# Forest and Rangeland Ecosystem Science Center 

In Cooperation with M ount Rainer National Park

## Inventory of Aquatic Breeding Amphibians, M ount Rainier National Park, 1994-1999

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

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Mount Rainier National Park (MORA) comprises $969 \mathrm{~km}^{2}$ 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 longterm 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.

Mount Rainier National Park (MORA) encompasses $969 \mathrm{~km}^{2}$ 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 $-{ }^{\circ} \mathrm{C}$ and mean July temperatures of 10 to $15{ }^{\circ} \mathrm{C}$ 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 ( $520-825 \mathrm{~m}$ ). 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).

## M ETHODS

## 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.

## W ater 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 $<3 \mathrm{~m}$, water samples were collected 1 m 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 ${ }^{\mathrm{TM}} 45 \mathrm{~mm}$ 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, W ater Temperature, and pH
Water temperature and pH were measured for lentic and lotic samples in the field using Beckman ${ }^{\text {TM }} 100$ and 200 series or Orion ${ }^{\text {TM }} 230 \mathrm{~A}$ 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 ${ }^{\mathrm{TM}} 44600$ or $\mathrm{YSI}^{\mathrm{TM}}$ portable meters. Conductivity of several samples was measured at MORA Resources Laboratory using a calibrated Beckman ${ }^{\mathrm{TM}}$ 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 ${ }^{\mathrm{TM}} 57$ or Orion ${ }^{\mathrm{TM}} 830$ meters with attached probes. Single measurements for DO and temperature were taken at mid-depth in the water column. At lentic sites, calibrated YSI ${ }^{\mathrm{TM}}$ 57 or Orion ${ }^{\mathrm{TM}} 830$ 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 1 m 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 1 m below the water surface.

## W ater Turbidity and Transparency M easurements

Turbidity was measured and recorded for each lotic site at MORA Resources Laboratory using a Hach ${ }^{\text {TM }} 2100$ A Turbidimeter. Samples were collected in the field by "hand-grab" in 125 ml 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 2 m deep and approximately 42 m long with 4 equal length sections of $12.5 \mathrm{~mm}, 18.5 \mathrm{~mm}, 25 \mathrm{~mm}$, and 33 mm 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 $<300 \mathrm{~m}$ ), the entire shoreline was surveyed. At least 100 m of shoreline were surveyed at larger lentic systems. The 100 m minimum was broken into several shorter transects to represent multiple habitats of each lentic system. However, all survey transects were at least 25 m long. Survey transects for lentic system with shoreline perimeters ž 300 m 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 50 m of forested woodland, 25 m of wet meadow, and 25 m of talus. Unique features measuring $<25 \mathrm{~m}$ 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 0.7 m ) while VES were used to survey shallow ponds (maximum depth $<0.7 \mathrm{~m}$ ).

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 ( $<3 \mathrm{~m}$ ),
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 $2-3 \mathrm{~m}$ 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 $=$ $\sim 1 \mathrm{~m}$ ). 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 $<3 \mathrm{~m}$ ). 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 100 m 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 100 m section of stream for reconnaissance and measured with a flexible meter tape. Crew members marked both ends of the 100 m section with surveyor's tape or ground stakes. Field crews then used a random number table or generator to select $101-\mathrm{m}$ survey locations within a 100 m stream section (e.g., meter 8 , meter 25 , meter 39 , meter 63 , etc.). The $101-\mathrm{m}$ survey locations were marked with surveyor's tape or ground stakes. Prior to the amphibian survey of each 1 m site, crew members mapped and recorded habitat features of each 100 m stream segment and $1-\mathrm{m}$ survey location. One person recorded vegetation and major physical parameters along the 100 m stream segment, while others recorded stream habitat variables at each 1-m survey location (see Bury and Corn, 1991).

Amphibian surveys were begun at locations on the downstream end of the 100 m stream segment to minimize disruption of other 1 m survey locations. Moving upstream, each proceeding 1 m survey location was surveyed for amphibians. One crewmember was responsible for recording amphibian observations while all other crew members conducted amphibian surveys. At each 1 m 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 $<2 \mathrm{~m}$, habitats were systematically inspected for amphibians from one bank to the other. In streams ž 2 m 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

$$
\left\{x_{i j} \mathrm{x} i=1,2, \ldots \ldots, n ; j=1,2, \ldots \ldots \ldots, p\right\}
$$

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

$$
\left\{x_{i j} \mathrm{x} i=1,2, \ldots \ldots, n ; j=1,2, \ldots \ldots \ldots, p\right\}
$$

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 ( $\mathrm{A}, \mathrm{B}, \mathrm{C}$, 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 ( $5833 / 100 \mathrm{~m}$ ) 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 $(\mathrm{P}=0.038)$. 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\%.

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 $(\mathrm{r}=0.486)$ 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 $(\mathrm{r}=0.791)$ 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 ( $\mathrm{r}<0.25$ ).

## 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 ( $\mathrm{n}=5$ ), July (33), August (52), and September (24) from 6/3/96 to 9/15/99. Most sites were located in the White ( $\mathrm{n}=25$ ), 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 ( $\mathrm{n}=303$ ), 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 $/ 100 \mathrm{~m}$ ) and the West Fork drainage ( 48.00 animals $/ 100 \mathrm{~m}$ ).

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 ( $101-\mathrm{m}$ sites) along a 100 m 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 $2 b$ 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 ( $\mathrm{P}<0.01$ ) 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).

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 coexistence 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 ( $\mathrm{n}=31$ ) 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 1890 m 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.

## Northw estern 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 1500 m 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.

## W estern 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 instream 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 ( $\mathrm{n}=77$ 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 clearcut 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, Dic amptodon 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 1410 m . Larvae at this site were observed in a stream pool with $2 \%$ gradient measured midway through the 100 m survey location. Although not typically found in streams A. gracile can utilize slowmoving 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 900 m west of the Cascade Range (Nussbaum et al., 1983). The elevation of our one site (Nisqually basin, elev. 896 m ) was at about the maximum elevation reported for $R$. aurora. The other site (Ohanapecosh basin, elev. 1504 m ) 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 M onitoring

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 M ethod

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.



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 2 b .


## 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 <br> tadpole <br> juvenile <br> adult | $\begin{aligned} & 314.78 \\ & 21007.14 \\ & 566.08 \\ & 1040.00 \end{aligned}$ |
| Rana sp. | True frogs | tadpole <br> adult | $\begin{aligned} & 1199.36 \\ & 7.14 \end{aligned}$ |
| Hyla regilla | Pacific tree frog | tadpole juvenile adult | $\begin{aligned} & 26.72 \\ & 2.10 \\ & 3.59 \end{aligned}$ |
| Bufo boreas | Western toad | tadpole <br> adult | $\begin{aligned} & 199.22 \\ & 2.18 \end{aligned}$ |
| Anuran | Unknown frog species | tadpole | 0.72 |
| Ambystoma gracile | Northwestern salamander | egg mass <br> larvae <br> neotene <br> adult | $\begin{aligned} & 2577.10 \\ & 4240.87 \\ & 901.56 \\ & 29.61 \end{aligned}$ |
| Ambystoma macrodactylum | Long-toed salamander | $\begin{aligned} & \text { egg mass } \\ & \text { larvae } \\ & \text { adult } \\ & \hline \end{aligned}$ | 1860.29 8864.43 161.00 |
| Ambystoma sp. unknown | Ambystomatidae | larvae | 558.01 |
| Taricha granulosa | Roughskin newt | egg mass <br> larvae <br> adult | $\begin{aligned} & 79.03 \\ & 72.58 \\ & 81.79 \end{aligned}$ |

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 <br> cascadae | Hyla <br> regilla | Bufo <br> boreas | Ambystoma <br> gracile | Ambystoma <br> macrodactylum | Taricha <br> 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.

| Parameter | Cluster |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: |
|  | 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 mean count | $\begin{aligned} & 50.0 \\ & 1.29 \end{aligned}$ | $\begin{aligned} & 73.1 \\ & 201.06 \\ & \hline \end{aligned}$ | $\begin{aligned} & 67.5 \\ & 19.00 \end{aligned}$ | $\begin{aligned} & 50.0 \\ & 21.39 \end{aligned}$ | $\begin{aligned} & 100.0 \\ & 0.82 \end{aligned}$ |
| - Hyla regilla \% sites mean count | $\begin{array}{r} 21.4 \\ 0.31 \\ \hline \end{array}$ | $\begin{aligned} & 1.5 \\ & 0.39 \end{aligned}$ | $\begin{aligned} & 5.2 \\ & 0.05 \end{aligned}$ | $\begin{aligned} & 0 \\ & 0 \end{aligned}$ | $\begin{aligned} & 0 \\ & 0 \end{aligned}$ |
| - Bufo boreas \% sites mean count | $\begin{aligned} & 0 \\ & 0 \\ & \hline \end{aligned}$ | $\begin{aligned} & 1.6 \\ & 3.27 \\ & \hline \end{aligned}$ | $\begin{aligned} & 3.6 \\ & 0.03 \\ & \hline \end{aligned}$ | $\begin{aligned} & 0 \\ & 0 \end{aligned}$ | $\begin{aligned} & 0 \\ & 0 \\ & \hline \end{aligned}$ |
| - Ambystoma gracile \% sites mean count | $\begin{aligned} & 57.1 \\ & 31.52 \end{aligned}$ | $\begin{aligned} & 41.8 \\ & 21.78 \end{aligned}$ | $\begin{aligned} & 80.5 \\ & 34.77 \end{aligned}$ | $\begin{aligned} & 62.5 \\ & 38.92 \end{aligned}$ | $\begin{aligned} & 0 \\ & 0 \end{aligned}$ |
| - Ambystoma macrodactylum <br> \% sites mean count | $\begin{aligned} & 14.3 \\ & 0.07 \\ & \hline \end{aligned}$ | $\begin{aligned} & 53.7 \\ & 120.84 \\ & \hline \end{aligned}$ | $\begin{aligned} & 24.7 \\ & 10.80 \\ & \hline \end{aligned}$ | $\begin{array}{r} 25.0 \\ 1.63 \\ \hline \end{array}$ | $\begin{aligned} & 0 \\ & 0 \\ & \hline \end{aligned}$ |
| - Taricha granulosa \% sites mean count | $\begin{aligned} & 21.4 \\ & 0.69 \end{aligned}$ | $\begin{aligned} & 4.5 \\ & 0.04 \end{aligned}$ | $\begin{aligned} & 22.1 \\ & 1.54 \end{aligned}$ | $\begin{aligned} & 12.5 \\ & 0.84 \end{aligned}$ |  |

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 |  |  |
| :--- | :---: | :---: | :---: | :---: |
|  | $\mathbf{1}$ | $\mathbf{2}$ | $\mathbf{3}$ |  |
| Elevation | -0.173 | $-\mathbf{0 . 5 4 2}$ | $\mathbf{0 . 4 3 8}$ |  |
| Area | $\mathbf{0 . 9 4 9}$ | -0.012 | 0.038 |  |
| Depth | $\mathbf{0 . 9 5 1}$ | 0.096 | 0.090 |  |
| Conductivity | 0.056 | $\mathbf{0 . 8 6 8}$ | -0.046 |  |
| PH | -0.037 | $\mathbf{0 . 7 5 6}$ | 0.044 |  |
| Alkalinity | 0.044 | 0.150 | $\mathbf{- 0 . 8 7 4}$ |  |
| Temperature | -0.246 | -0.095 | $\mathbf{- 0 . 7 9 8}$ |  |

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 <br> gracile | Ambystoma <br> macrodactylum | Bufo <br> boreas | Hyla <br> regilla | Rana <br> cascadae |
| :--- | :--- | :--- | :--- | :--- | :--- |
| Ambystoma <br> macrodactylum | -0.042 |  |  |  |  |
| Bufo <br> boreas | -0.028 | 0.000 | -0.007 |  |  |
| Hyla <br> regilla | -0.024 | -0.011 | -0.012 | -0.025 |  |
| Rana <br> cascadae | -0.081 | 0.005 | -0.011 | -0.012 | -0.043 |
| Taricha <br> granulosa | 0.486 | -0.020 |  |  |  |

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 <br> Larva <br> Neotene <br> Adult | $\begin{aligned} & 6.89 \\ & 4.51 \\ & 3.26 \\ & 0.02 \end{aligned}$ | $\begin{array}{r} 13.62 \\ 23.31 \\ 4.98 \\ 0.16 \end{array}$ |
| Ambystoma macrodactylum | Egg mass <br> Larva <br> Adult | $\begin{aligned} & 5.79 \\ & 4.96 \\ & 0.10 \end{aligned}$ | $\begin{array}{r} 9.57 \\ 49.63 \\ 0.90 \end{array}$ |
| Ambystoma sp. | Larva | 0.04 | 3.16 |
| Bufo boreas | Tadpole Adult | $\begin{array}{r} 6.43 \\ \mathrm{np} \\ \hline \end{array}$ | $\begin{array}{r} \mathrm{np} \\ 0.01 \end{array}$ |
| Hyla regilla | Tadpole Juvenile Adult | $\begin{aligned} & \mathrm{np} \\ & \mathrm{np} \\ & \mathrm{np} \end{aligned}$ | $\begin{aligned} & 0.15 \\ & 0.01 \\ & 0.02 \\ & \hline \end{aligned}$ |
| Rana cascadae | Egg mass <br> Tadpole <br> Juvenile <br> Adult | $\begin{array}{r} 0.03 \\ 4.50 \\ 0.18 \\ 1.40 \\ \hline \end{array}$ | $\begin{array}{r} 1.78 \\ 118.57 \\ 3.18 \\ 5.66 \end{array}$ |
| Rana sp. | Tadpole Adult | $\begin{aligned} & \mathrm{np} \\ & \mathrm{np} \end{aligned}$ | $\begin{aligned} & 6.81 \\ & 0.04 \end{aligned}$ |
| Taricha granulosa | Egg mass <br> Larva <br> Adult | $\begin{aligned} & 0.13 \\ & 1.66 \\ & 0.68 \end{aligned}$ | $\begin{aligned} & 0.43 \\ & 0.12 \\ & 0.35 \end{aligned}$ |

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 $100-\mathrm{m}$ 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 <br> 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 <br> 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 |

## APPENDIXI

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, <br> 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 <br> gracile | Ambystoma <br> macrodactylum | Bufo <br> boreas | Hyla <br> regilla | Rana <br> cascadae | Taricha <br> granulosa | Total Count |
| :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- |


| Wetland \# | Ambystoma <br> gracile | Ambystoma <br> macrodactylum | Bufo <br> boreas | Hyla <br> regilla | Rana <br> cascadae | Taricha <br> granulosa | Total Count |
| :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- |


| Wetland \# | Ambystoma <br> gracile | Ambystoma <br> macrodactylum | Bufo <br> boreas | Hyla <br> regilla | Rana <br> cascadae | Taricha <br> granulosa | Total Count |
| :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- |


| Wetland \# | Ambystoma <br> gracile | Ambystoma <br> macrodactylum | Bufo <br> boreas | Hyla <br> regilla | Rana <br> cascadae | Taricha <br> granulosa | Total Count |
| :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- |


| Wetland \# | Ambystoma <br> gracile | Ambystoma <br> macrodactylum | Bufo <br> boreas | Hyla <br> regilla | Rana <br> cascadae | Taricha <br> granulosa | Total Count |
| :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- |

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 |
| $\mathbf{2 4 0}$ |  | 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.

| Wetland \# | Ambystoma macrodactylum |  |  |  |
| :---: | :---: | :---: | :---: | :---: |
|  | 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.

| Wetland \# | Rana cascadae |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: |
|  | 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 |


| Wetland \# | Rana cascadae |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: |
|  | 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.

| Wetland \# | Taricha granulosa |  |  |  |
| :---: | :---: | :---: | :---: | :---: |
|  | 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 |  |
| 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 |  |
| 406 | White River Park | 5585 | 6 |
| 426 | Sunrise Lake | 5736 |  |
| 583 | LW33 | 3680 |  |
| 589 | Lower Deadwood | 5270 |  |
| 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 | 516 | 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 | 2490 | 7 |
| 1624 | Unnamed, Cowlitz drainage | 7 |  |

## APPENDIX II

Appendix IIa. Total amphibian count (all species, all life history stages) in $100-\mathrm{m}$ 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 <br> 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 <br> Ipsut Drainage | 43 | $9 / 3 / 97$ | 1 | 2740 | 139 |
| Carbon | Windfall (unnamed <br> 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 - | 77 | $8 / 19 / 98$ | 1 | 2820 | 40 |
| Backbone Ridge | 31 | $9 / 18 / 96$ | 1 | 4440 | 3 |  |
| Mowich | Blueberry Creek | 31 | 97 | $8 / 11 / 99$ | 1 | 4430 |
| Mowich | Crater Creek | 973 |  |  |  |  |
| 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 <br> 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 <br> the Slide / east of 410 | 86 | $7 / 14 / 99$ | 1 | 3520 | 32 |
| White | Unnamed below <br> the slide/ west of 410 | 87 | $7 / 14 / 99$ | 1 | 2220 | 13 |

Appendix IIb. Total amphibian count (all species, all life history stages) in $100-\mathrm{m}$ 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 <br> 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 <br> 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 outfow | 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 <br> Order | Elevation | Total Count |
| :--- | :--- | :---: | :---: | :---: | :---: | :---: |
| Unnamed Above <br> the Slide / east of 410 | White | 86 | $7 / 14 / 99$ | 1 | 3520 | 32 |
| Unnamed below <br> the slide/ west of 410 | White | 87 | $7 / 14 / 99$ | 1 | 2220 | 13 |
| Unnamed Creek | Ohanapecosh | 68 | $7 / 30 / 98$ | 1 | 1950 | 3 |
| Unnamed <br> in the Ipsut Drainage | Carbon | 43 | $9 / 3 / 97$ | 1 | 2740 | 139 |
| Upper Fork <br> 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) <br> 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 |  |  |
| Tanoma 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 | 20 | 1 |  |  |
| Unnamed |  |  |  |  |  |
|  |  | 18 |  |  |  |


| 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 <br> the Slide / east of 410 | 86 | 31 | 1 |  |  |
| Unnamed below <br> the slide/ west of 410 | 87 | 5 | 5 | 3 |  |
| Unnamed in the <br> Ipsut Drainage | 43 | 5 | 104 | 20 |  |
| Van Horn Creek | 45 | 32 | 106 | 28 |  |
| Windfall (unnamed) <br> 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 | 55 | Ohanapecosh | 2175 | 1 |
| Olallie Creek | 67 | Ohanapecosh | 3880 | 1 |
| Panther Creek | 22 | Nisqually | 4275 | 1 |
| Pearl Creek | 24 | Puyallup | 4320 | 1 |
| Praying Stream | Puyallup | 4110 | 1 |  |
| Scramble Creek | 35 | Ohanapecosh | 2640 | 1 |
|  | 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 lpsut 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 |

