Forest and Rangeland Ecosystem Science Center

In Cooperation with Mount Rainer National Park

Inventory of Aquatic Breeding Amphibians, Mount Rainier National Park, 1994-1999

January 2003

Mount Rainier from Eunice Lake. (NPS Photo)

U.S. Department of the Interior
U.S. Geological Survey

Inventory of Aquatic Breeding Amphibians, Mount Rainier National Park, 1994-1999

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ACKNOWLEDGMENTS

This study was a cooperative project between the National Park Service, Mount Rainier National Park and USGS Forest and Rangeland Ecosystem Science Center, and was funded by the National Resource Preservation Program. We are very grateful to the past and present staff at Mount Rainier National Park for assisting with this investigation. The following individuals were instrumental to the study as members of field crews: Betsy Albright, Christa Alexander, Frederico Bellone, Sara Breslow, Brendan Brokes, Darin Chapman, David Colvin, Mark Cookson, Sheryl Costello, John Darmohray, Jennifer Dove, Deanne Drake, Lisa Eigner, Andrew Franch, Daniel George, Tim Gould, Brian Hasebe, Roxanne Karimi, Dana Karlsberg, Alexis Kelley, Rich Lechleitner, Andrea Leslie, Neils Leuthold, Kirstin McDade, Heather Mitchell, Julian Moore, John Potanko, Nick Proudfoot, Neal Riley, Aaron Sailing, Bonnie Stadelmann, Lena Vogl, Jared Weybright, and Davina White. Peg Beauchamp and Tom Beauchamp assisted our efforts through water chemistry analysis and data entry. We would also like to thank Reed Glesne, Kurt Jenkins, and one anonymous individual for reviewing an early draft of this manuscript.

EXECUTIVE SUMMARY

Mount Rainier National Park (MORA) comprises 969 km^2 of area on the western slope of the Cascade Range in south-central Washington State. Nine major river basins drain the flanks of Mount Rainier, the Park's prominent geological formation. Glacial scour, moraine deposits, and debris flows have formed numerous lake basins within MORA. The number of amphibian species thought to occur in MORA is 15, however, only 13 species are documented.

The objective of the present study was to describe amphibian species presence, relative abundances, and distributions in and around aquatic habitats of MORA. Select environmental and habitat variables were measured at each survey location to investigate associations between habitats and amphibians. From 1994 to 1999, amphibian surveys were conducted using visual encounter survey or snorkel survey methods at randomly selected lentic habitats throughout MORA. Segments of randomly selected lentic habitats were surveyed for amphibians from 1996 through 1999 by thorough searches of stream substrates.

Amphibian species composition of MORA lentic habitats based on proportional abundances of amphibian species present was slightly complex given the presence of 6 species observed at variable abundances. Most lentic habitats had 3 or 4 species present with Cascade frog (*Rana cascadae*), Northwestern salamander (*Ambystoma gracile*), and Long-toed salamander (*Ambystoma macrodactylum*) more abundant than other amphibians at each lentic habitat. Furthermore, Cascade frog (*Rana cascadae*) was the most widely distributed and abundant amphibian species in lentic habitats of MORA. Northwestern salamander (*Ambystoma gracile*) and Long-toed salamander (*Ambystoma macrodactylum*) were also relatively common and abundant at lentic survey sites. Rough-skinned newt (*Taricha granulosa*) and Pacific treefrog (*Hyla regilla*) were observed in low to moderate abundance at few lentic habitats. Distribution of the latter species appears to have been restricted, in part, to the lower elevation lentic habitats in MORA. Western toad (*Bufo boreas*) was observed at only 4 lentic habitats and would appear to be relatively rare in MORA lentic habitats.

Species composition of lotic habitats was more simplified than that of the lentic habitats. Five amphibian species were observed at lotic habitats. Most lotic habitats in MORA had 2 amphibian species present. The Tailed frog (*Ascaphus truei*) and Pacific Giant salamander (*Dicamptodon tenebrosus*) was the most prevalent 2-species composition observed at lotic survey sites. Three species were relatively widely distributed at lotic habitats. Tailed frog was the most widely distributed and proportionally abundant species at lotic habitats. Pacific Giant salamander and Cascade frog (*R. cascadae*) were common at lotic habitats, however, less distributed and less abundant than Tailed frog. Two species were rare at lotic habitats. Northwestern salamander (*Ambystoma gracile*) was observed as several individuals at 1 survey site, and Red-legged frog (*Rana aurora*) was observed as single individuals at 2 lotic survey sites.

Associations between measured habitat variables and both amphibian presence and abundance were not evident from data collected during this initial inventory effort. There is suggestive evidence that certain lentic species were associated with habitat physical characteristics such as elevation, surface area, and maximum depth. Furthermore, the presence of fish may have a negative influence on the abundance of certain amphibians in lentic habitats but positive influence on the abundance of Rough-skinned newt (*Taricha granulosa*). Fish affects in the present study were difficult to assess given the unequal sample sizes between lentic habitats with fish and fishless habitats.

Of the species observed during this inventory effort, we were most concerned with the patchy distribution and low abundances of Red-legged frog (*Rana aurora*) and Western toad (*Bufo boreas*). We had anticipated observing greater abundances of both species, especially of earlier life history stages, and observing each species at a larger number of survey sites within MORA. Information from available literature indicates that the ranges of both species may be contracting throughout the Pacific Northwest. Abundances and distributions of the other amphibian species in MORA do not indicate serious concern for amphibian declines in the park. Among our recommendations for future amphibian studies in MORA is continued monitoring of known populations to detect differences between short-term and long-term population fluctuations and expanding the inventory effort to include a greater number of survey sites in both lentic and lotic habitats. We recommended that detailed investigations were required to assess habitat requirements and fish impacts on each amphibian species**.**

INTRODUCTION

Most of Mount Rainier National Park (MORA) is legislated wilderness area (228,480 acres or 97% of total land area) with the remaining 3% of MORA land area consisting of developed zones (i.e., visitor centers, roads, trials, campgrounds, and administrative facilities). Wilderness areas were created to protect and study natural ecosystems, and to provide for the use and enjoyment of areas as wilderness. Although MORA is protected from direct ecological threats, such as resource extraction, human activities still threaten wilderness areas from both within and outside wilderness boundaries (Cole and Landres, 1996). Of particular concern are potential threats to natural processes of aquatic resources and aquatic organisms since lakes and ponds of western U.S. wilderness areas are particularly susceptible to perturbations due to low dissolved constituents and low buffering capacities (Eilers et al., 1989). Proximity of MORA to the Seattle-Tacoma metropolitan area (40-70 miles to the southeast) and prevailing weather patterns of the Pacific Northwest, make MORA susceptible to potential industrial air-borne pollutants (Peterson et al., 1999, Cooper and Peterson, 2000).

The National Park Service (NPS) is charged with preserving natural and cultural resources within national park system lands. To better manage and preserve park resources, NPS staff personnel at MORA initiated an inventory and monitoring program. Natural resource inventory and monitoring programs are paramount to park management by accounting for presence, distribution, and variation of biotic and abiotic natural resources. Data from inventories also contribute to a statement of park resource condition in relation to a standard, preferably a natural or unimpaired state.

Focus on inventory and monitoring needs of amphibian populations has recently increased with reports of worldwide amphibian declines (Barinaga, 1990; Blaustein and Wake, 1990). Reported declines of amphibian populations have been attributed to pollutants, habitat destruction, ultraviolet radiation, and changing predator populations (Blaustein and Wake 1990; Bury et al. 1980; Phillips 1990; Wake 1991; Wyman 1990). Amphibian life history requirements expose many species to influences from both aquatic and terrestrial environments. As a result of vulnerability to threats in both environments, amphibians are often useful indicators of ecosystem health. Detection of amphibian population trends has been difficult due to a lack of long-term studies designed to differentiate between short-term oscillations and long-term trends (Pechmann et al., 1991). Particularly, few reports document the status of amphibian populations in the Pacific Northwest beyond anecdotal evidence from relatively short-term investigations.

The objective of this amphibian survey was to first describe species presence, relative abundances, and distributional limits within MORA. A secondary purpose of the survey was to describe environmental and habitat conditions at sample locations. This survey was also conducted to provide information for regional comparison between other amphibian surveys particularly recent surveys conducted in Olympic and North Cascades National Parks (i.e., Bury and Adams, 2000). Finally, this survey investigated field methods for surveying amphibians that may be beneficial for future monitoring efforts.

Study Area

Mount Rainier National Park (MORA) encompasses 969 km^2 in south-central Washington on the western slopes of the Cascades Mountains. Mount Rainier, an active volcano with an elevation of 4394 m, dominates the rugged and precipitous topography of MORA. Geologic processes and disturbances such as earthquakes, landslides, snow avalanches, floods, and volcanic eruptions were important events in shaping local topography. Geologic formations in MORA are dominated by andesite, granodiorite, and sandstone breccia.

Several climate zones exist at MORA due to the variation in elevation and geography of the park. General climate patterns at MORA are influenced by the Pacific Ocean (ca. 170 km to the west). Annual precipitation is about 1.5 m at the lower elevations and over 2.5 m at higher elevations. About 90% of the annual precipitation falls from November-April. Snow comprises the majority of higher elevation precipitation. Air temperatures are generally mild during both winter and summer with mean January temperatures of –4 to –1 °C and mean July temperatures of 10 to 15 °C at Paradise (elevation 1742 m). The southeast corner of MORA is generally the driest area, while northwest MORA is wettest.

Vegetation in MORA is diverse and representative of climatic conditions and elevation gradients. Over half of MORA is forested at low to moderate elevations, predominantly by old growth stands (200-1000 years old). Western hemlock, Douglas fir, and western red cedar dominate low elevation forests (520-825 m). Moderate elevation forests (825 to 1830 m) contain Pacific silver fir, Alaska yellow cedar, western white pine, and noble fir. Above 1375 m, trees become less dense as the forest grades into subalpine and alpine vegetation zones. Subalpine vegetation comprises a quarter of MORA land area and consists of dense pockets of trees (commonly Subalpine fir) widely dispersed throughout herbaceous meadows. Alpine zones occur above 2100 m elevation in MORA and are dominated by permanent snow and ice, and snowbed, talus, and heather vegetation communities.

MORA has 26 named glaciers and numerous snowfields. Runoff from glaciers and snowfields significantly effect MORA aquatic resources, particularly by effecting water temperature and sediment regimes downstream. Small mudflows resulting from glacier outburst floods or debris flows periodically but significantly altered some of the major river valleys in the park. Nine major river basins drain the flanks of Mount Rainier, and seven flow directly into the southern end of Puget Sound. Two basins enter the Cowlitz River System and drain into the Pacific Ocean southwest of MORA via the Columbia River. Park streams range in elevation from 400 to nearly 2300 m. Glacial scour, moraine deposits, and debris flows formed many of the lake basins within the park. Lakes, ponds, and other palustrine wetlands in MORA range in elevation from 600 to about 2100 m. Palustrine wetlands in MORA included shallow ponds with open water, aquatic beds, emergent vegetation, or forested or shrub wetlands.

Amphibian Records

Information on MORA amphibians dates back to 1905 with the collection of one salamander species (VanDenburg, 1906). As many as 15 amphibian species are thought to occur in MORA; however, only 13 species are documented: *Ambystoma gracile*, *A. macrodactylum*, *A. tigrinum*, *Ascaphus truei*, *Bufo boreas*, *Dicamptodon copei*, *D. tenebrosus*, *Plethodon vandykei*, *Rana aurora*, *R. cascadae*, *R. pretiosa*, *Rhyacotriton casacadae*, and *Taricha granulosa*. The one specimen of *Rana pretiosa* housed at MORA was examined by staff members of the Washington Natural Heritage Program and believed to have been incorrectly identified at time of collection.

Similarly, a specimen of *Ambystoma tigrinum* collected in 1938 and housed at MORA is thought misidentified or misnamed.

Species that are included on federal and state threatened and endangered species lists are of special concern during amphibian surveys in MORA. Two amphibian species previously documented in MORA (*Bufo boreas* and *Rana pretiosa*) are candidate species to the US Fish and Wildlife Service Threatened and Endangered Species List (US Fish and Wildlife website). *Rana pretiosa* is also listed by Washington Department of Fish and Wildlife as a state endangered species. Furthermore, *Bufo boreas*, *Plethedon vandykei*, and *Rhyacotriton cascadae*, are candidates to the Washington threatened and endangered species list. The state of Washington also lists both *Rana aurora* and *R. cascadae* as species of concern for the state (Washington Department of Fish and Wildlife).

METHODS

Site Selection and Survey Timing

Potential survey sites were identified on U.S. Geological Survey (USGS) 7.5 min topographic maps and Mount Rainier National Park (MORA) hydrograph and wetland data layers in the Geographic Information System (GIS). Lentic systems were stratified by elevation, area, maximum depth, geographic location, and state of permanence (permanent or intermittent) prior to random selection. Lentic sites were surveyed from late July until late September. Lotic systems were stratified by elevation, geographic location, and stream order before lotic survey sites were randomly selected. A unique stream segment number and corresponding wetland number were used to identify each survey site. Lotic sites were surveyed from late July until early September, when stream flows were low enough for safe access and improved water clarity.

Water Sample Collection

Lotic water samples were collected by "hand-grab" techniques at a downstream site within the stream survey area prior to amphibian surveys of the site by crew members. Water samples were captured from mid-water column in triple-rinsed sample bottles of high-density polyethylene (HDPE). Dissolved oxygen, conductivity, temperature, and pH were determined in the field using portable meters. Measurements of other water properties were conducted at MORA Resources Laboratory within 24 hr of sample collection.

Lentic water sampling was conducted from an inflatable boat, except at one site (aluminum Jon boat at Mowich Lake), over the deepest point of each lake. Samples were collected with either 1.5 L horizontal or 2.2 L vertical Van Dorn-style water samplers. At lentic sites with maximum depth < 3 m, water samples were collected 1m below the surface (alkalinity, conductivity, and pH analyses) or from a depth at midpoint between lake bottom and surface (chemical and ion concentration analyses). At lentic sites with maximum depth ž 3 m, water samples for all analyses were gathered from 1 m below the lake surface and 1 m above the lake bottom. Water samples collected at lentic sites were transferred directly from water samplers to collection bottles. Water samples used for determining pH, alkalinity, and conductivity were stored in 1L HDPE sample bottles that were triple-rinsed with de-ionized water prior to use. Water samples to be analyzed by Chemical Cooperative Analytical Laboratory (CCAL), Oregon State University, Corvallis, Oregon, for chemical and ion concentrations were transferred from water samplers into previously acid-washed 1L HDPE bottles. These samples were filtered through a Millipore™ 45mm pre-washed filter using a Nalgene filter holder, receiver, and hand-operated vacuum pump. Acid-washed sample bottles were triple-rinsed with de-ionized water before the filtered water was returned to the sample bottle.

While in the field, water samples requiring laboratory analysis were stored and transported in soft or hard-sided ice chests containing frozen "blue ice" packs. Upon return from the field, crew members placed water samples into a refrigerated unit. Water samples were analyzed within 24 hr of collection or shipped for analysis within 48 hr of collection.

Alkalinity, Conductivity, Water Temperature, and pH

Water temperature and pH were measured for lentic and lotic samples in the field using Beckman™ 100 and 200 series or Orion™ 230A portable meters with refillable or gel-filled combination electrodes and automatic temperature compensation (ATC) probes. Meters were calibrated with prepared pH solutions and electrodes were triple-rinsed with de-ionized water between uses. Temperature and pH measurements were recorded at intervals of 5, 10, and 15 min. Final measurements were recorded after the 15 min interval if instrument readings were stable or showed little change from the previous reading. Additional recording intervals of 5 min were required to obtain stable measurements for several samples. Water samples were kept cool and shaded during temperature and pH measurements.

Alkalinity was measured at MORA Resources Laboratory by means of potentiometric titration using a Hach digital titrator (Gran, 1953). Water sample conductivity was determined in the field using a self-calibrating Hach™ 44600 or YSI™ portable meters. Conductivity of several samples was measured at MORA Resources Laboratory using a calibrated Beckman™ Conductivity Bridge Model R6-16D bench meter. Conductivity calibration solutions were provided by CCAL.

Dissolved Oxygen Concentration (DO) and Temperature Profiles

At lotic sites, dissolved oxygen concentration (DO) was measured in the field using calibrated YSI™ 57 or Orion™ 830 meters with attached probes. Single measurements for DO and temperature were taken at mid-depth in the water column. At lentic sites, calibrated YSI™ 57 or Orion™ 830 meters with probes were used to measure both dissolved oxygen concentration and temperature depth profiles. For lentic sites, water temperature and DO were measured at 1m depth increments over the deepest point in each lake starting at the water surface and continuing to the lake bottom. If a portable meter was unavailable for use, dissolved oxygen concentration was determined in the field by using an azide modification titrimetric procedure with a starch indicator solution (Winkler, 1888; Standard Methods, 1985) on a water sample collected in a BOD bottle from 1m below the water surface.

Water Turbidity and Transparency Measurements

Turbidity was measured and recorded for each lotic site at MORA Resources Laboratory using a Hach™ 2100A Turbidimeter. Samples were collected in the field by "hand-grab" in 125ml HDPE bottles within the survey area prior to stream disturbance from other sampling. Samples were analyzed within 24 hr of collection and values are expressed in nephelometric transmission units (NTU). Sample cells were cleaned free of dust and smudges prior to insertion into unit.

A 20 cm-diameter, black and white Secchi disk was used to measure water transparency of lentic systems. Water transparency readings were taken between 1130 and 1500 hrs on the shaded side of the boat without sunglasses to maintain comparability between sites. Four ascending readings and four descending readings were averaged to determine mean Secchi depth reading.

Fish Presence

Fish presence at lentic habitats was determined by setting multiple-panel, variable mesh gill nets. Each gill net was 2m deep and approximately 42m long with 4 equal length sections of 12.5mm, 18.5mm, 25mm, and 33mm mesh sizes. Gill nets were generally fished one time for each lake using one to three nets used, depending upon the size of the lake. Nets were deployed using an inflatable boat perpendicular to the shore with smallest mesh size near shore. Nets were fished near the lake bottom. Nets were left in place from three to 24 hours, depending on the individual site and time available. Fish were removed from nets using the inflatable raft. Fish were euthanized upon capture. Information regarding species captured, individual total lengths, and overall condition was recorded on data sheets in the field. Fish were transported away from survey sites for disposal in park trash receptacles.

Lentic Amphibian Transects

It was not practical to standardize transect lengths for amphibian surveys due to variation in size of lentic systems. For small lakes, ponds, and wetlands (shoreline perimeter < 300m), the entire shoreline was surveyed. At least 100m of shoreline were surveyed at larger lentic systems. The 100m minimum was broken into several shorter transects to represent multiple habitats of each lentic system. However, all survey transects were at least 25m long. Survey transects for lentic system with shoreline perimeters ž 300m approximated percentages of adjacent terrestrial habitat types (e.g., forested woodland, wet meadow, talus). To determine transect lengths and locations, terrestrial habitat types were identified and percent of shoreline occupied by identified habitats for the lentic system were estimated. Transects locations and lengths were selected proportional to the estimated percent of shoreline occupied by each terrestrial habitat. Thus, if the shoreline of a lentic system was compromised of 50% forested woodland, 25% wet meadow, and 25% talus, then selected survey transects were 50m of forested woodland, 25m of wet meadow, and 25m of talus. Unique features measuring < 25m but occurring within a general habitat type were surveyed as part of the adjacent habitat. For example, small areas of concentrated woody debris within a sand/silt habitat were included in the survey of the sand/silt habitat. Transects were measured using a flexible meter tape prior to commencement of amphibian surveys. Transect measurements followed shoreline features at the water-land interface, such as bays and peninsulae. For small ponds, lakes, or wetlands where the entire shoreline was surveyed, GIS was used to measure surveyed area.

Transect width varied according to lentic system morphology. Transect width was typically defined as the distance from shoreline to a point at which water depth barely exceeded the length of a snorkel surveyor's reach. If time permitted and water depth was consistently within snorkel surveyor's reach, then the entire pond was surveyed. If time was limited and resulted in only a fraction of the habitat being snorkeled, then the surveyed area was mapped and documented on data sheets.

Lentic Amphibian Techniques

Amphibian distributions and relative abundances were assessed either by visual encounter surveys (VES; Bury and Majors, 1997) or by snorkel surveys (Tyler, 1996). Water depth was the primary criterion used to determine which survey technique was employed at each site. Snorkel surveys were conducted at deeper ponds (maximum depth ž 0.7m) while VES were used to survey shallow ponds (maximum depth < 0.7m).

Visual encounter surveys were performed by slowly walking/wading shoreline and nearshore areas in a zigzag pattern (Olsen et al., 1997). If a nearshore area was narrow (< 3m), then one surveyor walked/waded the pond edge while the other recorded amphibian observations and performed the collection of other data (e.g., water quality, temperature, etc.). If the nearshore area exceeded 2 - 3m in width or aquatic vegetation was dense in the area, two surveyors worked in tandem approximately 2 - 3m apart. Surveyors carried nets to capture amphibians for measurement and species identification.

Snorkel surveys were conducted by swimming a zigzag pattern parallel to shore along nearshore transects to identify and enumerate amphibian species for each life stage present (e.g., adult, larva, metamorph, tadpole, or egg mass). Snorkel area extended from the immediate nearshore to the point where the surveyor could no longer reach the lake bottom (water depth = ~1m). During snorkel surveys, the surveyor carefully searched through substrata (i.e., woody debris, talus, vegetation, etc.) in the nearshore environment in an effort to observe amphibians that may have otherwise been hidden from the surveyor's view (Tyler et al., 1998a). The surveyor faced toward areas not yet surveyed and avoided unnecessary movements during surveys to prevent startling unobserved amphibians or disturbing substrata that may reduce surveyor visibility. During snorkel surveys, the surveyor used a hand-held divelight to illuminate dark areas, such as undercut banks and shadows. Individual amphibians were captured during snorkel surveys with a small aquarium net to facilitate species identification.

Out of concern for crewmember safety and data accuracy, a second crewmember assisted the snorkel surveyor from shore by recording the surveyor's observations and surveying shallow water areas that were inaccessible to the snorkeler. As a safety precaution, the snorkel assistant always maintained close physical proximity to the snorkel surveyor (typically < 3m). During snorkel surveys, the surveyor verbally communicated amphibian species and numbers to the survey assistant. The snorkel assistant recorded information on data sheets and was diligent to observe and record amphibians that may have been undetected by the snorkeler. All amphibians observed in or fleeing from the survey area were recorded. Both the snorkel surveyor and survey assistant made efforts to avoid "double counting" amphibians in survey areas. Amphibian numbers were expressed as the number of individuals for each life history stage or egg masses per 100m of shoreline.

Besides shoreline transects, an additional transect was snorkeled away from shore for each lentic system. During surveys of additional transects, the surveyor snorkeled a minimum distance of 25 m perpendicular from shore toward the center of each pond or lake. Observations made during surveys of the additional transects were recorded on data sheets separate from shoreline transects. Data from the additional transects were used to determine amphibian species richness, relative numbers, life history stage, habitat utilization, and distribution for each lentic system.

Lotic Amphibian Transects

Upon arrival at each survey site, crew members selected a 100m section of stream for reconnaissance and measured with a flexible meter tape. Crew members marked both ends of the 100m section with surveyor's tape or ground stakes. Field crews then used a random number table or generator to select 10 1-m survey locations within a 100m stream section (e.g., meter 8, meter 25, meter 39, meter 63, etc.). The 10 1-m survey locations were marked with surveyor's tape or ground stakes. Prior to the amphibian survey of each 1m site, crew members mapped and recorded habitat features of each 100m stream segment and 1-m survey location. One person recorded vegetation and major physical parameters along the 100m stream segment, while others recorded stream habitat variables at each 1-m survey location (see Bury and Corn, 1991).

Lotic Amphibian Techniques

Amphibian surveys were begun at locations on the downstream end of the 100m stream segment to minimize disruption of other 1m survey locations. Moving upstream, each proceeding 1m survey location was surveyed for amphibians. One crewmember was responsible for recording amphibian observations while all other crew members conducted amphibian surveys. At each 1m survey location, the site was carefully searched for amphibians by an initial visual inspection of the area from wetted stream bank to wetted stream bank. Next, crew members searched for amphibians by lifting and replacing habitat features of the stream substrata such as woody debris and rocks across the stream width. Crew members carefully searched habitat edges and crevices by probing with feet, hands, or D-net, to flush animals into visible locations. At survey locations with stream width < 2m, habitats were systematically inspected for amphibians from one bank to the other. In streams ž 2m wide, crew members simultaneously started on opposite stream banks and worked toward the center of the stream. Amphibians were captured with D-nets or aquarium nets during surveys. Captured amphibians were measured and identified to species and life stage before release at capture sites following completion of the survey. Amphibian life stages were identified for each species except *Ascaphus truei* as adult, metamorph, larva, tadpole, or eggmass. Identification of *A. truei* life stages included categories for tadpole stages. *Ascaphus truei* tadpole stages included: tadpole-no further description, tadpole A-no limbs, tadpole B-hind-limb “buds”, tadpole C-hind-limbs only, tadpole D-hind-limbs and front-limbs.

Database Structure and Analyses

Lentic Structure

Data from the amphibian survey of lentic ecosystems in Mount Rainier National Park (MORA) were entered and maintained in a Microsoft ACCESS database. This database was condensed and modified for analytical purposes. The modified ACCESS database is organized into eight ACCESS tables: 1. *Amphibian Count Data*; 2. *Amphibian Species and Codes*; 3. *Sample Date and Wetland Transect Length*; 4. *Site Location and Corresponding Properties*; 5. *Site Specific AID File*; 6. *Imported Chemistry Data with Dates and Site Locations;* 7. *Wetland Chemistry Data; and 8. Depth, Temperature, Conductivity, Dissolved Oxygen, pH, and Alkalinity.* Metadata files and directions to access raw data for the lentic database can be accessed through the USGS Forest and Rangeland Science Center website (www.fresc.fsl.orst.edu)

ACCESS Table 1 in the modified database (*Amphibian Count Data*) represents the abundance (counts of individuals) of the different life history stages of each amphibian species, a corresponding code number, and the wetland sample number. This table was derived from data obtained from the original database in a table entitled *AmphibHabIt.* It was necessary to reformat the count data in this table to make data compatible with the statistical methods used for data summary and analysis. The final table used for most statistical analyses of species abundance is ACCESS Table 5 (*Site Specific AID File*). This table was derived from a series of queries in which each count in ACCESS Table 1 was divided by a corresponding transect length contained in ACCESS Table 3 (*Sample Date Wetland Transect Length*). In this case, this quotient was multiplied by 100 so each count represented the number of animals per 100 meters of transect.

A list of the life history stages of each species and common names are found in ACCESS Table 2 of the modified database (*Amphibian Species and Codes*) and in Table 1. Partitioning the data in this way provided the option to analyze data relative to individual life history stages, or to an entire species by merging its life history stages into one taxonomic entity. The deletion or merging of taxonomic units was performed by CLUSB4, a program designed for the cluster analysis of species abundance data (Aid Programs, Overton et al., 1987). Various output tables were constructed by linking ACCESS Tables 2 and 4 (*Site Locations and Corresponding Properties*) with the appropriate tables or queries, and then transferring the resulting output table to Microsoft EXCEL and WORD for editing and final presentation.

ACCESS Tables 6, 7, and 8 of the database contain supporting environmental information for the amphibian count data in ACCESS Tables 1 and 5. ACCESS Table 6 (*Imported Chemistry Data with Dates and Site Locations*) includes a variety of physical and chemical variables that describe 388 wetland and lotic sites. These variables include maximum depth, air and water temperature, conductivity, dissolved oxygen, pH, alkalinity, total nitrogen and phosphorus, ammonia, nitrate/nitrite, orthophosphate silica, and four cations. ACCESS Table 6 was imported from a corrected table of environmental variables obtained from personnel at Mount Rainier National Park. ACCESS Tables 7 and 8 were constructed from queries that linked Table 6 to wetland sites that were part of the 1994 - 1999 amphibian survey. ACCESS Table 7 (Wetland Chemistry Data) contains mean values for all of the variables found in ACCESS Table 6 matched up with 192 wetland sites. ACCESS Table 8 contains mean values for maximum depth, water temperature, conductivity, dissolved oxygen, pH, and alkalinity corresponding to 145 wetland sites. Data files used for the analysis of the chemical/ physical variables were derived from queries of ACCESS Tables 7 and 8, and the number of wetlands considered in these analyses varied depending on the number of missing observations associated with the set of variables under consideration.

Lentic Analysis

A cluster analysis was used to search for pattern in the wetland (lentic) amphibian database. The clustering program (CLUSB4) used with these data was designed to find clusters of observations in multivariate data. Specifically, it determines the minimum variance partition of a set of n observations in p dimensions

$$\{x_{ij} \text{ x } i = 1, 2, \ldots\ldots, n;\ j = 1, 2, \ldots\ldots, p\}$$

into k clusters. The clustering algorithm is an iterative approach that minimizes the sum of square deviations of each observation from its cluster mean (McIntire, 1973). Computations terminate when a local minimum is reached (i.e., when no observation can be shifted to another group and the sum of squares reduced). Before analysis, data are standardized by subtracting the abundance of species at each site from its mean abundance at all sites, and then dividing by the corresponding standard deviation. The effect of this transformation is to give all species equal weight in the analysis.

An ASCII data file for the cluster analysis of the species count data was extracted from the database: a 188 (rows) by 6 (columns) matrix representing the counts of 6 amphibian species (*Ambystoma gracile*, *A. macrodactylum*, *Hyla regilla*, *Rana cascadae*, *Bufo boreas*, and *Taricha granulosa*) at 188 sampling sites. For this analysis, counts for the different life history stages of each species were pooled, and the data represented the total count for each species. We conducted the analysis on the relative abundance of species compiled as the count of each species at a site divided by the total number of animals present at that site (i.e., the proportional abundance of each species, instead of its absolute abundance at each site, was used for the analysis). With this transformation, sites that have similar relative abundance values for the taxonomic groups will tend to cluster together regardless of differences in the total abundance of amphibians present at each site.

Patterns in the species count data matrix also were examined by detrended correspondence analysis (DCA; Hill, 1979). The algorithm of correspondence analysis (CA) is a two-way averaging procedure that calculates species scores as weighted averages of the sample scores and sample scores as weighted averages of the species scores. DCA extends this analysis to correct for: (1) compression at the end of the axes and (2) the tendency for the second axis to be a quadratic function of the first axis. The calculations are iterative and are terminated when the ordination scores approach constant values (Jongman et al., 1987). Interpretation of the results is facilitated by examination of plots of the species scores and samples scores simultaneously. In the case presented here, the graphic positions of six species of amphibians in ordination space were examined in relation to corresponding positions of 188 wetland sites.

A cluster analysis also was performed on three matrices of environmental data. Variables in these matrices were: maximum depth, water temperature, conductivity, dissolved oxygen, pH, and alkalinity (general environmental matrix); total nitrogen, ammonia, nitrate/nitrite, total phosphorus, and orthophosphate (nutrient matrix); and sodium, potassium, calcium, and magnesium (cation matrix). Because of missing observations in the environmental data, the number of wetland sites represented by these matrices were different: 145 sites (general environmental matrix), 31 sites (nutrient matrix), and 19 sites (cation matrix).

A separate cluster analysis was performed on a matrix of physical variables of elevation, area, and maximum depth. Because of missing observations in the environmental data, the number of lentic sites represented by these variables in the matrix 167 sites.

A principle components analysis (PCA) was used to examine for patterns between 7 physical and chemical environmental variables: Area, elevation, maximum depth, water temperature, alkalinity, conductivity, and pH. Principle components analysis explores correlations between multiple variables and organizes the resulting correlations into a set of orthogonal (perpendicular) axes. The first few PCA axes, upon which sample sites are positioned, represent the largest percentage of total variation that can be explained (Ludwig and Reynolds, 1988). Because of missing observations in the environmental data, the number of lentic sites represented in the PCA data matrix was 138.

Covariance among the environmental variables and between total amphibian abundance (count) and the variables represented in the three matrices of environmental data were examined by correlation and regression analyses. All correlation and regression analyses were performed by the computer program SYSTAT.

Lotic Structure

Data from the amphibian survey of lotic ecosystems in Mount Rainier National Park were entered and maintained in an ACCESS database. This database was condensed and modified for analytical purposes. The modified ACCESS database is organized into eleven ACCESS tables: 1. *Lotic Amphibian Capture Data*; 2. *Lotic Amphibian Site Names and Sample Dates*; 3. *Species Codes and Names*; 4. *Lotic Species Ten Cluster Structure*; 5. *Lotic Life History List and Codes*; 6. *Lotic Life History Preliminary AID File*; 7. *Lotic Life History Six Cluster Structure*; 8. *Lotic Ascaphus Tadpole Preliminary AID File*; 9. *Lotic Ascaphus Tadpole Six Cluster Structure*; 10. *Lotic Water Chemistry Data*; and 11. *Substrate Size Along Transects.* These tables are linked together by two variables, the site number (SITE) and a taxonomic acronym (SPECIES). Metadata files and directions for access to raw data for the lotic database can be accessed through the USGS Forest and Rangeland Science Center website (www.fresc.fsl.orst.edu).

ACCESS Table 1 in the modified database represents the presence of individual species at locations along a 100-meter transect; specification of life history stage and corresponding morphometric data also are included for each species. Site names and species codes corresponding to the capture data in ACCESS Table 1 are located in ACCESS Tables 2 and 3, respectively. These tables also contain site numbers, sampling dates, drainage region, stream order, water temperature, and site elevation (ACCESS Table 2), and species acronyms, scientific names, and common names (ACCESS Table 3). The total number of amphibians for each species along each 100-meter transect at each site were found by a query of ACCESS Tables 1, 2, and 3. These totals were saved as an EXCEL file, and later, converted to an ASCII file in the AID format for analysis.

ACCESS Table 1 in the modified database also lists the life history stage of each specimen collected along a 100-meter transect. A list of the life history stages of all species and their acronyms is found in ACCESS Table 5. A query of ACCESS Table 1 generated a preliminary AID file for the life history stages (ACCESS Table 6), and a final query of ACCESS Table 6 produced the final AID file for analysis. Because 96% of the amphibian specimens observed during the survey of lotic sites belonged to a single species (*Ascaphus truei*), the life history stages of this species were analyzed in detail. ACCESS Table 8 represents a preliminary AID file from which the final AID file for these analyses was derived. ACCESS Tables 4, 7, and 9 list the relative abundance of each taxon under consideration for the cluster analysis of sites relative to five species (ACCESS Table 4), three life history stages of *Ascaphus truei* (ACCESS Table 7), and four tadpole stages of *Ascaphus truei* (ACCESS Table 9).

ACCESS Tables 10 and 11 in the modified database contain supporting environmental information for the capture data (ACCESS Tables 1 and 2). ACCESS Table 10 has information for each site about air and water temperature, conductivity, dissolved oxygen, pH, turbidity, and alkalinity. ACCESS Table 11 has detailed data on substrate size. Both ACCESS Tables 10 and 11 are linked to the capture tables (ACCESS Tables 1 and 2) by the site number.

Lotic Analysis

Amphibians occurred at 84 of 114 sites examined during surveys of lotic systems. Only five species of amphibians were found during the survey (*Ambystoma gracile*, *Ascaphus truei*, *Dicamptodon tenebrosus*, *Rana aurora*, and *Rana cascadae*), and for the purpose of analysis, these species were classified into four life history stages (adult, larva, metamorph, or tadpole). *Ascaphus truei* was found in all four stages, whereas the other four species occurred in only one of the stages. In some cases, the tadpoles of *Ascaphus truei* were classified into four subcategories: A, B, C, and E. Consequently, eleven life history taxonomic groups were represented in the data.

A cluster analysis was used to search for pattern in the lotic amphibian database. The clustering program (CLUSB4) used with these data is designed to find clusters of observations in multivariate data (Overton et al., 1987). Specifically, it determines the minimum variance partition of a set of n observations in p dimensions

$$\{x_{ij} \text{ x } \; i = 1, 2, \ldots\ldots, n; \; j = 1, 2, \ldots\ldots, p\}$$

into k clusters. The clustering algorithm is an iterative approach that minimizes the sum of square deviations of each observation from its cluster mean (McIntire, 1973). Computations terminate when a local minimum is reached, i.e., when no observation can be shifted to another group and the sum of squares reduced. Before the analysis, the data are standardized by subtracting the abundance of species at each site from its mean abundance at all sites, and then dividing by the corresponding standard deviation. The effect of this transformation is to give all species equal weight in the analysis. Because of the high dominance of *Ascaphus truei* at the sampling sites, the transformation prevented the cluster structure from being determined by a single taxon.

Three ASCII data files for the cluster analyses were extracted from the database: (1) a matrix (84 rows by 5 columns) representing the counts of the 5 amphibian species at 84 sampling sites; (2) a matrix (77 rows by 3 columns) representing counts of 3 life history stages of *Ascaphus truei* (adult, metamorph, and tadpole) at 77 sampling sites; and (3) a matrix (47 rows by 4 columns) representing the counts of 4 tadpole stages of *Ascaphus truei* (A, B, C, and E) at 47 sampling sites. A cluster analysis was performed on each of the data files after the data were relativized (proportionalized) so the values for each site summed to unity. With this transformation, sites that have similar relative abundance values of the taxonomic groups will tend to cluster together regardless of differences in the total abundance of amphibians at the sites.

Various ordination algorithms were used to extract pattern from the lotic amphibian data set. Unfortunately, an ordination approach was unsuccessful in most cases because of the high dominance of *Ascaphus truei*. However, a principal components ordination (Jongman et al. 1987) of 77 lotic sites relative to the three life history stages of *A. truei* revealed clear gradients of relative abundance. The results of this analysis are displayed as the directional vectors for the three life history stages and a corresponding graph with the site ordinations. Interpretation is facilitated by the examination of the two graphs together.

Covariance between total amphibian abundance and selected environmental variables, and among the environmental variables, was examined by correlation analysis. Environmental variables included in the analysis were stream order, site elevation, water temperature at the time of sampling, conductivity, dissolved oxygen, turbidity, alkalinity, and substrate size. The number of sites considered in this analysis was reduced from the 114 to 62 because of missing observations in the environmental data.

RESULTS

Description of Lentic Sites and Species

The amphibian survey in wetland habitats of Mount Rainier National Park included sets of samples obtained at 399 transects from 205 sites during a 6-year period from 6/29/94 to 10/19/99. All samples were obtained in June, July, August, September or October. Amphibians were observed at 188 of 205 wetland sites, and on 341 of the 399 transects surveyed. There were a total of 270 visits to these sites, as some sites were sampled more than once during the multiple year sampling effort. Total amphibians found during each visit are listed in Table 2. Cases in which a site had multiple transects surveyed, summations of the number of amphibian animals and corresponding transect lengths for all samples from the site were obtained, and animal density was determined by dividing the total count by the total transect length and multiplying by 100. Therefore, all animal densities were expressed as the number of animals per 100 meters.

Fourteen of the 205 wetland sites exhibited counts of amphibians greater than 1000 animal units per 100 meters (Appendix Ia.). In this case, an animal unit is considered to be an egg mass, larva, juvenile, tadpole, neotenic individual, or an adult animal (Table 1). Sites 102, 121, 595, 1059, 845, and 879 had total counts greater than 2000 animal units per 100 meters. The highest number of amphibian animal units (5833/100 m) was observed at Buck Lake (White River watershed) on 7/25/94.

Appendix Ia. also lists the corresponding elevation for each site with amphibian animals and indicates whether or not fish were present at the time of sampling. There was no apparent relationship between the total number of animal units at a site and elevation ($r = 0.137$). The numbers of sites with and without fish were 31 and 174, respectively, and the corresponding mean numbers of animal units at these sites were 42.1 and 244.51 units per 100 meters. These means were significantly different (P = 0.038). However, the degree to which fish are responsible for these differences is still uncertain, because of the large difference in the sample size and variance, and the relatively low number of sites with fish.

The amphibians collected during the survey were partitioned into 9 taxonomic groups (Table 1). Six of these were identified to species, two groups were classified to genus, and the one was designated as a frog of identification. Specimens of the three unknown species may, in fact, be one of the known species, but their morphological condition did not permit a definitive identification. Of the known species, cascade frog (*Rana cascadae*) was the most abundant in all of the samples collectively, followed by long-toed salamander (*Ambystoma macrodactylum*), and northwestern salamander (*Ambystoma gracile*). The total number of animal units for six identified species is listed for each wetland site in Appendix Ib.

Each taxonomic group also was partitioned into different life history stages (Table 1). At this level of division, *Rana cascadae* tadpoles had the greatest number in the samples, followed by *Ambystoma macrodactylum* larvae and *Ambystoma gracile* larvae. The data also were sorted into tables summarizing the abundance of the life history stages of six species at the sites where they were observed (Appendices Ic, Id, Ie, If, Ig, and Ih). Of the 205 wetlands surveyed, we observed *Rana cascadae* at 149 sites, *Ambystoma gracile* at 111 sites, *Ambystoma macrodactylum* at 67 sites, *Taricha granulosa* at 24 sites, *Hyla regilla* at 8 sites, and *Bufo boreas* at 4 sites.

Lentic Species Cluster Analysis

For this analysis, the abundances of six species (*Rana cascadae*, *Bufo boreas*, *Hyla regilla*, *Ambystoma gracile*, *Ambystoma macrodactylum*, and *Taricha granulosa*) at 205 sites were proportionized so that the relative abundance of the taxa in each sample would sum to unity. Results of the analysis indicated that the most interpretable pattern generated from the clustering algorithm was the 7-cluster structure.

The 7-cluster structure partitioned the data into three large groups with 69, 85, and 25 sites (Table 2 and Appendix Ii). Cluster 1 (69 sites) was composed of sites dominated by *Rana cascadae*; the mean relative abundance of this species for these sites was 90.3% (Table 2). In contrast, the dominant species at the 85 sites grouped in cluster 6 was *Ambystoma gracile* (87.7%). The next largest group of sites was cluster 5 with 25 sites. Sites in this cluster had the highest mean relative abundance of *Ambystoma macrodactylum* (78.4%). *Ambystoma gracile* and *Rana cascadae* with mean relative abundance values of 10.5% and 11.0%, respectively, also were present in significant numbers at the sites in this cluster. Clusters 2 and 3 consisted of single sites, a site (Mystic Lake) with a high relative abundance of *Bufo boreas* (67.6%) and the only site (St. Andrews Lake) at which the relative abundance of *Hyla regilla* was 100%. These species were rare or absent at all of the other sites. Sites in Clusters 4 (3 sites) were dominated by *Taricha granulosa* (74.5%). *Ambystoma gracile* and *Rana cascadae* also were present at the sites in this cluster at mean relative abundances of 13.9% and 11.6%, respectively. The four sites in Cluster 7 had a greater richness of amphibian species than the other wetland sites. Mean relative abundance values of four species at these sites were: 41.7%, *Ambystoma gracile*; 28.9%, *Rana cascadae*; 19.9%, *Taricha granulosa*; and *Ambystoma macrodactylum*, 8.3%.

Ordination of Lentic Sites and Species

A detrended correspondence analysis (DCA) was performed on the same data matrix that was used for the cluster analysis. The ordination of the six amphibian species by DCA produced the two-dimensional configuration illustrated in Figures 1a and 1b. A comparison of the site ordinations (Fig. 1a) with the corresponding species ordinations (Fig. 1b) revealed amphibian abundance gradients at the 205 sites. For example, a plot of site ordination scores for the first two variables (Fig. 1a) illustrates a configuration similar to the arrangement of the species scores in Figure 1b. The points that make up the sides of the triangle in the lower left corner of the site ordination plot represent gradients of relative abundance between pairs of species. The sites represented by the points along the upper right side of the triangle exhibit different relative abundances of *Ambystoma gracile* and *Rana cascadae*; the lower right and left sides of the triangle show relative abundance gradients between *Ambystoma macrodactylum* and *Ambystoma gracile* and between *Ambystoma macrodactylum* and *Rana cascadae*, respectively. The individual sites with a high relative abundance of *Bufo boreas* or *Hyla regilla* are isolated on the right (site 859) and left side (site 489) of the graph at locations corresponding to these species positions on the species ordination (Fig. 1b). These are the same sites (Mystic Lake and St. Andrews Lake) that were identified as Clusters 2 and 3 (Table 2 and Appendix Ii). The three sites that were dominated by *Taricha granulosa* are located at the top of the ordination and are the same sites that were partitioned into Cluster 4 by the cluster analysis. These sites are Lake Marjorie (147), Lake George (1057), and Ricksecker Pond (1253).

Lentic Environmental Cluster Analysis

A cluster analysis was performed relative to the elevation, area, and maximum depth of 167 lentic survey sites. The 5-cluster structure partitioned the data into 2 large clusters of 83 and 61 sites respectively, and 3 smaller clusters of 14, 8, and 1 sites (Table 3). Clusters 1 and 2 were characterized by small and shallow lentic habitats, typically ponds. Cluster 1 sites were low elevation and cluster 2 sites were high elevation. Cluster 3 sites were also small in size, but moderate in depth and elevation relative to the sites of clusters 1 and 2 (Table 3). The sites of cluster 4 were quite large and deep compared to the sites of clusters 1-3, and were located at moderate elevations. The single site in cluster 5 was the largest and deepest lake of all the survey sites.

Rana cascadae, *Ambystoma gracile*, and *A. macrodactylum* dominated the amphibian assemblages in the five clusters (Table 3). *Rana cascadae* was present in all five clusters and occupied at least 50% of the sites in each cluster. *Ambystoma gracile* was present in clusters 1-4, achieving its greatest proportional distribution in cluster 3 (80.5% of sites). *Ambystoma macrodactylum* was also present in clusters 1-4 with its greatest proportional distribution occurring in cluster 2 (i.e., 53.7% of sites). *Hyla regilla* was present primarily in cluster 1, *Taricha granulosa* was present primarily in clusters 1 and 3, and *Bufo boreas* was encountered at very few sites in clusters 2 and 3.

Principle Components Analysis of Lentic Environmental Variables

A principle components analysis was performed on seven physical and chemical attributes for 138 lentic sites (Table 4). The first three rotated axes accounted for 73.8% of the total variance of the data. Area and depth were positively correlated with the first component axis, indicating that this axis represented site size. Axis two represented the contrast between conductivity and pH that were positively correlated with the axis and site elevation that was negatively correlated with axis two. The third component axis was positively correlated with elevation and negatively correlated with alkalinity and water temperature.

Correlation Analyses Among Lentic Species and Environmental Variables

Correlation coefficients expressing covariance between all possible pairs of six amphibian species indicated that co-occurrence among these species was low (Table 5). The highest correlation coefficient (r = 0.486) was between *Ambystoma gracile* and *Taricha granulosa*. Correlation coefficients between the abundances of other combinations of the six species were mostly negative and with absolute values less than 0.1

Environmental variables were divided up into three sets: (1) the general variables; (2) the nutrient variables; and (3) the cations. These divisions were based on variable type and the pattern of missing observations. The general variables included maximum depth, water temperature, conductivity, dissolved oxygen, pH, and alkalinity. The nutrient variables were total nitrogen, ammonia, nitrate/nitrite, total phosphorus, and orthophosphate; whereas the cations were sodium, potassium, calcium, and magnesium. Sample sizes associated with these three sets of variables were 145 sites (general variables), 31 sites (nutrients), and 19 sites (cations).

Correlation coefficients between environmental variables in all three sets and the total count of amphibians at the corresponding sites were all low, with absolute values less than 0.3 (Tables 6, 7, and 8). The highest correlations among the general variables were between alkalinity and water temperature (0.498) and between pH and conductivity (0.451); and other coefficients for this set of variables had absolute values less than 0.3 (Table 6). There was a relatively high positive correlation (r = 0.791) between total nitrogen and total phosphorus; absolute values of correlation coefficients for comparisons among other nutrient variables were all less than 0.3 (Table 7). Correlation coefficients among the cations sodium, calcium, and magnesium were all positive and greater than 0.7 (Table 8). The potassium ion had its highest correlation with sodium (0.559), but was not significantly correlated with calcium or magnesium ($r < 0.25$).

Lentic Fishless and Fish Habitats

Surveyors were able to detect the presence of most amphibian life history stages in lentic habitats with and without fish (Table 9). Standardized mean counts for nearly all amphibian species at various life stages were lower in the 31 sites with fish than in the 176 fishless sites. The mean counts for larval and adult *Taricha granulosa* were the only amphibian life stages to be higher in sites with fish than in fishless sites.

Description of Lotic Sites and Species

The amphibian survey of lotic systems in Mount Rainier National Park consisted of observations along 100m stretches at 114 stream sites located in a total of 8 different drainage areas (Appendices IIa and IIb). Five species of amphibians and 11 separate amphibian life history stages were encountered during the survey of 84 of these sites (Table 10), whereas no amphibians were found at the other 30 sites. Most of the survey sites were classified as either stream order 1 (62.3%) or stream order 2 (29.0%). There were 8 sites in third order streams, and one site each in fourth and fifth order streams. Transect surveys were made in June (n=5), July (33), August (52), and September (24) from 6/3/96 to 9/15/99. Most sites were located in the White (n=25), Nisqually (23) and Ohanapecosh (21) drainage areas (Appendices IIa and IIb).

Total number of amphibians was highest (> 100 animals found along a 100-meter transect) in Chinook Creek (n=303), Fisher's Hornpipe (193), Deer Creek (168), Van Horn Creek (166), Dick Creek (151), an unnamed creek in Carbon Drainage (139), Laughing Water Creek (107), and Panther Creek (105) (Appendices IIa and IIb). The highest mean number of animals (61.13 animals along a 100-meter transect) was found in the Carbon drainage followed by Ohanapecosh drainage (57.63 animals/100 m) and the West Fork drainage (48.00 animals/100 m).

However, there was considerable variation in amphibian numbers among the sites in these drainages (standard error of the mean > 19.0). About 96% of the animals observed during the survey were *Ascaphus truei*, and 87.7% of these were tadpoles (Tables 11 and 12). *Dicamptodon tenebrosus* (Pacific Giant Salamander) was the next most abundant amphibian, but its relative abundance was only 3.12% of the total number of animals (n=2884) observed at all sites. The other three species of amphibians (*Ambystoma gracile*, *Rana aurora*, and *Rana cascadae*) were rare, and their combined counts represented only 1.35% of the total number of amphibians observed. *Ascaphus truei* were found in three different life history stages (e.g., adult, metamorph, and tadpole), whereas the other four species were represented by only one life history stage, either as a larva or an adult (Table 10). The number of amphibians in each life history stage observed at the 84 sites during the survey is listed in Appendix IIc. *Ascaphus* tadpoles were classified into four groups (A, B, C, and E) at 47 of these sites. The abundance of each group at each of these sites is listed in Appendix IId.

Lotic Cluster Analysis

Grouped by Species - For this analysis, species abundance was expressed as a proportion of the total count for each sample (10 1-m sites) along a 100m stream location. Therefore, cluster structure was determined by the relative abundance of each species (not the raw counts) and each species or life history stage received equal weight.

Results of the cluster analysis of 84 lotic sites in relationship to the relative abundance of the five species of amphibians are presented in Table 13 and Appendix IIe. The clustering algorithm placed most of the sites (64) into Cluster 1 (Table 13). The mean relative abundance of *Ascaphus truei* in these samples was 99%, whereas the relative abundance of the other species (*Dicamptodon tenebrosus*) was 1%. Clusters 2 and 3 were 1-site clusters. Amphibians at site 85 (Cluster 2) were 75% *D. tenebrosus* and 25% *Rana aurora*. Corresponding percentages for site 84 (Cluster 3) were 23% *Ambystoma gracile*, 73% *A. truei*, and 3% *Rana cascadae*. Mean relative abundance of *A. truei* and *D. tenebrosus* was about the same at the four sites in Cluster 4, whereas amphibians at the four sites in Cluster 5 were 100% *R. cascadae* (Table 13). Clusters 6, 7, 8, 9, and 10 were 2-site clusters that were characterized by the absence of *Ambystoma gracile* and *Rana aurora*. Sites in Clusters 6 and 8 had a different proportional abundance of *A. truei* and *R. cascadae*, and Cluster 7 was composed of sites where *D. tenebrosus* was the only amphibian species present. *A. truei* and *D. tenebrosus* exhibited a different proportional abundance in Clusters 9 and 10.

Grouped by Life History Stage of Ascaphus - This analysis was performed on data from the 77 sites at which specimens of *Ascaphus truei* were observed. In this case, there were three taxonomic categories: *Ascaphus* adults, metamorphs, and tadpoles; and the different types of tadpoles (A, B, C, and E) were pooled and treated as a single group. Data transformations were the same as described above for the cluster analysis of the five species groups.

Most of the sites (57) were partitioned into Cluster 1 (Table 14 and Appendix IIf). Specimens collected at these sites were mostly tadpoles (relative abundance of 95.9%); the mean relative abundance of adults and metamorphs at these sites was 1.9% and 2.1%, respectively (Table 14). Clusters 2 (3 sites) and 3 (6 sites) included sites that where the dominant life history stage was metamorph (Cluster 2) or adult (Cluster 3). The adult stage of *A. truei* was the only life history stage that was found at sites 1, 8, 66, 96, 105, and 114 (Appendix IIf). The five sites in Cluster 4 had a mean relative abundance of metamorphs and tadpoles of 27.9% and 72.0%, respectively; whereas specimens found at the four sites in Cluster 5 had similar mean proportions of adults and tadpoles. The two sites in Cluster 6 had the most even distribution of specimens among the three life history groups: 12.5% (adults), 51.9% (metamorphs), and 35.6% (tadpoles).

Grouped by Tadpole Categories of Ascaphus - *Ascaphus* tadpoles at 47 sites were classified into four different groups: A, B, C, and E. A cluster analysis of these sites relative to the four groups of tadpoles generated a six-cluster structure for interpretation. Data transformations before this analysis were the same as described above for the cluster analysis of the five species groups.

Sites included in Clusters 1 (19 sites) and 4 (9 sites) were dominated by tadpole B (92.5%) and tadpole A (85.5%), respectively (Table 15 and Appendix IIg). Site 52 (Cluster 2) was the only site that exhibited an even distribution of the four tadpole groups, and the only site that had relatively high abundance of tadpole E (Table 15). The three sites in Cluster 5 had the highest mean relative abundance of tadpole C (45.4%), and the four sites in Cluster 6 had a relatively high mean abundance tadpoles A (45.4%), B (29,8%), and C (24.8%). The mean relative abundance of tadpoles B and C for the eleven sites in Cluster 3 was 78.2% and 18.0%, respectively.

PCA Ordination of Lotic Sites Relative to Life History Stages of *Ascaphus*

A principal components ordination of sites was performed on the same data matrix used for the cluster analysis relative to the three life history stages of *Ascaphus truei*. For this analysis the data were standardized by subtracting the mean from each variable and dividing by the standard deviation. This is equivalent to running the analysis on the correlation matrix instead of the covariance matrix. The results of this analysis are presented in two graphs (Figs. 2a and 2b). Figure 2a displays the directional vectors of the three life history stages, and Figure 2b illustrates the position of the sites relative to those vectors.

The rectangle of sites on the graph in Figure 2b indicates a group of sites where the specimens were mostly tadpoles. Most of the other points on the graph represent sites that are along relative abundance gradients of tadpoles and metamorphs or tadpoles and adults. For example, sites toward the lower right and upper right of Figure 2b have a higher relative abundance of adults and metamorphs, respectively; and sites clustered near the left tip of the angle of points are dominated by tadpoles.

Correlation Analysis of Lotic Species and Environmental Variables

Correlation coefficients expressing covariance between the relative abundance of the five species of amphibians were between -0.661 and 0.320 (Table 16). There were significant negative correlations ($P < 0.01$) between the relative abundances of *Ascaphus truei* and *Dicamptodon tenebrosus* (-0.658) and between *A. truei* and *Rana cascadae* (-0.661). The latter coefficients indicated that when the proportion of *A. truei* in a sample was high, the corresponding proportions of *D. tenebrosus* and *R. cascadae* were low.

All correlation coefficients between total counts of amphibian species and selected environmental variables were relatively low, between 0.246 and -0.270 (Table 17). The most significant correlations (absolute value > 0.4) among environmental variables were between conductivity and alkalinity (0.758), between water temperature and dissolved oxygen concentration (-0.516), between conductivity and dissolved oxygen concentration (0.483), and between dissolved oxygen concentration and alkalinity (0.476).

DISCUSSION

There is worldwide concern about the decline of amphibian species (Wake, 1991; Blaustein and Wake, 1995), particularly in areas relatively undisturbed by human activity such as high elevation regions of the western United States (Blaustein and Wake, 1990; Wissinger and Whiteman, 1992) and U.S. national parks (Bradford, 1989; Bradford et al., 1993; Fellers and Drost, 1993). This concern has increased research emphasis on documenting species occurrence and providing a suitable means to assess population status (Bury et al., 2000). Current assessments of amphibian populations have been difficult due to a lack of comparable data sets and long-term studies (Pechmann et al., 1991; Blaustein et al., 1994a; Olson and Leonard, 1997). Thus, recommendations for future amphibian surveys have emphasized the collection of quantitative data by use of efficient and repeatable methods (Heyer et al., 1994; Bury et al., 2000).

The National Park Service (NPS) recognizes the importance of baseline data in management decisions and has recently initiated inventory and monitor programs to gather baseline data for the natural resources within national park service system lands. Identification and documentation of breeding amphibian populations in national parks of western North America has been identified as a priority within the NPS inventory and monitor program. The directive of the NPS inventory and monitor program is to compile existing information and collect new information (NPS, 1999).

This report represents the first formal survey for amphibians in Mount Rainier National Park (MORA). The emphasis of this work was to document occurrence and determine relative abundances of amphibian species at lentic and lotic survey sites in MORA. Objectives of this survey were to describe amphibian assemblages, to explore relationships between species and habitat characteristics, and to determine the feasibility of sampling protocols for long-term monitoring of amphibian populations in MORA.

Lentic Surveys

Amphibian assemblages in MORA lentic habitats were more complex than assemblages in lotic habitats. This increased complexity can be attributed to the presence of more species and greater distribution of amphibian species in lentic habitats. Six species were encountered during lentic surveys of MORA (Table 1).

Amphibian distributions in other parts of North America have been described as expressions of life history traits along environmental gradients such as hydrologic period or canopy cover (Wellborn et al., 1996; Skelly et al., 1999; Snodgrass et al, 2000). Each of the six species encountered in MORA lentic surveys have relatively plastic life history traits, such as rapid embryo development or over-wintering larvae (Nussbaum et al., 1983; Leonard et al., 1993; Petranka, 1998), that permit utilization of most types of lentic habitats in MORA. However, differences in life history strategies between species may permit one species to better occupy certain habitats than other species. Brokes (2000) suggested that *Ambystoma gracile* and *A. macrodactylum* occupied different types of lentic habitats due to differences in life history strategies. This habitat segregation between the two species probably contributes to regional co-existence of both species.

Rana cascadae, *Ambystoma gracile*, and *A. macrodactylum* co-occurred in a variety of MORA sites at all elevations (Table 3). Distribution and abundance of *R. cascadae* did not appear to be related to wetland size or elevation. However, *A. macrodactylum* was proportionally more abundant in small, shallow lentic sites at comparatively higher elevation, while *A. gracile* densities were generally greater in lentic sites that tended to larger, deeper, and lower elevation.

Brokes (2000) characterized ponds with allotopic *A. macrodactylum* populations as smaller, shallower, and higher in elevation than ponds with allotopic *A. gracile* populations. The bottom substrate of *A. macrodactylum* ponds also had less organic content than *A. gracile* ponds (Brokes, 2000).

Distributions of *Hyla regilla* and *Taricha granulosa* also appeared to be related to wetland size and elevation (Table 3). *Hyla regilla* were observed in small and shallow lentic sites with the lowest elevations, and *T. granulosa* was observed most often in larger, deeper habitats at low elevations.

Observations of *Bufo boreas* were rare. *Bufo boreas* was observed at 4 sites and did not appear to be associated with any particular type of lentic habitat (Table 3).

A variety of direct and indirect interactions, such as predation and competition (Morin, 1986; Cortwright, 1988; Sredl and Collins, 1992), may have contributed to structuring amphibian assemblages in MORA. Cortwright and Nelson (1990) found that predation by larval ambystomatid salamanders was the dominant factor determining survival of larvae of four other amphibian species in pond enclosures. Aquatic salamanders in Pacific Northwest mountain lakes function as top predator in the absence of fish (Sprules, 1972; Taylor, 1983). Thus, predation by larval salamanders may have influenced proportional abundances of anuran tadpoles or other larval salamander species in MORA. Competition may also influence amphibian assemblages in MORA as larval salamanders (Efford and Mathias, 1969; Efford and Tsumura, 1973; Licht, 1975; Nussbaum et al., 1983; Taylor, 1984) and anuran tadpoles (Nussbaum et al., 1983; Leonard et al., 1993) observed in MORA have similar food items in their diets.

Fish presence may also influence amphibian abundances in MORA ponds and lakes. Fewer individuals of all life history stages were observed in lentic habitats containing fish than in fishless habitats, except for adult and larval *T. granulosa* which had higher densities in systems with fish (Table 9). Monello and Wright (1999) found that the presence of non-native fish was the greatest factor influencing amphibian occurrence and reproduction in ponds of the Palouse region of Idaho. The presence of fish has been reported to influence the survival, distributions, and abundances of larval *A. macrodactylum* (Tyler et al., 1998a; 1998b; Funk and Dunlap, 1999), *A. gracile* (Taylor, 1983; Tyler et al., 1998b), *H. regilla* (Monello and Wright, 1999; Adams, 2000), and *R. cascadae* (Bury et al., 2000). *Taricha granulosa*, on the other hand, is well protected from predators because the skin of larvae and adults contains a potent toxin (Nussbaum et al., 1983). Sample size differed in the present study between sites with fish (n=31) and sites without fish (176), making fish impacts on amphibians in MORA lentic sites difficult to assess.

Cascades Frog, *Rana cascadae*

Rana cascadae was the most widespread and abundant amphibian in MORA lentic survey sites. *Rana cascadae* is able to use a wide array of wetland habitats between 600 and nearly 1890m in Washington and is common in mountain meadows that remain damp and contain small ponds or potholes (Nussbaum et al., 1983; Leonard et al., 1993). This species is most common in small pools adjacent to streams (Leonard et al., 1993).

Fellers and Drost (1993) have noted local extinctions and reduced distributions of *R. cascadae* in Lassen National Park, California. Embryos and adults appear susceptible to the harmful effects of ultraviolet radiation (Blaustein et al., 1994b; Fite et al., 1998). Currently, there are no known published reports of *R. cascadae* population declines north of the central portion of the Cascades Range of Oregon, although Bury et al. (2000) reported observing few or no *R. cascadae* in ponds containing introduced fish for Olympic and North Cascades National Parks in Washington.

Northwestern Salamander, *Ambystoma gracile*

Ambystoma gracile was the second most widespread amphibian in MORA lentic survey sites and only slightly less abundant than *R. cascadae* and *A. macrodactylum.* Metamorphosed adults of this species occupy a wide variety of terrestrial habitats and oviposit in slow-moving streams, ponds, and lakes from sea level to nearly 1800m in Washington (Nussbaum et al., 1983; Leonard et al., 1993). Fish have been shown to influence survival and behavior of larval *A. gracile* (Liss et al., 1995; Tyler et al., 1998b), but there are no reports that this species is in decline throughout its range.

Long-toed Salamander, *Ambystoma macrodactylum*

Ambystoma macrodactylum was ranked third in sites occupied and second in abundance for amphibians in MORA lentic survey sites. Introduced fish may locally influence this salamander in Pacific Northwest mountain lakes (Tyler et al., 1998a; Funk and Dunlap, 1999); however, *A. macrodactylum* may be able to regionally co-exist with fish by utilization of ephemeral wetlands and other fishless habitats as breeding sites (Bury et al., 2000). There are currently no reports of population declines for this salamander in the Pacific Northwest.

Rough-skinned Newt, *Taricha granulosa*

Taricha granulosa is the most commonly encountered salamander in the Pacific Northwest (Nussbaum et al., 1983). *Taricha granulosa* was present at 24 sites scattered along the northern, southern, and western MORA boundaries. Elevation likely limited *T. granulosa* distribution in MORA since *T. granulosa* are reported to occur from sea level to about 1500m in Washington (Leonard et al., 1993). Distribution patterns of newts in MORA appear similar to those observed in Olympic and North Cascades National Parks where few occurred at higher elevations (Bury et al., 2000). Although introduced fish and crayfish negatively effected populations of California newt (*Taricha torosa*) in streams of southern California (Gamradt and Kats, 1996), there are no known published reports of newt declines in the Pacific Northwest.

Pacific Treefrog, *Hyla regilla*

Hyla regilla was observed at 8 sites in MORA. This species never occurred at high larval or adult densities except at St. Andrews Lake where all 24 individual amphibians encountered were *H. regilla*. *Hyla regilla* is the most common and widespread frog in the Pacific Northwest, breeding in a variety of shallow, vegetated wetlands (Nussbaum et al., 1983). Distribution of *H. regilla* was restricted to low elevation sites of the western park boundary and southeastern corner of MORA. High elevation and northern range limitations have been proposed as limiting the presence of *H. regilla* in mountain lakes of Olympic and North Cascades National Parks (Bury et al., 2000), and elevation probably restricted the distribution of *H. regilla* in MORA lentic survey sties. Exotic fish have been shown to reduce survival of *H. regilla* larvae at low elevation habitats in Washington (Adams, 2000), but there are no indications of population declines for *H. regilla* in the Pacific Northwest.

Western Toad, *Bufo boreas*

Bufo boreas was rare in MORA lentic surveys. Toad observations consisted of individual adults at three different survey sites and a large aggregation of tadpoles in Mystic Lake. Historically, this species was distributed throughout western North America and found in all but the driest portions of Washington; however, *B. boreas* is now uncommon in the Puget Sound lowland of western Washington (Leonard et al., 1993; Adams et al., 1998; 1999) and the North Cascades

(Leonard et al., 1993). Some occur on the western side of the Olympic peninsula (R.B. Bury, pers. comm.). *Bufo boreas* is currently considered a candidate species to the Washington State threatened and endangered species list (Washington Department of Fish and Wildlife, Species of Concern List, 6/21/2000), and populations of *B. boreas* in Colorado, Wyoming, and New Mexico, are also candidates to the federal threatened and endangered species list (U.S. Fish and Wildlife Service, 1995). Ultraviolet radiation has been implicated in *B. boreas* declines for the Oregon Cascades Range (Blaustein et al., 1994b), however no measurable effect of ultraviolet radiation on toad embryos was reported in the Rocky Mountains of Colorado (Corn, 1998). Significant avian predation on breeding adult *B. boreas* in Oregon Cascades Range and southern Rocky Mountains of Colorado has also been reported (Olson, 1989; Corn, 1993). Reports from amphibian surveys in Idaho (Monello and Wright, 1999), low elevation sites in Washington (Adams et al., 1998; 1999), and the national parks of Washington (Bury et al., 2000) indicated absences of *B. boreas* from suitable habitats in the Pacific Northwest, but the authors caution that historic records for these regions are few. Based on the distribution and habitat requirements described in Nussbaum et al. (1983) and Leonard et al. (1993), we anticipated observing more western toads in MORA.

Lotic Surveys

Cluster analyses of data obtained during amphibian surveys of lotic habitats indicated that amphibian assemblages in the streams and rivers of MORA were not complex. Five amphibian species were encountered during surveys of lotic sites, but most assemblages were typically composed of two species (Table 13).

These two-species communities in MORA were also common in streams of the southern Washington Cascades Range. Bury et al. (1991) found that 2-species amphibian communities occurred in 33% of sampled streams while 40% of the sampled streams contained 3-species communities. Many of the 2- and 3-species communities in streams of the southern Washington Cascades contained the most common amphibians: tailed frog (*Ascaphus truei*), torrent salamander (*Rhycotriton* sp.), and/or both giant salamanders (*Dicamptodon tenebrosus* and *D. copei*) (Bury et al., 1991). Most 2-species assemblages in MORA were comprised of *A. truei* and *Dicamptodon* sp. or of *A. truei* and *Rana cascadae.*

The most abundant and widely distributed amphibians in MORA streams were *Ascaphus truei* and *Dicamptodon* sp. Both taxa are reportedly common in silt-free headwater streams of the Pacific Northwest (Nussbaum et al., 1983; Leonard et al., 1993). *Ascaphus truei*, *Dicamptodon* sp., or both taxa, were observed at all but 4 lotic sites surveyed.

Although *Ascaphus truei* and *Dicamptodon* sp. were often observed at the same MORA sites, they frequently occurred at different proportional abundances. Differing patterns of in-stream microhabitat use or interspecific predation may partly account for these differences. There is gathering evidence that *A. truei* and *Dicamptodon* sp. utilize different microhabitats in streams (Parker, 1991; Bury et al., 1991; Welsh and Ollivier, 1998; Diller and Wallace, 1999; Dupuis and Steventon, 1999; Wilkins and Peterson, 2000). Furthermore, Hawkins (1994) suggested that direct or indirect predation of *A. truei* by *Dicamptodon* sp. might affect local abundances of *A. truei* tadpoles. Larger larval *Dicamptodon* sp. are known to prey upon the larvae of amphibian species (Nussbaum et al., 1983; Petranka, 1998).

Three other amphibian species were also observed during surveys of MORA lotic sites (Table 11 and Appendix IIc). Each of these species was relatively rare in MORA streams compared to *A. truei* and *Dicamptodon* sp. A total of 30 adult *Rana cascadae* were observed at 13 sites and were typically encountered as scattered individuals or small concentrations of individuals.

Seven larval *Ambystoma gracile* were observed at one site and 2 adult *Rana aurora* were observed as individuals at different sites.

Tailed Frog, *Ascaphus truei*

The tailed frog has adapted to life in cold, clear, mountain streams of the Pacific Northwest (Nussbaum et al., 1983). Tailed frog tadpoles and adults were the most frequently encountered amphibian (n=77 sites) in the MORA survey and were also locally abundant ($\geq$20 individuals/site) at 37 sites (Appendix IIc).

We observed, *A. truei* tadpoles in greater frequency and abundance than adult or metamorphosed individuals. Most studies have found *A. truei* tadpoles to be more abundant or more readily detected than combined numbers of adults and metamorphosed individuals in stream surveys (Bury et al., 1991; Dupuis and Steventon, 1999; Diller and Wallace, 1999). In MORA, *A. truei* tadpoles were nearly 7 times more abundant than the combined total numbers of adults and metamorphosed individuals. This tadpole to adult ratio in MORA streams closely resembled the tadpole to adult ratio observed from a survey of Cascade Range streams in southern Washington (Bury et al., 1991).

The observation of certain life history stages of *Ascaphus truei* was influenced by survey date. Adult and tadpole *A. truei* were typically abundant or present regardless of survey date. However, recently metamorphosed individuals and tadpoles of late development stage were usually first observed during July surveys, with the highest counts of recently metamorphosed individuals and later-stage tadpoles occurring at sites from mid-August through September (Appendices IIb, IIc, and IId). *Ascaphus truei* breed during the fall months or spring and oviposit the following summer (Nussbaum et al., 1983; Leonard et al., 1993). Larvae may require several years before metamorphosing in July-September. Metamorphosis is completed by September for most populations (Nussbaum et al., 1983).

Populations of *A. truei* can be negatively influenced by human activities, especially clear-cut logging practices (Corn and Bury, 1989; Welsh, 1990; Welsh and Lind, 1991). Fine sediment loading in watersheds following logging or road building has been identified as the principal perturbation affecting populations of *A. truei* (Dupuis and Steventon, 1999).

Giant Salamander, *Dicamptodon* sp.

No effort was made to determine species for the *Dicamptodon* genus. *Dicamptodon tenebrosus* is the most common aquatic salamander in the Pacific Northwest occurring from southwestern British Columbia to coastal northern California (Nussbaum et al., 1983; Petranka, 1998). *Dicamptodon copei* inhabits mountain streams of Olympic peninsula, southwest Washington, and northwest Oregon (Petranka, 1998). The southern portion of MORA may overlap with the northern distribution limit for *Dicamptodon copei*.

Ninety individual *Dicamptodon* sp. were observed at 24 survey sites ranging in density from 1 to 9 individuals at these sites. These levels were similar to numbers observed for *Dicamptodon tenebrosus* in Oregon and California streams (Hawkins et al., 1983; Corn and Bury, 1989; Parker, 1991). *Dicamptodon* sp. was only encountered in the larval or paedomorphic form during MORA lotic surveys. Larvae outnumbered metamorphosed individuals in most *Dicamptodon* sp. populations (Petranka, 1998).

Dicamptodon sp. was observed in most watersheds surveyed in MORA, but most frequently occurred in the Nisqually, Ohanapecosh, and Carbon River drainages (6, 6, and 5 sites, respectively). None were observed in the White River drainage. This watershed may represent an eastern range limit for *Dicamptodon tenebrosus* and *D. copei* in MORA based on range descriptions for these species in Washington (Nussbaum et al., 1983; Petranka, 1998).

Dicamptodon sp. can be negatively influenced by forestry practices that lead to stream siltation (Bury and Corn, 1988; Corn and Bury, 1989; Petranka, 1998). At present, there are no known reports of population decline for *Dicamptodon tenebrosus* or *Dicamptodon copei*.

Northwestern Salamander, *Ambystoma gracile*

Larval *Ambystoma gracile* were observed in a first order stream at an elevation of 1410m. Larvae at this site were observed in a stream pool with 2% gradient measured midway through the 100m survey location. Although not typically found in streams *A. gracile* can utilize slow-moving portions of streams as breeding habitat (Nussbaum et al., 1983; Leonard et al., 1993).

Cascades Frog, *Rana cascadae*

Rana cascadae is a pond-breeding amphibian but adults can be common in moist meadows and along streams during summer months (Nussbaum et al., 1983; Leonard et al., 1993). In MORA, 30 adult *R. cascadae* were encountered at 13 stream sites.

Red-legged Frog, *Rana aurora*

Rana aurora was rare in MORA lotic surveys, with a single adult observed at each of two survey sites. Adults of this pond-breeding amphibian can occur considerable distances from water and along stream corridors during the non-breeding season (Nussbaum et al., 1983), thus possibly explaining *R. aurora* presence in the lotic survey. The elevation of MORA sites may limit *R. aurora* distribution in the park, as this species commonly inhabits moist forests, wetlands, and riparian areas below elevations of 900m west of the Cascade Range (Nussbaum et al., 1983). The elevation of our one site (Nisqually basin, elev. 896m) was at about the maximum elevation reported for *R. aurora*. The other site (Ohanapecosh basin, elev. 1504m) where *R. aurora* was observed was considerably higher than the reported elevation maximum in Washington (Nussbaum et al., 1983; Leonard et al., 1993; Corkran and Thoms, 1996). Since adult *R. aurora* often resemble other adult ranid frogs, such as *R. cascadae* or *R. pretiosa* (Nussbaum et al., 1983; Leonard et al., 1993; Corkran and Thoms, 1996), it is possible that the individual at the Ohanapecosh site was misidentified.

The observation of *Rana aurora* in MORA is of special interest since populations of the southern red-legged frog (*Rana aurora draytonii*) have decreased in California (Fisher and Shaffer, 1996). *Rana aurora draytonii* is currently listed as threatened for California (California Department of Fish and Game website, US Fish and Wildlife website). Although Adams et al. (1998, 1999) reported that *R. aurora* was common and locally abundant at several surveyed wetlands along the southern end of Washington's Puget Sound, Nussbaum et al. (1983) report that *R. aurora* was becoming less common in the Willamette Valley of Oregon. Oregon Department of Fish and Wildlife lists *R. aurora* as a sensitive vertebrate in Oregon (Marshall et al., 1992).

Recommendations for Future Monitoring

Amphibian populations are often variable (Pechmann et al., 1991), and detection of population changes may present the greatest challenge in monitoring amphibians (Houlahan et al., 2000). Thus, emphasis should be on long-term monitoring to discern between natural variation in population levels and declines possibly caused by human activity (Pechmann et al., 1991). Amphibian monitoring efforts in MORA should continue to include selected measurements of environmental and habitat conditions, as well as amphibian populations. Perceived threats to MORA amphibian populations from human activities, such as logging, road building, and fish introductions, are likely minimal in MORA, as these activities are no longer regularly conducted in MORA. However, other anthropogenic threats such as increased ultraviolet radiation and air pollutants leading to acidification of wetlands may have local and regional ramifications for MORA amphibians. The measurement of environmental variables would assist in detection of human related disturbances, such as airborne pollutants. For example, ozone is increasingly drifting into MORA from the Seattle-metropolitan area (Peterson et al., 1999; Cooper and Peterson, 2000).

Nine amphibian species were observed during this survey of MORA lotic and lentic sites. Several species were present, and often abundant, in many of these sites. Other species were absent or present only in low numbers at surveyed sites. At present, factors influencing distribution, abundance, and amphibian assemblage composition in MORA are unclear. Future research should focus on long-term monitoring to detect possible fluctuations in amphibian populations but should also include investigations that lead to an understanding of factors contributing to the structure of amphibian communities in MORA.

In MORA, several amphibians, such as *Ascaphus truei*, *Rana cascadae*, *Ambystoma gracile*, and *A. macrodactylum*, were widely distributed and locally abundant in many sites. Other amphibian species observed in surveys appeared to have more restricted and moderate abundance in certain habitats (i.e., *Dicamptodon* sp., *Hyla regilla*, *Taricha granulosa*). *Bufo boreas* and *Rana aurora* were rare with patchy distributions and seldom abundant in seemingly suitable habitats. For these last two species, extra efforts should be taken to verify presence, determine abundance, and identify potential breeding sites within MORA. Future survey efforts should consider *Dicamptodon tenebrosus* and *D. copei* separately. *Dicamptodon copei* has a more restricted regional distribution than *D. tenebrosus* (Petranka, 1998) and, therefore, local population fluctuations may have greater regional ramifications for this species.

Continued vigilance concerning introduced species is warranted given the number of field reports implicating the negative impacts of introduced fish (Tyler et al., 1998a; Larson and Hoffman, 2002) and bullfrogs (Kiesecker and Blaustein, 1998) on native amphibians in the Pacific Northwest region. Studies similar to current fish removal efforts at several lakes in MORA would help illuminate potential impacts fish have on amphibians (R.L. Hoffman, pers. comm.). A study using paired fish and fishless sites, preferably those suitable to fish habitation, would also help assess the impact of fish on amphibians in MORA. Bullfrogs were not observed in MORA during this survey. Limited thermal tolerance in bullfrogs may exclude them from colonizing higher elevation waters such as those in MORA (Nussbaum et al., 1983; Leonard et al., 1993). However reports that implicate the negative impacts of bullfrogs on native amphibians (Moyle, 1973; Hayes and Jennings, 1988; Fisher and Shaffer, 1996) warrant continued vigilance concerning the presence of bullfrogs in MORA.

Survey Method

Visual encounter surveys (VES) were performed for amphibian surveys at most lentic habitats in MORA following protocol similar to Olson et al. (1997). Snorkel surveys (i.e., Liss et al., 1995; Tyler et al., 1998a; Brokes, 2000) were also employed to census amphibians in nearshore areas of MORA ponds and lakes. Brokes (2000) reported no difference between numbers of larval salamanders observed between the two techniques; however, numbers were derived from few observations at three ponds. Funk and Dunlap (1999) reported no difference in ability to detect amphibian presence and absence between VES and snorkel surveys. Analysis of unpublished amphibian survey data indicated that snorkel survey techniques provided higher observed numbers of aquatic life history stages (embryos and larvae) while VES produced higher observed numbers of terrestrial or semi-terrestrial life history stages (juveniles and adults) (T. Tyler, pers. comm.). Snorkel survey techniques may provide beneficial data for cause-and-effect investigations or for studies where a reasonable density estimate is necessary for analysis of aquatic amphibian life stages (i.e., measuring fish impacts on larval salamander density; Tyler et al., 1998a). However, methods such as VES may prove more useful for population surveys where analyses will consist of proportional abundances and habitats occupied (i.e., National Park amphibian surveys; Bury et al., 2000). The latter is particularly true given safety concerns and time constraints of surveys performed in large, remote, and rugged areas such as MORA.

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FIGURES

Figure 1. Detrended correspondence analysis of proportional abundance of six amphibian species observed at 205 lentic sites during a 1994-1999 survey of Mount Rainier National Park revealed amphibian abundance gradients by site ordination (a) and by species ordination (b).

Figure 1a.

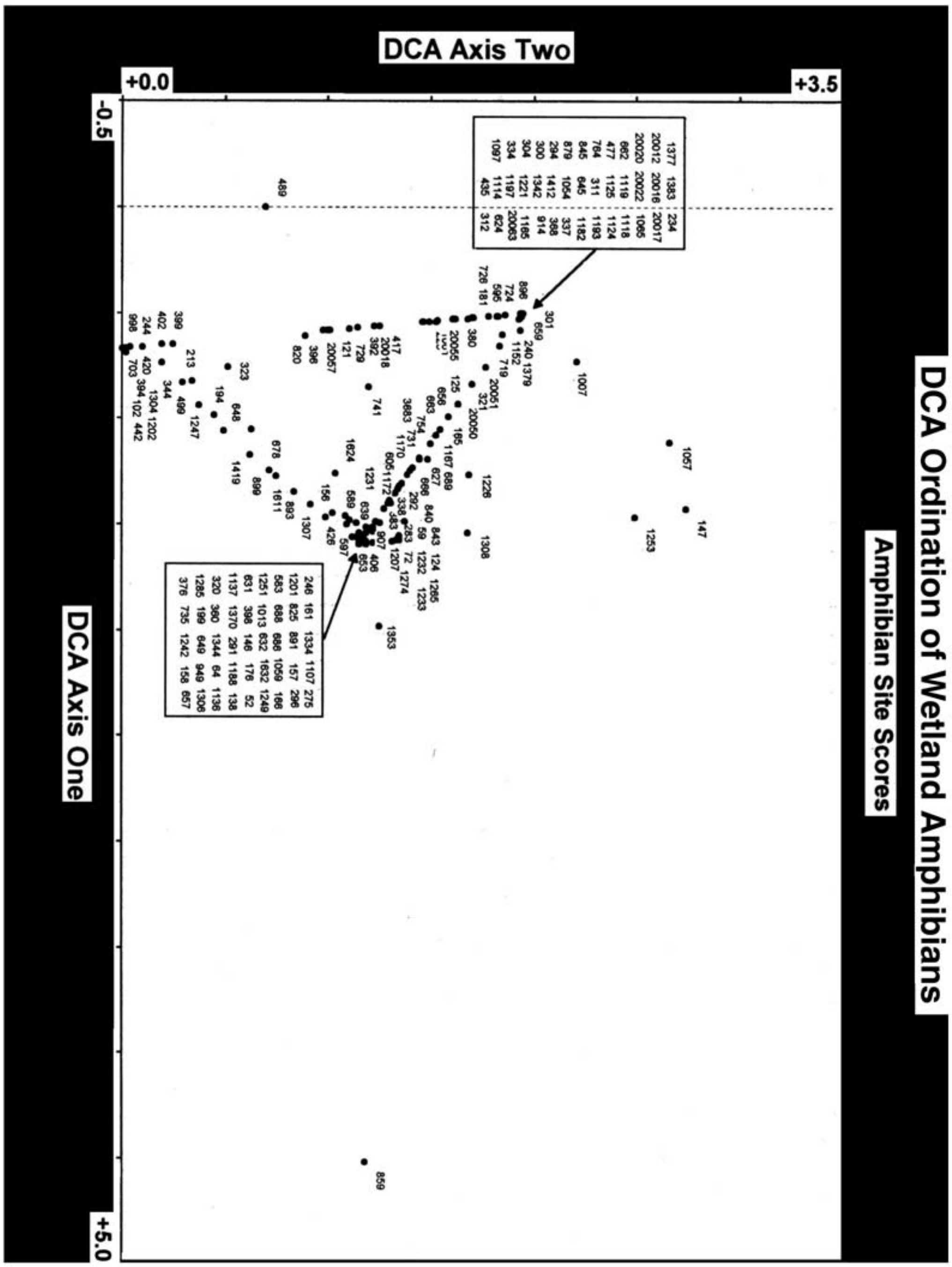


Figure 1b.

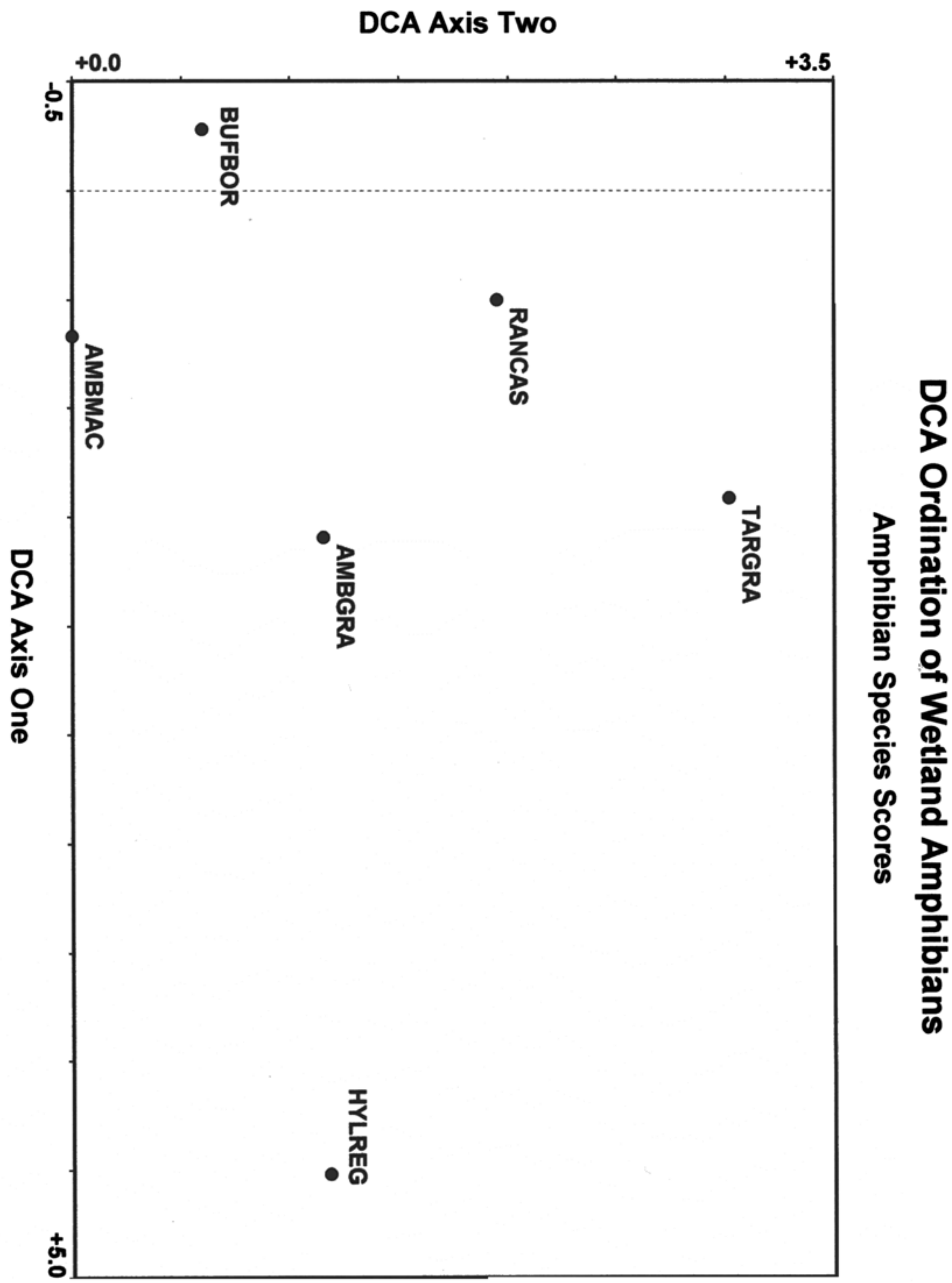

DCA Ordination of Wetland Amphibians
Amphibian Species Scores
DCA Axis Two
+0.0
+3.5
DCA Axis One
-0.5
+5.0
BUFBOR
RANCAS
AMBMAC
TARGRA
AMBGRA
HYLREG

Figure 2. Ordination of a principle components analysis of 77 lotic sites relative to three life history stages of *Ascaphus truei* observed during a 1996-1999 survey in Mount Rainier National Park indicated directional vectors for each life history stage (a) as reflected by site ordination (b).

Figure 2a.

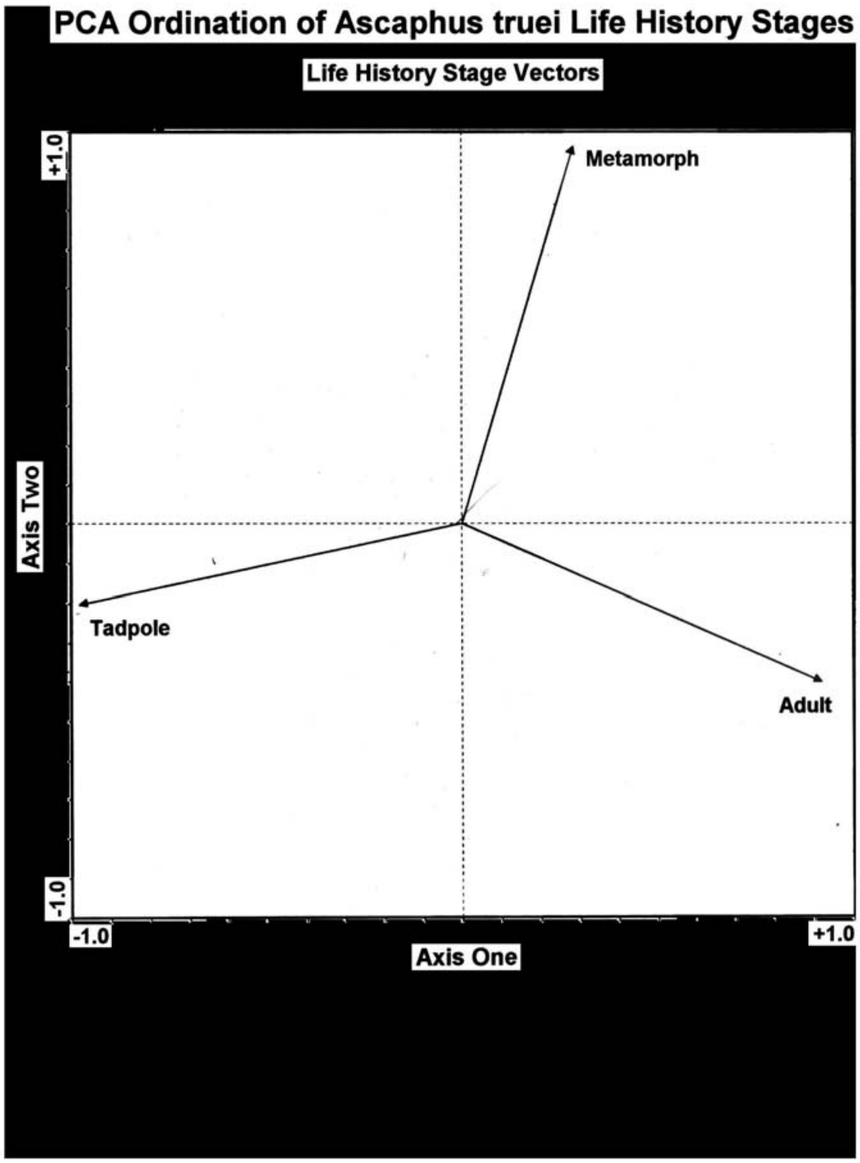
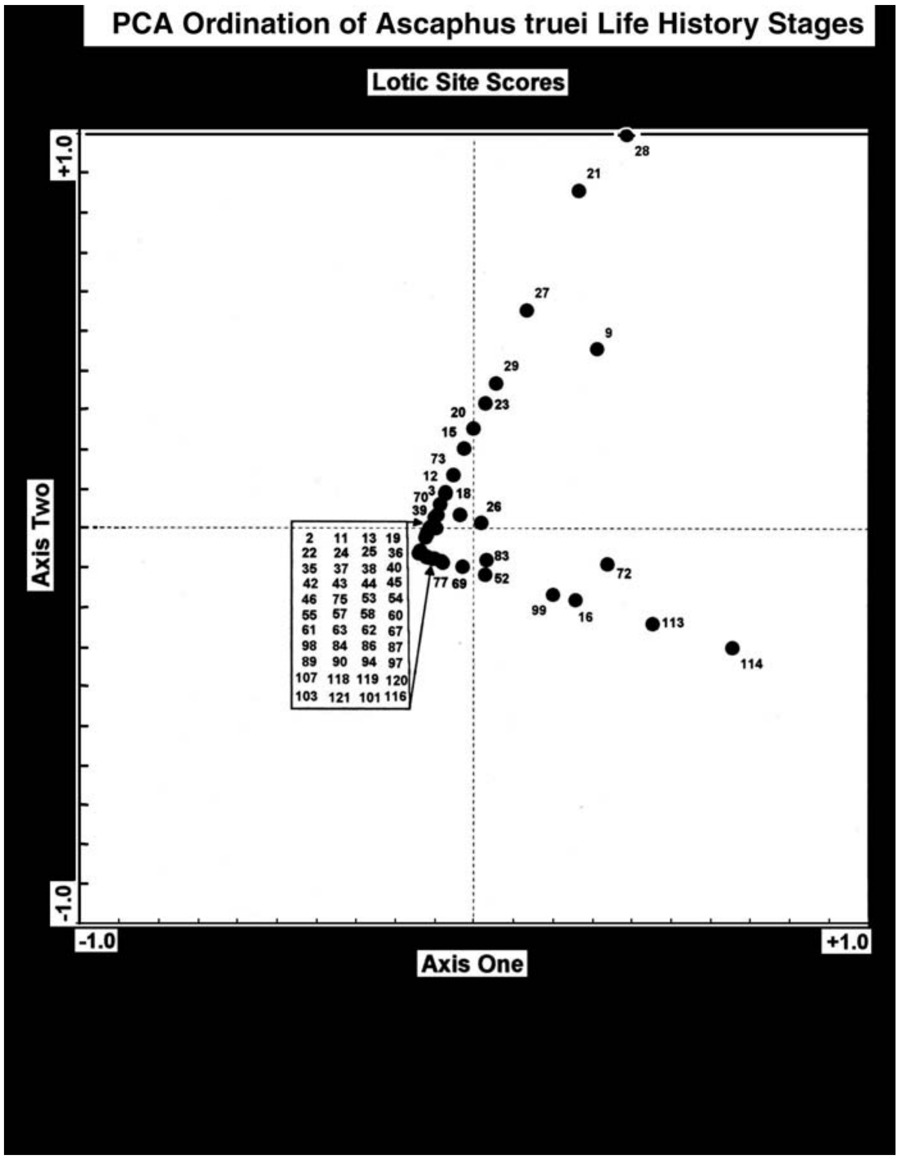


Figure 2b.


PCA Ordination of Ascaphus truei Life History Stages
Lotic Site Scores
Axis Two
Axis One
+1.0
-1.0
-1.0
+1.0
28
21
27
9
29
23
20
15
73
12
70
3
18
39
26
83
72
77
69
52
99
16
113
114
2 11 13 19
22 24 25 36
35 37 38 40
42 43 44 45
46 75 53 54
55 57 58 60
61 63 62 67
98 84 86 87
89 90 94 97
107 118 119 120
103 121 101 116

TABLES

Table 1. Total number of each amphibian life history stage found during a 1994-1999 amphibian survey of lentic sites in Mount Rainier National Park. The data were standardized to 100-meter transect lengths per site, and then summed over all wetlands.

Species	Common Name	Life History Stage	Total Count
Rana cascadae	Cascade frog	egg mass	314.78
		tadpole	21007.14
		juvenile	566.08
		adult	1040.00
Rana sp.	True frogs	tadpole	1199.36
		adult	7.14
Hyla regilla	Pacific tree frog	tadpole	26.72
		juvenile	2.10
		adult	3.59
Bufo boreas	Western toad	tadpole	199.22
		adult	2.18
Anuran	Unknown frog species	tadpole	0.72
Ambystoma gracile	Northwestern salamander	egg mass	2577.10
		larvae	4240.87
		neotene	901.56
		adult	29.61
Ambystoma macrodactylum	Long-toed salamander	egg mass	1860.29
		larvae	8864.43
		adult	161.00
Ambystoma sp. unknown	Ambystomatidae	larvae	558.01
Taricha granulosa	Roughskin newt	egg mass	79.03
		larvae	72.58
		adult	81.79

Table 2. Cluster analysis of 188 lentic sites recognized a 7-cluster structure relative to six amphibian species. Values represent the mean proportional abundance for each species, and the number of sites in each cluster (size).

Cluster	Size	Rana cascadae	Hyla regilla	Bufo boreas	Ambystoma gracile	Ambystoma macrodactylum	Taricha granulosa
1	69	0.903	0.000	0.000	0.035	0.062	0.000
2	1	0.149	0.000	0.676	0.000	0.175	0.000
3	1	0.000	1.000	0.000	0.000	0.000	0.000
4	3	0.116	0.000	0.000	0.139	0.000	0.745
5	25	0.110	0.000	0.000	0.105	0.784	0.000
6	85	0.090	0.003	0.000	0.877	0.022	0.008
7	4	0.289	0.011	0.000	0.417	0.083	0.199

Table 3. K-means cluster analysis on 3 environmental variables [area (ha), elevation (ft), and maximum depth (max. depth; m)] partitioned 167 lentic sites into 5 distinct clusters. Mean measurements of area, elevation, and depth are provided for each cluster. For each species in each cluster, mean counts for larval, juvenile, and adult life history stages and percent of sites occupied (% sites) within a cluster were used to summarize amphibian diversity of clusters. Embryos were excluded from amphibian mean counts.

	Cluster				
Parameter	**1**	**2**	**3**	**4**	**5**
Number of sites	14	61	83	8	1
Mean Elevation	3023	5634	4794	4575	4941
Mean Area	0.53	0.60	0.83	6.79	45.3
Mean Max. Depth	1.59	1.86	2.97	23.05	55.40
• Rana cascadae					
% sites	50.0	73.1	67.5	50.0	100.0
mean count	1.29	201.06	19.00	21.39	0.82
• Hyla regilla					
% sites	21.4	1.5	5.2	0	0
mean count	0.31	0.39	0.05	0	0
• Bufo boreas					
% sites	0	1.6	3.6	0	0
mean count	0	3.27	0.03	0	0
• Ambystoma gracile					
% sites	57.1	41.8	80.5	62.5	0
mean count	31.52	21.78	34.77	38.92	0
• Ambystoma macrodactylum					
% sites	14.3	53.7	24.7	25.0	0
mean count	0.07	120.84	10.80	1.63	0
• Taricha granulosa					
% sites	21.4	4.5	22.1	12.5	0
mean count	0.69	0.04	1.54	0.84	0

Table 4. Principle components analysis performed on 7 environmental variables from 138 lentic sites identified 3 polar axes that accounted for 73.8% of the variance in the data. Correlation coefficients from a correlation analysis between the PCA axes and environmental variables are provided. Significant correlation coefficients are shown in bold type.

	Axis		
	1	2	3
Elevation	-0.173	**-0.542**	**0.438**
Area	**0.949**	-0.012	0.038
Depth	**0.951**	0.096	0.090
Conductivity	0.056	**0.868**	-0.046
PH	-0.037	**0.756**	0.044
Alkalinity	0.044	0.150	**-0.874**
Temperature	-0.246	-0.095	**-0.798**

Table 5. Pearson correlation coefficients expressing covariance among six species of amphibians observed during a 1994 – 1999 survey of lentic sites in Mount Rainier National Park.

Species	**Ambystoma gracile**	**Ambystoma macrodactylum**	**Bufo boreas**	**Hyla regilla**	**Rana cascadae**
Ambystoma macrodactylum	-0.042				
Bufo boreas	-0.028	0.000			
Hyla regilla	-0.024	-0.011	-0.007		
Rana cascadae	-0.081	0.005	-0.012	-0.025	
Taricha granulosa	0.486	-0.020	-0.011	-0.012	-0.043

Table 6. Correlation coefficients expressing the relationship between the total count of amphibians (COUNT) at 145 lentic sites in Mount Rainier National Park and a set of environmental variables: maximum water depth (DEPTH), water temperature (TEMP), conductivity (COND), dissolved oxygen (DO), pH (PH), and alkalinity (ALKA).

Variable	COUNT	DEPTH	TEMP	COND	DO	PH
DEPTH	-0.089					
TEMP	0.115	-0.253				
COND	-0.029	0.177	-0.001			
DO	0.053	-0.027	-0.218	0.135		
PH	0.124	0.037	0.066	0.451	0.072	
ALKA	-0.034	-0.024	0.498	0.142	-0.151	0.123

Table 7. Pearson correlation coefficients expressing the relationship between the total count of amphibians (COUNT) at 31 lentic sites in Mount Rainier National Park and a set of nutrient variables: total nitrogen (TOT-N), ammonia (NH3), nitrate/nitrite (NO3/N02), total phosphorus (TOT-P), and orthophosphate (PO4).

Variable	COUNT	TOT-N	NH3	NO3/NO2	TOT-P
TOT-N	0.033				
NH3	-0.237	0.030			
NO3/NO2	-0.121	-0.201	0.284		
TOT-P	0.112	0.791	-0.162	-0.133	
PO4	0.099	0.200	0.068	0.045	0.395

Table 8. Pearson correlation coefficients expressing the relationship between the total count of amphibians (COUNT) at 19 wetland sites in Mount Rainier National Park and a set of cation variables: sodium, potassium, calcium, and magnesium.

Variable	Count	Sodium	Potassium	Calcium
Sodium	0.067			
Potassium	0.290	0.559		
Calcium	0.110	0.798	0.153	
Magnesium	0.147	0.780	0.203	0.980

Table 9. Mean numbers of amphibian species and life history stage found along 100 m transects at 31 lentic sites with fish present and 176 lentic sites without fish. Each life history stage was not present (np) for each category.

Species	Life History Stage	With Fish	Without Fish
Ambystoma gracile			
	Egg mass	6.89	13.62
	Larva	4.51	23.31
	Neotene	3.26	4.98
	Adult	0.02	0.16
Ambystoma macrodactylum			
	Egg mass	5.79	9.57
	Larva	4.96	49.63
	Adult	0.10	0.90
Ambystoma sp.			
	Larva	0.04	3.16
Bufo boreas			
	Tadpole	6.43	np
	Adult	np	0.01
Hyla regilla			
	Tadpole	np	0.15
	Juvenile	np	0.01
	Adult	np	0.02
Rana cascadae			
	Egg mass	0.03	1.78
	Tadpole	4.50	118.57
	Juvenile	0.18	3.18
	Adult	1.40	5.66
Rana sp.			
	Tadpole	np	6.81
	Adult	np	0.04
Taricha granulosa			
	Egg mass	0.13	0.43
	Larva	1.66	0.12
	Adult	0.68	0.35

Table 10. List of amphibian species, life history statge, and corresponding code number, acronym, common name, and life history stage found during a 1996 – 1999 survey of lotic habitats in Mount Rainier National Park.

Species Name	Code	Acronym	Common Name	Stage
Ambystroma gracile	1	AMGRL	Northwestern salamander	Larva
Ascaphus truei	2	ASTRA	Tailed frog	Adult
Ascaphus truei	3	ASTRM	Tailed frog	Metamorph
Ascaphus truei	4	ASTRT	Tailed frog	Tadpole
Ascaphus truei	5	ASTRTA	Tailed frog	Tadpole A
Ascaphus truei	6	ASTRTB	Tailed frog	Tadpole B
Ascaphus truei	7	ASTRTC	Tailed frog	Tadpole C
Ascaphus truei	8	ASTRTE	Tailed frog	Tadpole E
Dicamptodon tenebrosus	9	DITEL	Pacific Giant Salamander	Larva *Rana*
aurora	10	RAAUA	Red-legged Frog	Adult *Rana*
cascadae	11	RACAA	Cascade Frog	Adult

Table 11. Total number of amphibians for five species observed during a 1996-1999 survey of lotic ecosystems in Mount Rainier National Park. The number of animals in 100-m transects were determined at each site, and these values were summed over a total of 114 sites.

Species	Common Name	Acronym	Total Count
Ambystroma gracile	Northwestern salamander	**AMBGRA**	7
Ascaphus truei	Tailed frog	**ASCTRU**	2755
Dicamptodon tenebrosus	Pacific Giant Salamander	**DICTEN**	90
Rana aurora	Red-legged Frog	**RANAUR**	2
Rana cascadae	Cascade Frog	**RACCAS**	30

Table 12. Total number of amphibians for five species partitioned by life history stage. The animals were observed during a 1996 - 1999 survey of lotic ecosystems in Mount Rainier National Park. The of animals in 100-m transects were determined at each site, and these values were summed over a total of 114 sites.

Species Name	Common Name	Stage	Acronym	Total Count
Ambystroma gracile	Northwestern Salamander	Larva	**AMGRL**	7
Ascaphus truei	Tailed frog	Adult	**ASTRA**	70
Ascaphus truei	Tailed frog	Metamorph	**ASTRM**	269
Ascaphus truei	Tailed frog	Tadpole	**ASTRT**	2416
Dicamptodon tenebrosus	Pacific Giant Salamander	Larva	**DITEL**	90
Rana aurora	Red-legged Frog	Adult	**RAAUA**	2
Rana cascadae	Cascade Frog	Adult	**RACAA**	30

Table 13. Cluster analysis of lotic sites relative to five amphibian species identified during a 1996-1999 survey in Mount Rainier National Park. Values include cluster, number of sites (size), and the mean proportional abundances of *Ambystoma gracile* (AMBGRA), *Ascaphus truei* (ASCTRU), *Dicamptodon tenebrosus* (DICTEN), *Rana aurora* (RANAUR), and *Rana cascadae* (RACCAS) for each cluster.

Cluster	Size	AMBGRA	ASCTRU	DICTEN	RANAUR	RACCAS
1	64	0.00	0.99	0.01	0.00	0.00
2	1	0.00	0.00	0.75	0.25	0.00
3	1	0.23	0.73	0.00	0.00	0.03
4	4	0.00	0.48	0.53	0.00	0.00
5	4	0.00	0.00	0.00	0.00	1.00
6	2	0.00	0.31	0.00	0.00	0.69
7	2	0.00	0.00	1.00	0.00	0.00
8	2	0.00	0.77	0.00	0.00	0.23
9	2	0.00	0.75	0.25	0.00	0.00
10	2	0.00	0.25	0.75	0.00	0.00

Table 14. Cluster analysis of lotic sites relative to three life history stages of *Ascaphus truei*: adult, metamorph, and tadpole. Animals were observed during a 1996 - 1999 survey in Mount Rainier National Park. Values include cluster number, number of sites in each cluster (size), and the mean proportional abundance of *A. truei* adults (ASTRA), *A. truei* metamorphs (ASTRM), and *A. truei* tadpoles (ASTRT).

Cluster	Size	ASTRA	ASTRM	ASTRT
1	**57**	**0.019**	**0.021**	**0.959**
2	**3**	**0.021**	**0.846**	**0.133**
3	**6**	**1.000**	**0.000**	**0.000**
4	**5**	**0.001**	**0.279**	**0.720**
5	**4**	**0.556**	**0.023**	**0.421**
6	**2**	**0.125**	**0.519**	**0.356**

Table 15. Cluster analysis of lotic sites relative to four tadpole stages of ***Ascaphus truei*:** A, B, C, and E. Animals were observed during a 1996-1999 survey in Mount Rainier National Park. Values include cluster number, number sites in each cluster (size), and proportional abundance of A. truei at tadpole stages A B, C, and E in each cluster.

Cluster	Size	Stage A	Stage B	Stage C	Stage E
1	19	0.050	0.925	0.025	0.000
2	1	0.273	0.273	0.273	0.182
3	11	0.038	0.782	0.180	0.000
4	9	0.855	0.139	0.004	0.002
5	3	0.086	0.453	0.454	0.007
6	4	0.454	0.298	0.248	0.000

Table 16. Correlation coefficients expressing the covariance between the relative abundance of all possible pairs of amphibian species observed during a 1996-1999 amphibian survey of lotic sites in Mount Rainier National Park. The species are *Ambystoma gracile* (AMBGRA), *Ascaphus truei* (ASCTRU), *Dicamptodon tenebrosus* (DICTEN), *Rana aurora* (RANAUR), and *Rana cascadae* (RANCAS).

Species	AMBGRA	ASCTRU	DICTEN	RANAUR
ASCTRU	**-0.036**			
DICTEN	**-0.043**	**-0.658**		
RANAUR	**-0.013**	**-0.290**	**0.320**	
RANCAS	**-0.020**	**-0.661**	**-0.119**	**-0.035**

Table 17. Correlation coefficients expressing the covariance between the total count of amphibians at 84 lotic sites and selected environmental variables. Samples were obtained during a 1996 - 1999 amphibian survey of lotic ecosystems in Mount Rainier National Park. The variables are: total count of amphibians (COUNT), stream order (ORDER), elevation (ELEV), water temperature (TEMP), conductivity (COND), dissolved oxygen (DO), turbidity (TURB), alkalinity (ALKA), mean substrate size (SUBS).

Variable	Count	Order	Elev	Temp	Cond	DO	Turb	Alka
Order	0.084							
Elev	-0.270	-0.021						
Temp	0.246	0.030	-0.281					
Cond	-0.127	-0.046	-0.275	-0.113				
DO	-0.192	0.045	0.001	-0.516	0.483			
Turb	-0.110	0.040	0.161	-0.079	-0.045	-0.045		
Alka	0.024	0.073	-0.282	-0.153	0.758	0.476	-0.134	
Subs	0.112	0.009	-0.163	0.198	-0.137	-0.211	0.000	-0.169

APPENDIX I

Appendix Ia. Fish presence (Fish) and total amphibian count per 100-meter transect (Total Count) calculated for each lentic site (wetland #) on each sampling date during the 1994-1999 survey in Mount Rainier National Park. Date is formatted as month/day/year, elevation is reported in ft, and fish presence is recorded as yes or no. Total count is the sum of all individuals and/or egg masses observed for each site sampling date adjusted to number per 100 m.

Site Location	Wetland	Date	Elevation	Total Count	Fish
Adelaide Lake	124	7/30/97	4536.0	42.55	Yes
Adjacent to Hidden Lake	305	7/20/94	5915.0	0.00	Yes
Anderson Lake	843	8/11/98	5354.0	21.33	No
Aurora Lake	845	8/19/96	5502.0	2713.18	No
Base of Slide Mountain	168	9/28/99	4602.0	0.00	No
Beaver Ponds	1632	7/10/96	2155.0	1.43	Yes
Bench Lake	1308	7/11/96	4541.0	0.00	Yes
Bench Lake	1308	7/26/99	4490.0	4.67	Yes
Bench on trail to Lake James	20017	7/31/97	4000.0	1026.67	No
Berkeley Park	442	8/25/97	6400.0	1.64	No
Berkeley Park	338	8/26/97	5450.0	22.48	No
Between Louise and Reflection Lakes	1304	7/16/96	4902.0	186.44	No
Blue Lake	1611	8/18/98	4435.0	23.20	Yes
Carbon River	39	7/23/97	2000.0	0.00	No
Chenuis Lake on NPS boundary	52	9/3/97	4112.0	156.40	No
Chenuis Lakes	158	8/12/97	5090.0	242.68	No
Chenuis Lakes	165	8/12/97	4940.0	8.39	No
Chenuis Lakes	176	8/13/97	4956.0	127.27	No
Chenuis Lakes	20020	8/13/97	5040.0	9.30	No
Cliff Lake	1370	8/22/96	5216.0	24.22	No
Cliff Lake	1370	8/10/98	5216.0	136.80	Yes
Clover Lake	376	7/5/94	5751.0	607.78	No
Clover Lake	376	8/15/94	5751.0	382.22	No
Cowlitz Divide	1226	9/23/97	4260.0	95.36	No
Cowlitz Divide	1233	9/23/97	4260.0	130.93	No
Dick Lake	296	8/8/96	5680.0	168.46	No
Dick lake; White River Park	296	7/21/94	5680.0	86.00	No
Elysian Fields	294	8/19/97	5700.0	457.39	No
Elysian Fields	300	8/19/97	5620.0	194.67	No
Elysian Fields	304	8/19/97	5720.0	151.81	No
Elysian Fields	310	8/19/97	5710.0	67.30	No
Elysian Fields	311	8/19/97	5717.0	539.83	No
Elysian Fields	20050	8/19/97	5700.0	162.35	No
Elysian Fields	20051	8/19/97	5700.0	38.79	No
Eunice Lake	246	8/6/97	5354.0	211.97	No
Fairy pools, Paradise loop road	1054	7/16/96	5260.0	3263.49	No
Fan Lake	1013	8/31/98	5325.0	11.20	No
Faraway Pond	1201	7/8/96	5200.0	38.36	No

Site Location	Wetland	Date	Elevation	Total Count	Fish
First wetland south of Eagle Peak Trail	1412	7/15/96	4779.0	41.22	No
Frog Heaven	1167	8/13/96	4429.0	120.00	No
Ghost Lake	686	8/23/99	4290.0	13.00	No
Glacier Basin	595	9/24/97	5960.0	617.76	No
Glacier Basin pond	595	7/24/95	5972.0	2383.90	No
Glacier Basin pond	595	8/27/95	5972.0	1727.53	No
Golden Lakes	648	7/29/96	4924.0	230.67	No
Golden Lakes	657	7/29/96	4989.0	61.11	No
Golden Lakes	649	7/30/96	4912.0	95.24	No
Golden Lakes	3683	7/30/96		18.18	No
Golden Lakes	605	7/31/96	4521.0	1.18	Yes
Golden Lakes	659	7/31/96	5056.0	38.29	No
Golden Lakes	663	7/31/96	5062.0	31.08	No
Golden Lakes	666	8/12/96	5131.0	7.22	No
Golden Lakes	20012	8/12/96	5280.0	342.47	No
Golden lakes	631	8/13/96	4693.0	87.78	No
Golden Lakes	624	8/27/96	4454.0	6.93	No
Golden Lakes	627	8/27/96	4464.0	76.98	No
Golden Lakes	632	8/27/96	4499.0	173.86	No
Golden Lakes	639	8/28/96	4974.0	116.45	No
Golden Lakes	645	8/28/96	4908.0	52.69	No
Golden Lakes	653	8/28/96	4911.0	78.02	No
Golden Lakes	678	8/28/96	5124.0	41.30	No
Golden Lakes area	656	8/28/96	4998.0	13.92	No
Green Lake	156	8/6/97	3185.0	33.67	Yes
Green Lake	156	7/7/99	3150.0	77.78	Yes
Green Park	275	8/8/94	5844.0	176.85	No
Grove of the Patriarchs (Ohana River)	1197	9/3/98	2168.0	2.00	Yes
Harry lake; White River Park	292	7/21/94	5660.0	9.83	Yes
Hidden Lake	291	7/13/94	5921.0	0.00	Yes
Hidden Lake	291	8/21/94	5921.0	0.00	Yes
Hidden Lake, White River Park	291	8/13/95	5927.0	1.56	Yes
Huckleberry basin	286	7/27/94	5528.0	0.00	Yes
Huckleberry basin	392	8/3/94	5985.0	666.67	No
Huckleberry basin	20063	8/16/94	6400.0	56.08	No
Huckleberry drainage	20061	7/19/94	6164.0	0.00	No
Huckleberry drainage	20061	8/16/94	6164.0	0.00	No
Huckleberry drainage	172	7/12/95	5426.0	127.17	No
Huckleberry drainage	181	7/12/95	5481.0	8.02	No
Huckleberry drainage	20060	7/13/95	6170.0	0.00	No
Huckleberry drainage	59	7/18/95	4968.0	1805.00	No
Huckleberry drainage	121	7/19/95	4877.0	2183.07	No
Huckleberry drainage	125	7/19/95	4872.0	136.02	No
Huckleberry drainage	394	7/26/95	6047.0	760.45	No

Site Location	Wetland	Date	Elevation	Total Count	Fish
Huckleberry drainage	396	7/26/95	6044.0	11.59	No
Huckleberry drainage	161	8/1/95	4871.0	33.33	No
Huckleberry drainage	166	8/1/95	4904.0	581.37	No
Huckleberry drainage	181	8/7/95	5481.0	404.35	No
Huckleberry drainage	20060	8/8/95	6170.0	0.00	No
Huckleberry drainage	121	8/15/95	4877.0	125.93	No
Huckleberry drainage	125	8/15/95	4872.0	52.17	No
Huckleberry drainage	401	8/21/95	6724.0	0.00	No
Huckleberry drainage	157	8/22/95	4903.0	33.39	No
Huckleberry drainage	161	8/22/95	4871.0	115.56	No
Huckleberry drainage	166	8/22/95	4904.0	89.75	No
Huckleberry drainage	394	8/28/95	6048.0	355.40	No
Huckleberry drainage	396	8/29/95	6044.0	1.05	No
Indian Bar	879	9/10/97	5160.0	3010.00	No
Indian Henry’s	20016	7/22/96	5277.0	1356.25	No
Indian Henry’s	1124	8/7/96	5078.0	10.00	No
Indian Henry’s	1061	8/8/96	5405.0	29.31	No
Lake Allen	1307	7/22/96	4584.0	283.33	No
Lake Allen	1307	9/19/96	4584.0	40.00	No
Lake Eleanor	72	7/18/95	4984.0	109.72	Yes
Lake George	1057	7/24/96	4291.0	2.00	Yes
Lake George	1057	7/27/99	4240.0	34.90	Yes
Lake James	194	7/29/97	4350.0	72.87	Yes
Lake Marjorie	147	7/30/97	4560.0	67.01	Yes
Laughing Water Pond	1334	6/17/98	3040.0	455.27	No
LM17 605	8/4/99	4521.0	7.33	Yes	
LM23 632	8/10/99	4499.0	108.67	No	
LM30 649	8/3/99	4912.0	166.67	No	
LM32 648	8/5/99	4924.0	14.00	No	
LM42 659	8/11/99	5056.0	436.00	No	
LM43 662	8/11/99	5062.0	16.22	No	
LN26 631	8/9/99	4693.0	139.33	No	
Louise Lake	1221	6/30/98	4460.0	0.00	Yes
Louise Lake	1221	7/21/99	4600.0	0.67	Yes
Lower Deadwood	589	8/25/99	5270.0	39.00	Yes
Lower Palisades area	234	8/7/94	5463.0	37.92	Yes
Lower Palisades, White River Park	240	9/13/95	5507.0	6.86	No
LP17 891	7/29/99	4514.0	192.94	No	
LP19 899	7/29/99	4450.0	33.08	Yes	
LW33 583	9/1/99	3680.0	43.00	Yes	
LZ17 1188	7/8/96	5010.0	74.58	No	
LZ20 1170	7/9/98	4960.0	4.12	No	
Marsh Lake (small)	1306	6/18/98	3945.0	592.59	No
Mazama Ridge	1172	7/15/96	5335.0	18.57	No
Mazama Ridge	1165	7/16/96	5320.0	30.34	No
Mazama Ridge	1182	7/16/96	5267.0	30.03	No

Site Location	Wetland	Date	Elevation	Total Count	Fish
Mazama Ridge	20022	7/16/96	5268.0	13.05	No
Mazama Ridge	1182	9/2/97	5260.0	163.51	No
Mazama Ridge	1172	9/4/97	5335.0	20.25	No
Mazama Ridge	1188	9/4/97	5180.0	10.34	No
Mirror Lake	998	8/6/96	5418.0	58.00	No
Mountain Meadows	283	7/17/97	4282.0	96.81	No
Mowich Lake	312	8/5/97	4950.0	0.00	Yes
Mowich Lake	312	8/12/98	4950.0	52.38	Yes
Mystic Lake	489	9/9/97	5700.0	294.53	Yes
Near Lake Eleanor	64	7/7/95	4924.0	105.91	No
Near Lake James cabin	20018	7/31/97	4600.0	306.41	No
Near Mystic Lake	477	9/9/97	6092.0	57.97	No
Near Reflection Lake	1249	7/3/96	4854.0	98.41	No
Near Sunrise Lake	417	7/6/94	5685.0	145.78	No
Near Sunrise Lake	417	8/9/94	5685.0	384.20	No
Near Sunrise Lake	417	7/1/96	5685.0	61.77	No
Near Sunrise Lake	417	7/7/98	5530.0	98.00	No
Off Gobbler's Knob trail	1059	9/16/96	4851.0	317.39	No
Ohana Hot Springs	1421	7/30/98	1938.0	0.00	No
Owyhigh Lakes	724	8/6/97	5180.0	178.33	No
Owyhigh Lakes	726	8/6/97	5180.0	45.63	No
Owyhigh Lakes	729	8/6/97	5180.0	165.14	Yes
Palisades area, lower Palisades	234	9/6/94	5463.0	0.00	Yes
Palisades region	406	7/7/96	5585.0	38.78	No
Palisades Region	399	7/11/96	5934.0	185.35	No
Palisades Region	344	7/24/96	5550.0	938.60	No
Palisades region	402	7/26/96	5885.0	79.11	No
Palisades region	20055	8/14/96	5686.0	994.09	No
Paradise Meadows	1136	8/1/96	5016.0	1030.77	No
Paradise treatment plant wetland	1114	8/19/96	5042.0	79.75	No
Pond next to Lake Eleanor	59	9/12/95	4968.0	18.56	No
Pond north of High Lakes Trail	1152	7/15/96	5428.0	31.41	No
Pond off Nisqually Vista trail	1097	8/19/96	5337.0	158.88	No
Prospect Creek basin	323	8/2/94	5563.0	199.72	No
Prospect Creek basin	380	8/2/94	5900.0	153.61	No
Prospect Creek basin	360	8/3/94	5766.0	59.39	No
Prospect Creek basin	323	9/7/94	5563.0	47.28	No
Prospect Creek basin	360	9/7/94	5766.0	176.03	No
Prospect Creek basin	392	9/7/94	5975.0	1073.37	No
Prospect Creek basin	351	8/3/95	5787.0	594.80	No
Prospect Creek basin	351	8/29/95	5787.0	1171.00	No
Prospect Creek basin	323	7/20/96	5564.0	1083.98	No
Prospect Creek Basin	351	7/25/96	5787.0	679.41	No
Prospect Creek Basin	360	7/25/96	5766.0	125.26	No
Reflection Lakes	1242	7/1/96	4854.0	0.85	Yes
Ricksecker Pond	1253	9/9/96	4301.0	22.50	No

Site Location	Wetland	Date	Elevation	Total Count	Fish
SE of Frog Heaven, near "Oh-My!" curve	1202	8/13/96	4464.0	118.25	No
Seattle Park	368	8/27/97	5364.0	36.20	No
Shadow Lake	499	9/2/99	6190.0	28.40	No
Sheep Lake	1137	8/12/98	4855.0	109.60	No
Shriner Lake	949	9/16/98	4891.0	25.60	No
Shriner Lake	949	8/24/99	4891.0	81.33	No
Small Reflection Lake	1251	7/2/96	4854.0	65.19	No
Snow Lake	1342	7/11/96	4678.0	1.25	Yes
Snow Lake	1342	7/23/97	4679.0	1.42	Yes
Snow Lake	1342	8/2/99	4678.0	0.67	Yes
So. Golden Lakes area	678	8/13/96	5124.0	1.96	No
South Golden Lakes	688	7/30/96	5286.0	28.83	No
South Golden Lakes	689	7/30/96	5464.0	8.74	No
South Golden Lakes	719	7/30/96	5318.0	18.83	No
South of Indian Bar	896	9/10/97		1945.26	No
South Puyallup River drainage	959	8/5/96	4665.0	0.00	No
Spray Park	435	8/11/97	5740.0	446.09	No
Squaw Lakes	1118	8/7/96	5031.0	36.00	No
Squaw Lakes	1119	8/7/96	4990.0	5.07	No
Squaw Lakes area	1107	8/7/96	5050.0	37.01	No
Squaw Lakes area	1125	8/7/96	5000.0	12.83	No
St. Andrews Creek drainage	893	8/20/96	4522.0	40.00	No
St. Andrews Creek drainage	899	8/20/96	4502.0	91.00	No
St. Andrews Lake	859	8/19/96	5905.0	24.00	No
St. Jacobs Lake	1247	7/8/98	4700.0	33.65	No
Stevens Canyon Marsh	1353	7/1/98	2050.0	17.42	No
Steven's Ridge	1207	9/2/98	4610.0	120.20	No
Sunrise Lake	426	6/29/94	5736.0	516.67	No
Sunrise Lake	426	8/14/94	5736.0	113.33	No
Tadpole Lake	896	8/24/98	5330.0	261.60	No
Tahoma Creek trail wetland	1007	8/21/96	3472.0	1.41	No
Tatoosh range, Lane Peak area	1377	8/20/96	5072.0	0.20	No
Tatoosh range, west of Cliff lake	1383	8/20/96	5055.0	3.33	No
Three Lakes	1273	7/28/98	4676.0	0.00	No
Three Lakes	1274	7/28/98	4671.0	61.60	No
Three Lakes	1285	7/28/98	4540.0	30.00	No
Tipsoo Lake	703	7/21/98	5301.0	114.20	Yes
Tom Lake, White River park	320	7/26/94	5480.0	41.40	No
Unnamed lake	900	8/24/98	5737.0	0.00	No
Unnamed lake	1226	8/25/98	4264.0	88.80	No
Unnamed lake	1231	8/25/98	4356.0	113.60	No
Unnamed lake	1233	8/25/98	4295.0	41.46	No
Unnamed lake	1359	9/1/98	5944.0	0.00	No
Unnamed lake	1265	9/2/98		21.43	No
Unnamed lake	840	9/8/98	4939.0	12.80	No

Site Location	Wetland	Date	Elevation	Total Count	Fish
Unnamed lake	754	9/9/98	5193.0	24.12	No
Unnamed lake	764	9/9/98	5734.0	14.56	No
Unnamed lake	1065	9/10/98	3867.0	10.00	No
Unnamed lake	1068	9/10/98	3853.0	0.00	No
Unnamed lake	1069	9/10/98	3845.0	0.00	No
Unnamed lake	820	9/14/98	5259.0	114.29	No
Unnamed lake	825	9/14/98	5221.0	46.40	No
Unnamed lake	907	9/16/98	4980.0	8.00	No
Unnamed lake	914	9/16/98	4980.0	1.00	No
Unnamed lake	731	9/21/98	4710.0	66.23	No
Unnamed lake	735	9/22/98	5835.0	70.74	No
Unnamed lake below Mt Fremont	401	9/23/99	6725.0	0.00	No
Unnamed Lake, Mazama Ridge	1152	7/23/98	5427.0	29.41	No
Unnamed Lake, near Cayuse Pass	741	7/20/98	5014.0	65.79	No
Unnamed lake, Steven's Ridge	1193	9/2/98	4537.0	3.00	No
Unnamed lake, Steven's Ridge	1208	9/2/98	4675.0	0.00	No
Unnamed lake, Tatoosh Range	1379	8/10/98	5071.0	119.13	No
Unnamed Lake, Three Lakes area	1232	7/27/98	4700.0	81.05	No
Unnamed lake, White River drainage	146	9/27/99	4975.0	6.00	No
Unnamed pond across SR123	1344	7/30/98	2198.0	47.87	No
Unnamed, Cowlitz drainage	1624	7/22/98	2405.0	15.00	No
Upper Deadwood	597	8/25/99	5280.0	73.00	No
Upper Johnson Lake	1419	8/13/98	5009.0	120.95	No
Vernal Park	301	9/10/97	5820.0	878.24	No
White River drainage	146	7/17/95	5008.0	140.00	No
White River drainage	138	7/25/95	4837.0	16.33	Yes
White River drainage	199	8/14/95	5260.0	120.64	No
White River drainage	138	8/20/95	4837.0	17.05	Yes
White River drainage	146	9/5/95	5008.0	38.36	No
White River drainage	138	9/27/99	4750.0	6.67	Yes
White River Park	334	7/11/94	5554.0	0.74	No
White River Park	337	7/11/94	5556.0	0.75	No
White River Park	20057	7/11/94	5928.0	8.02	No
White River Park	391	7/20/94	5980.0	634.22	No
White River Park	321	8/9/94	5296.0	53.68	No
White River Park	20057	8/9/94	5928.0	410.82	No
White River Park	406	9/11/95	5585.0	178.89	No
White River Park, above Clover Lake	391	8/15/94	6022.0	514.91	No
White River park, below Dege Peak	420	7/12/94	6256.0	173.04	No
White River Park, below Dege peak	420	8/14/94	6256.0	6.69	No
White River Park, below Dege Peak	420	7/19/96	6257.0	203.63	No
White River Park, Harry Lake	292	9/20/95	5679.0	72.57	Yes
White River Ponds	383	9/22/97	3250.0	4.11	Yes
White River ponds	383	10/18/99	3236.0	4.67	Yes

Site Location	Wetland	Date	Elevation	Total Count	Fish
White River Ponds	390	10/19/99	3253.0	0.00	Yes
White River ponds	398	10/19/99	3223.0	18.00	No
White River ponds, Crystal Peak trailhead	362	10/18/99	3160.0	0.00	Yes
White River watershed, “Buck lake”	102	7/25/94	5610.0	5833.33	No
Windy Gap	213	9/23/97	5732.0	4.29	No
Windy Gap	225	9/23/97	5705.0	4.22	No
Windy Gap	244	9/23/97	5775.0	6.61	No

Appendix Ib. Total number of amphibians in each of six species found at 205 lentic sites during a survey of Mount Rainier National Park from 1994 through 1999. Data from all transects were pooled, and total numbers were adjusted and expressed as the number of individuals and egg masses per 100 meters. Total numbers for each species per site were calculated by summing the number of egg masses, larval forms, juveniles, neotenes, and adults observed during all sampling dates for each site.

Wetland #	*Ambystoma gracile*	*Ambystoma macrodactylum*	*Bufo boreas*	*Hyla regilla*	*Rana cascadae*	*Taricha granulosa*	Total Count
39							0.00
52	155.81				0.58		156.39
59	687.56					81.92	769.48
64	104.89				1.02		105.91
72	100.00					9.72	109.72
102		5833.33					5833.33
121		556.35			598.15		1154.50
124	38.44					4.12	42.56
125	42.24				51.87		94.11
138	11.50						11.50
146	21.89						21.89
147	9.28				1.03	58.10	68.41
156	40.61	10.15					50.76
157	33.39						33.39
158	242.07				0.61		242.68
161	61.36						61.36
165	4.20				4.20		8.40
166	253.02				0.65		253.67
168							0.00
172		21.96			105.21		127.17
176	125.25				2.02		127.27
181		28.64			177.54		206.18
194	21.59	49.93			1.35		72.87
199	112.60				8.04		120.64
213		3.75			0.54		4.29
225		1.05			3.16		4.21
234					31.44		31.44

Wetland #	*Ambystoma gracile*	*Ambystoma macrodactylum*	*Bufo boreas*	*Hyla regilla*	*Rana cascadae*	*Taricha granulosa*	Total Count
240	0.98				5.88		6.86
244		6.61					6.61
246	211.97						211.97
275	175.93				0.93		176.86
283	77.12			0.65	18.71	0.32	96.80
286							0.00
291	0.66						0.66
292	20.68				7.35		28.03
294					457.39		457.39
296	132.16				0.43		132.59
300					194.66		194.66
301		38.49			839.75		878.24
304					151.29		151.29
305							0.00
310		11.87			55.43		67.30
311	4.88				534.96		539.84
312					0.82		0.82
320	41.39						41.39
321	21.22				32.46		53.68
323	48.69	259.47			71.28		379.44
334					0.74		0.74
337					0.75		0.75
338	18.17				4.30		22.47
344	78.07	811.39			48.24		937.70
351		183.52			658.66		842.18
360	110.94	1.41			7.93		120.28
362							0.00
368					36.21		36.21
376	493.33	0.56			0.56		494.45
380		25.95			127.66		153.61
383	3.72				0.68		4.40
390							0.00
391		143.64			430.92		574.56
392		358.85			511.17		870.02
394		553.57			4.36		557.93
396		3.16			3.16		6.32
398	18.00						18.00
399		167.054			18.30		185.34
401							0.00
402		75.05			4.06		79.11
406	82.70	4.22			5.06		91.98
417		52.17			93.11		145.28
420		125.25			2.55		127.80
426	179.99	28.33					208.32
435					446.09		446.09

Wetland #	*Ambystoma gracile*	*Ambystoma macrodactylum*	*Bufo boreas*	*Hyla regilla*	*Rana cascadae*	*Taricha granulosa*	Total Count
442		0.41					0.41
477					57.97		57.97
489		51.56	199.22		43.75		294.53
499	5.26	21.91			1.23		28.40
583	43.00						43.00
589	33.00	5.00			1.00		39.00
595		194.32			1335.31		1529.63
597	66.00	5.00			2.00		73.00
605	3.83				1.28		5.11
624					6.93		6.93
627	48.01				28.96		76.97
631	117.92		0.83		1.25		120.00
632	130.25		0.42		0.42	1.69	132.78
639	100.74	10.16			5.54		116.44
645			1.08		51.61		52.69
648	17.78	33.33			0.88	0.44	52.43
649	119.46	5.27			1.32	3.74	129.79
653	69.24	5.49			3.30		78.03
656	4.64				4.64		9.28
657	61.11						61.11
659	22.47	3.13			220.48		246.08
662					16.21		16.21
663	17.57				13.51		31.08
666	4.33				2.16		6.49
678	6.07	7.08			1.01		14.16
686	13.00						13.00
688	27.43				1.40		28.83
689	5.46				3.28		8.74
703		113.07			1.14		114.21
719	2.77				9.26		12.03
724		11.67			166.67		178.34
726		5.63			40.01		45.64
729		71.43			93.72		165.15
731	41.67				24.56		66.23
735	67.69	2.54				0.59	70.82
741	18.42	17.76			29.60		65.78
754	14.71				8.83	0.59	24.13
764		0.10			14.47		14.57
820	2.04	61.22			51.02		114.28
825	43.20				2.40	0.80	46.40
840	9.60				3.20		12.80
843	17.77				1.78	1.78	21.33
845					2713.18		2713.18
859				24.00			24.00
879					3010.00		3010.00
891	192.95						192.95

Wetland #	*Ambystoma gracile*	*Ambystoma macrodactylum*	*Bufo boreas*	*Hyla regilla*	*Rana cascadae*	*Taricha granulosa*	Total Count
893	26.00	14.00					40.00
896		80.32			1196.50		1276.82
899	30.87	26.09					56.96
900							0.00
907	7.20				0.80		8.00
914					1.00		1.00
949	51.64				4.00	0.36	56.00
959							0.00
998		58.00					58.00
1007					1.06	0.35	1.41
1013	11.20			11.20			
1054	73.02				3180.95		3253.97
1057					2.52	5.25	7.77
1059	8.70						8.70
1061		6.90			22.41		29.31
1065					10.00		10.00
1068							0.00
1069							0.00
1097					158.87		158.87
1107	34.62				2.36		37.00
1114					79.75		79.75
1118					36.00		36.00
1119					5.06		5.06
1124					10.00		10.00
1125					11.51		11.51
1136	11.96				1018.80		1030.76
1137	106.40				3.20		109.60
1152		1.98			28.44		30.42
1165					30.34		30.34
1167	63.33				56.67		120.00
1170	2.87				1.23		4.10
1172	16.74				3.00		19.74
1182					73.50		73.50
1188	28.43				0.49		28.92
1193					3.00		3.00
1197					2.00		2.00
1201	38.37						38.37
1202		116.79		0.73	0.73		118.25
1207	98.52				21.67		120.19
1208							0.00
1221					0.33		0.33
1226	51.30				25.13	16.56	92.99
1231	97.60			1.60	14.40		113.60
1232	71.58				1.59	7.89	81.06
1233	68.15				21.79		89.94
1242	0.85						0.85

Wetland #	*Ambystoma gracile*	*Ambystoma macrodactylum*	*Bufo boreas*	*Hyla regilla*	*Rana cascadae*	*Taricha granulosa*	Total Count
1247	6.01	25.24			2.40		33.65
1249	86.47	1.71			1.14		89.32
1251	65.19						65.19
1253	6.25					16.25	22.50
1265	16.67				4.76		21.43
1273							0.00
1274	59.20					2.40	61.60
1285	29.00		1.00	30.00			
1304		0.89			7.14		8.03
1306	577.78	0.93	0.93			12.96	592.60
1307	136.00	50.00					186.00
1308	2.00					0.80	2.80
1334	446.08			0.61	0.61	7.97	455.27
1342					1.00		1.00
1344	46.56				1.31		47.87
1353	9.90	0.34		3.07	2.39		15.70
1359							0.00
1370	79.45				0.40		79.85
1377					0.20		0.20
1379		10.07			109.06		119.13
1383					3.33		3.33
1412	0.63				40.60		41.23
1419	50.33	69.93			0.34	0.34	120.94
1421							0.00
1611	14.40	8.80					23.20
1624	6.00	5.00		0.67	2.00	1.33	15.00
1632	1.43						1.43
3683	11.82				5.46		17.28
20012					342.47		342.47
20016					1356.25		1356.25
20017					1026.67		1026.67
20018		113.46			192.95		306.41
20020					9.30		9.30
20022					13.06		13.06
20050	72.94				89.42		162.36
20051	11.93				26.86		38.79
20055		211.23			782.87		994.10
20057		102.20			107.21		209.41
20060							0.0
20061							0.00
20063					56.08		56.08

Appendix Ic. Numbers for each *Ambystoma gracile* life history stage observed at lentic sites during a 1994-1999 amphibian survey of Mount Rainier National Park. Numbers represent pooled data transect data for all sampling dates at a site expressed as number of individuals or egg masses per 100 m. Data are sorted by wetland number.

	Ambystoma gracile				
Wetland #	**Egg Mass**	**Larvae**	**Neotene**	**Adult**	**Total**
52	45.93	108.72	1.16		155.81
59	209.60	474.01	3.39	0.56	687.56
64	84.52	14.26	6.11		104.89
72	25.00	69.44	5.56		100.00
124	28.83	9.61			38.44
125	42.24				42.24
138	4.88	5.23	1.39		11.50
146	7.30	13.30	0.43	0.86	21.89
147	9.28				9.28
156	35.03	5.58			40.69
157	22.64	9.62	1.13		33.39
158	12.80	221.95	7.32		242.07
161	53.03	8.33			61.36
165	2.67	1.34		0.19	4.20
166	50.67	202.35			253.02
176	68.69	45.45	11.11		125.25
194	4.05	17.54			21.59
199	36.19	76.41			112.60
240		0.98			0.98
246		211.97			211.97
275	62.96	5.56	107.41		175.93
283	77.12				77.12
291		0.66			0.66
292	1.63	18.51	0.27	0.27	20.68
296	10.43	60.00	60.43	1.30	132.16
311		4.48		0.40	4.88
320	14.01	3.18	24.20		41.39
321	13.73	4.99	2.50		21.22
323	11.29	27.76	9.64		48.69
338	18.17				18.17
344	20.18	57.89			78.07
360	30.51	48.68	31.75		110.94
376	3.33	263.33	226.67		493.33
383	3.72				3.72

	Ambystoma gracile				
Wetland #	**Egg Mass**	**Larvae**	**Neotene**	**Adult**	**Total**
398	18.00				18.00
406	10.34	52.95	18.78	0.63	82.70
426	8.33	148.33	23.33		179.99
499			2.81	2.45	5.26
583	43.00				43.00
589	18.00	10.00	5.00		33.00
597	4.00	34.00	26.00	2.00	66.00
605	2.55	0.85		0.43	3.83
627	46.49	1.52			48.01
631	66.67	48.75	2.50		117.92
632	66.81	60.92	2.52		130.25
639	36.04	64.70			100.74
648	8.89	8.00	0.89		17.78
649	31.62	80.81	6.59	0.44	119.46
653	32.97	32.97	3.30		69.24
656	4.64				4.64
657	53.33	5.56	2.22		61.11
659	18.29	4.18			22.47
663	12.16		5.41		17.57
666	2.89		1.44		4.33
678	1.35	2.02	2.36	0.34	6.07
686	2.00	7.00	4.00		13.00
688	23.91	2.11	1.41		27.43
689		5.46			5.46
719	1.23		1.54		2.77
731		41.67			41.67
735		34.61	33.08		67.69
741	13.16	5.26			18.42
754	3.53	11.18			14.71
820		2.04			2.04
825	4.00	39.20			43.20
840		9.60			9.60
843	1.33	16.44			17.77
891	121.18	34.12	36.47	1.18	192.95
893	20.00	6.00			26.00
899	29.13	0.87	0.87		30.87
907		7.20			7.20
949	1.82	38.91	9.09	1.82	51.64
1013		11.20			11.20
1054	73.02				73.02

	Ambystoma gracile				
Wetland #	**Egg Mass**	**Larvae**	**Neotene**	**Adult**	**Total**
1059	4.35		4.35		8.70
1107	32.28		2.36		34.64
1136	11.11	0.85			11.96
1137	17.60	35.20	53.60		106.40
1167	63.33				63.33
1170		1.23	0.41	1.23	2.87
1172		16.74			16.74
1188		6.86	21.57		28.43
1201	1.35	1.35	35.67		38.37
1207		98.52			98.52
1226	20.24	27.57	0.35	3.14	51.30
1231	24.80	71.20		1.60	97.60
1232	15.79	54.74		1.05	71.58
1233	24.02	44.13			68.15
1242	0.85				0.85
1247		1.20		4.81	6.01
1249	30.72	49.49	2.28	3.98	86.47
1251	48.89	16.30			65.19
1253	5.00	1.25			6.25
1265		16.67			16.67
1274	57.60	1.60			59.20
1285	19.00	10.00			29.00
1306	288.89	287.96		0.93	577.78
1307	23.00	110.00	3.00		136.00
1308	2.00				2.00
1334	33.09	412.99			446.08
1344	21.64	24.92			46.56
1353	9.90				9.90
1370	4.35	0.79	74.31		79.45
1412	0.63				0.63
1419	8.78	41.55			50.34
1611		0.80	13.60		14.40
1624	2.67	3.33			6.00
1632	1.43				1.43
3683	11.82				11.82
20050		72.94			72.94
20051	0.85	11.08			11.93

Appendix Id. Numbers for each *Ambystoma macrodactylum* life history stage observed at lentic sites during a 1994-1999 amphibian survey of Mount Rainier National Park. Numbers represent pooled pooled transect data for all sampling dates at a site expressed as number of individuals or egg masses per 100 m. Data were sorted by wetland number.

	Ambystoma macrodactylum			
Wetland #	**Egg Mass**	**Larvae**	**Adult**	**Total**
102		5833.33		5833.33
121		556.35		556.35
156	10.15			10.15
172		21.96		21.96
181		28.64		28.64
194	48.58	1.35		49.93
213		3.75		3.75
225		1.05		1.05
244		6.41	0.21	6.61
301		36.92	1.57	38.49
310	1.58	10.29		11.87
323	259.47			259.47
344	607.89	173.68	29.82	811.39
351	12.53	170.99		183.52
360	1.41			1.41
376	0.56			0.56
380		25.95		25.95
391	0.78	142.86		143.64
392		358.85		358.85
394	339.29	208.62	5.66	553.57
396		0.53	2.63	3.16
399		130.43	36.61	167.04
402	24.34	50.71		75.05
406	1.69		2.53	4.22
417		38.19	13.98	52.17
420	85.09	36.97	3.19	125.25
426	8.33		20.00	28.33
442			0.41	0.41
489		50.78	0.78	51.56
499	0.35		21.56	21.91
589	5.00			5.00
595	93.57	93.89	6.86	194.32
597	5.00			5.00

Wetland #	*Ambystoma macrodactylum* Egg Mass	Larvae	Adult	Total
639	0.92	9.24		10.16
648	33.33			33.33
649	0.88	4.39		5.27
653		5.49		5.49
659	3.13			3.13
678		7.08		7.08
703	113.07			113.07
724		10.00	1.67	11.67
726		5.63		5.63
729		70.86	0.57	71.43
735		2.54		2.54
741	15.13		2.63	17.76
764		0.10		0.10
820		61.22		61.22
893	1.00	13.00		14.00
896	0.32	80.00		80.32
899	2.61	23.48		26.09
998		57.50	0.50	58.00
1061		6.90		6.90
1152	0.66		1.32	1.98
1202		116.79		116.79
1247	22.84		2.40	25.24
1249	1.14		0.57	1.71
1304			0.89	0.89
1306	0.93			0.93
1307	50.00			50.00
1353	0.34			0.34
1379	10.07			10.07
1419	1.35	67.57	1.01	69.93
1611		7.20	1.60	8.80
1624	4.00	1.00		5.00
20018	92.95	20.51		113.46
20055		211.23		211.23
20057		100.20	2.00	102.20

Appendix Ie. Numbers for each *Bufo boreas* life history stage observed at lentic sites during a 1994-1999 amphibian survey of Mount Rainier National Park. Numbers represent pooled transect data for all sampling dates at a site expressed as number of per 100 m. Data were sorted by wetland number.

	Bufo boreas		
Wetland #	**Tadpole**	**Adult**	**Total**
489	199.22		199.22
631		0.83	0.83
632		0.42	0.42
1306		0.93	0.93

Appendix If. Numbers for each *Hyla regilla* life history stage observed at lentic sites during a 1994-1999 amphibian survey of Mount Rainier National Park. Numbers represent pooled transect data for all sampling dates at each site expressed as number of individuals per 100 m. Data were sorted by wetland number.

	Hyla regilla			
Wetland #	**Tadpole**	**Juvenile**	**Adult**	**Total**
283			0.65	0.65
645		1.08		1.08
859	24.00			24.00
1202			0.73	0.73
1231			1.60	1.60
1334			0.61	0.61
1353	2.05	1.02		3.07
1624	0.67			0.67

Appendix Ig. Numbers for each *Rana cascadae* life history stage observed at lentic sites during a 1994-1999 amphibian survey of Mount Rainier National Park. Numbers represent pooled transect data for all sampling dates at a site transects and are expressed as number of individuals or egg masses per 100 m. Data were sorted by wetland number.

	Rana cascadae				
Wetland #	**Egg Mass**	**Tadpole**	**Juvenile**	**Adult**	**Total**
52				0.58	0.58
64				1.02	1.02
121		551.59	31.22	15.34	598.15
125		19.88	27.02	4.97	51.87
147				1.03	1.03
158			0.61		0.61
165			2.86	1.34	4.20
166			0.65		0.65
172	1.83	91.49	6.40	5.49	105.21
176			1.01	1.01	2.02
181		171.82	2.86	2.86	177.54
194				1.35	1.35
199		8.04			8.04
213				0.54	0.54
225		3.16			3.16
234		27.11	3.25	1.08	31.44
240		5.88			5.88
275				0.93	0.93
283		3.87	2.90	11.94	18.71
292		1.91		5.44	7.35
294		443.77	4.54	9.08	457.39
296				0.43	0.43
300	180.00	3.33	11.33		194.66
301		780.05	45.56	14.14	839.75
304		132.12	2.07	17.10	151.29
310		25.34	3.96	26.13	55.43
311		517.28	6.86	10.82	534.96
312				0.82	0.82
321			16.23	16.23	32.46
323		55.99	4.23	11.06	71.28
334				0.74	0.74
337				0.75	0.75
338			1.91	2.39	4.30
344		17.54	13.16	17.54	48.24

	Rana cascadae				
Wetland #	**Egg Mass**	**Tadpole**	**Juvenile**	**Adult**	**Total**
351		650.38	6.16	2.12	658.66
360			3.17	4.76	7.93
368		31.65	1.27	3.29	36.21
376				0.56	0.56
380		103.79	5.71	18.16	127.66
383				0.68	0.68
391	0.39	392.46	13.74	24.33	430.92
392		478.47	10.37	22.33	511.17
394	0.44	0.87	1.31	1.74	4.36
396			1.05	2.11	3.16
399	11.44		1.14	5.72	18.30
402			2.03	2.03	4.06
406	0.84	1.05	1.27	1.90	5.06
417	17.22	49.93	0.50	25.46	93.11
420			0.96	1.59	2.55
435		443.48		2.61	446.09
477			57.97		57.97
489		43.75			43.75
499				1.23	1.23
589				1.00	1.00
595		1223.96	81.72	29.63	1335.31
597				2.00	2.00
605			0.43	0.85	1.28
624			5.94	0.99	6.93
627			28.96		28.96
631			0.83	0.42	1.25
632				0.42	0.42
639			0.92	4.62	5.54
645		15.05	33.33	3.23	51.61
648			0.44	0.44	0.88
649			1.32		1.32
653		2.20	1.10		3.30
656			3.48	1.16	4.64
659	3.66	212.64		4.18	220.48
662	4.05			12.16	16.21
663				13.51	13.51
666			0.72	1.44	2.16
678			0.67	0.34	1.01
688			0.70	0.70	1.40
689				3.28	3.28

	Rana cascadae				
Wetland #	**Egg Mass**	**Tadpole**	**Juvenile**	**Adult**	**Total**
703				1.14	1.14
719			5.56	3.70	9.26
724		111.67	3.33	51.67	166.67
726		3.13	6.88	30.00	40.01
729		66.86	2.00	24.86	93.72
731		8.77	8.77	7.02	24.56
741	1.97	0.66		26.97	29.60
754			1.18	7.65	8.83
764		14.29		0.18	14.47
820				51.02	51.02
825				2.40	2.40
840				3.20	3.20
843				1.78	1.78
845		2713.18			2713.18
879		3000.00		10.00	3010.00
896		1180.00	1.90	14.60	1196.50
907				0.80	0.80
914				1.00	1.00
949			0.36	3.64	4.00
1007			1.06		1.06
1054		3174.60		6.35	3180.95
1057	1.01			1.51	2.52
1061	1.72	14.66		6.03	22.41
1065				10.00	10.00
1097		147.66	10.28	0.93	158.87
1107	0.79		0.79	0.79	2.36
1114		79.75			79.75
1118				36.00	36.00
1119		4.34		0.72	5.06
1124		6.00		4.00	10.00
1125		11.51			11.51
1137				3.20	3.20
1152	8.60			19.84	28.44
1165	15.83		2.64	11.87	30.34
1167		56.67			56.67
1170				1.23	1.23
1172				3.00	3.00
1182	15.40	48.42		9.68	73.50
1188				0.49	0.49

	Rana cascadae				
Wetland #	**Egg Mass**	**Tadpole**	**Juvenile**	**Adult**	**Total**
1193				3.00	3.00
1197				2.00	2.00
1202				0.73	0.73
1207				21.67	21.67
1221				0.33	0.33
1226			5.58	19.55	25.13
1231				14.40	14.40
1232	0.53		0.53	0.53	1.59
1233		5.03	8.94	7.82	21.79
1247				2.40	2.40
1249	0.57			0.57	1.14
1265				4.76	4.76
1285				1.00	1.00
1334				0.61	0.61
1342				1.00	1.00
1344				1.31	1.31
1353		1.71	0.34	0.34	2.39
1370				0.40	0.40
1377				0.20	0.20
1379		85.57	3.36	20.13	109.06
1383				3.33	3.33
1412		34.53		6.07	40.60
1419				0.34	0.34
1624		2.00			2.00
3683			4.55	0.91	5.46
20012		342.47			342.47
20016	25.00	1256.25		75.00	1356.25
20017	18.89	1005.56		2.22	1026.67
20018	1.28	153.85	17.95	19.87	192.95
20020			9.30		9.30
20022	1.31		0.65	11.10	13.06
20050		68.24		21.18	89.42
20051		5.12	12.79	8.95	26.86
20055		738.55	1.48	42.84	782.87
20057	2.00	100.20		5.01	107.21
20063		56.08			56.08

Appendix Ih. Numbers for each *Taricha granulosa* life history stage observed at lentic sites during a 1994-1999 amphibian survey of Mount Rainier National Park. Numbers represent pooled data pooled transect data for all sampling dates at a site expressed as number of individuals or egg masses per 100 m. Data were sorted by wetland number.

	Taricha granulosa			
Wetland #	**Egg Mass**	**Larvae**	**Adult**	**Total**
59	75.14		6.78	81.92
72			9.72	9.72
124			4.12	4.12
147	3.93	51.55	2.62	58.10
283			0.32	0.32
632		1.27	0.42	1.69
648		0.44		0.44
649		3.74		3.74
735			0.59	0.59
754			0.59	0.59
825			0.80	0.80
843			1.78	1.78
949			0.36	0.36
1007			0.35	0.35
1057			5.25	5.25
1226			16.56	16.56
1232			7.89	7.89
1253		16.25		16.25
1274			2.40	2.40
1306			12.96	12.96
1308	0.80			0.80
1334			7.97	7.97
1419			0.34	0.34
1624			1.33	1.33

Appendix Ii. A cluster analysis of lentic sites surveyed during 1994-1999 in Mount Rainier National Park relative to six amphibian species revealed a 7-cluster organization of the data. Data are sorted by cluster, and elevation is reported in ft.

Wetland #	Site Location	Elevation	Cluster
125	Huckleberry drainage	4872	1
172	Huckleberry drainage	5426	1
181	Huckleberry drainage	5481	1
225	Windy Gap	5705	1
234	Lower Palisades area	5463	1
240	Lower Palisades, White River Park	5507	1
294	Elysian Fields	5700	1
300	Elysian Fields	5620	1
301	Vernal Park	5820	1
304	Elysian Fields	5720	1
310	Elysian Fields	5710	1
311	Elysian Fields	5717	1
312	Mowich Lake	4950	1
321	White River Park	5296	1
334	White River Park	5554	1
337	White River Park	5556	1
351	Prospect Creek basin	5787	1
368	Seattle Park	5364	1
380	Prospect Creek basin	5900	1
391	White River Park, above Clover Lake	6022	1
392	Huckleberry basin	5985	1
417	Near Sunrise Lake	5530	1
435	Spray Park	5740	1
477	Near Mystic Lake	6092	1
595	Glacier Basin pond	5972	1
624	Golden Lakes	4454	1
645	Golden Lakes	4908	1
659	Golden Lakes	5056	1
662	LM43	5062	1
719	South Golden Lakes	5318	1
724	Owyhigh Lakes	5180	1
726	Owyhigh Lakes	5180	1
729	Owyhigh Lakes	5180	1
741	Unnamed Lake, near Cayuse Pass	5014	1
764	Unnamed	5734	1
845	Aurora Lake	5502	1
879	Indian Bar	5160	1
896	Tadpole	5330	1
914	Unnamed	4980	1
1054	Fairy pools - Paradise loop road	5260	1
1061	Indian Henry’s	5405	1

Wetland #	Site Location	Elevation	Cluster
1065	Unnamed	3867	1
1097	Pond off Nisqually Vista trail	5337	1
1114	Paradise treatment plant wetland	5042	1
1118	Squaw Lakes	5031	1
1119	Squaw Lakes	4990	1
1124	Indian Henry's	5078	1
1125	Squaw Lakes Area	5000	1
1152	Unnamed Lake, Mazama Ridge	5427	1
1165	Mazama Ridge	5320	1
1182	Mazama Ridge	5260	1
1193	Unnamed, Steven's Ridge	4537	1
1197	Grove of the Patriarchs (Ohana River)	2168	1
1221	Louise Lake	4460	1
1342	Snow Lake	4678	1
1377	Tatoosh, Lane Peak area	5072	1
1379	Unnamed Lake, Tatoosh Rnge	5071	1
1383	Tatoosh range, W of Cliff lake	5055	1
1412	First wetland south of Eagle Peak trail	4779	1
20012	Golden Lakes	5280	1
20016	Indian Henry's	5277	1
20017	Bench on trail to Lake James	4000	1
20018	Near Lake James Cabin	4600	1
20020	Chenuis Lakes	5040	1
20022	Mazama Ridge	5268	1
20050	Elysian Fields	5700	1
20051	Elysian Fields	5700	1
20055	Palisades region	5686	1
20063	Huckleberry basin	6400	1
489	Mystic Lake	5700	2
859	St. Andrews Lake	5905	3
147	Lake Marjorie	4560	4
1057	Lake George	4240	4
1253	Ricksecker Pond	4301	4
102	White River watershed, "Buck lake"	5610	5
121	Huckleberry drainage	4877	5
194	Lake James	4350	5
213	Windy Gap	5732	5
244	Windy Gap	5775	5
323	Prospect Creek basin	5563	5
344	Palisades Region	5550	5
394	Huckleberry drainage	6048	5
396	Huckleberry drainage	6044	5
399	Palisades Region	5934	5
402	Palisades Region	5885	5
420	White River park, below Dege Peak	6256	5
442	Berkeley Park	6400	5

Wetland #	Site Location	Elevation	Cluster
499	Shadow Lake	6190	5
648	Golden lakes	4924	5
678	Golden Lakes	5124	5
703	Tipsoo Lake	5301	5
820	Unnamed	5259	5
899	St. Andrews Creek drainage	4502	5
998	Mirror Lake	5418	5
1202	SE of Frog Heaven, near “Oh-My!” curve	4464	5
1247	St. Jacobs Lake	4700	5
1304	Between Louise & Reflection Lakes	4902	5
1419	Upper Johnson Lake	5009	5
20057	White River Park	5928	5
52	Chenuis Lake on NPS boundary	4112	6
59	Pond next to Lake Eleanor	4968	6
64	Near Lake Eleanor	4924	6
72	Lake Eleanor	4984	6
124	Adelaide Lake	4536	6
138	White River drainage	4750	6
146	Unnamed Lake in White River drainage	4975	6
156	Green Lake	3168	6
157	Huckleberry drainage	4903	6
158	Chenuis Lakes	5090	6
161	Huckleberry drainage	4871	6
165	Chenuis Lakes	4940	6
166	Huckleberry drainage	4904	6
176	Chenuis Lakes	4956	6
199	White River drainage	5260	6
246	Eunice Lake	5354	6
275	Green Park	5844	6
283	Mountain Meadows	4282	6
291	Hidden Lake	5921	6
292	White River Park, Harry Lake	5679	6
296	Dick Lake; White River Park	5680	6
320	Tom Lake, White River Park	5480	6
338	Berkeley Park	5450	6
360	Prospect Creek basin	5766	6
376	Clover Lake	5751	6
383	White River ponds	3236	6
398	White River ponds	3223	6
406	White River Park	5585	6
426	Sunrise Lake	5736	6
583	LW33	3680	6
589	Lower Deadwood	5270	6
597	Upper Deadwood	5280	6
605	Golden Lakes	4521	6
627	Golden Lakes	4464	6

Wetland #	Site Location	Elevation	Cluster
631	Golden Lakes	4693	6
632	Golden Lakes	4499	6
639	Golden Lakes	4974	6
649	Golden Lakes	4912	6
653	Golden Lakes	4911	6
656	Golden Lakes area	4998	6
657	Golden Lakes	4989	6
663	Golden Lakes	5062	6
666	Golden Lakes	5131	6
686	Ghost Lake	4290	6
688	South Golden Lakes	5286	6
689	South Golden Lakes	5464	6
731	Unnamed	4710	6
735	Unnamed	5835	6
754	Unnamed	5193	6
825	Unnamed	5221	6
840	Unnamed	4939	6
843	Anderson Lake	5354	6
891	LP17	4514	6
893	St. Andrews Creek drainage	4522	6
907	Unnamed	4980	6
949	Shriner Lake	4891	6
1013	Fan Lake	5325	6
1059	Off Gobbler's Knob trail	4851	6
1107	Squaw Lakes area	5050	6
1136	Paradise Meadows	5016	6
1137	Sheep Lake	4855	6
1167	Frog Heaven	4429	6
1170	LZ20	4960	6
1172	Mazama Ridge	5335	6
1188	Mazama Ridge	5180	6
1201	Faraway Pond	5200	6
1207	Steven's Ridge	4610	6
1231	Unnamed	4356	6
1232	Unnamed, Three Lakes area	4700	6
1233	Cowlitz Divide	4260	6
1242	Reflection Lakes	4854	6
1249	Near Reflection Lake	4854	6
1251	Small Reflection	4854	6
1265	Unnamed		6
1274	Three Lakes	4671	6
1285	Three Lakes	4540	6
1306	Marsh Lake (small)	3945	6
1307	Lake Allen	4584	6
1334	Laughing Water Pond	3040	6
1344	Pond across SR123 from Stv. Cany. Ent.	2198	6

Wetland #	Site Location	Elevation	Cluster
1353	Stevens Canyon Marsh	2050	6
1370	Cliff Lake	5216	6
1611	Blue Lake	4435	6
1632	Beaver Ponds	2155	6
3683	Golden Lakes		6
1007	Tahoma Creek trail wetland	3472	7
1226	Cowlitz Divide	4260	7
1308	Bench Lake	4490	7
1624	Unnamed, Cowlitz drainage	2405	7

APPENDIX II

Appendix IIa. Total amphibian count (all species, all life history stages) in 100-m transects observed during a 1996-1999 survey of lotic ecosystems in Mount Rainier National Park. Data are sorted alphabetically by drainage and site name. Date entries given in month/day/year format, and elevation reported in ft.

Drainage	Site Name	Site	Date	Stream Order	Elevation	Total Count
Carbon	Dick Creek	37	8/19/97	1	4400	151
Carbon	Doe Creek	44	9/4/97	1	3380	28
Carbon	Falls Creek	36	8/12/97	1	2300	55
Carbon	Falls Creek	52	7/14/98	1	2321	14
Carbon	June Creek	39	8/13/97	1	2700	68
Carbon	Moraine Creek	38	8/20/97	1	5220	14
Carbon	Unnamed in the Ipsut Drainage	43	9/3/97	1	2740	139
Carbon	Windfall (unnamed between June and Falls	40	8/14/97	1	2090	20
Cowlitz	Basalt Creek	71	8/11/98	2	5620	0
Cowlitz	Maple Creek	63	7/21/98	2	2740	14
Cowlitz	Nickel Creek	61	7/16/98	3	3265	50
Cowlitz	Stevens Creek	79	9/1/98	2	5090	0
Cowlitz	Sunbeam Creek	64	7/23/98	2	4545	0
Cowlitz	Taos Creek	83	9/2/98	3	2350	35
Cowlitz	Twin Falls Creek	62	7/22/98	1	3330	36
Cowlitz	Unicorn Creek	72	8/13/98	2	3515	14
Cowlitz	Unnamed	73	8/17/98	2	2815	23
Cowlitz	Unnamed	74	8/17/98	2	2795	0
Cowlitz	Unnamed - Backbone Ridge	77	8/19/98	1	2820	40
Mowich	Blueberry Creek	31	9/18/96	1	4440	3
Mowich	Crater Creek	97	8/11/99	1	4430	73
Mowich	Crater Creek	101	8/9/99	2	3620	10
Mowich	Grant Creek	96	8/10/99	1	3840	2
Mowich	Lee Creek	100	8/10/99	1	4720	0
Mowich	Unnamed	102	8/4/99	1	4590	0
Nisqually	Ararat Tumbler	8	7/24/96	1	3800	5
Nisqually	Cackling Creek	1	6/3/96	1	3450	2
Nisqually	Carter Falls South	18	8/14/96	1	3550	30
Nisqually	Deadhorse Creek	15	8/12/96	1	5000	26
Nisqually	Devil's Dream	28	9/9/96	1	4800	16
Nisqually	Eagle High Ephemeral	5	7/6/96	1	4440	1
Nisqually	Eagle Peak Creek	6	7/15/96	1	2940	82

Drainage	Site Name	Site	Date	Stream Order	Elevation	Total Count
Nisqually	Edith Creek	13	8/8/96	1	5600	1
Nisqually	Fish Creek	7	7/18/96	1	3120	46
Nisqually	Fisher's Hornpipe	29	9/10/96	2	4730	193
Nisqually	Goat's Cap Creek	25	8/22/96	1	3590	7
Nisqually	Goat's Spine Creek	26	8/26/96	1	3480	55
Nisqually	Golden Gate runoff	16	8/13/96	1	5530	2
Nisqually	Kautz Heli-Ripper Pad Stream	14	8/9/96	1	2340	0
Nisqually	Paradise Runoff West	17	8/13/96	1	6040	0
Nisqually	Pearl Creek	22	8/19/96	2	4320	2
Nisqually	Revelation's Brook	34	8/5/97	1	3040	0
Nisqually	Southern West SLope Ararat	21	8/15/96	1	2840	7
Nisqually	Tahoma tributary	20	8/15/96	2	2870	48
Nisqually	Tenas Creek	9	7/25/96	1	2320	16
Nisqually	Tributary of Fish Creek	3	7/1/96	1	3170	9
Nisqually	Upper Fork of Tatoosh Creek	19	8/14/96	1	4700	33
Nisqually	West Side One	4	7/3/96	1	2520	0
Ohanapecosh	Boulder Creek	78	8/26/98	1	6520	0
Ohanapecosh	Boundry Creek	59	6/29/98	2	3350	1
Ohanapecosh	Boundry Creek	69	8/4/98	2	3270	50
Ohanapecosh	Chinook Creek	70	8/5/98	2	2870	303
Ohanapecosh	Deer Creek	76	8/18/98	3	3200	168
Ohanapecosh	Deer Creek	80	8/31/98	3	4800	0
Ohanapecosh	Dewey Creek	53	7/9/98	2	4160	57
Ohanapecosh	Kotsuck Creek	60	7/6/98	2	4360	23
Ohanapecosh	Kotsuck Creek Meadows	56	7/6/98	2	5120	0
Ohanapecosh	Laughing Water Creek	57	7/13/98	2	2920	107
Ohanapecosh	Ohanapecosh River	75	8/20/98	5	2175	49
Ohanapecosh	Olallie Creek	54	7/15/98	3	3880	11
Ohanapecosh	Panther Creek	67	7/27/98	2	4275	105
Ohanapecosh	Sheep Creek Outlet	55	6/11/98	1	2640	4
Ohanapecosh	Unnamed	58	6/29/98	1	2725	3
Ohanapecosh	Unnamed	66	7/29/98	2	4825	4
Ohanapecosh	Unnamed	81	8/25/98	2	6020	0
Ohanapecosh	Unnamed	82	8/25/98	3	5560	0
Ohanapecosh	Unnamed	84	9/3/98	1	4625	30
Ohanapecosh	Unnamed	85	6/9/98	1	4934	4
Ohanapecosh	Unnamed Creek	68	7/30/98	1	1950	3
Puyallup	Broken Bridge Creek	30	9/17/96	1	4980	15

Drainage	Site Name	Site	Date	Stream Order	Elevation	Total Count
Puyallup	Finality Creek	32	9/19/96	1	5000	0
Puyallup	Lake 4500 outflow	23	8/21/96	1	4380	11
Puyallup	Mirror Creek	2	7/2/96	1	4590	18
Puyallup	North Puyallup Camp Creek	27	8/29/96	1	3740	91
Puyallup	Praying Stream	24	8/21/96	1	4110	9
Puyallup	Scramble Creek	12	8/1/96	1	3910	22
Puyallup	St. Andrews Creek	89	7/20/99	2	3980	3
Puyallup	Swift Creek	95	8/3/99	1	5060	0
Puyallup	Unnamed	92	7/27/99	1	3895	0
Puyallup	Unnamed	93	7/26/99	2	3920	0
Puyallup	Unnamed	94	7/28/99	1	4260	4
Puyallup	Waterfall Creek	11	7/31/96	1	3820	44
Puyallup	Yew Creek	10	7/29/96	1	3420	0
West Fork	Fern Brook	41	8/25/97	1	3230	0
West Fork	Lake James Outflow	46	9/10/97	1	4520	9
West Fork	Mosquito Morass	33	7/30/97	1	4420	0
West Fork	Starigarden Stream	42	8/27/97	1	3300	12
West Fork	Umberstone Creek	35	8/6/97	1	3820	5
West Fork	Van Horn Creek	45	9/9/97	1	4650	166
White	Ada Creek	111	9/20/99	2	3350	0
White	Crystal Creek	90	7/19/99	1	3320	24
White	Eleanor Creek	119	9/13/99	2	4675	2
White	Huckleberry Creek	116	7/9/99	4	3080	21
White	Inter Fork	110	9/27/99	3	4700	0
White	Josephine Creek	121	9/15/99	2	3760	27
White	Klickitat Creek	98	8/17/99	2	3440	4
White	Prospector Creek	113	9/16/99	3	4765	4
White	Shaw Creek	88	7/19/99	2	3658	0
White	Shaw Creek	99	8/18/99	2	5210	17
White	Sunrise Creek	107	8/31/99	2	5060	5
White	Unnamed	103	8/23/99	2	4360	3
White	Unnamed	104	8/24/99	1	4985	0
White	nnamed	105	8/25/99	1	5800	5
White	Unnamed	106	8/26/99	1	4520	1
White	Unnamed	108	9/2/99	1	5760	1
White	Unnamed	109	9/1/99	1	5718	0
White	Unnamed	112	9/17/99	1	6400	0
White	Unnamed	114	9/22/99	1	5775	2
White	Unnamed	115	9/21/99	1	4895	0

Drainage	Site Name	Site	Date	Stream Order	Elevation	Total Count
White	Unnamed	117	9/23/99	1	6420	0
White	Unnamed	118	8/8/99	2	3230	1
White	Unnamed	120	9/14/99	2	3964	21
White	Unnamed Above the Slide / east of 410	86	7/14/99	1	3520	32
White	Unnamed below the slide/ west of 410	87	7/14/99	1	2220	13

Appendix IIb. Total amphibian count (all species, all life history stages) in 100-m transects observed during a 1996-1999 survey of lotic ecosystems in Mount Rainier National Park. Data are sorted alphabetically by site name. Date entries given in month/day/year format, and elevation reported in ft.

Site Name	Drainage	Site	Date	Stream Order	Elevation	Total Count
Ada Creek	White	111	9/20/99	2	3350	0
Ararat Tumbler	Nisqually	8	7/24/96	1	3800	5
Basalt Creek	Cowlitz	71	8/11/98	2	5620	0
Blueberry Creek	Mowich	31	9/18/96	1	4440	3
Boulder Creek	Ohanapecosh	78	8/26/98	1	6520	0
Boundry Creek	Ohanapecosh	59	6/29/98	2	3350	1
Boundry Creek	Ohanapecosh	69	8/4/98	2	3270	50
Broken Bridge Creek	Puyallup	30	9/17/96	1	4980	15
Cackling Creek	Nisqually	1	6/3/96	1	3450	2
Carter Falls South	Nisqually	18	8/14/96	1	3550	30
Chinook Creek	Ohanapecosh	70	8/5/98	2	2870	303
Crater Creek	Mowich	97	8/11/99	1	4430	73
Crater Creek	Mowich	101	8/9/99	2	3620	10
Crystal Creek	White	90	7/19/99	1	3320	24
Deadhorse Creek	Nisqually	15	8/12/96	1	5000	26
Deer Creek	Ohanapecosh	76	8/18/98	3	3200	168
Deer Creek	Ohanapecosh	80	8/31/98	3	4800	0
Devil’s Dream	Nisqually	28	9/9/96	1	4800	16
Dewey Creek	Ohanapecosh	53	7/9/98	2	4160	57
Dick Creek	Carbon	37	8/19/97	1	4400	151
Doe Creek	Carbon	44	9/4/97	1	3380	28
Eagle High Ephemeral	Nisqually	5	7/6/96	1	4440	1
Eagle Peak Creek	Nisqually	6	7/15/96	1	2940	82
Edith Creek	Nisqually	13	8/8/96	1	5600	1
Eleanor Creek	White	119	9/13/99	2	4675	2
Falls Creek	Carbon	36	8/12/97	1	2300	55

Site Name	Drainage	Site	Date	Stream Order	Elevation	Total Count
Falls Creek	Carbon	52	7/14/98	1	2321	14
Fern Brook	West Fork	41	8/25/97	1	3230	0
Finality Creek	Puyallup	32	9/19/96	1	5000	0
Fish Creek	Nisqually	7	7/18/96	1	3120	46
Fisher's Hornpipe	Nisqually	29	9/10/96	2	4730	193
Goat's Cap Creek	Nisqually	25	8/22/96	1	3590	7
Goat's Spine Creek	Nisqually	26	8/26/96	1	3480	55
Golden Gate runoff	Nisqually	16	8/13/96	1	5530	2
Grant Creek	Mowich	96	8/10/99	1	3840	2
Huckleberry Creek	White	116	7/9/99	4	3080	21
Inter Fork	White	110	9/27/99	3	4700	0
Josephine Creek	White	121	9/15/99	2	3760	27
June Creek	Carbon	39	8/13/97	1	2700	68
Kautz Heli-Ripper Pad Stream	Nisqually	14	8/9/96	1	2340	0
Klickitat Creek	White	98	8/17/99	2	3440	4
Kotsuck Creek	Ohanapecosh	60	7/6/98	2	4360	23
Kotsuck Creek Meadows	Ohanapecosh	56	7/6/98	2	5120	0
Lake 4500 outflow	Puyallup	23	8/21/96	1	4380	11
Lake James Outflow	West Fork	46	9/10/97	1	4520	9
Laughing Water Creek	Ohanapecosh	57	7/13/98	2	2920	107
Lee Creek	Mowich	100	8/10/99	1	4720	0
Maple Creek	Cowlitz	63	7/21/98	2	2740	14
Mirror Creek	Puyallup	2	7/2/96	1	4590	18
Moraine Creek	Carbon	38	8/20/97	1	5220	14
Mosquito Morass	West Fork	33	7/30/97	1	4420	0
Nickel Creek	Cowlitz	61	7/16/98	3	3265	50
North Puyallup Camp Creek	Puyallup	27	8/29/96	1	3740	91
Ohanapecosh River	Ohanapecosh	75	8/20/98	5	2175	49
Olallie Creek	Ohanapecosh	54	7/15/98	3	3880	11
Panther Creek	Ohanapecosh	67	7/27/98	2	4275	105
Paradise Runoff West	Nisqually	17	8/13/96	1	6040	0
Pearl Creek	Nisqually	22	8/19/96	2	4320	2
Praying Stream	Puyallup	24	8/21/96	1	4110	9
Prospector Creek	White	113	9/16/99	3	4765	4
Revelation's Brook	Nisqually	34	8/5/97	1	3040	0
Scramble Creek	Puyallup	12	8/1/96	1	3910	22
Shaw Creek	White	88	7/19/99	2	3658	0
Shaw Creek	White	99	8/18/99	2	5210	17
Sheep Creek Outlet	Ohanapecosh	55	6/11/98	1	2640	4

Site Name	Drainage	Site	Date	Stream Order	Elevation	Total Count
Southern West SLope Ararat	Nisqually	21	8/15/96	1	2840	7
St. Andrews Creek	Puyallup	89	7/20/99	2	3980	3
Starigarden Stream	West Fork	42	8/27/97	1	3300	12
Stevens Creek	Cowlitz	79	9/1/98	2	5090	0
Sunbeam Creek	Cowlitz	64	7/23/98	2	4545	0
Sunrise Creek	White	107	8/31/99	2	5060	5
Swift Creek	Puyallup	95	8/3/99	1	5060	0
Tahoma tributary	Nisqually	20	8/15/96	2	2870	48
Taos Creek	Cowlitz	83	9/2/98	3	2350	35
Tenas Creek	Nisqually	9	7/25/96	1	2320	16
Tributary of Fish Creek	Nisqually	3	7/1/96	1	3170	9
Twin Falls Creek	Cowlitz	62	7/22/98	1	3330	36
Umberstone Creek	West Fork	35	8/6/97	1	3820	5
Unicorn Creek	Cowlitz	72	8/13/98	2	3515	14
Unnamed	Cowlitz	73	8/17/98	2	2815	23
Unnamed	Cowlitz	74	8/17/98	2	2795	0
Unnamed	Mowich	102	8/4/99	1	4590	0
Unnamed	Ohanapecosh	58	6/29/98	1	2725	3
Unnamed	Ohanapecosh	66	7/29/98	2	4825	4
Unnamed	Ohanapecosh	81	8/25/98	2	6020	0
Unnamed	Ohanapecosh	82	8/25/98	3	5560	0
Unnamed	Ohanapecosh	84	9/3/98	1	4625	30
Unnamed	Ohanapecosh	85	6/9/98	1	4934	4
Unnamed	Puyallup	92	7/27/99	1	3895	0
Unnamed	Puyallup	93	7/26/99	2	3920	0
Unnamed	Puyallup	94	7/28/99	1	4260	4
Unnamed	White	103	8/23/99	2	4360	3
Unnamed	White	104	8/24/99	1	4985	0
Unnamed	White	105	8/25/99	1	5800	5
Unnamed	White	106	8/26/99	1	4520	1
Unnamed	White	108	9/2/99	1	5760	1
Unnamed	White	109	9/1/99	1	5718	0
Unnamed	White	112	9/17/99	1	6400	0
Unnamed	White	114	9/22/99	1	5775	2
Unnamed	White	115	9/21/99	1	4895	0
Unnamed	White	117	9/23/99	1	6420	0
Unnamed	White	118	8/8/99	2	3230	1
Unnamed	White	120	9/14/99	2	3964	21
Unnamed - Backbone Ridge	Cowlitz	77	8/19/98	1	2820	40

Site Name	Drainage	Site	Date	Stream Order	Elevation	Total Count
Unnamed Above the Slide / east of 410	White	86	7/14/99	1	3520	32
Unnamed below the slide/ west of 410	White	87	7/14/99	1	2220	13
Unnamed Creek	Ohanapecosh	68	7/30/98	1	1950	3
Unnamed in the Ipsut Drainage	Carbon	43	9/3/97	1	2740	139
Upper Fork of Tatoosh Creek	Nisqually	19	8/14/96	1	4700	33
Van Horn Creek	West Fork	45	9/9/97	1	4650	166
Waterfall Creek	Puyallup	11	7/31/96	1	3820	44
West Side One	Nisqually	4	7/3/96	1	2520	0
Windfall (unnamed) between June and Falls	Carbon	40	8/14/97	1	2090	20
Yew Creek	Puyallup	10	7/29/96	1	3420	0

Appendix IIc. Number of amphibian life history stages observed for each site during a 1996 - 1999 survey of lotic ecosystems in Mount Rainier National Park. Acronyms refer to *Ambystroma gracile* larva (AMGRL), *Ascaphus truei* adult (ASTRA), *A. truei* metamorph (ASTRM), *A. truei* tadpole (ASTRT), *Dicamptodon tenebrosus* larva (DITEL), *Rana aurora* adult (RAAUA), and *Rana cascadae* adult (RACAA). Data sorted alphabetically by site name.

Site Name	Site	AMGRL	ASTRA	ASTRM	ASTRT	DITEL	RAAUA	RACAA
Ararat Tumbler	8		5					
Blueberry Creek	31					3		
Boundry Creek	59					1		
Boundry Creek	69		4		46			
Broken Bridge Creek	30			12	3			
Cackling Creek	1		2					
Carter Falls South	18		2	3	25			
Chinook Creek	70		1	26	271	5		
Crater Creek	97				71	2		
Crater Creek	101				10			
Crystal Creek	90				24			
Deadhorse Creek	15			6	20			
Deer Creek	76			22	144	2		
Devil's Dream	28		1	15				
Dewey Creek	53				56			1
Dick Creek	37				151			
Doe Creek	44				22	6		

Site Name	Site	AMGRL	ASTRA	ASTRM	ASTRT	DITEL	RAAUA	RACAA
Eagle High Ephemeral	5							1
Eagle Peak Creek	6			6	70	5	1	
Edith Creek	13				1			
Eleanor Creek	119				2			
Falls Creek	36			2	50	3		
Falls Creek	52		3		11			
Fish Creek	7			6	39	1		
Fisher’s Hornpipe	29		1	73	119			
Goat’s Cap Creek	25				7			
Goat’s Spine Creek	26		7	5	39	4		
Golden Gate runoff	16		1		1			
Grant Creek	96		2					
Huckleberry Creek	116		3		18			
Josephine Creek	121				27			
June Creek	39		1	4	58	5		
Klickitat Creek	98				4			
Kotsuck Creek	60		1		22			
Lake 4500 outflow	23			1	2	8		
Lake James Outflow	46				2	7		
Laughing Water Creek	57		2		105			
Maple Creek	63				14			
Mirror Creek	2			1	17			
Moraine Creek	38				14			
Nickel Creek	61		1		49			
North Puyallup	27			49	42			
Camp Creek								
Ohanapecosh River	75			2	45	2		
Olallie Creek	54				10			1
Panther Creek	67				105			
Pearl Creek	22				2			
Praying Stream	24				9			
Prospector Creek	113		3		1			
Scramble Creek	12			3	19			
Shaw Creek	99		3		4			10
Sheep Creek Outlet	55				2	2		
Southern West	21			4	1	2		
SLope Ararat								
St. Andrews Creek	89				3			
Starigarden Stream	42				6	6		
Sunrise Creek	107				5			
Tahoma tributary	20			13	34	1		

Site Name	Site	AMGRL	ASTRA	ASTRM	ASTRT	DITEL	RAAUA	RACAA
Taos Creek	83		7	1	27			
Tenas Creek	9		2	4	2	8		
Tributary of Fish Creek	3			1	8			
Twin Falls Creek	62		1		32	1		2
Umberstone Creek	35				2	3		
Unicorn Creek	72		6	1	4			3
Unnamed	58				3			
Unnamed	66		4					
Unnamed	73			4	19			
Unnamed	84	7			22			1
Unnamed	85					3	1	
Unnamed	94				3			1
Unnamed	103				3			
Unnamed	105		1					4
Unnamed	106							1
Unnamed	108							1
Unnamed	114		2					
Unnamed	118				1			
Unnamed	120		1		19			1
Unnamed - Backbone Ridge	77		3		37			
Unnamed Above the Slide / east of 410	86				32			
Unnamed below the slide/ west of 410	87				13			
Unnamed Creek	68							3
Unnamed in the Ipsut Drainage	43			1	129	9		
Upper Fork of Tatoosh Creek	19			2	31			
Van Horn Creek	45				166			
Waterfall Creek	11			2	42			
Windfall (unnamed) between June and Falls	40				19	1		

Appendix IId. Number of *Ascaphus truei* tadpoles observed at lotic sites during a 1996-1999 survey in Mount Rainier National Park. Tadpoles were identified and enumerated by development stage A, B, C, or E. Data was sorted alphabetically by site name.

Site Name	Site	Stage A	Stage B	Stage C	Stage E
Boundry Creek	69	2	35	5	
Chinook Creek	70	13	211	24	
Crater Creek	97	46	20		
Crater Creek	101	6	2	2	
Crystal Creek	90	21	3		
Deer Creek	76	2	109	25	
Dewey Creek	53	27	27		
Dick Creek	37	16	134	1	
Doe Creek	44		19	3	
Eleanor Creek	119		2		
Falls Creek	36	37	10	2	1
Falls Creek	52	3	3	3	2
Huckleberry Creek	116	1	12	5	
Josephine Creek	121		24	3	
June Creek	39	51	5		
Klickitat Creek	98		4		
Kotsuck Creek	60	11	6	5	
Lake James Outflow	46	2			
Laughing Water Creek	57	9	84	8	
Maple Creek	63		10	3	
Moraine Creek	38	1	10	3	
Nickel Creek	61	2	27	19	1
Ohanapecosh River	75	1	20	23	
Olallie Creek	54		9	1	
Panther Creek	67	8	87	6	
Prospector Creek	113		1		
Shaw Creek	99	1	3		
Sheep Creek Outlet	55	2			
St. Andrews Creek	89	3			
Starigarden Stream	42	2	2	2	
Sunrise Creek	107		5		
Taos Creek	83		23	2	
Twin Falls Creek	62	6	11	14	
Umberstone Creek	35		2		
Unicorn Creek	72		3	1	
Unnamed	73		18		
Unnamed	84	1	20	1	

Site Name	Site	Stage A	Stage B	Stage C	Stage E
Unnamed	94	1	2		
Unnamed	103		3		
Unnamed	118		1		
Unnamed	120		19		
Unnamed - Backbone Ridge	77		32	5	
Unnamed Above the Slide / east of 410	86	31	1		
Unnamed below the slide/ west of 410	87	5	5	3	
Unnamed in the Ipsut Drainage	43	5	104	20	
Van Horn Creek	45	32	106	28	
Windfall (unnamed) between June and Falls	40		19		

Appendix IIe. Ten-cluster structure of amphibian data obtained during a 1996-1999 survey of lotic sites in Mount Rainier National Park. Data is organized by cluster and elevation is reported in ft.

Site Name	Site	Drainage	Elevation	Cluster
Ararat Tumbler	8	Nisqually	3800	1
Boundry Creek	69	Ohanapecosh	3270	1
Broken Bridge Creek	30	Puyallup	4980	1
Cackling Creek	1	Nisqually	3450	1
Carter Falls South	18	Nisqually	3550	1
Chinook Creek	70	Ohanapecosh	2870	1
Crater Creek	97	Mowich	4430	1
Crater Creek	101	Mowich	3620	1
Crystal Creek	90	White	3320	1
Deadhorse Creek	15	Nisqually	5000	1
Deer Creek	76	Ohanapecosh	3200	1
Devil’s Dream	28	Nisqually	4800	1
Dewey Creek	53	Ohanapecosh	4160	1
Dick Creek	37	Carbon	4400	1
Eagle Peak Creek	6	Nisqually	2940	1
Edith Creek	13	Nisqually	5600	1
Eleanor Creek	119	White	4675	1
Falls Creek	36	Carbon	2300	1
Falls Creek	52	Carbon	2321	1
Fish Creek	7	Nisqually	3120	1
Fisher’s Hornpipe	29	Nisqually	4730	1

Site Name	Site	Drainage	Elevation	Cluster
Goat's Cap Creek	25	Nisqually	3590	1
Goat's Spine Creek	26	Nisqually	3480	
Golden Gate runoff	16	Nisqually	5530	1
Grant Creek	96	Mowich	3840	1
Huckleberry Creek	116	White	3080	1
Josephine Creek	121	White	3760	1
June Creek	39	Carbon	2700	1
Klickitat Creek	98	White	3440	
Laughing Water Creek	57	Ohanapecosh	2920	1
Maple Creek	63	Cowlitz	2740	1
Mirror Creek	2	Puyallup	4590	1
Moraine Creek	38	Carbon	5220	1
Nickel Creek	61	Cowlitz	3265	1
North Puyallup Camp Creek	27	Puyallup	3740	1
Ohanapecosh River	75	Ohanapecosh	2175	1
Olallie Creek	54	Ohanapecosh	3880	1
Panther Creek	67	Ohanapecosh	4275	1
Pearl Creek	22	Nisqually	4320	1
Praying Stream	24	Puyallup	4110	1
Prospector Creek	113	White	4765	1
Scramble Creek	12	Puyallup	3910	1
St. Andrews Creek	89	Puyallup	3980	1
Sunrise Creek	107	White	5060	1
Tahoma tributary	20	Nisqually	2870	1
Taos Creek	83	Cowlitz	2350	1
Tributary of Fish Creek	3	Nisqually	3170	1
Twin Falls Creek	62	Cowlitz	3330	1
Unnamed	58	Ohanapecosh	2725	1
Unnamed	66	Ohanapecosh	4825	1
Unnamed	73	Cowlitz	2815	1
Unnamed	103	White	4360	1
Unnamed	114	White	5775	1
Unnamed	118	White	3230	1
Unnamed	120	White	3964	1
Unnamed - Backbone Ridge	77	Cowlitz	2820	1
Unnamed Above the Slide / east of 410	86	White	3520	1
Unnamed below the slide/ west of 410	87	White	2220	1
Unnamed in the Ipsut Drainage	43	Carbon	2740	1
Upper Fork of Tatoosh Creek	19	Nisqually	4700	1
Van Horn Creek	45	West Fork	4650	1

Site Name	Site	Drainage	Elevation	Cluster
Waterfall Creek	11	Puyallup	3820	1
Windfall (unnamed between June and Falls	40	Carbon	2090	1
Unnamed	85	Ohanapecosh	4934	2
Unnamed	84	Ohanapecosh	4625	3
Sheep Creek Outlet	55	Ohanapecosh	2640	4
Starigarden Stream	42	West Fork	3300	4
Tenas Creek	9	Nisqually	2320	4
Umberstone Creek	35	West Fork	3820	4
Eagle High Ephemeral	5	Nisqually	4440	5
Unnamed	106	White	4520	5
Unnamed	108	White	5760	5
Unnamed Creek	68	Ohanapecosh	1950	5
Shaw Creek	99	White	5210	6
Unnamed	105	White	5800	6
Blueberry Creek	31	Mowich	4440	7
Boundry Creek	59	Ohanapecosh	3350	7
Unicorn Creek	72	Cowlitz	3515	8
Unnamed	94	Puyallup	4260	8
Doe Creek	44	Carbon	3380	9
Southern West SLope Ararat	21	Nisqually	2840	9
Lake 4500 outflow	23	Puyallup	4380	10
Lake James Outflow	46	West Fork	4520	10

Appendix IIf. Six-cluster structure of amphibian data obtained during a 1996-1999 survey of lotic sites in Mount Rainier National Park. The analysis was based on three life history stages of *Ascaphus truei*: adult, metamorph, and tadpole. Data are organized by cluster and elevation is reported in ft.

Site Name	Site	Drainage	Elevation	Cluster
Boundary Creek	69	Ohanapecosh	3270	1
Carter Falls South	18	Nisqually	3550	1
Chinook Creek	70	Ohanapecosh	2870	1
Crater Creek	97	Mowich	4430	1
Crater Creek	101	Mowich	3620	1
Crystal Creek	90	White	3320	1
Deer Creek	76	Ohanapecosh	3200	1
Dewey Creek	53	Ohanapecosh	4160	1
Dick Creek	37	Carbon	4400	1
Doe Creek	44	Carbon	3380	1
Eagle Peak Creek	6	Nisqually	2940	1
Edith Creek	13	Nisqually	5600	1
Eleanor Creek	119	White	4675	1
Falls Creek	36	Carbon	2300	1
Falls Creek	52	Carbon	2321	1
Fish Creek	7	Nisqually	3120	1
Goat’s Cap Creek	25	Nisqually	3590	1
Goat’s Spine Creek	26	Nisqually	3480	1
Huckleberry Creek	116	White	3080	1
Josephine Creek	121	White	3760	1
June Creek	39	Carbon	2700	1
Klickitat Creek	98	White	3440	1
Kotsuck Creek	60	Ohanapecosh	4360	1
Lake James Outflow	46	West Fork	4520	1
Laughing Water Creek	57	Ohanapecosh	2920	1
Maple Creek	63	Cowlitz	2740	1
Mirror Creek	2	Puyallup	4590	1
Moraine Creek	38	Carbon	5220	1
Nickel Creek	61	Cowlitz	3265	1
Ohanapecosh River	75	Ohanapecosh	2175	1
Olallie Creek	54	Ohanapecosh	3880	1
Panther Creek	67	Ohanapecosh	4275	1
Pearl Creek	22	Nisqually	4320	1
Praying Stream	24	Puyallup	4110	1
Scramble Creek	12	Puyallup	3910	1
Sheep Creek Outlet	55	Ohanapecosh	2640	1
St. Andrews Creek	89	Puyallup	3980	1

Site Name	Site	Drainage	Elevation	Cluster
Starigarden Stream	42	West Fork	3300	1
Sunrise Creek	107	White	5060	1
Taos Creek	83	Cowlitz	2350	1
Tributary of Fish Creek	3	Nisqually	3170	1
Twin Falls Creek	62	Cowlitz	3330	1
Umberstone Creek	35	West Fork	3820	1
Unnamed	58	Ohanapecosh	2725	1
Unnamed	84	Ohanapecosh	4625	1
Unnamed	94	Puyallup	4260	1
Unnamed	103	White	4360	1
Unnamed	118	White	3230	1
Unnamed	120	White	3964	1
Unnamed - Backbone Ridge	77	Cowlitz	2820	1
Unnamed Above the Slide / east of 410	86	White	3520	1
Unnamed below the slide/ west of 410	87	White	2220	1
Unnamed in the Ipsut Drainage	43	Carbon	2740	1
Upper Fork of Tatoosh Creek	19	Nisqually	4700	1
Van Horn Creek	45	West Fork	4650	1
Waterfall Creek	11	Puyallup	3820	1
Windfall (unnamed) between June and Falls	40	Carbon	2090	1
Broken Bridge Creek	30	Puyallup	4980	2
Devil’s Dream	28	Nisqually	4800	2
Southern West SLope Ararat	21	Nisqually	2840	2
Ararat Tumbler	8	Nisqually	3800	3
Cackling Creek	1	Nisqually	3450	3
Grant Creek	96	Mowich	3840	3
Unnamed	66	Ohanapecosh	4825	3
Unnamed	105	White	5800	3
Unnamed	114	White	5775	3
Deadhorse Creek	15	Nisqually	5000	4
Fisher’s Hornpipe	29	Nisqually	4730	4
Lake 4500 outflow	23	Puyallup	4380	4
Tahoma tributary	20	Nisqually	2870	4
Unnamed	73	Cowlitz	2815	4
Golden Gate runoff	16	Nisqually	5530	5
Prospector Creek	113	White	4765	5
Shaw Creek	99	White	5210	5
Unicorn Creek	72	Cowlitz	3515	5
North Puyallup Camp Creek	27	Puyallup	3740	6
Tenas Creek	9	Nisqually	2320	6

Appendix IIg. Six-cluster structure of amphibian data obtained during a 1996-1999 survey of lotic sites in Mount Rainier National Park. Analysis was based on four tadpole life history stages of *Ascaphus truei*: Stage A, Stage B, Stage C, and Stage E. Data are organized by cluster and elevation is reported in ft.

Site Name	Site	Drainage	Elevation	Cluster
Chinook Creek	70	Ohanapecosh	2870	1
Dick Creek	37	Carbon	4400	1
Eleanor Creek	119	White	4675	1
Klickitat Creek	98	White	3440	1
Laughing Water Creek	57	Ohanapecosh	2920	1
Olallie Creek	54	Ohanapecosh	3880	1
Panther Creek	67	Ohanapecosh	4275	1
Prospector Creek	113	White	4765	1
Shaw Creek	99	White	5210	1
Sunrise Creek	107	White	5060	1
Taos Creek	83	Cowlitz	2350	1
Umberstone Creek	35	West Fork	3820	1
Unnamed	73	Cowlitz	2815	1
Unnamed	84	Ohanapecosh	4625	1
Unnamed	94	Puyallup	4260	1
Unnamed	103	White	4360	1
Unnamed	118	White	3230	1
Unnamed	120	White	3964	1
Windfall (unnamed between June and Falls	40	Carbon	2090	1
Falls Creek	52	Carbon	2321	2
Boundry Creek	69	Ohanapecosh	3270	3
Deer Creek	76	Ohanapecosh	3200	3
Doe Creek	44	Carbon	3380	3
Huckleberry Creek	116	White	3080	3
Josephine Creek	121	White	3760	3
Maple Creek	63	Cowlitz	2740	3
Moraine Creek	38	Carbon	5220	3
Unicorn Creek	72	Cowlitz	3515	3
Unnamed - Backbone Ridge	77	Cowlitz	2820	3
Unnamed in the Ipsut Drainage	43	Carbon	2740	3
Van Horn Creek	45	West Fork	4650	3
Crater Creek	97	Mowich	4430	4
Crystal Creek	90	White	3320	4
Dewey Creek	53	Ohanapecosh	4160	4
Falls Creek	36	Carbon	2300	4

Site Name	Site	Drainage	Elevation	Cluster
June Creek	39	Carbon	2700	4
Lake James Outflow	46	West Fork	4520	4
Sheep Creek Outlet	55	Ohanapecosh	2640	4
St. Andrews Creek	89	Puyallup	3980	4
Unnamed Above the Slide / east of 410	86	White	3520	4
Nickel Creek	61	Cowlitz	3265	5
Ohanapecosh River	75	Ohanapecosh	2175	5
Twin Falls Creek	62	Cowlitz	3330	5
Crater Creek	101	Mowich	3620	6
Kotsuck Creek	60	Ohanapecosh	4360	6
Starigarden Stream	42	West Fork	3300	6
Unnamed below the slide/ west of 410	87	White	2220	6