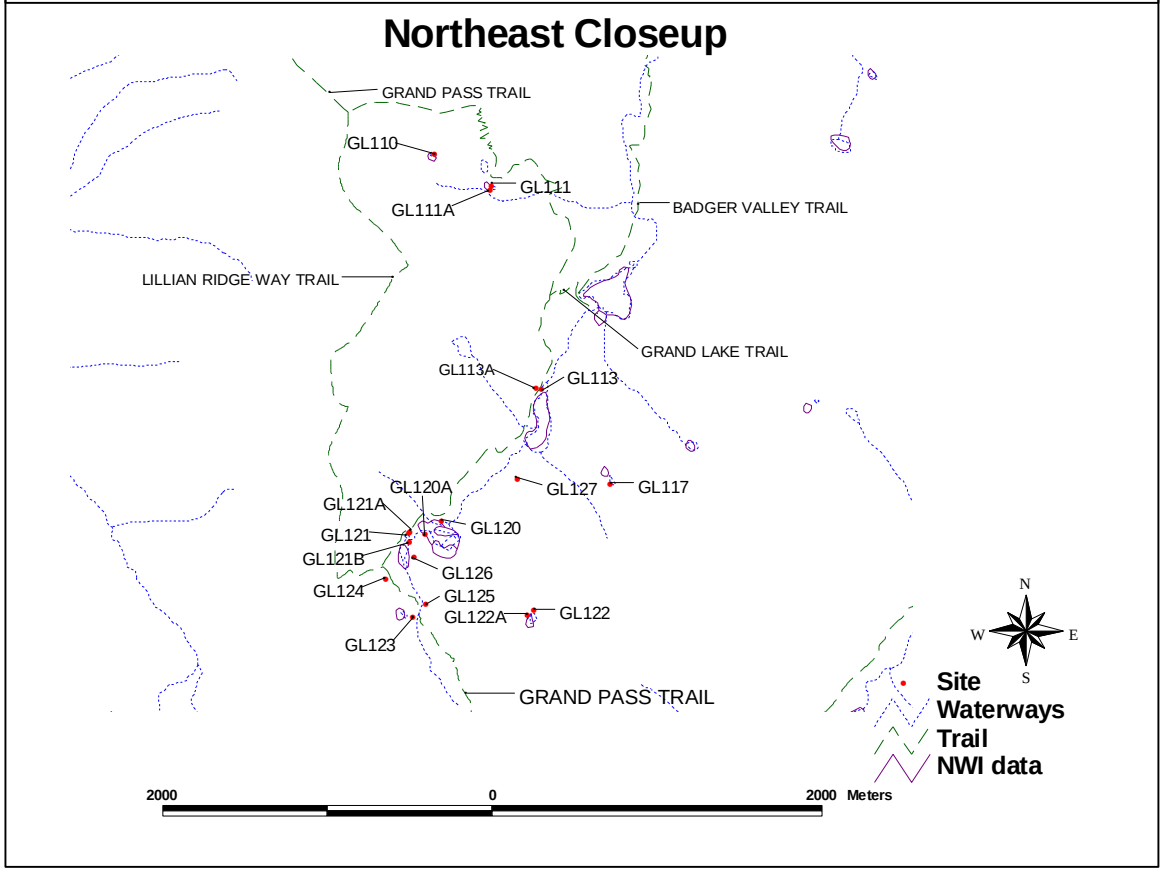
DRAINAGE	SITE ID	UTM EAST	UTM NORTH	*Ambystoma gracile*	*Ambystoma macrodactylum*	*Bufo boreas*	*Pseudacris regilla*	*Rana aurora*	*Rana cascadae*	*Taricha granulosa*
LYRE	EAGLE1	432667	5321867	2	2	0	1	0	1, 2	1, 2
LYRE	EAGLE2	432805	5322017	1,2	0	1	1, 2	0	1, 2	1
LYRE	EAGLE3	432841	5322183	2	0	0	1	1	1	2
OZETTE	ERICSON BAY POND	376427	5330414	2	0	2	2	2	0	0
GREY WOLF	GL110	473242	5304827	0	1, 2	0	0	0	1, 2	0
GREY WOLF	GL111	473589	5304634	0	0	0	0	0	1, 2	0
GREY WOLF	GL111A	473581	5304603	0	0	0	0	0	1	0
GREY WOLF	GL113	473890	5303396	0	1	0	0	0	1,2	0
GREY WOLF	GL113A	473856	5303401	0	2	0	0	0	1,2	0
GREY WOLF	GL117	474309	5302820	0	2	0	0	0	1, 2	0
GREY WOLF	GL120	473280	5302593	0	2	0	0	0	1, 2	0
GREY WOLF	GL120A	473183	5302517	0	1, 2	0	0	0	1, 2	0
GREY WOLF	GL121	473081	5302521	0	2	0	0	0	1, 2	0
GREY WOLF	GL121A	473089	5302530	0	2	0	0	0	1, 2	0
GREY WOLF	GL121B	473088	5302468	0	0	0	0	0	0	0
GREY WOLF	GL122	473844	5302052	0	0	0	0	0	0	0
GREY WOLF	GL122A	473805	5302023	0	0	0	0	0	0	0
GREY WOLF	GL123	473109	5302014	0	0	0	0	0	1, 2	0
GREY WOLF	GL124	472943	5302245	0	0	0	0	0	0	0
GREY WOLF	GL125	473189	5302094	0	2	0	0	0	1, 2	0
GREY WOLF	GL126	473118	5302375	0	0	0	0	0	1, 2	0
GREY WOLF	GL127	473745	5302852	0	2	0	0	0	1, 2	0
HOH	HOH-1	423370	5296581	2	0	0	1, 2	1, 2	0	1
HOH	HOH-2	430064	5301054	0	0	0	2	2	0	0
HOH	HOH-3	430015	5301018	0	0	0	2	1, 2	0	0
HOH	HOH-3A	430077	5301036	2	0	0	0	2	0	0
HOH	HOH-4	430100	5301060	2	0	0	0	2	0	0
MORSE CRK	LAKE ANGELES	467733	5316919	0	0	0	0	0	1	1
MORSE CRK	LAKE ANGELES-A			0	2	0	1	0	1, 2	1

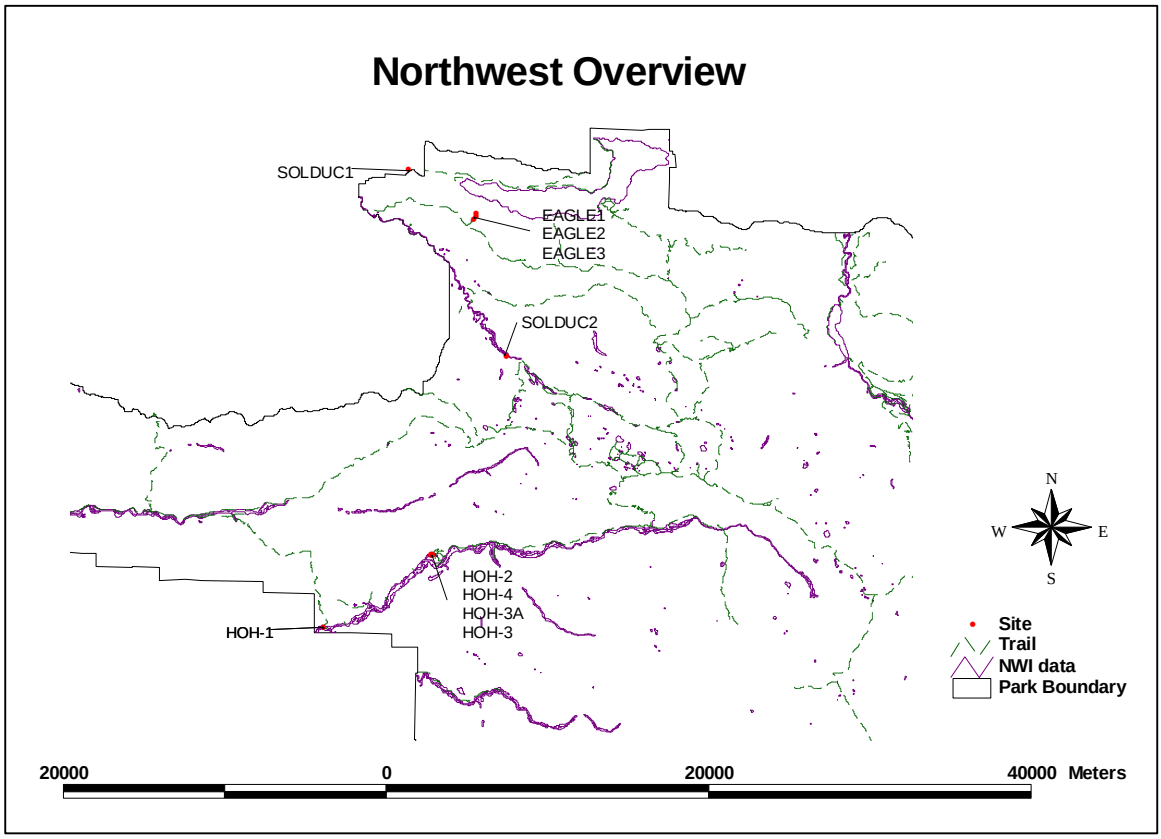
DRAINAGE	SITE ID	UTM EAST	UTM NORTH	*Ambystoma gracile*	*Ambystoma macrodactylum*	*Bufo boreas*	*Pseudacris regilla*	*Rana aurora*	*Rana cascadae*	*Taricha granulosa*
NF QUINAULT	NFQ-IRELY	449414	5268131	2	0	2	2	1, 2	0	1
MORSE CRK	PJ LAKE	469083	5310230	0	0	2	0	0	1	0
OZETTE	SEAFIELD LAKE	374500	5338900	2	0	0	0	2	0	0
SOLDUC	SOLDUC1	428597	5324925	2	0	0	2	0	0	0
SOLDUC	SOLDUC2	434675	5313353	2	0	0	0	1	0	0
QUINAULT	SR800	460338	5265358	0	0	0	0	0	2	0
QUINAULT	SR801	460339	5265355	0	0	0	0	0	0	0
WYNOOCHEE	SR802	458750	5264880	1, 2	1, 2	0	0	0	1, 2	0
WYNOOCHEE	SR802A	458724	5264832	0	0	0	0	0	1, 2	0
WYNOOCHEE	SR802B	458791	5264861	2	0	0	0	0	1, 2	0
WYNOOCHEE	SR803	458784	5264913	0	2	0	0	0	1, 2	0
WYNOOCHEE	SR803A	458780	5264929	0	2	0	0	0	1	0
WYNOOCHEE	SR804	458811	5264916	0	1, 2	0	0	0	1, 2	0
WYNOOCHEE	SR804A	458809	5264926	0	0	0	0	0	1, 2	0
QUINAULT	SR805	461586	5264651	2	0	0	0	0	0	0
SKOKOMISH	SR806	463486	5265772	2	1, 2	0	0	0	1	0
SKOKOMISH	SR806A	463422	5265751	0	0	0	0	0	0	0
SKOKOMISH	SR806B	463420	5265759	0	0	0	0	0	2	0
SKOKOMISH	SR806C	463414	5265760	0	0	0	0	0	0	0
SKOKOMISH	SR806D	463412	5265762	0	2	0	0	0	1	0
SKOKOMISH	SR806E	463414	5265765	0	0	0	0	0	1, 2	0
SKOKOMISH	SR806F	463403	5265779	0	2	0	0	0	0	0
SKOKOMISH	SR806G	463418	5265780	0	0	0	0	0	0	0
SKOKOMISH	SR807	463563	5265673	2	2	0	0	0	0	0
SKOKOMISH	SR808	463375	5265792	0	1, 2	0	0	0	1, 2	0
SKOKOMISH	SR809	463315	5265814	2	2	0	0	0	1, 2	0
SKOKOMISH	SR809A	463329	5265815	0	0	0	0	0	0	0
SKOKOMISH	SR809B	463326	5265819	0	0	0	0	0	0	0
SKOKOMISH	SR809C	463328	5265821	0	0	0	0	0	1	0
SKOKOMISH	SR810	463214	5265732	2	0	0	0	0	1, 2	0
QUINAULT	SR812	462526	5266575	2	0	0	0	0	1	0
SKOKOMISH	SR813	463956	5265969	0	0	0	0	0	0	0

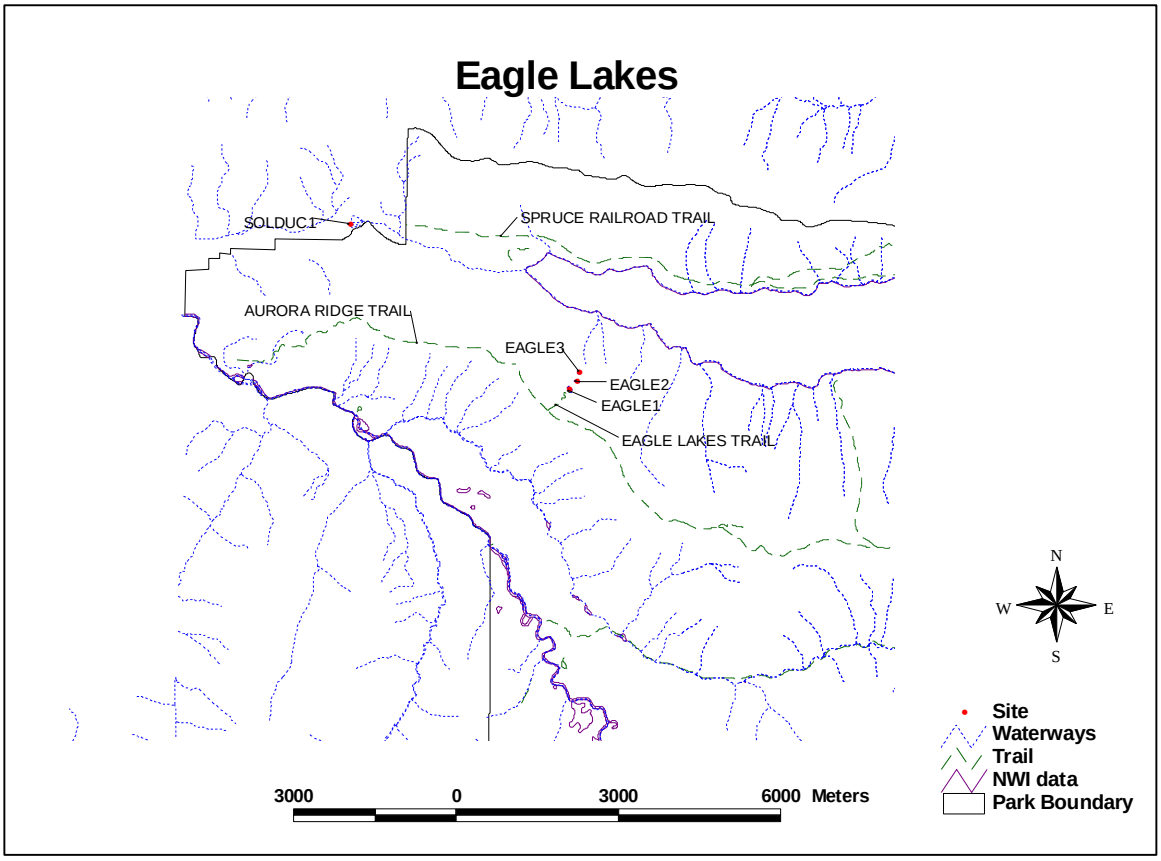
DRAINAGE	SITE ID	UTM EAST	UTM NORTH	*Ambystoma gracile*	*Ambystoma macrodactylum*	*Bufo boreas*	*Pseudacris regilla*	*Rana aurora*	*Rana cascadae*	*Taricha granulosa*
SKOKOMISH	SR814	464205	5266160	0	0	0	0	0	0	0
SKOKOMISH	SR815	464509	5266174	0	0	0	0	0	0	0
SKOKOMISH	SR816	464659	5266084	1, 2	0	0	0	0	1, 2	0
SKOKOMISH	SR817	465182	5266315	0	0	0	0	0	1	0
SKOKOMISH	SR818	463112	5265646	2	2	0	0	0	1, 2	0
SKOKOMISH	SR818A	463126	5265641	0	0	0	0	0	0	0
SKOKOMISH	SR818B	463106	5265644	0	2	0	0	0	1	0
SKOKOMISH	SR819	463028	5265740	0	0	0	0	0	1, 2	0
SKOKOMISH	SR820	462831	5265633	0	2	0	0	0	1, 2	0
SKOKOMISH	SR821	462836	5265628	0	2	0	0	0	1, 2	0
SKOKOMISH	SR822	462833	5265621	0	0	0	0	0	1, 2	0
SKOKOMISH	SR823	462833	5265616	0	0	0	0	0	1, 2	0
SKOKOMISH	SR824	462810	5265624	0	0	0	0	0	1	0
OZETTE	WILLOUGHBY LAKE	374964	5343788	0	0	0	0	0	1	0

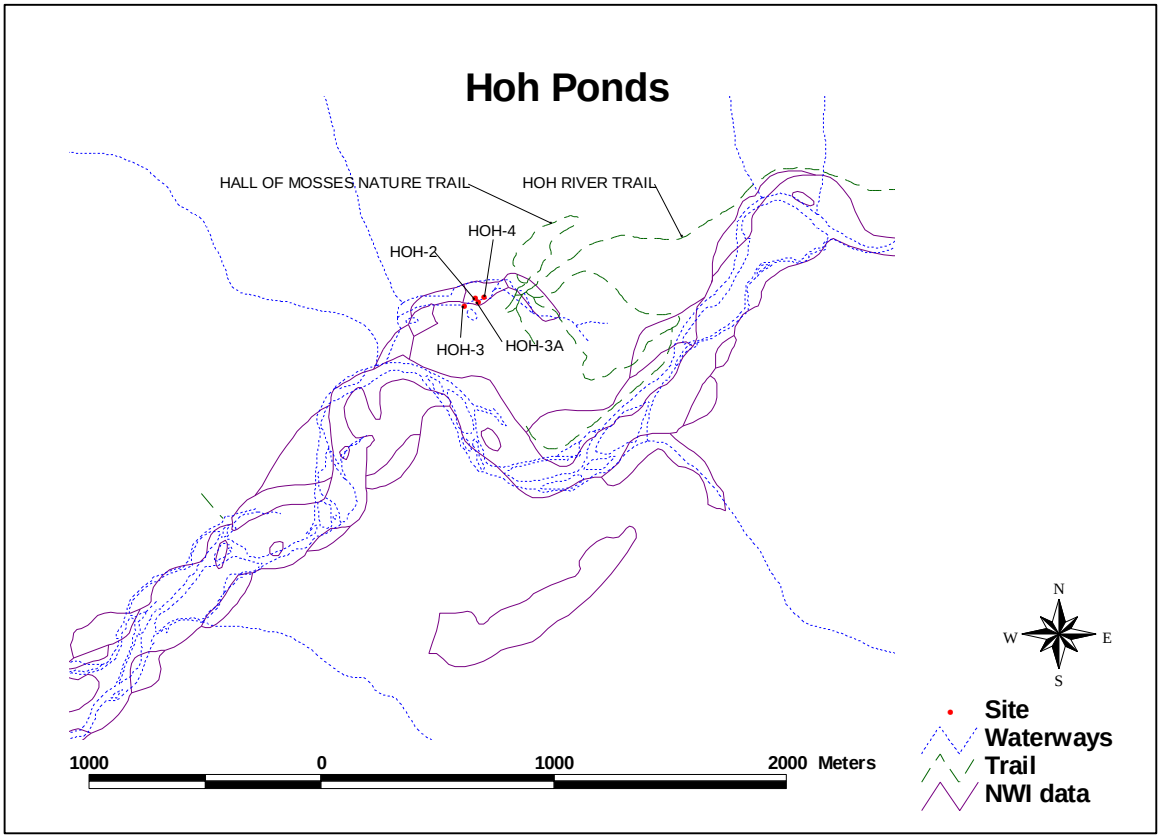
Appendix K. Site location maps for pond and stream surveys.

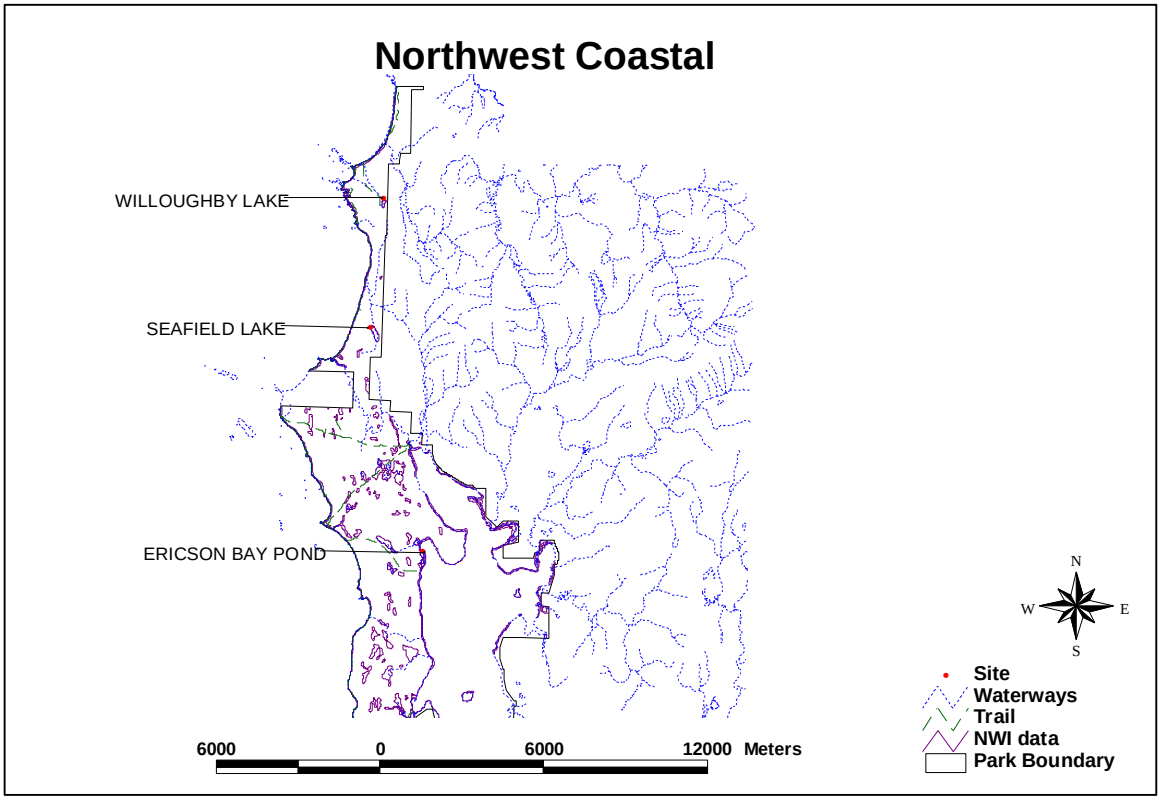

Northeast Overview
LAKE ANGELES
PJ LAKE
GL120
GL110
GL111
GL111A
GL127
GL113
GL113A
GL120A
GL121A
GL121
GL126
GL121B
GL117
GL122
GL122A
GL124
GL123
GL125
N
W
E
S
8000
0
8000
16000 Meters
Site
Trail
NWI data
Park Boundary


Northeast Closeup
GRAND PASS TRAIL
GL110
GL111
GL111A
BADGER VALLEY TRAIL
LILLIAN RIDGE WAY TRAIL
GRAND LAKE TRAIL
GL113A
GL113
GL120A
GL127
GL117
GL121A
GL121
GL120
GL121B
GL126
GL124
GL125
GL122A
GL122
GL123
GRAND PASS TRAIL
N
W
E
S
Site
Waterways
Trail
NWI data
2000
0
2000 Meters

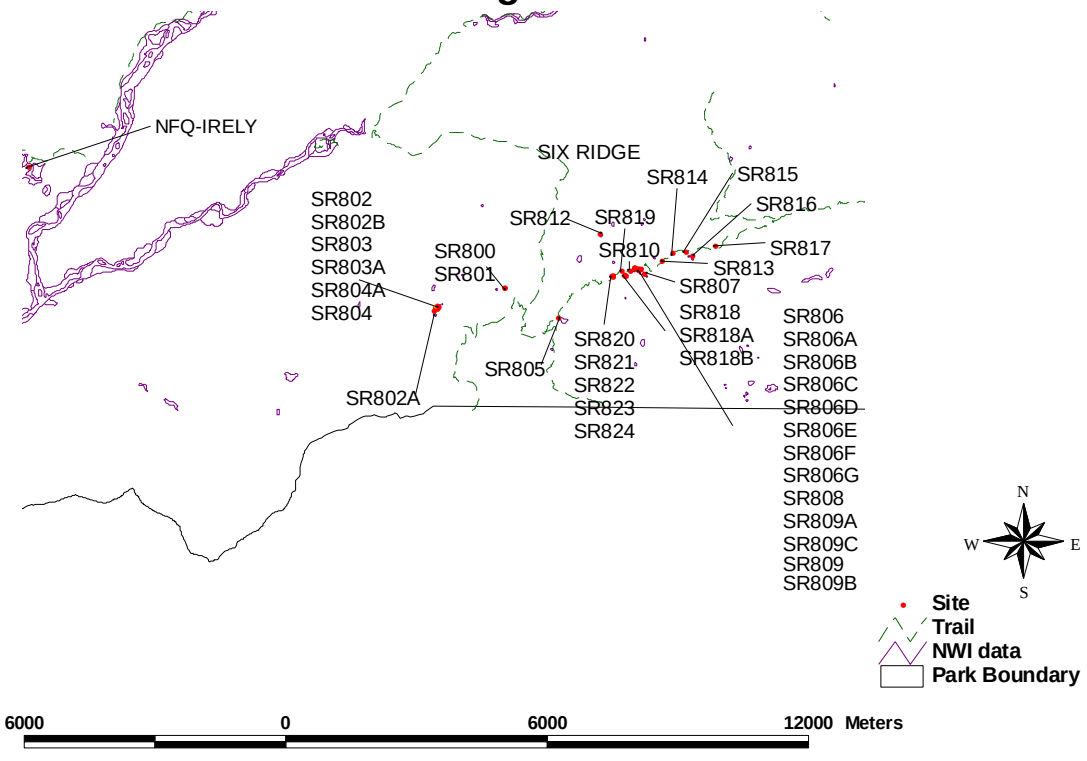

Northwest Overview
SOLDUC1
EAGLE1
EAGLE2
EAGLE3
SOLDUC2
HOH-2
HOH-4
HOH-3A
HOH-3
HOH-1
N
W
E
S
Site
Trail
NWI data
Park Boundary
20000
0
20000
40000 Meters


Eagle Lakes
SOLDUC1
SPRUCE RAILROAD TRAIL
AURORA RIDGE TRAIL
EAGLE3
EAGLE2
EAGLE1
EAGLE LAKES TRAIL
N
W
E
S
Site
Waterways
Trail
NWI data
Park Boundary
3000
0
3000
6000 Meters

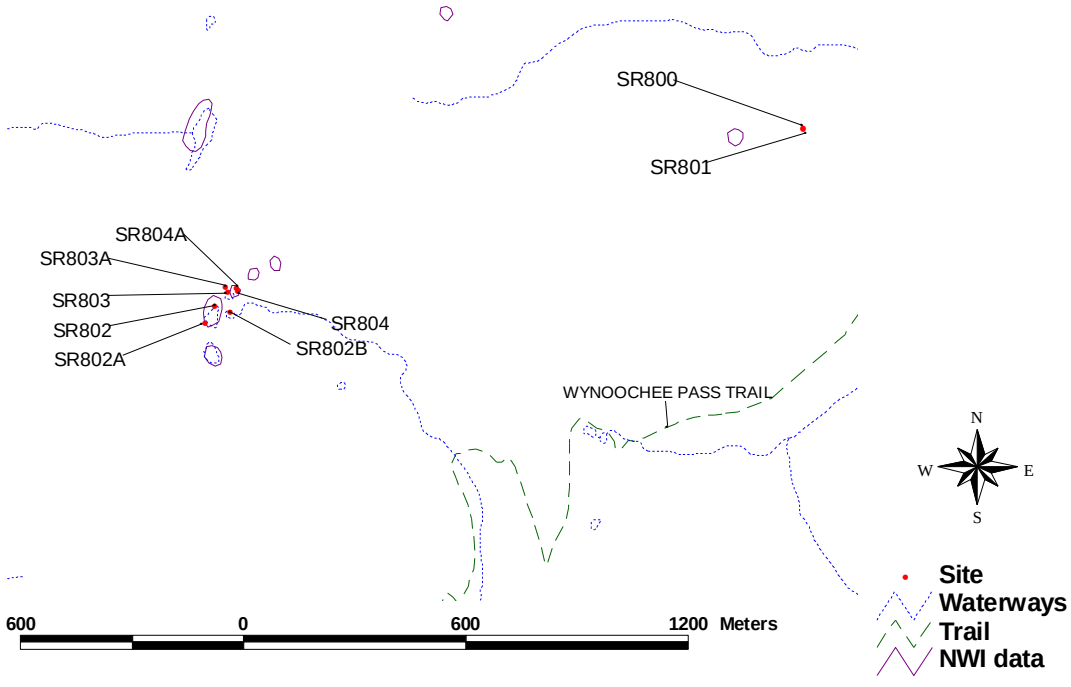

Hoh Ponds
HALL OF MOSSES NATURE TRAIL
HOH RIVER TRAIL
HOH-4
HOH-2
HOH-3
HOH-3A
1000
0
1000
2000 Meters
N
W
E
S
Site
Waterways
Trail
NWI data

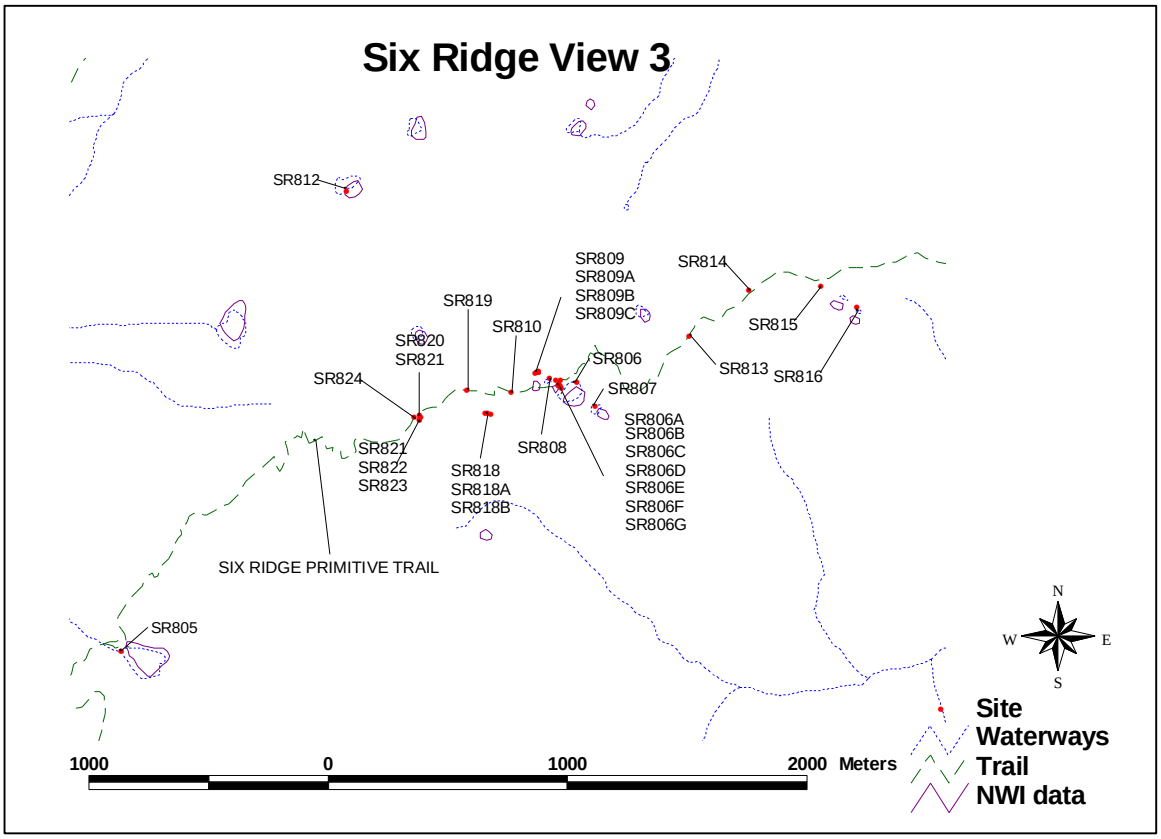

Northwest Coastal
WILLOUGHBY LAKE
SEAFIELD LAKE
ERICSON BAY POND
6000
0
6000
12000 Meters
N
W
E
S
Site
Waterways
Trail
NWI data
Park Boundary

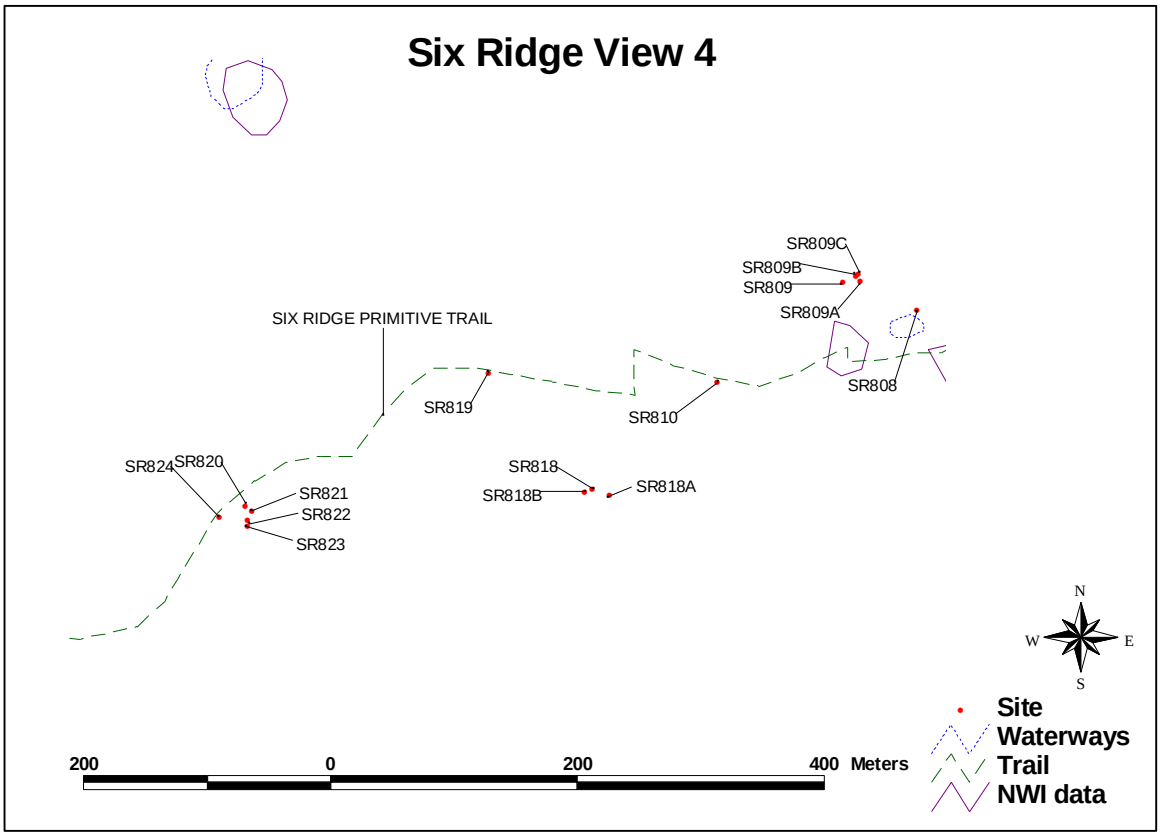
Six Ridge Overview

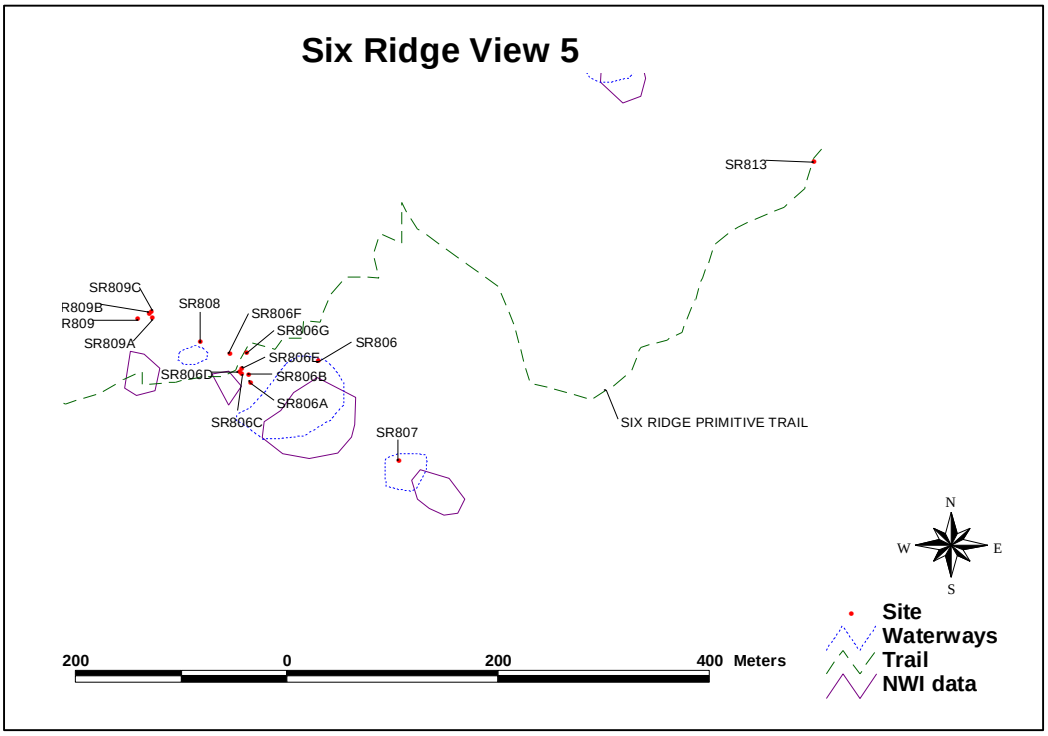


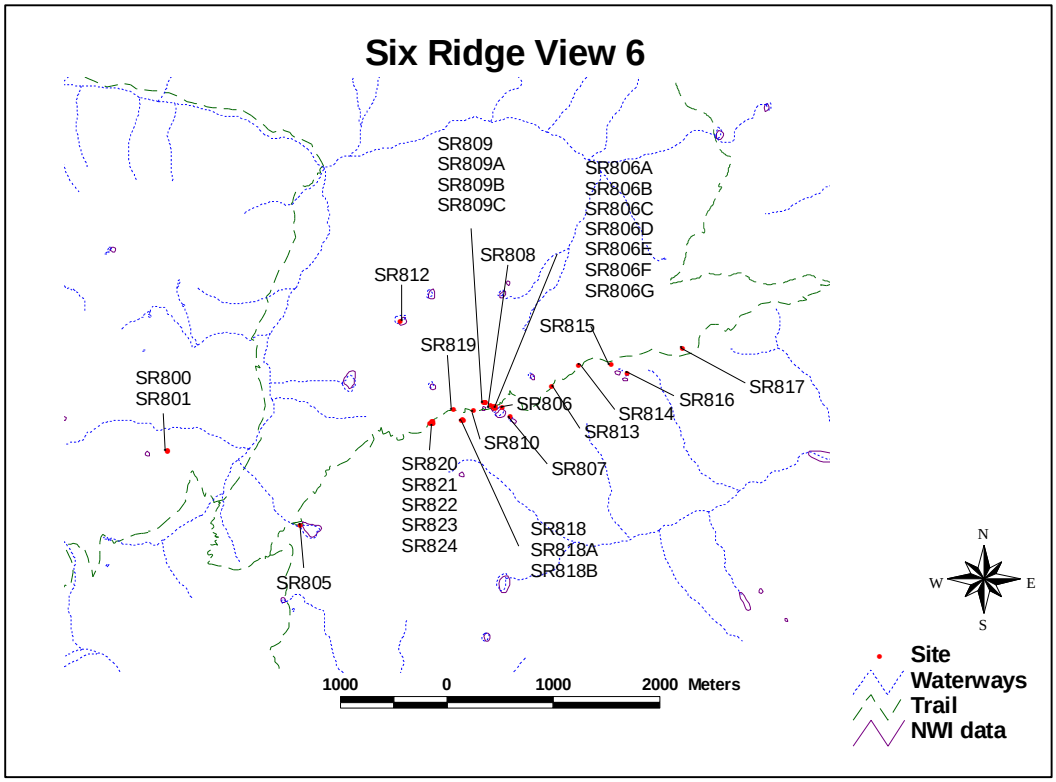
Six Ridge View 2




Six Ridge View 3
SR812
SR809
SR809A
SR809B
SR809C
SR814
SR819
SR810
SR815
SR820
SR821
SR806
SR824
SR813
SR816
SR807
SR806A
SR806B
SR806C
SR806D
SR806E
SR806F
SR806G
SR821
SR822
SR823
SR808
SR818
SR818A
SR818B
SIX RIDGE PRIMITIVE TRAIL
SR805
N
W
E
S
1000
0
1000
2000 Meters
Site
Waterways
Trail
NWI data


Six Ridge View 4
SR809C
SR809B
SR809
SR809A
SIX RIDGE PRIMITIVE TRAIL
SR808
SR819
SR810
SR824
SR820
SR818
SR818B
SR818A
SR821
SR822
SR823
N
W
E
S
200
0
200
400 Meters
Site
Waterways
Trail
NWI data


Six Ridge View 5
SR813
SR809C
R809B
R809
SR809A
SR808
SR806F
SR806G
SR806E
SR806
SR806D
SR806B
SR806A
SR806C
SR807
SIX RIDGE PRIMITIVE TRAIL
N
W
E
S
200
0
200
400 Meters
Site
Waterways
Trail
NWI data


Six Ridge View 6
SR809
SR809A
SR809B
SR809C
SR806A
SR806B
SR806C
SR806D
SR806E
SR806F
SR806G
SR808
SR812
SR815
SR819
SR800
SR801
SR806
SR816
SR817
SR814
SR813
SR810
SR807
SR820
SR821
SR822
SR823
SR824
SR818
SR818A
SR818B
SR805
N
W
E
S
1000
0
1000
2000 Meters
Site
Waterways
Trail
NWI data