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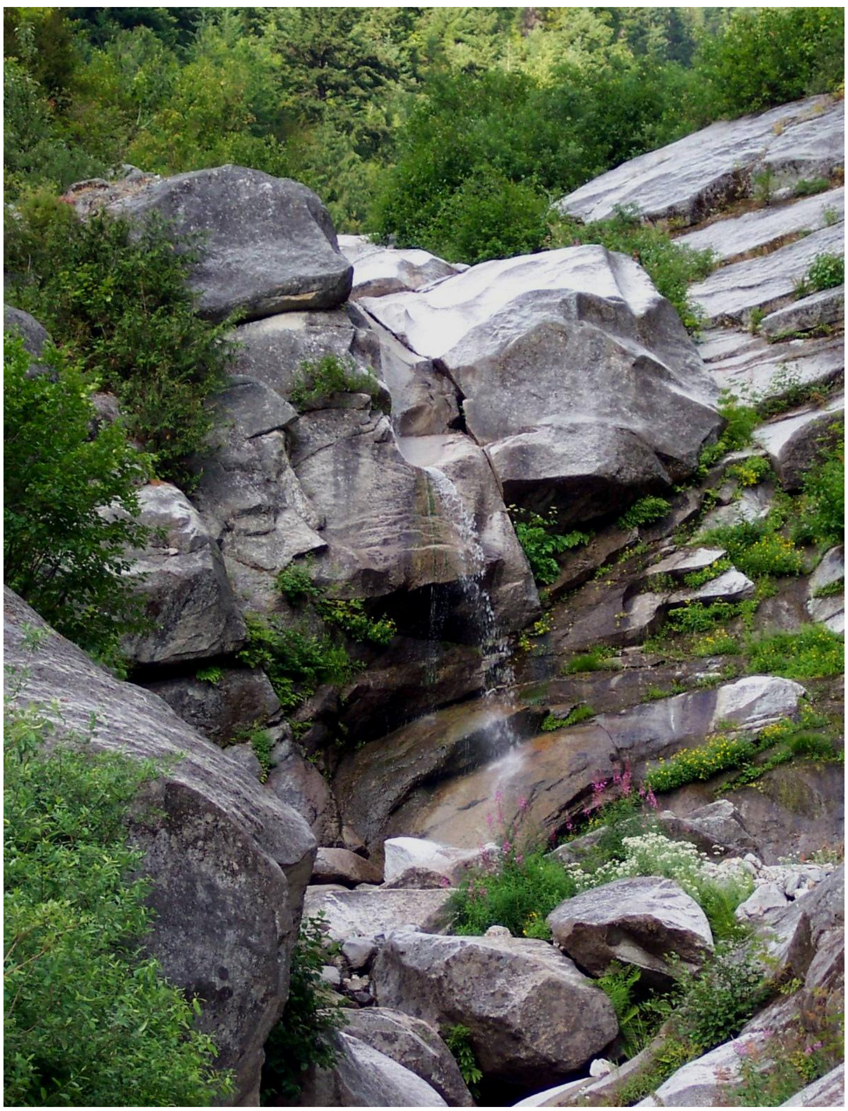
Natural Resource Technical Report NPS/NCCN/NRTR—2009/169



ON THE COVER
Unnamed tributary to the Chilliwack River
Photograph courtesy of NPS files

A Survey of Stream Amphibian Species Composition and Distribution in the North Cascades National Park Service Complex, Washington State (2005)

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U.S. Department of the Interior
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Contents

Figures

Tables

Page

Executive Summary

The North Cascades National Park Service Complex (NOCA) is located in northwestern Washington State and encompasses 275,684 hectares. It is comprised of three management units: North Cascades National Park, Ross Lake National Recreation Area and the Lake Chelan National Recreation Area. Approximately 93% of this area is managed as federally Designated Wilderness. The region's wet maritime climate causes high amounts of precipitation, which in turn creates a high abundance and diversity of aquatic resources. Twelve species of amphibians have been documented in NOCA: *Ascaphus truei, Pseudacris (Hyla) regilla, Rana aurora, Rana cascadae, Rana luteiventris, Bufo boreas, Ambystoma gracile, Ambystoma macrodactylum, Dicamptodon tenebrosus, Ensatina eschscholtzii, Taricha granulosa* and *Plethodon vehiculum.*

A total of 168 stream segments were sampled from nine watersheds across NOCA during two different inventory efforts conducted from 1996-98 and from 2003-04. Two stream obligate amphibians species, *A. truei* and *D. tenebrosus,* which require lotic habitats to complete their life cycles, were found in 54% of the stream segments sampled. We found the distribution of *A. truei* to be widespread across NOCA and within previously established environmental constraints. The site occupancy of this species varied across the east-west precipitation gradient. To the west of the orographic divide, they were found in 75% of the sites surveyed, and on the eastern side they were detected in 37% of the sites surveyed.

Our surveys expanded the documented range of *D. tenebrosus* in NOCA from a previous single sighting near the North Cascades Visitors Center in the Newhalem Creek watershed to thirteen new sites in the Chilliwack and Skagit watersheds. In Canada, *D. tenebrosus* are only found in the Chilliwack River and Cultus Lake watershed and these findings may be significant for the conservation status of this species since NOCA lands represent the majority of the protected habitat for this isolated British Columbian population.

Acknowledgments

This project was funded through the National Park Service's Inventory and Monitoring program and by the North Cascades National Park Complex. We wish to express sincere gratitude to Stefan Wodzicki and Carmen Welch for assuming leadership roles in planning and carefully collecting field data as well as supervising SCA volunteers. We are grateful for the assistance of Natasha Antonova for GIS support and Lise Grace for data management support and meticulously reviewing this document.

Introduction

Amphibians are important components in many ecosystems occupying key trophic positions in food webs of both aquatic and terrestrial systems. In some forest ecosystems, amphibians may comprise the majority of the vertebrate biomass (Burton and Likens 1975, Bury 1988). As adults they can be top carnivores, and as larvae or juveniles, they may be the major food source of many other animals including birds, mammals, fish, and invertebrates. Reports concerning the recent global and national declines in amphibian populations have sparked an increased interest in monitoring these species (Barinaca 1990; Blaustein and Wake 1990; Bury et al. 1980; Wake 1991). Nearly one-third (32%) of the world's amphibian species are listed as vulnerable, endangered, or critically endangered by the IUCN (2005) Red List. For comparison, 12% of all avian and 23% of all mammal species are similarly listed. This concern is especially acute when the declines occur in areas traditionally believed to be protected such as National Parks and Designated Wilderness Areas (Blaustein and Wake 1990, Pilliod and Peterson 2001, Wake 1991). Currently three species of amphibians that are potentially found in the North Cascades National Park Service Complex (NOCA) are listed for special management status by either the Washington Department of Fish and Wildlife or the U.S. Fish and Wildlife Service (Table 1).

Table 1. Amphibian species potentially found in North Cascades National Park and their conservation status.

Common Name	**Scientific Name**	**Documneted in NOCA**	**Federal Status**	**State Status**
Tailed Frog	*Ascaphus truei*	Yes	None	None
Pacific Chorus Frog	*Pseudacris (Hyla) regilla*	Yes	None	None
Red-legged Frog	*Rana aurora*	Yes	Species of Concern	None
Cascades Frog	*Rana cascadae*	Yes	None	None
Columbia Spotted Frog	*Rana luteiventris*	Yes	Species of Concern	Candidate
Western Toad	*Bufo boreas*	Yes	Species of Concern	Candidate
Northwestern Salamander	*Ambystoma gracile*	Yes	None	None
Long-Toed Salamander	*Ambystoma macrodactylum*	Yes	None	None
Pacific Giant Salamander	*Dicamptodon tenebrosus*	Yes	None	None
Ensatina	*Ensatina eschscholtzii*	Yes	None	None
Roughskin Newt	*Taricha granulosa*	Yes	None	None
Western Redback Salamander	*Plethodon vehiculum*	Yes	None	None

Since amphibians occupy both aquatic and terrestrial environments and possess permeable skin, they are potentially at an increased risk from exposure to a wide range of stressors found in both of these environments. Reported declines have been attributed to disease (Bradford 1991; Carey 1993; Pounds and Crump 1994), non-native predator populations, ultra-violet radiation (Blaustein et al. 1994a), pollution (Hine et al. 1981; Freda 1986; Beebee et al. 1990; Dunson et al. 1992), changing hydrologic regimes and habitat alteration (Bury et al. 1980; Corn and Bury 1989; Dodd 1991; Petranka et al. 1993). As such, monitoring for changes in amphibian population sizes and/or distributions has the potential to provide an early warning signal of environmental degradation.

While many species of amphibians are often encountered in stream corridors, the tailed frog (*Ascaphus truei*) and the Pacific giant salamander (*Dicamptodon tenebrosus*) comprise the only obligate stream-amphibian fauna of North Cascades National Park. Both of these species are endemic to the Pacific Northwest (Nussbaum 1983, Northern Prairie Wildlife Research Center 2004) and are adapted to existence in the habitats found in this region. *A. truei* is the sole species representing the family Ascaphidae and is considered to be one of the most primitive frog species alive in the world today (Cannatella and Hillis 1993). This species has a long larval period, and in the North Cascades it spends between two to four years in cold, clear, rocky streams until emerging as an adult (Nussbaum 1983, Bury and Adams 2000, and Brown 1990). Even after this point sexual maturity is likely not reached for another three to four years (Daugherty and Sheldon 1982). *D. tenebrosus* has two distinct life history patterns. Some individuals metamorphose into terrestrial adults after spending 18 to 24 months in well oxygenated streams, while other individuals exhibit paedogeny and remain in the stream as reproductively viable neotenes throughout their life spans. In small streams, this species has been shown to contribute over 95% of the predator biomass, out-weighing salmonid species (Murphy and Hall 1981).

Several surveys conducted since 1989 have documented the presence of 10 species of amphibians in NOCA. These surveys included a cooperative study conducted with Oregon State University assessing the ecological effects of stocked trout in naturally fishless lakes. This study, conducted from 1989-1993, documented three salamander species: *Ambystoma macrodactylum* in east and west slope lakes, *Ambystoma gracile*, and *Taricha granulosa* in west slope lakes. Additionally, four Anuran amphibians were found on both sides of the Pacific Crest: *Bufo boreas* in lakes, *Pseudacris (Hyla) regilla*, *A. truei*, and *Rana luteiventris* in and adjacent to streams.

In 1991, a Stehekin Valley Vertebrate Inventory (east slope) was conducted by NOCA staff (Kuntz and Glesne 1993). Pitfall traps in this study yielded five amphibian species: *Rana cascadae*, *P. regilla*, *R. luteiventris, B. boreas,* and *A. macrodactylum.* In 1993-1994, pitfall traps were installed and monitored by NOCA staff at Park Slough near Newhalem (west slope). The Park Slough pitfall traps captured *Ensatina eschscholtzii* and *Rana aurora*, and additionally, nearby fish traps in the Park Slough spawning channels have caught *B. boreas*.

In 1995, an arthropod study using pitfall traps was initiated in lower Big Beaver Valley, a drainage to the west of Ross Lake. This trapping effort resulted in the incidental take of eight species of amphibians: *B. boreas, A. truei, P. regilla, R. luteiventris, A. macrodactylum, A. gracile, T. granulosa,* and *E. eschscholtzii.*

As part of a four year program to inventory amphibians in Pacific Northwest National Parks, three watersheds were surveyed in NOCA from 1996 through 1998. During the 1996 field season, amphibian abundance and distribution data were collected from 27 stream reaches, 30 individual seeps, and 21 lakes and ponds in the Big Beaver Creek watershed (Holmes and Glesne 1997). The only amphibian species captured in streams was *A. truei* while *A. gracile* was only captured in seeps. Six species of amphibians, *A. gracile, A. macrodactylum, B. boreas, P. regilla, R. luteiventris, and T. granulosa,* were found in the lakes and ponds surveyed.

In 1997, during the second year of the study, amphibian abundance and distribution data were collected from 28 stream reaches, seven individual seeps, and 15 lakes and ponds in the Bridge Creek watershed (Holmes and Glesne 1998). Again, only *A. truei* was captured from streams. One amphibian, *A. macrodactylum,* was found at a seep location and *A. macrodactylum, B. boreas, P. regilla, R. cascadae,* and *R. luteiventris* were found in the lakes and ponds surveyed.

In the final year of the study, 1998, amphibian abundance and distribution data were collected from 19 stream reaches and 72 lakes and ponds from areas in the Bridge Creek and Thunder Creek watersheds (Holmes and Glesne 1999). *A. truei* and *R. cascadae* were the only amphibians captured in stream habitats. Nine species of amphibians were found in the lakes and ponds surveyed: *A. gracile, A. macrodactylum, A. truei, B. boreas, P. regilla, R. aurora, R. cascadae, R. luteiventris,* and *T. granulosa*.

Additional amphibian surveys were conducted in 2003 and 2004 focusing solely on stream amphibians within NOCA. During this effort, abundance and distribution data were collected from 96 stream reaches in the Chilliwack, Skagit/Diablo, Little Beaver, Ross Lake, and Stehekin watersheds. A total of six species were documented during this effort. *B. boreas, P. regilla, R. aurora* and *R. cascadae* were caught incidentally in riparian habitats while *A. truei* and *D. tenebrosus* were collected from lotic habitats.

This report summarizes the data collected from the stream amphibian sampling efforts conducted during the 1996-98 and the 2003-04 survey efforts. The primary objectives of these projects were to document species presence, relative abundance and distribution within NOCA and secondarily to evaluate the environmental factors affecting distribution of these species.

Study Area

The North Cascades National Park Service Complex (NOCA) is located in northwestern Washington State and encompasses 275,684 hectares. It is comprised of three management units: North Cascades National Park, Ross Lake National Recreation Area and the Lake Chelan National Recreation Area (Figure 1). Approximately 93% of this area is managed as designated wilderness. Surrounding the park on the west, south and east are 1.9 million hectares of National Forest lands, of which 763,890 hectares are designated wilderness and most of which are contiguous to the park. NOCA's northern boundary is the international border with the Canadian province of British Columbia. The adjacent to NOCA’s boundary in British Columbian lands are managed as provincial forest, recreation area, and protected park lands.

The region’s wet maritime climate causes high amounts of precipitation, which in turn creates a high abundance and diversity of aquatic resources. A 1971 inventory identified 318 glaciers in NOCA, more than in all of the other National Parks within the conterminous states combined. The heavy precipitation giving rise to these glaciers also contributes to the creation of 591 ponds and lakes and approximately 3,225 kilometers of rivers and streams (excluding intermittent streams, which may increase the total to over 10,000 km) located in the park complex. NOCA watersheds eventually flow into four major river systems: Columbia River, Fraser River, Skagit River and Nooksack River.

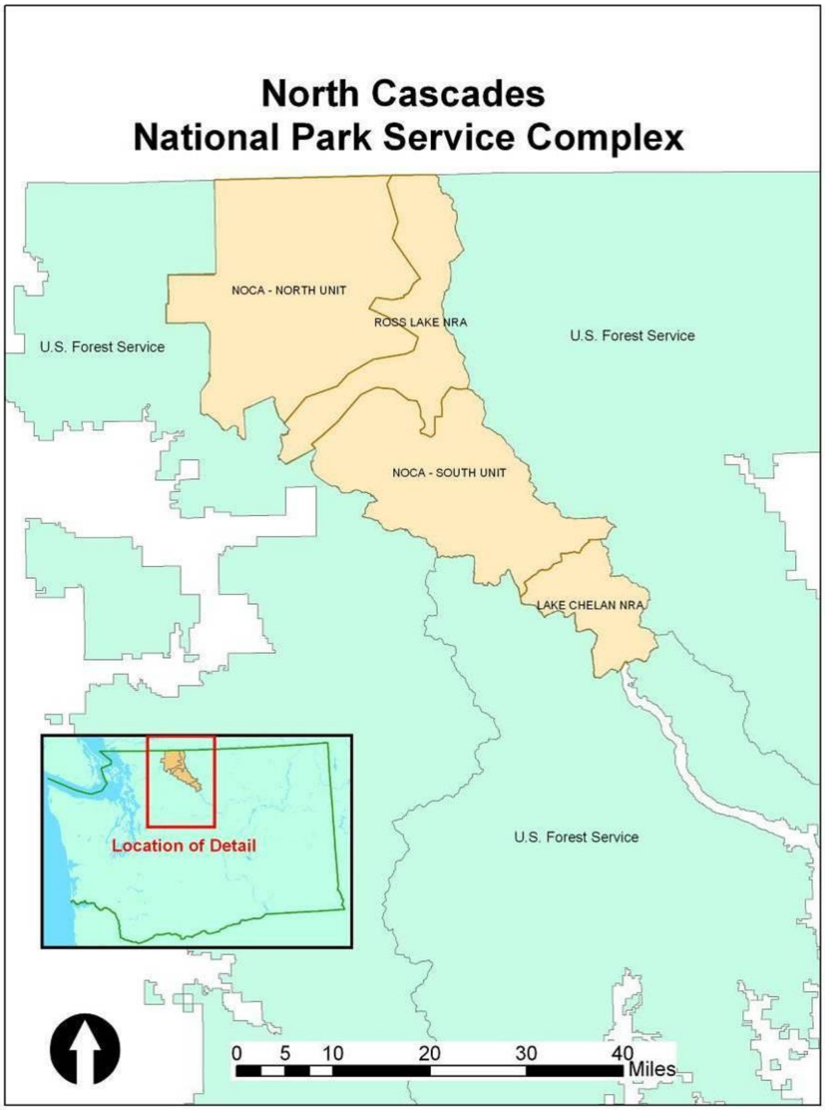


Figure 1. Location of North Cascades National Park Service Complex and jurisdictional boundaries.

The landscape within NOCA is characterized by deep, forested valleys between high, glaciated mountain peaks that have been shaped through a combination of uplifted granitic formations and substantial glaciation. Underlain by sedimentary and metamorphic rock, it contrasts with the adjoining Southern Cascades which are composed primarily of rock of volcanic origin. Watersheds typically begin in high elevation glaciers and snow fields, then drop in numerous, cascading streams down precipitous valley walls into classic, U-shaped valley floors carved by glaciers during the Pleistocene. Mainstem streams are generally sinuous and braided across relatively broad, flat valley bottoms.

Westerly trending weather patterns combined with the high topographic relief have created distinct east-west precipitation patterns. Precipitation gradients occur along either side of an orographic divide defined by the Picket Range, in the northern portion of the park, and the

Pacific Crest Divide to the south (Sumioka et al. 1998)(Figure 2). On the west of this divide, precipitation averages between 203 and 897 cm annually, while to the east precipitation drops to an average of 76 cm in the lower elevations of the Stehekin Valley.

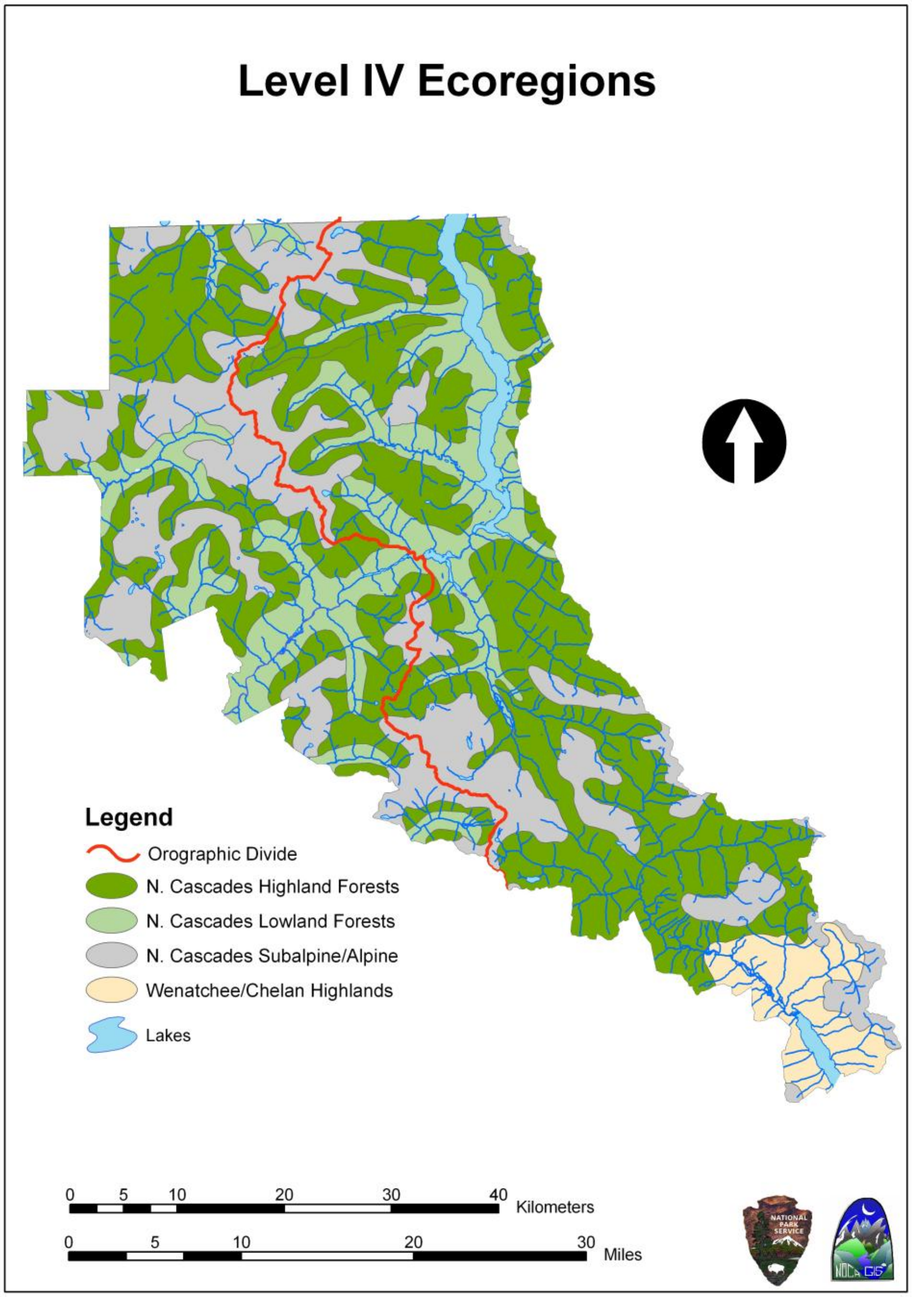


Figure 2. Level IV Ecoregions found within the North Cascades National Park Service Complex.

Elevation and precipitation gradients in combination with the area's geology and soils have given rise to four distinct ecoregions within the park complex: North Cascades Lowland Forest, North Cascades Highland Forest, North Cascades Subalpine/Alpine, and the Wenatchee/Chelan Highlands (Omernik 1987 & 2002) (Figure 2). Located in the foothills and in the broad lowlying glaciated valleys of the Cascade Mountains, the North Cascades Lowland Forest ecoregion consists of productive western hemlock (*Tsuga heterophylla*), Douglas-fir *(Pseudotsuga menziesii*), and western red cedar (*Thuja plicata*) forests that have developed under the mild maritime climate. The colder climatic conditions found at higher elevations allow for the development of deeper and more persistent snow pack, favoring the development of Pacific silver fir (*Abies amabilis*) and mountain hemlock (*Tsuga mertensiana*) forests which comprise the North Cascades Highland Forest ecoregion. Consisting of steep valley walls, glaciated ridges, high-gradient streams, and tarns, this is the dominant ecoregion within NOCA. Found at the highest elevations of the park, the North Cascades Subalpine/Alpine ecoregion is characterized by permanent snow and ice fields, glaciers, bare rock and subalpine meadows. The lower elevations of the Stehekin watershed, located in the southeastern portion of NOCA are dominated by the Wenatchee/Chelan Highlands ecoregion. This ecoregion shares many of the physiographic characteristics of the Highland Forest ecoregion, but the leeward climatic conditions support forests dominated by Douglas-fir, lodgepole pine (*Pinus contorta*) and ponderosa pine (*Pinus ponderosa*).

Methods

A total of 168 stream segments were sampled from nine watersheds across NOCA during two different inventory efforts (Figure 3, Table 2 and Appendix B). The first effort was conducted from 1996 through 1998 as part of a larger four year project to survey lake, pond and stream amphibians in Pacific Northwest National Parks. The later effort conducted in 2003 and 2004 focused solely on stream amphibians in NOCA. All data collection and amphibian sampling was conducted during low flow periods from the first week of June through the first week in October. Detailed protocols and examples of the data sheets are presented in Appendix A and in Holmes and Glesne (1997, 1998 and 1999).

Table 2. Sample effort for stream amphibians in NOCA. N = the number of stream segments surveyed.

Watershed	Year Sampled	N	Linear Distance Surveyed (km)
Big Beaver	1996	27	2.22
Bridge	1997	28	2.80
Bridge	1998	6	0.60
Chilliwack	2003	24	4.04
Little Beaver	2004	8	1.06
Lower Stehekin	2004	14	2.04
Ross	2004	15	1.12
Skagit	2003	23	3.66
Thunder	1998	11	1.10
Upper Stehekin	2004	12	1.33
All Watersheds Combined		168	19.97

Stream Segment Selection and Delineation

Since smaller streams have been identified as the primary habitat for stream amphibians (Bury and Corn 1991; Nussbaum et al. 1983), our sampling effort focused on wadeable first, second and third order headwater tributaries. On occasion, some larger fourth order stream channels were sampled. Due to the difficulty of off trail travel, a series of non-random stream segments were chosen when accessible within one day's travel from trails or roads.

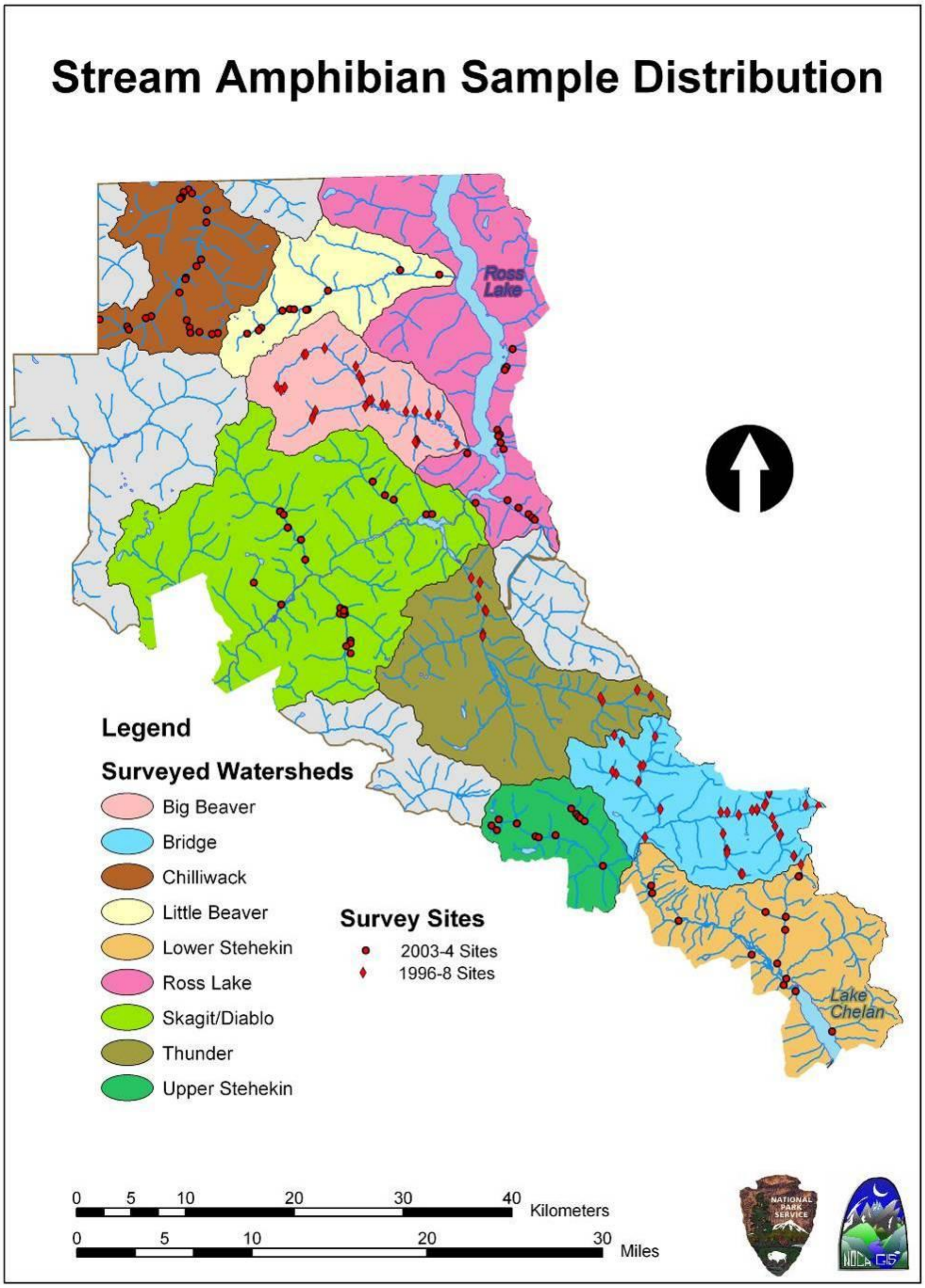


Figure 3. North Cascades National Park Service Complex stream amphibian sample site distribution.

The length of stream sampled differed between the inventory efforts. The 1996-98 effort collected samples from within a 100 meter stream segment. The later effort used a segment length defined as an area 20 to 40 times the bankfull width, with no less than 50 meters of a stream sampled when the bankfull width was less than 1.5 meters. At the starting point for each reach, one crewmember stretched a measuring tape or used a string box to delineate the area to be sampled taking care to not disturb the streambed. Along this route 10 sample stations were measured out at preselected random intervals. Streams that crossed trails and roads were sampled beginning approximately 10 to50 meters upstream of the trail to minimize impacts of these developments on the segment sampled.

Amphibian Sampling
Amphibians were sampled at each of the randomly selected stations. For the 1996-98 effort 1 meter wide belt transects spanning the entire wetted channel were used, while the 2003-04 effort sampled a 3 square meter block of the best available habitat. This resulted in a standard sample area for the 2003-04 inventory effort and a variable sample area during the1996-98 inventory effort, ranging from 0.2 to 17.2 square meters. These differences should be kept in mind when comparing amphibian count and density data between the efforts. Amphibian collection methods were the same for each sample effort.

First, a visual sweep of the wetted sample area and adjacent riparian habitat, 1 meter from the wetted channel, was made for any highly mobile adults and metamorphs. Stream obligate species that were captured during the riparian sweeps were included in further data analysis while stream facultative species were documented but not included in any of the data analysis. Next the aquatic habitat was sampled by placing a kick net in the stream securely against the substrate while picking up and examining all moveable substrate upstream within one meter of the net. Large or unmovable substrate was rubbed by hand to dislodge any amphibians present. Substrate which was moved was replaced as near to its original position as possible to minimize disruption to the habitat. The net was moved throughout the sample area until the whole area had been thoroughly searched. In areas with little to no flow, small aquarium dip nets and hands were used to capture organisms. To avoid recapture, specimens were kept in plastic buckets filled with water until the area had been thoroughly searched. All captured amphibians were then identified to species, life stage, and sex when possible. Additionally, head width, total body length, snout to vent length and limb measurements were made following methods outlined in Bury and Major (1997).

Habitat and Reach Characterization
A series of 13 measurements were made at each sample site to characterize, the streams hydrology and physical habitat. At the beginning of each sample site, the streams overall aspect, water temperature and conductivity were measured. During the 1996-98 survey effort conductivity was measured with a Solomat 520c hand held meter, and during the 2003-04 survey effort a YSI 30 hand held meter was used. The average stream channel gradient was also calculated for each reach from measurements made using a hand held clinometer. During the 1996-98 effort the gradient was calculated from three measurements taken at the beginning, middle and end of each reach while for the 2003-04 effort the gradient was calculated from measurements made at each station. To compensate for these differences, gradient was also determined using 1:24,000 scale maps (SSHIAP 2000) categorizing the stream segments into eight groups: <1%, 1-2%, 2-4%, 4-8% 8-20% and >20%. Stream order was determined following methods outlined by Strahler (1952). Additional measurements made at each station for both survey efforts included wetted channel width paired with water depth and velocity

measurements made at three evenly spaced intervals along the same transect. Water velocity was measured to the nearest 0.01 meter/second at 0.6 of the water depth using Swoffer 3000 and Global Flow Probe 101 flow meters. Substrate was visually estimated and classified into dominant/subdominant categories of bedrock, boulder (>256 mm diameter), cobble (64-256 mm diameter), gravel (2-64 mm diameter), sand (1-2 mm diameter), and silt. The percent contribution of six habitat types along with the type and percent contribution of instream cover were visually estimated for the amphibian sample areas. Habitat types were classified as obscured from view, cascade (> 3.5% gradient), riffle, pool, pool tailout, subsurface flow and other (usually falls). Instream cover was recorded as large woody debris (>10 cm diameter), organic debris, and undercut banks. Canopy cover was also measured at each station in the middle of the wetted channel using a concave spherical densitometer. The average was calculated from four measurements taken facing upstream, downstream, left and right bank.

Riparian vegetation data was also collected during the 1996-98 surveys to assess the species composition and age class of both overstory and understory. Results from these measurements are presented in Holmes and Glesne (1997, 1998 and 1999).

Data Analysis

Comparisons of amphibian densities between the two survey efforts were not made due to the uncertain relationship between the different transect and block methods of sampling used. Additionally, data were excluded from the Thunder Creek watershed because these sites were selected based on a prior knowledge regarding the presence of *A. truei*. Data were also excluded from transect and blocks dominated by subsurface flow since they could not be sampled for amphibians.

Since the landscape in NOCA plays a role in shaping the areas habitats and climate, as well as potentially limiting the ability of amphibians to disperse throughout the Park. The frequency of occurrence (detection rate) for each amphibian species was calculated relative to orographic position, ecoregion and watershed:

$$\text{Detection Rate} = \frac{\sum \text{transects or blocks where } \textit{A. truei} \text{ were detected}}{\text{total \# of transect or blocks surveyed in a stream segment}}.$$

Normal probability plots and Fligner-Killeen tests (Conover, Johnson and Johnson 1981) indicated that the water quality, habitat and stream channel characteristic data were not normally distributed or homogeneous in their variances. Therefore, the nonparametric Kruskal-Wallis rank sum test (Hollander and Wolfe 1973) was used to test for significant differences in these attributes between sites where *A. truei* were found and where they were not. Chi Squared tests (Patefield 1981) were used to test for significant differences in detection rates of *A. truei* across the orographic divide, between ecoregions and for categorical data.

Table 3. Summary of landform, water chemistry and stream channel characteristics for stream amphibian survey sites conducted in NOCA from 1996 to1998 and from 2003 to 2004. Interquartile Range (IQR) = 3rd Quartile subtracted from the 1st Quartile and contains 50 percent of the data.

		Elevation (m)		Aspect (Degrees from N)		Gradient Class	Stream Order	Conductivity (µS)		Water Temperature (C)		Canopy Cover (%)		Wetted Width (m)		Water Depth (m)	
Watershed	N	Median	IQR	Median	IQR	mode	mode	Median	IQR	Median	IQR	Median	IQR	Median	IQR	Median	IQR
Big Beaver	27	774	229	90	90	> 20%	2	30.8	31.8	8	5	65	59	3.6	1.4	0.17	0.13
Bridge	34	1207	447	90	45	> 20%	1	22.0	23.5	8	4	62	62	1.6	3.4	0.10	0.13
Chilliwack	24	807	220	60	86	> 20%	3	25.0	17.0	10	4	68	52	2.3	4.8	0.12	0.18
Little Beaver	8	775	119	49	104	> 20%	1	22.0	20.3	11	2	79	37	4.5	3.9	0.19	0.14
Lower Stehekin	14	506	754	107	74	8 - 20%	2	41.0	13.0	13	4	86	16	4.4	3.4	0.20	0.13
Ross	21	564	29	106	72	> 20%	1	84.8	78.7	10	2	96	8	1.9	2.4	0.11	0.13
Skagit	23	407	125	104	60	> 20%	1	21.2	25.4	11	4	87	34	2.6	4.6	0.13	0.19
Thunder	11	597	652	90	45	> 20%	1	38.4	21.8	12	5	100	24	1.8	0.9	0.12	0.11
Upper Stehekin	6	1204	367	152	49	> 20%	2	28.0	13.8	12	5	25	55	3.8	7.0	0.13	0.22
All Watersheds Combined	168	780	607	90	83	> 20%	1	28.5	28.1	10	4	77	56	2.6	4.1	0.13	0.17

Results

A total length of 19.97 kilometers of streams representing roughly 0.3% of the total 1:24,000 USGS mapped lotic resources in NOCA were surveyed for amphibians during the two survey efforts. Streams were sampled across a broad range of landscape and stream channel characteristics. Sample sites were located on all aspects and ranged from 124 to 1,829 meters in elevation. Stream sizes ranged from first through fourth order with a maximum wetted width and depth of 26.5 and 1.8 meters respectively. Summary statistics for landform, water chemistry and stream channel characteristics are presented in Table 3. Hydrologic and habitat characteristics for sample sites are presented in Appendix C. Thirteen of the streams surveyed appeared only as crenulations and were not mapped as perennial streams on 1:24,000 USGS topographic maps, and many of the mapped perennial streams were dry at the time surveys were being conducted and could not be sampled.

Amphibian Captures

A total of 893 individuals representing six species were collected in streams and riparian habitats during both of the survey efforts (Appendix D). Ten of these individuals were represented by *B. boreas, H. regilla, R. aurora* and *R. cascadae.* Since these species are considered facultative stream species and were collected in very low numbers they were excluded from further analysis. Stream obligate species were found in 54% of the 168 stream segments sampled. Both of the stream obligate species, *A. truei* and *D. tenebrosus,* predicted to occur in NOCA were detected.

Dicamptodon tenebrosus

D. tenebrosus were found infrequently and exhibited a restricted range, with 44 individuals collected from 13 tributaries and stream reaches in the Chilliwack and Skagit/Diablo watersheds (Figure 4, Table 4). Both of these watersheds lay to the west of the orographic divide, and all specimens within them were found below 824 meters of elevation and only in streams with gradients greater than 8% (Table 5).

In the sites where *D. tenebrosus* was found, densities ranged from 0.03 to 0.33 individuals/m^2 with a median density of 0.07 individuals/m^2. The highest number captured in a surveyed segment was eight. This occurred at Sites 13 and 42, which were located in unnamed tributaries in the lower Chilliwack and Skagit River watersheds respectively (site characteristics can be found in Appendices B and C). In the sites where *D. tenebrosus* was present the median number of individuals captured was two with an interquartile range of five individuals. The snout to vent lengths (SVL) ranged from 15 to 99 mm with a median SVL of 53 mm. All of the individuals captured were in the wetted channel and were most likely immature specimens as determined by the presence of gills and short SVL.

Table 4. Summary of Dicamptodon tenebrosus capture information for the watersheds inventoried in NOCA from 1996 to 1998 and from 2003 to 2004. N = number of stream segments sampled.

		Dicamptodon tenebrosus				
		individuals	stream segment	Density (individuals/m^2)		
Watershed	N	captured	detection rate (%)	median	1st Quartile	3rd Quartile
Big Beaver	27	0	0	0	0	0
Bridge	34	0	0	0	0	0
Chilliwack	24	13	17	<0.0001	0	<0.0001
Little Beaver	8	0	0	0	0	0
Lower Stehekin	14	0	0	0	0	0
Ross	15	0	0	0	0	0
Skagit	23	31	39	<0.0001	0	0.050
Thunder	11	0	0	0	0	0
Upper Stehekin	12	0	0	0	0	0
All Watersheds Combined	168	44	8	0	0	0

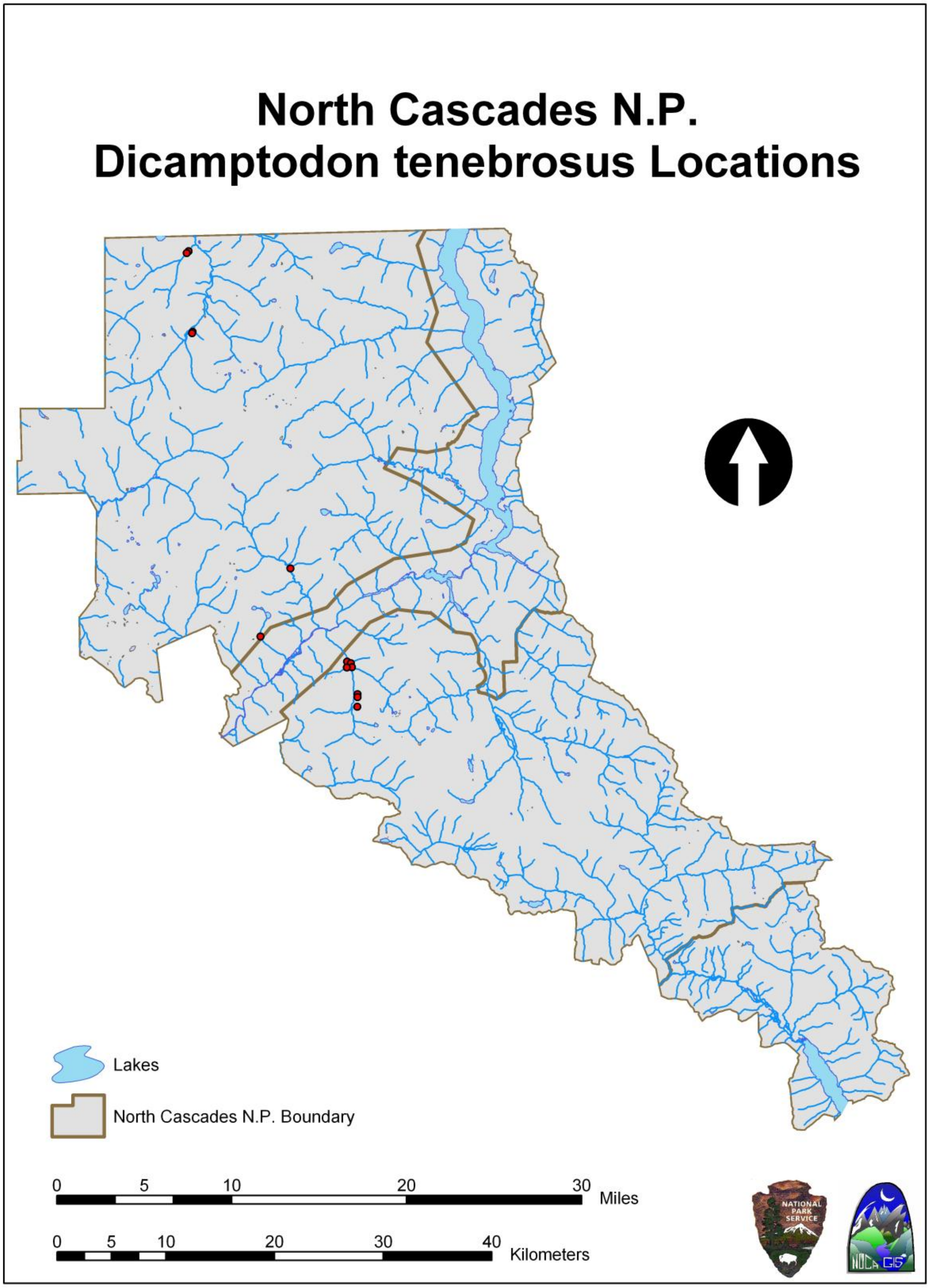


Figure 4. Dicamptodon tenebrosus capture locations in the North Cascades National Park Service Complex.

Table 5. Summary of landform and habitat characteristics for the sites where Ascaphus truei and Dicamptodon tenebrosus were detected from inventories conducted in NOCA from 1996 to 1998 and from 2003 to 2004.

Category, Variable	*Ascaphus truei*		*Dicamptodon tenebrosus*	
	Median	Range	Median	Range
Landform Cahracteristics				
Elevation (m)	759	184 - 1707	608	354 - 824
Aspect (Degrees from N)	110	0 - 180	59	30 - 120
Gradient Category (%)*	>20	1 - >20	>20	8 - >20
Stream Order*	1	1 - 4	1	1 - 3
Water Quality				
Water Temperature (C)	10	6 - 18	12	9 - 17
Conductivity (μS)	32.7	10.1 - 134.2	28.1	15.1 - 57.2
Channel Characteristics				
Wetted Width (m)	2.2	0.25 - 23.4	1.8	0.7 - 11
Bankfull Width (m)	3.7	0.5 - 35.5	2.5	0.72 - 12
Water Velocity (m/s)	0.48	0 - 4.00	0.59	0.04 - 2.08
Water Depth (m)	0.12	<0.05 - 1.2	0.06	<0.05 - 0.7
Canopy Cover (%)	87	0 - 100	95	33 - 100
Substrate Type*	Boulder/ Cobble	Bedrock - Sand/Gravel	Cobble/ Boulder	Bedrock - Sand/Gravel
Instream Cover				
Large Woody Debris (%)	6	0 - 50	9	0 - 50
Organic Debris (%)	4	0 - 60	14	0 - 50
Cut Bank (%)	3	0 - 100	1	0 - 20
Instream Habitat				
Cascade (%)	21	0 - 100	39	0 - 85
Riffle (%)	33	0 - 100	14	0 - 100
Pool (%)	19	0 - 100	28	0 - 100
Tail-out (%)	1	0 - 100	1	0 - 25
Subsurface (%)	0	0 - 55	4	0 - 60
Obscured (%)	0	0 - 80	9	0 - 34
Other (falls) (%)	0	0	0	0

* Reported as mode for categorical data.

Ascaphus truei
A total of 841 *A. truei* were captured, making this the most abundant and wide spread species detected (Figure 5, Table 6). The highest number of individuals captured was 73 from Site 43 (located in an unnamed tributary to lower Newhalem Creek in the Skagit watershed). However, the median value was much lower with only four individuals captured per stream segment. Densities within stream segments ranged up to 2.43 individuals/m^2 with a median density of 0.01 individuals/m^2.

In the stream segments where *A. truei* were detected, their distribution was highly variable, and they were not detected in most of the transects/blocks searched. In the 86 stream segments where this species was detected a total of 837 transects/blocks were searched, and individuals were detected in only 313 or 37% of them. Additionally, within the stream segments where *A. truei* were detected they were typically only found in one of the ten transects/blocks searched with a modal detection rate of 10% (Figure 6).

Table 6. Summary of Ascaphus truei capture information for the watersheds inventoried in NOCA from 1996 to 1998 and from 2003 to 2004. N = number of stream segments sampled.

		Ascaphus truei				
		individuals	stream segment	Density (individuals/m^2)		
Watershed	N	captured	detection rate (%)	median	1st Quartile	3rd Quartile
Big Beaver	27	47	52	0.010	0	0.095
Bridge	34	21	29	<0.0001	0	0.009
Chilliwack	24	259	79	0.070	0.033	0.573
Little Beaver	8	18	25	<0.0001	0	0.056
Lower Stehekin	14	29	29	<0.0001	0	0.025
Ross	15	40	47	<0.0001	0	0.100
Skagit	23	304	70	0.100	0	0.587
Thunder	11	103	91*	0.284	0.172	0.554
Upper Stehekin	12	20	33	<0.0001	0	0.033
All Watersheds Combined	168	841	51	0.010	0	0.167

* Streams selected for sampling in the Thunder Creek drainage were previously known to contain *A. truei*.

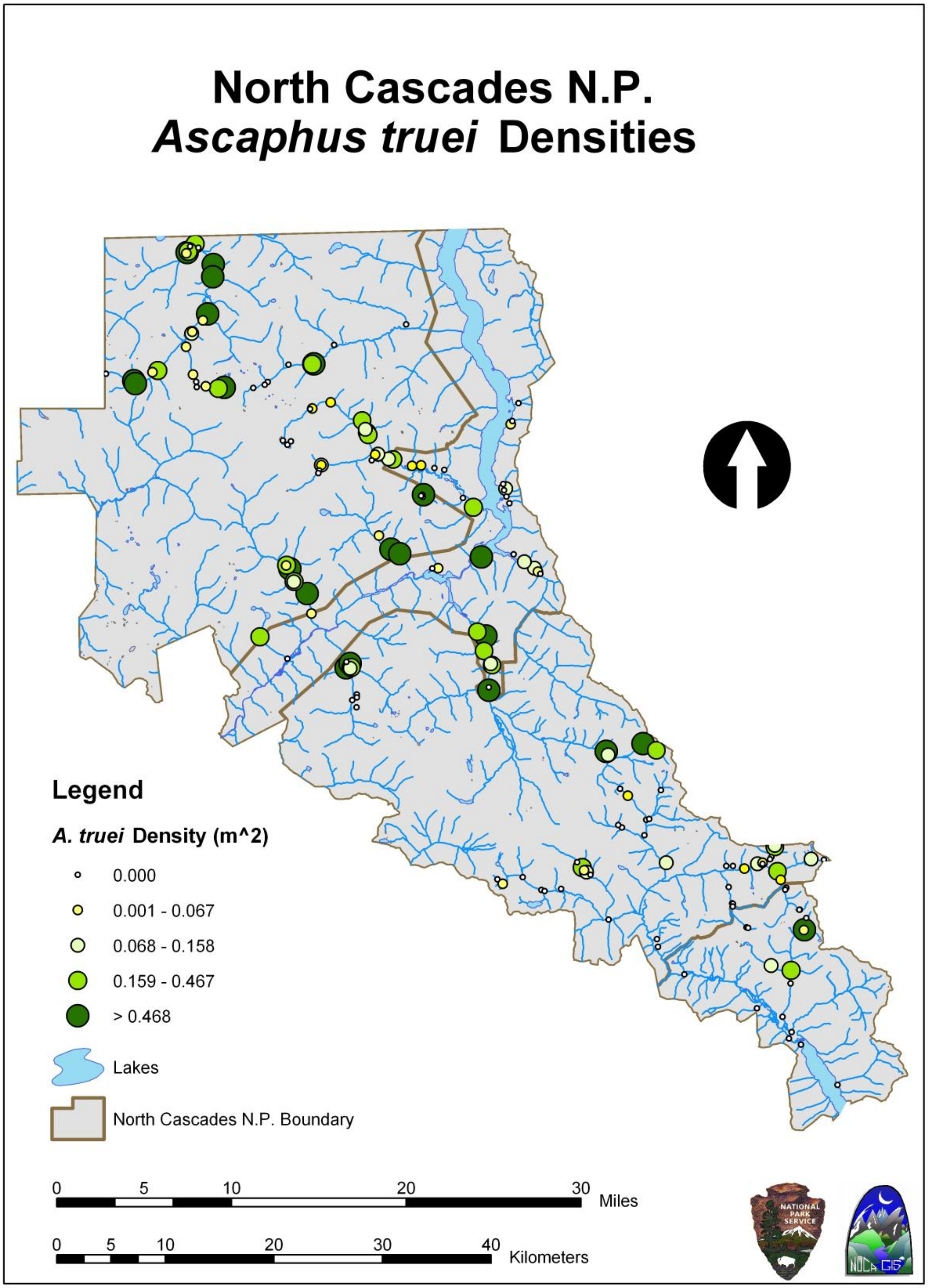


Figure 5. Ascaphus truei capture locations and densities across the North Cascades National Park Service Complex.

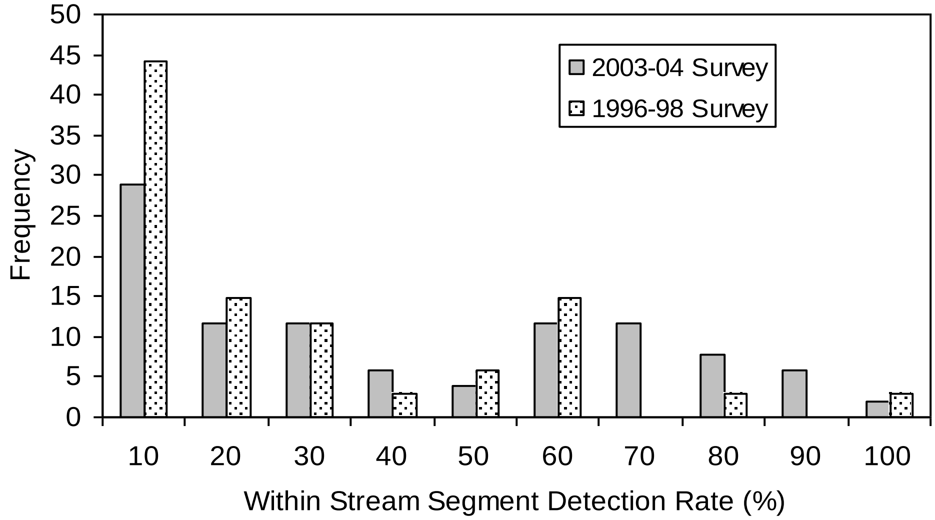


Figure 6. Histogram comparing Ascaphus truei detection rates between the 2003-04 and 1996-98 surveys within the stream segments where A. truei were found.

While *A. truei* were found in all of the watersheds surveyed, their frequency of occurrence varied across the orographic divide and between ecoregions (Table 7). Most apparent was a significantly higher frequency of occurrence to the west of the orographic divide ($X^2 = 16.8$, $p < 0.01$). The North Cascades Lowland Forest ecoregion also had a significantly higher frequency of occurrence than the North Cascade Highland Forest ecoregion ($X^2 = 3.7$, $p = 0.05$). Small and unequal sample sizes did not allow for Chi Square testing between ecoregions when parsed into orographic zones. However, despite the small sample size, it appeared that *A. truei* were more likely to be found in western subalpine habitats than eastern subalpine habitats. Additionally, *A. truei* were more likely to be found in Lowland Forests rather than Highland Forests to the east of the orographic divide. Conversely, they were more likely to occur in the Highland Forests rather than Lowland Forest to the west of the orographic divide.

Table 7. The frequency of occurrence for A. truei within ecoregions, orographic zones and for a combination of both factors (shaded area). The numbers in parenthesis are the total number of sample sites within that particular category. Thunder Creek watershed sites were previously identified as containing A. truei and were omitted from this analysis.

		Orographic Position	
		East	West
Ecoregion		37(110)	75(47)
Alpine/Subalpine	29(7)	0(4)	67(3)
Wenatchee/Chelan Highlands	22(9)	22(9)	No Data
North Cascades Highland Forest	42(67)	34(56)	82(11)
North Cascades Lowland Forest	60(74)	49(41)	73(33)

Table 8. The number of Ascaphus truei individuals captured in each age class and as a percentage (in parentheses) of the total for the surveyed watersheds in NOCA.

	Age Class			
Watershed	Tadpole	Metamorph	Adult	Total
Big Beaver	40 (85)	1 (2)	6 (13)	47
Bridge	12 (57)	4 (19)	5 (24)	21
Chilliwack	210 (81)	32 (12)	17 (7)	259
Little Beaver	18 (100)	0 (0)	0 (0)	18
Lower Stehekin	27 (93)	1 (3)	1 (3)	29
Ross	34 (85)	2 (5)	4 (10)	40
Skagit	277 (91)	19 (6)	8 (3)	304
Thunder	94 (91)	7 (7)	2 (2)	103
Upper Stehekin	15 (75)	0 (0)	5 (25)	20
All Watersheds Combined	727 (86)	66 (8)	48 (6)	841

A. truei tadpoles were captured in greater frequency and abundance than either metamorphosing or adult individuals (Table 8). Adult male and female *A. truei* were captured in essentially equal proportions represented by 21 male, 19 female and 9 unknown/escapes. Six stream reaches in Thunder Creek and Fisher Creek watersheds were intensively sampled for *A. truei* tadpoles in an effort to determine the number of age class cohorts present. While it appeared that three or possibly four age classes were present in these streams, the small sample sizes (25-56) and lack of time series data made reliable assessments of age classes uncertain (Appendix D). The surveys conducted in 2003-04 did not employ any high intensity or time series sampling however, several age classes appear to be present in NOCA streams (Appendix D, Figures D1 through D3).

Landform, hydrologic and stream habitat characteristics for each stream segment were compiled and are reported in Appendix C. Water velocity data had many missing values due to equipment malfunction or water depths that were too shallow for the equipment to operate properly. The high detection rates of *A. truei* allowed for comparisons to be made between those sites where this species were detected and those where they were not detected (Figures 7, 8, 9 & 10). Conductivity and the percent area dominated by pools were significantly higher in the sites where *A. truei* were detected and those sites where weren't (Figures 7 and 9 and Table 9). Conversely, stream channel aspect, water velocity, percent area covered by organic debris, cut banks, and the amount of the habitat area dominated by riffles were significantly lower in the sites where *A. truei* were detected and where they weren't (Figures 7, 8 and 9 and Table 9).

***Ascaphus truei* and *Dicamptodon tenebrosus* Concurrence**

A. truei were found in 69% of the stream segments where *D. tenebrosus* were found. However, in these streams, the two species were found together in only 31% of the same sample units.

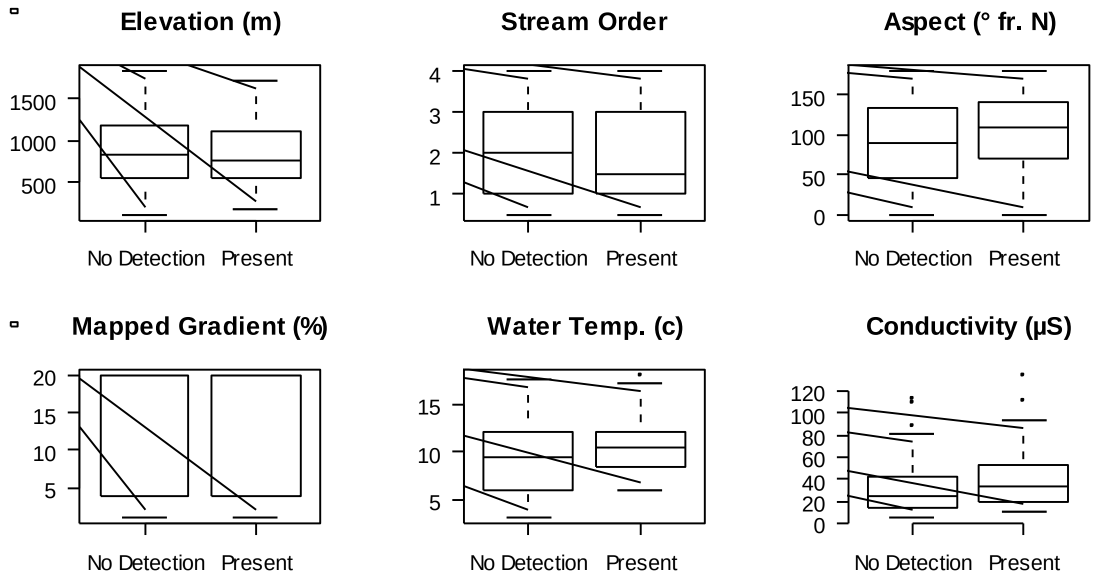


Figure 7. Boxplots comparing the median, 25th and 75th percentiles (boxes), and 5th and 95th percentiles (whiskers) for the landform and water quality characteristics of the sites where Ascaphus truei were found and where they were not detected.

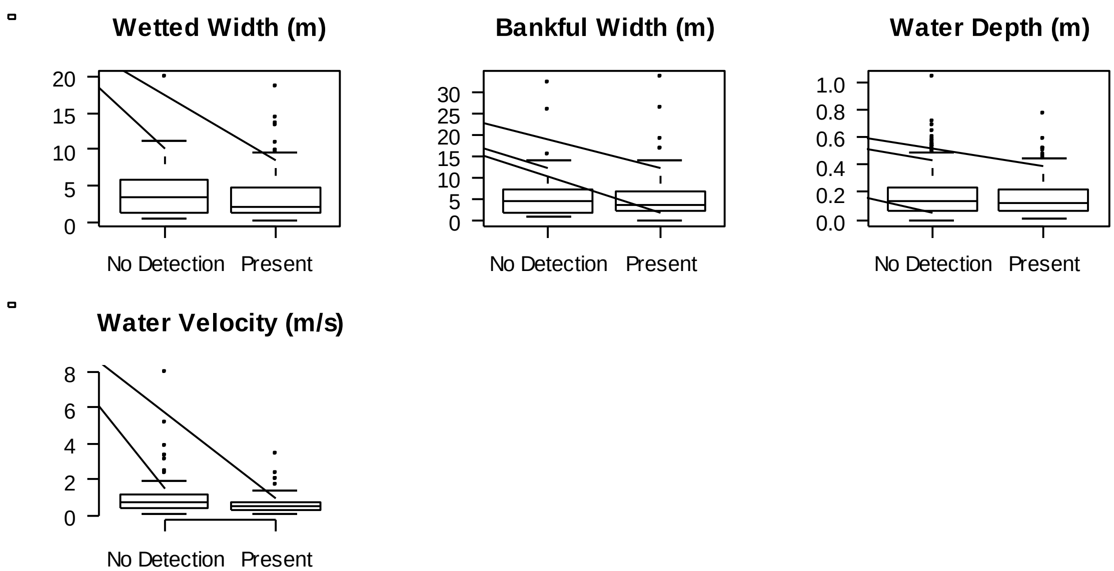


Figure 8. Boxplots comparing the median, 25th and 75th percentiles (boxes), and 5th and 95th percentiles (whiskers) for the hydrologic characteristics of the sites where Ascaphus truei were found and where they were not detected.

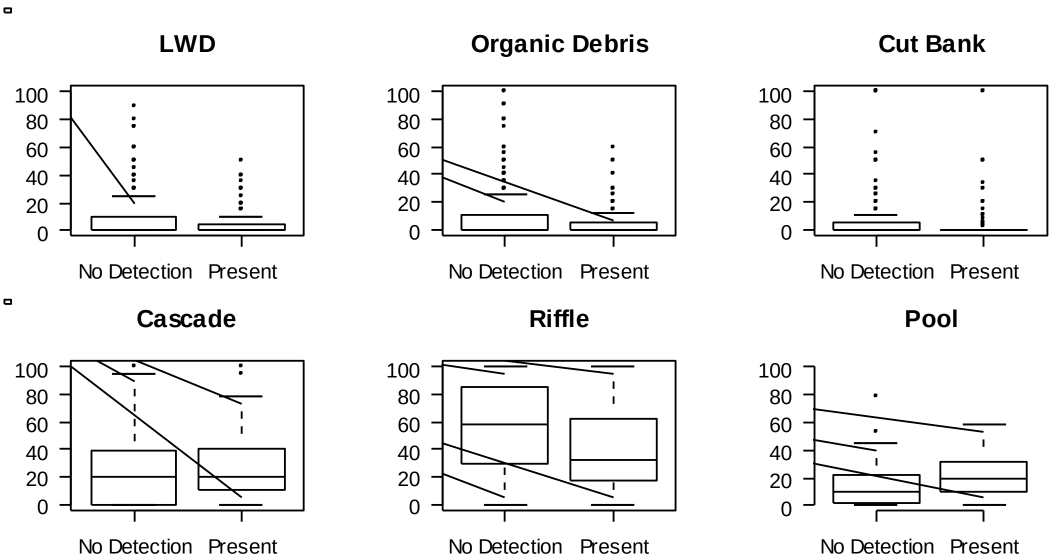


Figure 9. Boxplots comparing the median, 25th and 75th percentiles (boxes), and 5th and 95th percentiles (whiskers) for the stream habitat characteristics of the sites where Ascaphus truei were found and where they were not detected. Values are the percent cover of the habitat types. (LWD= Large Woody Debris)

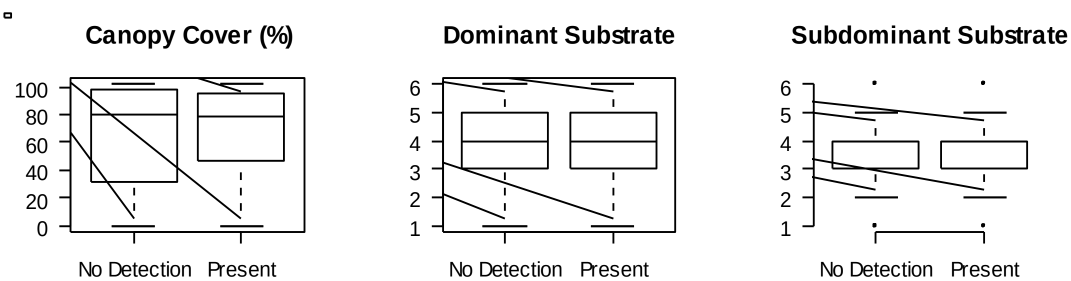


Figure 10. Boxplots comparing the median, 25th and 75th percentiles (boxes), and 5th and 95th percentiles (whiskers) for the percent overstory canopy cover and substrate types for the sites where Ascaphus truei were found and where they were not detected. (Substrate categories: 1=Silt, 2=Sand, 3=Gravel, 4=Cobble, 5=Boulder, 6=Bedrock)

Table 9. Results from Kruskal-Wallis tests showing significantly different stream attribute and habitat characteristics between the sites where *Ascaphus truei* were found and where they were not detected.

	X^2	p-value
Aspect	3.78	0.05
Conductivity	5.71	0.02
Water Velocity	4.15	0.04
Organic Debris	7.18	< 0.01
Cut Bank	13.15	< 0.01
Riffle	5.312	0.02
Pool	13.41	< 0.01

Discussion

Overall, our findings were consistent with much of the previous work that has been conducted concerning stream amphibians in the Pacific Northwest. Both Olympic (OLYM) and Mt. Rainier (MORA) National Parks had higher site occupancy rates for the two species that we found at NOCA. Using survey techniques similar to those we used in this project, *A. truei* were found in 58 and 68% of the streams surveyed and *Dicamptodon* species were detected in 35 and 21% of the streams surveyed at OLYM and MORA respectively(Bury and Adams 2000; Tyler et al. 2003). In NOCA, *A. truei* were detected in 51% of the sites and *D. tenebrosus* were detected in only 8% of the sites. However, these percentages change when the sites to the east of the orographic divide are excluded. When considering only the western portion of NOCA, the detection rates of *A. truei* rise to 75% and the detection rates of *D. tenebrosus* increase to 28%. These findings illustrate the predominant east-west trend in distribution and site occupancy that we expected to find. It appears that the optimal conditions for *A. truei* and the only suitable habitat for *D. tenebrosus* occur in the western 93,477 hectares of the Park, an area encompassing roughly only one third of NOCA. Since the Pacific Crest is considered the leading factor influencing the vegetation composition (Franklin and Dyrness 1973) and ecoregions (Omernik 2002) in the Cascade Mountains, we believed it would similarly determine distribution of stream amphibian communities and were surprised that the dominant predictor was the orographic divide which is located approximately 20 kilometers west of the Pacific Crest.

Water temperature has been identified as one the dominant factors in predicting the occurrence of *A. truei* and is likely contributing to the difference in site occupation between the east and west sides of NOCA. Developing embryos and tadpoles have a narrow range of water temperature tolerances that vary only from 5 to 18.5°C (Brown 1975). While none of the streams that we surveyed exceeded 18°C, water temperatures falling below 5°C could impact *A. truei* in NOCA. Dupuis et al. (2000) found that a thick blanket of snow is necessary for *A. truei* to persist in colder eastern climates. Since the eastern portions of NOCA have a more continental climate with lower temperatures and less snow pack, it is possible that water temperatures drop below tolerable levels and limit the occurrence of this species in the eastern portion of the park.

Other than higher site occupancy to the west of the orographic divide, *A. truei* are almost ubiquitous throughout NOCA and were found in every watershed surveyed and in almost all habitat types. In fact, the only predictable habitats where this species would not found were in streams dominated to a large extent by active glaciers and containing glacial till with highly mobile substrate. On a macroenvironment scale we found the streams containing *A. truei* had higher conductivities and more southern aspects than streams where they were not found. Similarly on a microhabitat scale we found the transect and blocks containing *A. truei* had higher amounts of slow water pool habitats, fewer cut banks and less organic debris. These results should be interpreted as only a few of the components that influence the occurrence of this species in a larger context of historical biogeography, stochastic disturbance events and interactions with other species (Welsh and Lind 2002).

A. truei occurrence is closely related to cobble substrates which provide refuge in their interstitial spaces and adequate surface area for foraging (Bury and Adams 2000; Corn and Bury 1998; Wilkins and Peterson 2000) The likelihood of finding this species decreases with increases in fine sediment which fill these interstitial spaces and blankets periphyton (Dupuis and Stevenson, 1999; Richardson et al., 1995; Welsh and Ollivier, 1998; Wilkins and Peterson, 2000). We did not find any significant differences in substrate size between the sites where *A. truei* were detected and where they were not. Since over 75% of the transects and blocks we surveyed were composed of cobble and/or boulders, it is unlikely that we would find any significant differences in these variables. However, a comparison of the substrate distributions for the transects and blocks within the streams where *A. truei* were found reveals that we were more likely to find this species in habitats without fine sediments (Figure 11).

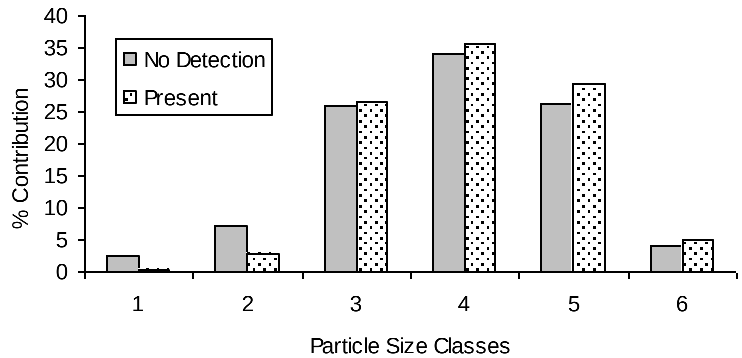


Figure 11. Histogram comparing the substrate distributions between the transects and blocks where A. truei were present and where they were not detected within the stream segments where they were found. (Substrate categories: 1=Silt, 2=Sand, 3=Gravel, 4=Cobble, 5=Boulder, 6=Bedrock).

While the populations of *A. truei* and *D. tenebrosus* in the park are in close geographic proximity to each other, they are separated by large topological features and climatological gradients. Dispersal between watersheds is likely to be minimal, especially when these boundaries occur in the higher elevations of the park or are composed of large bodies of open water such as the Ross Lake reservoir. Other studies have suggested that the responses of stream amphibians to stress can vary from region to region (Welsh and Lind 2002). Given this information, it is recommended that future monitoring take into consideration the differences that occur across the orographic divide and that population trends might be better assessed on a watershed scale.

Our surveys expanded the documented range of *D. tenebrosus* in NOCA from a previous single sighting near the North Cascades Visitors Center in the Newhalem Creek watershed to thirteen sites in the Chilliwack and Skagit watersheds. These findings are especially significant for the conservation status of this species in British Columbia. Since *D. tenebrosus* are only found in the Chilliwack River and Cultus Lake watersheds (MELP 2000) and NOCA lands represent the majority of the protected habitat for this isolated British Columbian population.

It is possible that *D. tenebrosus* are more common in NOCA than our survey results suggest. While Bury and Corn (1991) found that the failure to detect this species was less than one percent when using the same methods we used, their work was conducted in the Coast Range of Oregon where *D. tenebrosus* is much more common. In surveys designed to determine the presence of stream amphibians, the British Columbia Ministry of Environment Lands and Parks recommend using a time constrained hand collection technique targeting the most suitable habitat in a stream and specified searching for 120 minutes to detect *D. tenebrosus* (MELP 2000). In our surveys we spent an average of 53 minutes searching in a reach, and this may not been enough time to detect this species.

At this time, most of the watersheds in NOCA have been surveyed for stream amphibians. We have not investigated the Bacon Creek, Baker River, Cascade River and Depot Creek watersheds in the western portions of the park or the Panther Creek watershed which feeds into the Ross Lake Reservoir on the eastern side of the park. While these watersheds represent only a small area of NOCA, they do comprise a significant portion of the west slope habitat warranting future monitoring for these species.

Literature Cited

Barinaca, M. 1990. Where have all the froggies gone? Science 20:1033-1034.

Beebee, T. J. C., R. J. Flower, A. C. Stevenson, S. T. Patrick, P. G. Appleby, C. Fletcher, C. Marsh, J. Natkanski, B. Rippey, and R. W. Battarbee. 1990. Decline of the natterjack toad *Bufo calamita* in Britain: palaeoecological, documentary, and experimental evidence for breeding site acidification. Biological Conservation 53:1-20.

Bishop, C. A., and K. E. Petit, eds. 1992. Declines in Canadian amphibian populations: designing a national monitoring strategy. Canadian Wildlife Service Occasional Paper 76:1-120.

Blaustein, A. R., and D. B. Wake. 1990. Declining amphibian populations: a global phenomenon? Trends in Ecology and Evolution 5:203-204.

Blaustein, A. R. 1994. Chicken Little or Nero's fiddle? A perspective on declining amphibian populations. Herpetologica 50:85-97.

Blaustein, A. R., P. D. Hoffman, D. G. Hokit, J. M. Kiesecker, S.C. Walls, and J. B. Hays. 1994a. UV repair and resistance to solar UV-B in amphibian eggs: a link to population declines? Proceedings of the National Academy of Sciences 91:1791-1795.

Blaustein, A. R., D. B. Wake, and W. P. Sousa. 1994b. Amphibian declines: judging stability, persistence, and susceptibility of populations to local and global extinction. Conservation Biology 8:60-71.

Bradford, D. F. 1983. Winterkill, oxygen relations, and energy metabolism of a submerged dormant amphibian, *Rana muscosa*. Ecology 64:1171-1183.

Bradford, D. F. 1989. Allotopic distribution of native frogs and introduced fishes in high Sierra Nevada lakes of California: implication of the negative effect of fish introductions. Copeia:775-778.

Bradford, D. F. 1991. Mass mortality and extinction in a high-elevation population of *Rana muscosa*. Journal of Herpetology 5:174-177.

Brown H. A. 1990. Morphological variation and age-class determination in overwintering tadpoles of the tailed from, *Ascaphus truei*. Journal of Zoology 220:171-184.

Burton, T. A. and G. E. Likens. 1975. Salamander populations and biomass in the Hubbard Brook Experimental Forest, New Hampshire. Copeia:541-546.

Bury, R. B., C. K. Dodd, Jr., and G. M. Fellers. 1980. Conservation of the Amphibia of the United States: a review. U.S. Fish and Wildlife Service Research Publication. 134:1-34.

Bury, R. B. 1988. Habitat relationships and ecological importance of amphibians and reptiles. Pages 61-76 in Raedke, K.J. Streamside Management: Riparian wildlife and forestry interactions. Seattle, Washington. University of Washington Press.

Bury, R. B. and P. S. Corn. 1991. Sampling methods for amphibians in streams in the Pacific Northwest. United States Forest Service, Pacific Northwest Research Station. Portland, Oregon. PNW-GTR-275.

Bury, R. B. and D. J. Major. 1997. Integrated sampling for amphibians communities in montane habitats. Pages 75-82. In: Olson, D.H., W.P. Leonard, and R.B. Bury editors. Sampling amphibians in lentic habitats: methods and approaches for the Pacific Northwest. Olympia, Washington: Northwest Fauna 4.

Bury, R. B. and M. J. Adams. 2000. Inventory and Monitoring of Amphibians in North Cascades and Olympic National Parks, 1995-1998. United States Geological Survey, Forest and Rangeland Ecosystem Science Center. Corvallis, OR.

Cannatella, D. C. and D. M. Hillis. 1993. Amphibian relationships: phylogenetic analysis of morphology and molecules. Herpetological Monographs 6:1-7.

Carey, C. 1993. Hypothesis concerning the causes of the disappearance of boreal toads from the mountains of Colorado. Conservation Biology 7:355-362.

Chambers, J. M., Cleveland, W. S., Kleiner, B. and Tukey, P. A. 1983. Graphical Methods for Data Analysis. Wadsworth & Brooks/Cole. Pg. 62.

Conover, W. J., M. E. Johnson and M. M. Johnson. 1981. A comparative study of tests for homogeneity of variances, with applications to the outer continental shelf bidding data. Technometrics 23: 351-53.

Corn, P. S. 1994. What we know and don’t know about amphibian declines in the west. Pages 59-67 in Sustainable Ecological Systems: Implementing an Ecological Approach to Land Management. USDA Forest Service, Rocky Mountain Forest and Range Experiment Station, Ft. Collins, Colorado, General Technical Report RM-247.

Corn, P. S., and R. B. Bury. 1989. Logging in western Oregon: responses of headwater habitats and stream amphibians. Forest Ecology and Management 29:39-57.

Corn, P. S., and J. C. Fogelman. 1984. Extinction of montane populations of the northern leopard frog (*Rana pipiens*) in Colorado. Journal of Herpetology 18:147-152.

Corkran, C. C. and C. Thoms. 1996. Amphibians of Oregon, Washington and British Columbia. Lone Pine Publishing, Redmond WA.

Daugherty, C. H. and A. L. Sheldon. 1982. Age-specific movement patterns of the frog *Ascaphus truei*. Herptologica 38:468-474.

Dodd, C. K., Jr. 1991. The status of the Red Hills salamander *Phaeognathus hubrichti*, Alabama, USA, 1976-1988. Biological Conservation 55:57-75.

Dunson, W. A., R. L. Wyman, and E. S. Corbett. 1992. A symposium on amphibian declines and habitat acidification. Journal of Herpetology 16:349-352.

Dupuis, L. and D. Stevenson. 1999. Riparian management and the tailed frog in northern coastal forests. Forest Ecology and Management 124:35-43.

Dupuis, L. A., F. L. Brunnell, P. A. Friele. 2000. Determinants of the tailed frog's range in British Columbia, Canada. Northwest Science 74(2):109-115.

Franklin, J. F., and C. T. Dyrness. 1973. Natural vegetation of Oregon and Washington. Gen. Tech. Report PNW-8. USDA, Forest Service, Pacific Northwest Forest and Range Exp. Stn., Portland, OR. 417 pp.

Freda, J. 1986. The influence of acidic pond water on amphibians: a review. Water, Air, and Soil Pollution 30:439-450.

Hayes, M. P., and M. R. Jennings. 1986. Decline of ranid frog species in western North America: are bullfrogs (*Rana catesbeiana*) responsible? Journal of Herpetology 20:490-509.

Hine, R. L., B. L. Les, and B. F. Hellmich. 1981. Leopard frog populations and mortality in Wisconsin, 1974-76. Wisconsin Department of Natural Resources Tech. Bull. 122:1-39.

Holmes R. E. and R. S. Glesne. 1997. NOCA NRPP Amphibian Inventory Big Beaver Watershed 1996 – Progress Report. North Cascades National Park, Sedro-Woolley, WA.

Holmes R. E. and R. S. Glesne. 1998. NOCA NRPP Amphibian Inventory Bridge Creek Watershed 1997 – Progress Report. North Cascades National Park, Sedro-Woolley, WA.

Holmes R. E. and R. S. Glesne. 1999. NOCA NRPP Amphibian Inventory North Cascades National Park Service Complex 1998 – Progress Report. North Cascades National Park, Sedro-Woolley, WA.

Hollander, M and D. A. Wolfe. 1973. Nonparametric statistical inference. New York: John Wiley and Sons. Pages 68-75 (Wilcox test). Pages 115-120 (Kruskal test). Pages 185-194 (Kendall correlation).

IUCN (The World Conservation Union). 2004. Global Amphibian Assessment. <www.globalamphibians.org>. Downloaded on 22 August 2005.

Kuntz, R. C. and R. S. Glesne. 1993. Stehekin Valley vertebrate inventory. National Park Service Technical Report NPS/PNROSU/NRTR-95-03. 285 p.

MELP (Ministry of Environment, Lands and Parks) 2000. Inventory Methods for Tailed Frog and Pacific Giant Salamander. Standards for Components of British Columbia's Biodiversity Number 39. <http://www.for.gov.bc.ca/ric >. Downloaded on 4 June 2004.

Murphy, M. L. and J. D. Hall. 1981. Varied effects of clear-cut logging on predators and their habitat in small streams of the Cascades Mountains, Oregon. Canadian Journal of Fisheries and Aquatic Sciences 38:137-145.

Nussbaum, R. A., Brodie, E. D. and R. M. Storm. 1983. Amphibians and Reptiles of the Pacific Northwest. University of Idaho Press, Moscow ID.

Omernik, J. M. 1987. Ecoregions of the conterminous United States. Annals of the Association of American Geographers. 77(1):118-125.

Omernik, J. M. 2002. Draft: Level III and IV Ecoregions of the Northwestern United States http://www.epa.gov/wed/pages/ecoregions/ecoregions.htm. Downloaded on 3 June 2003.

PNRS (The Pacific Northwest Research Station). 2005. <http://www.fs.fed.us/pnw/olympia/wet/2000/sams.htm>. Downloaded on 10 October 2005.

Patefield, W. M. 1981. Algorithm AS159. An efficient method of generating r x c tables with given row and column totals. Applied Statistics 30: 91-97.

Pechmann, J. H. K., D. E. Scott, R. D. Semlitsch, J. P. Caldwell, L. J. Vitt, and J. W. Gibbons. 1991. Declining amphibian populations: the problem of separating human impacts from natural fluctuations. Science 253:892-895.

Pechmann, J. H. K., and H. M. Wilbur. 1994. Putting declining amphibian populations in perspective: natural fluctuations and human impacts. Herpetologica 50:65-84.

Petranka, J. W., M. E. Eldridge, and K. E. Haley. 1993. Effects of timber harvesting on southern Appalachian salamanders. Conservation Biology 7:363-370.

Pilliod, D. S. and C. R. Peterson. 2001. Local and landscape effects of introduced trout on amphibians in historically fishless watersheds. Ecosystems 4:322-333.

Pounds, J. A., and M. L. Crump. 1994. Amphibian declines and climate disturbance: the case of the golden toad and harlequin frog. Conservation Biology 8:72-85.

Richards, S. J., K. R. McDonald, and R. A. Alford. 1993. Declines in populations of Australia's endemic tropical rainforest frogs. Pacific Conservation Biology 1:66-77.

SSHIAP. 2000. Salmon and Steelhead Habitat Inventory and Assessment Project: Standard Approach and Methodology. Northwest Indian Fisheries Commission.

Strahler, A. N. 1952. Dynamic Basis of Geomorphology. Geological Society of America, Bulletin 63, pages 923-938.

Sumioka, S. S., D. L. Kreoch, K. D. Kasiuch 1998. Annual Precipitation for state of Washington, 1930-1957, *in* USGS WR Investigation Report 97-4277, Tacoma, Washington. 91 pp.

Tyler T. J., C. D. McIntire, B. Samora, R. L. Hoffman, G. L. Larson. 2003. Inventory of Aquatic Breeding Amphibians, Mount Rainier National Park, 1994-1999. United States Geological Survey, Forest & Rangeland Ecosystem Science Center. Corvallis, OR.

Wake, D. B. 1991. Declining amphibian populations. Science 203:860.

Welsh, H. H. and L. M. Ollivier. 1998. Stream amphibians as indicators of ecosystem stress: a case study from California's redwoods. Ecological Applications 8(4):1118-1132.

Welsh, H. H. and A. J. Lind. 2002. Multiscale habitat relationships of stream amphibians in the Klamath-Siskiyou region of California and Oregon. Journal of Wildlife Management 66(3):581-602.

Wilkins, N. R and N. P. Peterson. 2000. Factors related to amphibian occurrence and abundance in headwater streams draining second-growth Douglas-fir forests in southwestern Washington. Forest Ecology and Management 139:79-91.

Appendix A. Amphibian Monitoring Survey Forms and Methods

Stream Amphibian Survey Data Form 1a - NOCA

Watershed (7th Field HUC)		Stream Name		NOCA Segment ID	
Reach Number	UTM -N	UTM -E	Day	Month	Year
Observers				Recorder	

Current Weather			Description of Site Location and Additional Comments:
Weather w/in last 24 hours			
Cloud Cover	Precipitation	Flow	
CL=Clear	D=Dry	I = Intermitent	
PC= Part Cloudy	F=Fog	L = Low	
CO=Overcast	M=Mist	M = Moderate	
	LR=Light Rain	E = Elevated	
	HR=Heavy Rain	H = High	
	SL=Sleet	B = Bankful	
	SN=Snow	F- Flood	

Air Temp. C F	Water Temp. C F	Aspect (in degrees, looking dwn str)	Conductivity

Transect 1	Location (m)	Survey Start Time	Survey End Time	# Surveyors	Gradient (%)		
Wetted Width meters		Bankful Width meters		Substrate			
				Dominant		Subdominant	
Bankful Depths meters (LB to RB)				BR = Bedrock	BO = Boulder	CO = Cobble	GR = Gravel
1/4	1/2	3/4	Max	SA = Sand	Silt/Clay = SI		
Water Depth meters (LB to RB)				Canopy Cover (dots covered)			
1/4	1/2	3/4	Max	UP	LB	Down	Right
Water Velocity meters / S (LB to RB)				Instream Cover (%)	LWD	Org. Debris	U.C. Banks
1/4	1/2	3/4	Max				
Habitat Type (%)	Obscured	Cascade	Riffle	Pool	Tailout	Subsurface	Other
Photo # Description							

Transect 2	Location (m)	Survey Start Time	Survey End Time	# Surveyors	Gradient (%)		
Wetted Width meters		Bankful Width meters		Substrate			
				Dominant		Subdominant	
Bankful Depths meters (LB to RB)				BR = Bedrock	BO = Boulder	CO = Cobble	GR = Gravel
1/4	1/2	3/4	Max	SA = Sand	Silt/Clay = SI		
Water Depth meters (LB to RB)				Canopy Cover (dots covered)			
1/4	1/2	3/4	Max	UP	LB	Down	Right
Water Velocity meters / S (LB to RB)				Instream Cover (%)	LWD	Org. Debris	U.C. Banks
1/4	1/2	3/4	Max				
Habitat Type (%)	Obscured	Cascade	Riffle	Pool	Tailout	Subsurface	Other
Photo # Description							

Figure A1. NOCA Stream Amphibian Survey form (above, 1 of 2). Sheets for recording data from transects three through eight are identical and were omitted to save space.

General watershed and site information (top of form):

Watershed (7th Field HUC) – Record the name of the downstream watershed (e.g. upper Skagit). A watershed is defined as the section of stream designated as a 7th field HUC (Hydrologic Unit Code), and receiving flow from the survey area.

Stream Name – Record the major stream name (e.g. Little Beaver Creek, Marble Creek, etc.). Unnamed tributaries are designated T1, T2, etc. The labeling starts over at T1 when surveying in a new 7th field HUC.

NOCA Segment ID – Record the segment ID for each data collection site. The segment ID for named streams is the first two letters of the 7th field HUC, the first two letters of the stream name, the letters MS (indicating a mainstem sample) and the reach number (R1, R2, etc.) (For example., the NOCA segment ID for a sample on the lowest reach of Ruby Creek would be RURUMSR1. The segment ID for unnamed streams is the first two letters from the 7th field HUC, the tributary identification number (T1, T2 etc.) and the reach number (R1. R2, etc.) (For example, the NOCA segment ID for the lowest reach of the first unnamed tributary flowing into Ruby Creek would be RUT1R1.

Reach Number - Record the number assigned to the reach. Reach numbers are assigned in order to distinguish separate amphibian surveys that were conducted in the same stream. For example: on Rainbow Creek, Reach 1 started at the Stehekin River road bridge; Reach 2 was upstream of the Rainbow creek falls; and Reach 3 was near the headwaters. Reach 1 is always the lowest section of stream, followed by Reach 2 which is the next section upstream, and so on.

UTM-N - Record the Universal Transverse Mercator (UTM) zone (e.g. 10 S) and the number representing the measurement of the North-South position within the zone (e.g. 559741). The seven digit number is referred to as the “northing” and is measured in meters. The UTM-N is obtained using ArcView (computer based geographic information system) program, and amphibian survey locations are also mapped in ArcView.

UTM-E - Record the Universal Transverse Mercator (UTM) number representing the measurement of the East-West position within the previously recorded zone (e.g. 428211). The six digit number is referred to as the “easting” and is measured in meters. The UTM-E is obtained using the ArcView, and amphibian survey locations are also mapped in Arc View.

Day – Record the date when data was collected. Use a 2 digit number representing the day of month (e.g. 07, 18, etc.).

Month –Record the month when data was collected. Use a 2 digit number representing the month (e.g. 07, 10, etc.).

Year –Record the year when data was collected. Use a 4 digit number representing the year (e.g. 2004).

Observers – Record the first and last initials of the biologists and technicians participating in field data collection.

Recorder – Record the first and last initials of the biologist or technician recording the field data. This person is responsible for ensuring that the data sheets are completely filled out and error checked.

Current Weather – Record the codes reflecting the cloud cover, precipitation and flow at the time of the survey. Select from the following list of codes:

Cloud Cover	Precipitation	Flow
CL = Clear	**D** = Dry	**I** = Intermittent
PC = Part Cloudy	**F** = Fog	**L** = Low
CO = Overcast	**M** = Mist	**M** = Moderate
	LR = Light Rain	**E** = Elevated
	HR = Heavy Rain	**H** = High
	SL = Sleet	**B** = Bankfull
	SN = Snow	**F** = Flood

Weather w/in last 24 hours – Record the codes reflecting the cloud cover, precipitation and flow within the 24 hours prior to the start of the survey. Select from the following list of codes:

Cloud Cover	Precipitation	Flow
CL = Clear	**D** = Dry	**I** = Intermittent
PC = Part Cloudy	**F** = Fog	**L** = Low
CO = Overcast	**M** = Mist	**M** = Moderate
	LR = Light Rain	**E** = Elevated
	HR = Heavy Rain	**H** = High
	SL = Sleet	**B** = Bankfull
	SN = Snow	**F** = Flood

Description of Site Location and Additional Comments: – Record narrative site description information and additional comments (e.g. unique site characteristics, details on location, characteristics of actual stream, etc.).

Air Temp. C F (Celsius or Fahrenheit) - Circle the appropriate grade of temperature (C – Celsius or F – Fahrenheit) and record the air temperature in degrees at the beginning of the survey (e.g. 8.3 (C) or 47 (F) etc.). Air temperature is taken in the shade within the riparian area.

Water Temp. C F (Celsius or Fahrenheit) - Circle the appropriate scale of temperature (C – Celsius or F – Fahrenheit) and record the water temperature in degrees at the beginning of the survey (e.g. 8.3 (C) or 47 (F)). The thermometer should be placed in a section of running water (riffle), out of direct sun light and allowed to stabilize for at least one minute.

Aspect (in degrees, looking down stream) – Record the aspect (direction stream is flowing) in degrees, facing downstream. Aspect is the degree reading (taken with a compass) while facing downstream at the lower end of the survey site.

Conductivity - Record the conductivity of the water at the lower end of the surveyed reach. Conductivity is taken with hand-held conductivity meter following manufacturer instructions.

Individual transect information:
Location (m) – Record the distance (meters) from the downstream end of survey reach to the transect site.

Survey Start Time – Record in military time (hour and minute) when searching for amphibians begins in the transect.

Survey End Time – Record in military time (hour and minute) when searching for amphibians ends in the transect.

 # Surveyors – Record the number of persons participating in the survey for amphibians in this transect.

Gradient (%) – Record the measured gradient (in percent) at each transect site. Gradient is measured by, looking through the clinometer along an artificial line between two points (equidistant from the surface of the stream) and reading the percent (%) scale.

Wetted Width meters – Record the measured wetted width at each transect site. Wetted width is the measured horizontal distance perpendicular to the channel axis from water's edge on one side to water's edge on the opposite side to the nearest 0.1 meter. Do not include gravel bars in the wetted width. For transects that have non-uniformed widths, an average width is recorded

Bankfull Width – Record the measured bankfull width (BfW) at a minimum of three transect sites, to the nearest 0.1 meter. Bankfull is defined as the high streamflow event occurring on average every 1.5 years. Bankfull width is the measured distance, perpendicular to the stream-flow, from the bankfull indicator on the left bank to the bankfull indicator on the right bank (or level line distance from the best indicator to the point where the line intersects the bank (ground) on the opposite side of the stream). Select sections of fast water units that have a straight and relatively narrow channel since such sites offer the clearest bankfull indicators.

Bankfull Depths meters ¼, ½, ¾, Max (LB to RB) – Record the measured bankfull depth (distance from BfW tape to the any element of the channel bed) at 25 percent of the BfW, 50 percent of BFW, and 75 percent of BfW, to the nearest 0.01 meter (start measurements on the left bank of the stream and proceed toward the right bank, facing downstream) at the transect site. Also record the measured maximum bankfull depth (along this same line) to the nearest 0.01 meter. It is expected that some of these measurements will be made outside of the wetted channel atop dry streambed since the survey is performed under low streamflow conditions.

Water Depths meters ¼, ½, ¾, Max (LB to RB) – Record the measured water depth (distance from the surface of the water to any element of the channel bed) at 25 percent of the wetted width, 50 percent of wetted width, and 75 percent of wetted width, to the nearest 0.01 meter (start measurements on the left bank of the stream and proceed toward the right bank, facing downstream) at each transect site. Also record the measured maximum wetted depth (along this same line) to the nearest 0.01 meter. Water depths were measured along the same transect line as bankfull depths (when bankfull depth was measured).

Water Velocity meters / S ¼, ½, ¾, Max (LB to RB) – Record the measured water velocity (average velocity reading from flow meter) at 25 percent of the wetted width, 50 percent of wetted width, and 75 percent of wetted width, to the nearest 0.001 cubic meters per second (start measurements on the left bank of the stream and proceed toward the right bank, facing downstream) at each transect site. Also record the measured maximum measured water velocity (along this same line) to the nearest 0.001 cubic meter per second.

Substrate Dominant – Record the code reflecting the dominant substrate within the wetted channel at the transect site. Select from the following list of codes:

BR = Bedrock	**BO** = Boulder	**CO** = Cobble
GR = Gravel	**SA** = Sand	**SI** = Silt/Clay

Substrate diameter (diameter is the distance across the intermediate axis, neither the longest nor the shortest of the three mutually perpendicular axes) is visually estimated as one of six categories: 1) bedrock (diameter of > 4000 mm); 2) boulder (diameter of 256 – 4000 mm); 3) cobble (diameter of 64 – 256 mm); or 4) gravel (diameter of 2 – 64 mm); 5) sand (diameter of < 2 mm); or 6) silt/clay (feels smooth when rubbed between fingers diameter).

Substrate Subdominant – Record the code reflecting the subdominant substrate within the wetted channel at the transect site. Select from the following list of codes:

BR = Bedrock	**BO** = Boulder	**CO** = Cobble
GR = Gravel	**SA** = Sand	**SI** = Silt/Clay

Substrate diameter (diameter is the distance across the intermediate axis, neither the longest nor the shortest of the three mutually perpendicular axes) is visually estimated as one of six categories: 1) bedrock (diameter of > 4000 mm); 2) boulder (diameter of 256 – 4000 mm); 3) cobble (diameter of 64 – 256 mm); or 4) gravel (diameter of 2 – 64 mm); 5) sand (diameter of < 2 mm); or 6) silt/clay (feels smooth when rubbed between fingers).

Canopy Cover (dots covered) UP, LB, Down, Right – Record each of the four systematic canopy closure readings (sky obscured by vegetation) in the appropriate space. Readings are taken using a densitometer held 12 to 18 inches in front of surveyor at elbow height (make sure the densitometer is level and your head reflection just touches the outside grid). The four readings are taken while standing in the middle of the wetted channel: **(Up)** facing directly upstream; **(LB)** facing left bank; **(Down)** facing downstream; and **(Right)** facing right bank. Record the number of dots obscured by vegetation in the **(%)** column. The actual canopy closure rating (sum the four readings; multiply by 1.04; divide by 4) is calculated in the office.

Instream Cover (%) LWD, Org. Debris, U.C. Banks – Record the estimated percent cover provided by large woody debris (LWD), organic debris (Org. Debris) and undercut banks (U.C. Banks) for the transect site. Record cover area provided to the nearest one percent (total surface area equals 100%).

- **Large woody debris** must: 1) be dead (or eminently dying with no chance of survival); 2) have a root system that is wholly or partially detached and is no longer capable of supporting the log's weight; 3) have a diameter of at least 10 centimeters for at least 2 meters of its length; and 4) intrude into the wetted channel.
- **Organic debris** refers to dead organic matter providing cover within the transect. Organic debris must: 1) be dead (or eminently dying with no chance of survival) debris smaller than the classification for LWD; 2) be within the wetted channel. This can include small chunks of wood, sticks and leaf litter.

- **Undercut banks** are banks that have had there base cut away by water action along the natural or man-made overhangs in the stream.

Habitat Type (%) – Record the percent of each habitat type (Obscured, Cascade, Riffle, Pool, Tailout, Subsurface or Other) that occurs in transect. Only habitat types present should be recorded. The total habitat type percent must total 100 %. (e.g., Obscured-20%, Pool-50%, Tailout-5%, Subsurface-25%).

Habitat unit types are defined as:

- **Obscured Units** – Sometimes it is impossible to identify habitat units such as when a stream runs through a culvert, under a logjam, or through a large undercut bank. When habitat units cannot be seen or their boundaries cannot be identified, record the habitat unit as obscured.
- **Cascade** – Cascades are steep areas with a water surface gradient exceeding 3.5 percent. Some cascades are very short and smooth, such as slip-face cascades located on the downstream faces of channel bars or bedrock outcrops. Step-pool cascades occur where boulder or cobble substrate forms stair-steps. They often are very turbulent, and have numerous small pools associated with the cobble/boulder steps.
- **Riffle** – Riffles are shallow, low gradient areas that do not meet the residual pool depth requirement. They are distinguished from cascades by having a water surface gradient of less than 3.5 percent. Many riffles exhibit surface turbulence associated with increased velocity and shallow water depth over gravel or cobble beds. However, the riffle classification also includes shallow areas without surface turbulence such as glides and pocketwater conditions that do not meet the minimum pool depth requirement.
- **Pool** – Pools are deep water with a low water surface gradient (generally less than 1%). They are typically created by scouring adjacent to obstructions or impoundment of water behind channel blockages and hydraulic controls such as logjams, bedforms or beaver dams.
- **Tailout** – Tailouts are situated on the downstream end of pools, in the transitional area between the pool and the head of the downstream riffle. They are areas of moderately shallow water with an even, laminar flow and a lack of pronounced surface turbulence. These units provide deposition sites for fine bedload materials. They have a flat, smooth bottom, lacking the scour typically associated with the pool. Tailouts are most commonly found in larger, low-gradient channels associated with elongated pools that have well-sorted substrate. They are uncommon in small, high-gradient streams with coarse substrate.
- **Sub-Surface Flow** – Occasionally, stream reaches will alternate between wet and dry areas, or be completely dry. If the stream is dry because of extreme low flow associated with drought, it is not an appropriate time to conduct a habitat unit survey because information generated will not be useful for comparative purposes. On the other hand, if intermittent flow is a typical low flow condition, or if it appears to be resulting from conditions such as coarse sediment aggradation, then documenting its occurrence is useful. When intermittent dry areas are encountered in the main channel, they are recorded as sub-surface flow units. Only main channel sub-surface flow areas are counted and recorded, dry side-channels and dry secondary units are not recorded.
- **Other** – Any habitat unit type that does not fit the above definitions. Make a note (in the comments section) of the observed type.

Photo #/Description – Record the number of the photograph that corresponds to that transect. Write a small description of the photograph that was taken. (e.g., Photo # 3, Looking upstream into T3, Alexis sampling in middle of transect).

Watershed	Stream Name	Seg. ID	Date

Transect 9	Location (m)	Survey Start Time	Survey End Time	# Surveyors	Gradient (%)

Wetted Width meters		Bankful Width meters		Substrate			
				Dominant		Subdominant	
Bankful Depths meters (LB to RB)				BR = Bedrock	BO = Boulder	CO = Cobble	GR = Gravel
1/4	1/2	3/4	Max	SA = Sand	Silt/Clay = SI		
Water Depth meters (LB to RB)				Canopy Cover (dots covered)			
1/4	1/2	3/4	Max	UP	LB	Down	Right
Water Velocity meters / S (LB to RB)				Instream Cover (%)	LWD	Org. Debris	U.C. Banks
1/4	1/2	3/4	Max				
Habitat Type (%)	Obscured	Cascade	Riffle	Pool	Tailout	Subsurface	Other
Photo # Description							

Transect 10	Location (m)	Survey Start Time	Survey End Time	# Surveyors	Gradient (%)

Wetted Width meters		Bankful Width meters		Substrate			
				Dominant		Subdominant	
Bankful Depths meters (LB to RB)				BR = Bedrock	BO = Boulder	CO = Cobble	GR = Gravel
1/4	1/2	3/4	Max	SA = Sand	Silt/Clay = SI		
Water Depth meters (LB to RB)				Canopy Cover (dots covered)			
1/4	1/2	3/4	Max	UP	LB	Down	Right
Water Velocity meters / S (LB to RB)				Instream Cover (%)	LWD	Org. Debris	U.C. Banks
1/4	1/2	3/4	Max				
Habitat Type (%)	Obscured	Cascade	Riffle	Pool	Tailout	Subsurface	Other
Photo # Description							

Species	Age	Sex	Total Length	SVL	Head Width	Hind Leg Length	Fore Leg Length	Position	Cover Size (L x W)
			mm	mm	mm	mm	mm		x cm
			mm	mm	mm	mm	mm		x cm
			mm	mm	mm	mm	mm		x cm
			mm	mm	mm	mm	mm		x cm
			mm	mm	mm	mm	mm		x cm
			mm	mm	mm	mm	mm		x cm
			mm	mm	mm	mm	mm		x cm
			mm	mm	mm	mm	mm		x cm
			mm	mm	mm	mm	mm		x cm
			mm	mm	mm	mm	mm		x cm
			mm	mm	mm	mm	mm		x cm
			mm	mm	mm	mm	mm		x cm
			mm	mm	mm	mm	mm		x cm
			mm	mm	mm	mm	mm		x cm
			mm	mm	mm	mm	mm		x cm
			mm	mm	mm	mm	mm		x cm
			mm	mm	mm	mm	mm		x cm
			mm	mm	mm	mm	mm		x cm
			mm	mm	mm	mm	mm		x cm

Species		**Age**		**Position**
Cascades Frog - RACA	Red-legged Frog - RAAU	Adult -A	Neotene - N	In net - I
Northwestern Salamander - AMGR	Spotted Frog - RAPR	Larvae - L	Unknown - U	On substrate - 0
Pacific Chorus Frog - PSRE	Tailed Frog - ASTR	Metamorph - M		Under substrate - U
Pacific Giant Salamander - DITE	Western Toad - BUBO			On dry bank - D

Figure A2. NOCA Stream Amphibian Survey form (above, 2 of 2).

Individual transect information continued (see page 1 description above):

Species collected and individual measurements:

Transect - Record the number of the transect where each amphibian was collected.

Species – Record the four letter species code for each amphibian collected. Use the following four letter codes:

Cascades Frog – **RACA** (*Rana cascadae*)
Northwestern Salamander – **AMGR** (*Ambystoma gracile*)
Pacific Chorus frog – **PSRE** (*Pseudacris regilla*)
Pacific Giant Salamander – **DITE** (*Dicamptodon tenebrosus*)
Red-legged Frog – **RAAU** (*Rana aurora*)
Spotted Frog – **RAPR** (*Rana pretiosa*)
Tailed Frog – **ASTR** (*Ascaphus truei*)
Western Toad – **BUBO** (*Bufo boreas*)

Age – Record the life stage of each amphibian collected. Select from the following single letter codes:

Adult – **A**   Neotene – **N**   Larvae – **L**   Unknown – **U**   Metamorph - **M**

Sex – Record the sex of each amphibian collected. Select from the following single letter codes:

Male – **M**   Female – **F**   Unknown – **U**

Total Length (mm) – Record the total measured length of each amphibian collected to the nearest millimeter. The length of an animal is measured in a straight line from the tip of the snout to the tip of the tail.

SVL (mm) – Record the total measured snout to vent length (SVL) of each amphibian collected to the nearest millimeter. Snout to vent length is the length of an animal as measured in a strait line from the tip of the snout to the posterior end of the vent. The vent is the external opening of the cloaca, located in the area between the two hind legs. This measurement is not recorded for larval amphibians such as tailed frogs.

Head Width (mm) – Record the total measured head width of each amphibian collected to the nearest millimeter. Head width is the maximum head width measured as observed from the dorsal (top) view of the amphibian.

Hind Leg Length (mm) – Record the total measured length of the hind (posterior) leg of each amphibian collected to the nearest millimeter. Amphibians have two hind (posterior) legs that are usually the same size. If a size difference does occur take the length of the longer leg. The hind leg length is the length from the tip of the toe to the joint with the abdomen of the amphibian.

Fore Leg Length (mm) – Record the total measured length of the fore (anterior) leg of each amphibian collected to the nearest millimeter. Amphibians have two fore (anterior) legs that are usually the same length. If a length difference does occur take the length of the longer leg. The fore leg length is the distance from the tip of the toe to the joint with the abdomen of the amphibian.

Position – Record the position where each amphibian was located when found. Select from the following single letter codes:

In net – **I**   Under substrate – **U**   On substrate – **O**   On dry bank – **D**

Cover Size (L x W) (cm) – Record the measured length and width of the cover where each amphibian was collected. This measurement is recorded when the amphibian was found Under substrate – **U** or On substrate - **O**. This measurement is usually the piece of substrate or organic debris under or on which the individual amphibian was found.

Appendix B. Sample Locations and Landform Characteristics

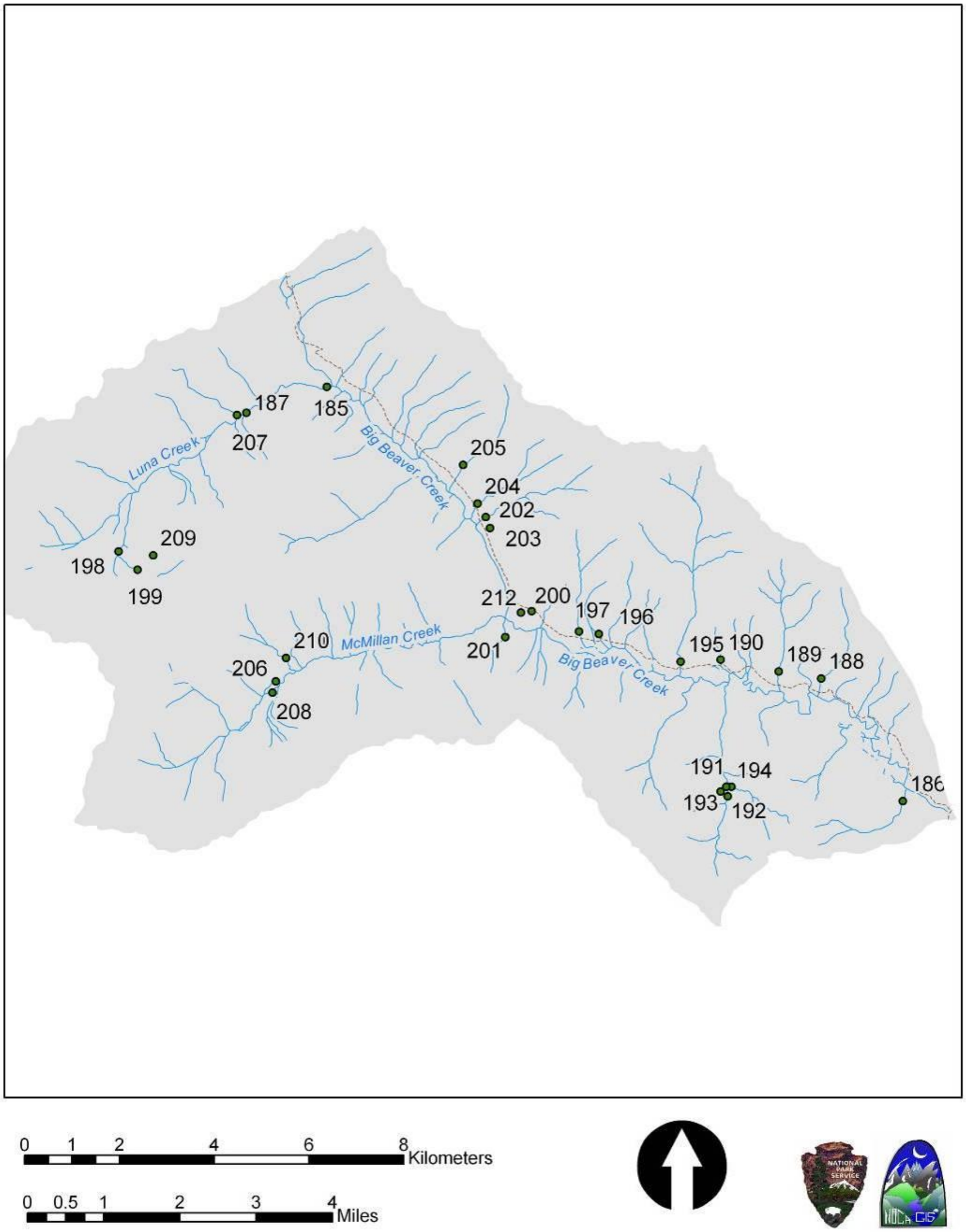


Figure B1. Sample locations within the Big Beaver watershed. Sample numbers correspond to Table B1.

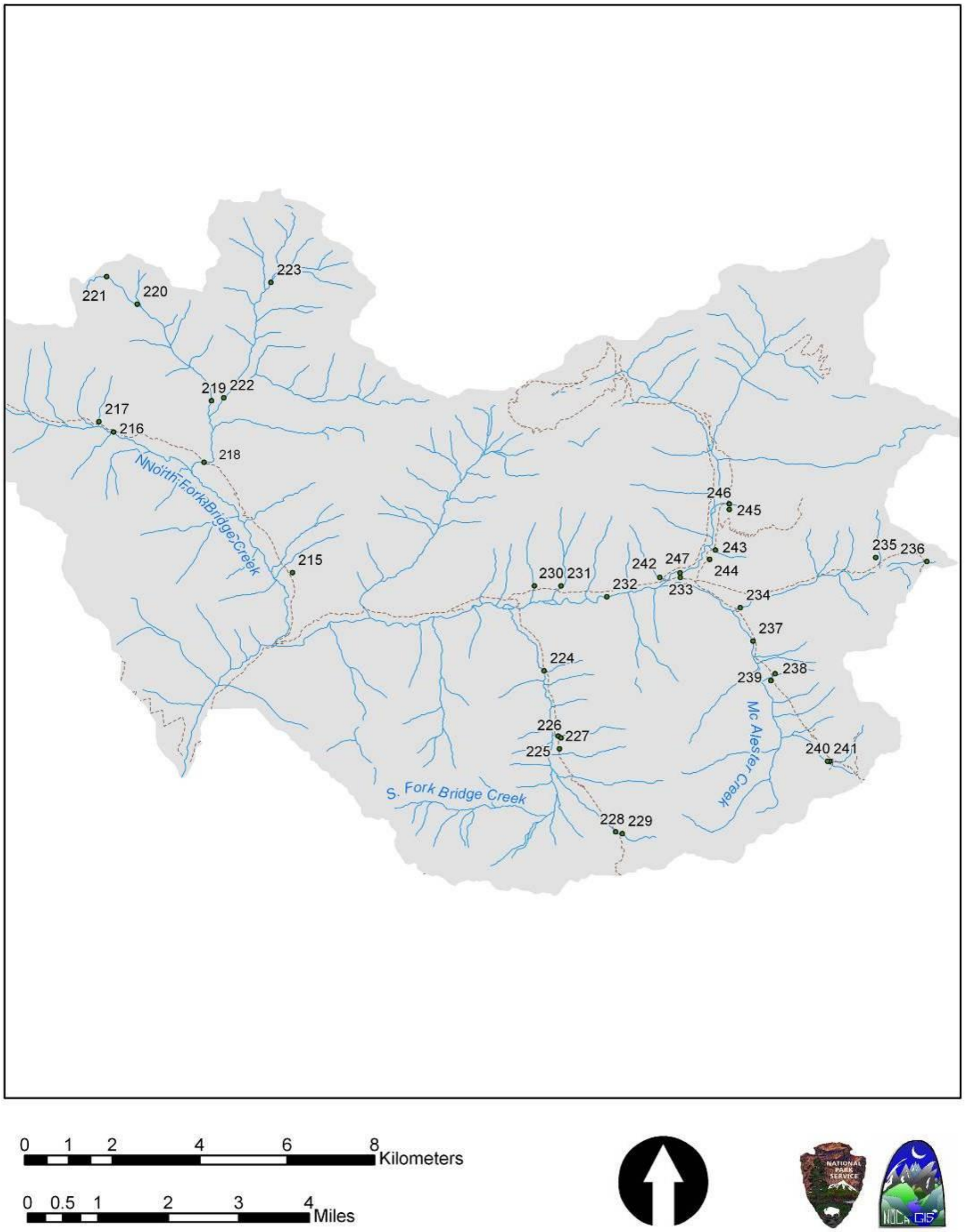
Appendix B (continued).

Table B1. Stream amphibian sample locations and landform characteristics within the Big Beaver watershed, NOCA (UTM, Zone 10, NAD 27).

Survey ID	Stream Name	Site #	Sample Date	Northing	Easting	Orographic Position	Ecoregion	Elevation (m)	Gradient Class (%)	Stream Order	Aspect (°from N)
185	Luna	1	Aug-20-1996	5413100	629000	East	NC Lowland Forest	777	<1	3	90
186	T1 Big Beaver	1	July-3-1996	5404300	641170	East	NC Lowland Forest	518	>20	2	0
187	Luna	2	Oct-3-1996	5412550	627300	East	NC Lowland Forest	814	3-4	3	45
188	T2 Big Beaver	1	July-2-1996	5406900	639450	East	NC Lowland Forest	561	>20	1	135
189	T3 Big Beaver	1	July-9-1996	5407050	638550	East	NC Lowland Forest	564	>20	2	180
190	T4 Big Beaver	1	July-10-1996	5407300	637320	East	NC Lowland Forest	534	>20	1	180
191	7 Mile	1	Oct-1-1996	5404600	637440	East	NC Lowland Forest	854	8-20	2	0
192	7 Mile	2	Oct-1-1996	5404400	637470	East	NC Lowland Forest	884	8-20	2	0
193	7 Mile	3	Oct-1-1996	5404500	637325	East	NC Lowland Forest	817	8-20	3	0
194	T1 7 Mile	1	Sep-30-1996	5404600	637550	East	NC Lowland Forest	884	>20	2	45
195	39 Mile	1	Aug-22-1996	5407260	636480	East	NC Lowland Forest	546	>20	2	180
196	T5 Big Beaver	1	July-10-1996	5407850	634750	East	NC Lowland Forest	598	>20	1	135
197	T6 Big Beaver	1	July-10-1996	5407900	634330	East	NC Highland Forest	598	>20	2	180
198	Luna	2	Sep-17-1996	5409600	624600	East	NC Highland Forest	1174	>20	2	0
199	Luna	3	Sep-18-1996	5409210	625000	East	NC Highland Forest	1493	>20	2	45
200	T7 Big Beaver	1	July-11-1996	5408330	633330	East	NC Lowland Forest	585	>20	1	135
201	T8 Big Beaver	1	July-17-1996	5407780	632770	East	NC Lowland Forest	628	>20	1	90
202	T10 Big Beaver	1	Aug-21-1996	5410330	632360	East	NC Lowland Forest	774	>20	2	135
203	T9 Big Beaver	1	July-16-1996	5410100	632450	East	NC Lowland Forest	774	>20	1	135
204	T11 Big Beaver	1	July-16-1996	5410620	632185	East	NC Lowland Forest	780	>20	2	135
205	T12 Big Beaver	1	Aug-21-1996	5411440	631880	East	NC Lowland Forest	823	>20	1	135
206	McMillan	1	Aug-12-1996	5406840	627920	East	NC Lowland Forest	762	3-4	3	90
207	T1 Luna	1	Oct-3-1996	5412500	627100	East	NC Lowland Forest	817	8-20	1	90
208	McMillan (Side Channel)	1	Aug-13-1996	5406600	627850	East	NC Lowland Forest	762	3-4	3	45
209	T1 Luna Lake	1	Sep-18-1996	5409520	625330	East	NC Highland Forest	1555	>20	1	180
210	T1 McMillan	1	Aug-14-1996	5407340	628140	East	NC Lowland Forest	780	8-20	2	135
212	Big Beaver	1	July-11-1996	5408300	633100	East	NC Lowland Forest	573	1-2	4	90

Appendix B (continued).

Figure B2. Sample locations within the Bridge Creek watershed. Sample numbers correspond to Table A2.



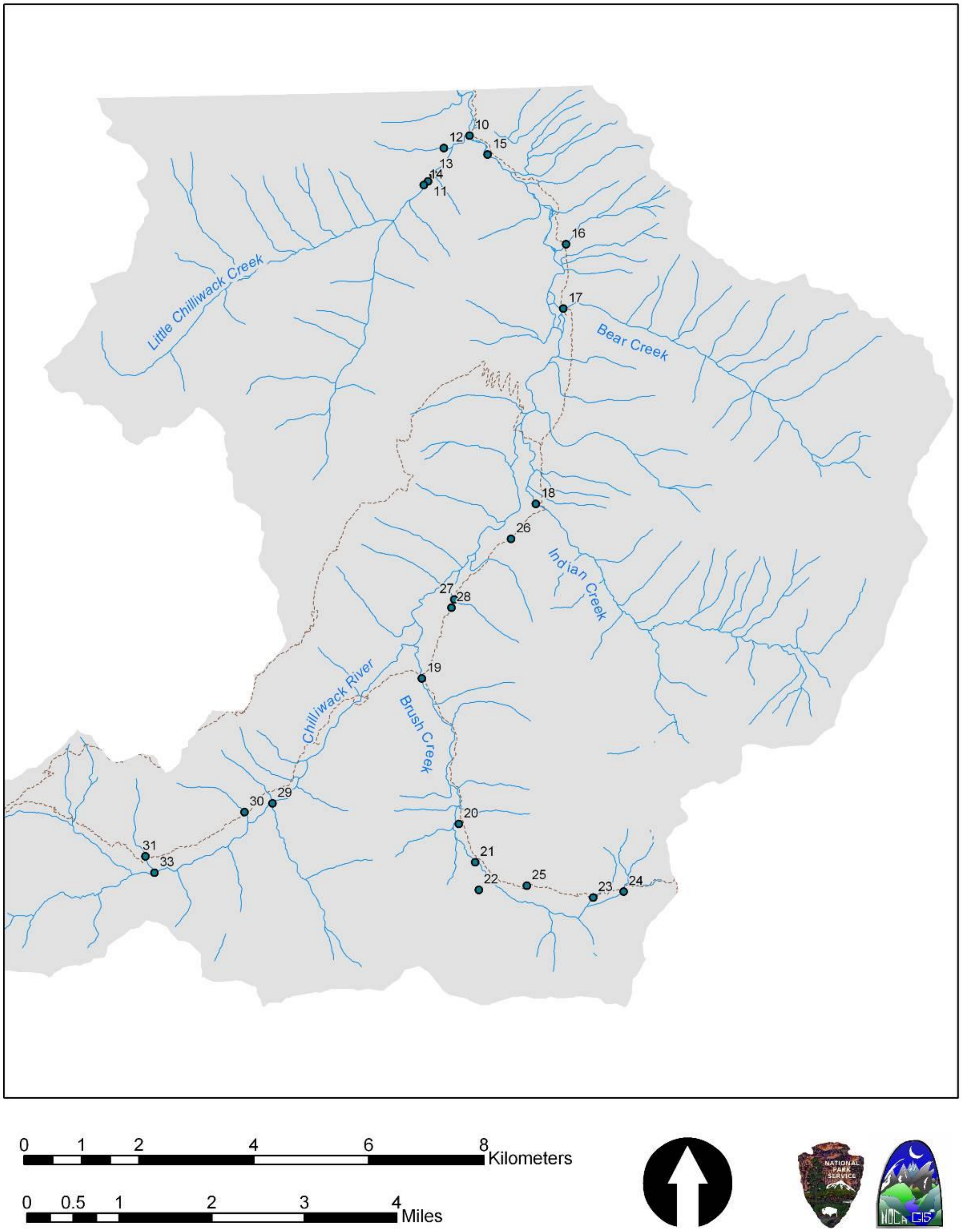
Appendix B (continued)

Table B2. Stream amphibian sample locations and landform characteristics within the Bridge Creek watershed, NOCA (UTM, Zone 10, NAD 27).

Survey ID	Stream Name	Site #	Sample Date	Northing	Easting	Orographic Position	Ecoregion	Elevation (m)	Gradient Class (%)	Stream Order	Aspect (°from N)
213	Rainbow	1	July-29-1997	5365650	672800	East	NC Highland Forest	1817	>20	1	90
215	T1 North Fork Bridge	1	Aug-13-1997	5370750	659900	East	NC Highland Forest	927	>20	1	90
216	North Fork Bridge	1	Aug-12-1998	5373980	655810	East	NC Highland Forest	1134	2-4	2	135
217	T2 North Fork Bridge	1	Aug-12-1997	5374220	655380	East	NC Highland Forest	1073	>20	1	180
218	Grizzly	1	Aug-12-1997	5373950	657300	East	NC Highland Forest	963	8-20	3	90
219	Fisher	1	Aug-11-1998	5374700	658050	East	NC Highland Forest	1164	8-20	2	180
220	Fisher	2	Sep-15-1998	5376920	656350	East	NC Highland Forest	1646	4-8	1	135
221	Fisher	3	Sep-14-1998	5377550	655650	East	NC Highland Forest	1591	2-4	1	135
222	Grizzly	2	Aug-11-1998	5374770	658330	East	NC Highland Forest	1176	8-20	3	135
223	Grizzly	3	Sep-16-1998	5377420	659410	East	NC Highland Forest	1506	4-8	3	180
224	South Fork Bridge	1	Sep-9-1997	5368500	665660	East	NC Highland Forest	1073	2-4	3	45
225	T1 South Fork Bridge	1	July-10-1997	5367000	665980	East	NC Highland Forest	1170	>20	1	90
226	T2 South Fork Bridge	1	July-10-1997	5366960	666050	East	NC Highland Forest	1189	>20	1	90
227	T3 South Fork Bridge	1	July-10-1997	5366710	666010	East	NC Highland Forest	1195	>20	1	90
228	T4 South Fork Bridge	1	July-9-1997	5364800	667300	East	NC Subalpine/Alpine	1591	8-20	1	45
229	T4 South Fork Bridge	2	July-9-1997	5364760	667450	East	NC Subalpine/Alpine	1597	>20	1	45
230	Frisco	1	July-1-1997	5370450	665440	East	NC Highland Forest	1073	>20	1	180
231	T1 Bridge	1	6-26-1997	5370450	666050	East	NC Highland Forest	1082	>20	2	135
232	Bridge	1	Sep-8-1997	5370200	667100	East	NC Highland Forest	1048	2-4	4	90
233	Fireweed	1	6-27-1997	5370670	668780	East	NC Highland Forest	1125	4-8	1	135
234	East Fork Bridge	1	Sep-2-1997	5369950	670150	East	NC Highland Forest	1231	>20	3	90
235	Stilleto	1	Aug-20-1997	5371100	673250	East	NC Highland Forest	1707	>20	1	180
236	T1 East Fork Bridge	1	July-15-1997	5371010	674420	East	NC Subalpine/Alpine	1829	>20	1	90
237	McAlester	1	Sep-10-1997	5369180	670440	East	NC Highland Forest	1280	4-8	3	0
238	T1 McAlester	1	Sep-4-1997	5368430	670950	East	NC Highland Forest	1402	>20	1	45
239	T2 McAlester	1	Sep-7-1997	5368270	670850	East	NC Highland Forest	1463	>20	1	90
240	T4 Mc Alester	1	July-31-1997	5366420	672200	East	NC Highland Forest	1768	>20	1	90
241	T3 Mc Alester	1	July-31-1997	5366420	672150	East	NC Highland Forest	1682	>20	1	90
242	T2 Bridge	1	July-2-1997	5370640	668310	East	NC Highland Forest	1122	>20	1	180
243	T4 Bridge	1	July-23-1997	5371270	669580	East	NC Highland Forest	1219	>20	1	90
244	T3 Bridge	1	July-23-1997	5371060	669450	East	NC Highland Forest	1189	>20	1	90
245	T6 Bridge	1	Sep-3-1997	5372330	669900	East	NC Highland Forest	1280	>20	1	90
246	T5 Bridge	1	Sep-3-1997	5372200	669900	East	NC Highland Forest	1250	>20	1	112
247	Bridge	2	Sep-5-1997	5370800	668770	East	NC Highland Forest	1122	4-8	3	180

Appendix B (continued).

Figure B3. Sample locations within the Chilliwack watershed. Sample numbers correspond to Table A3.



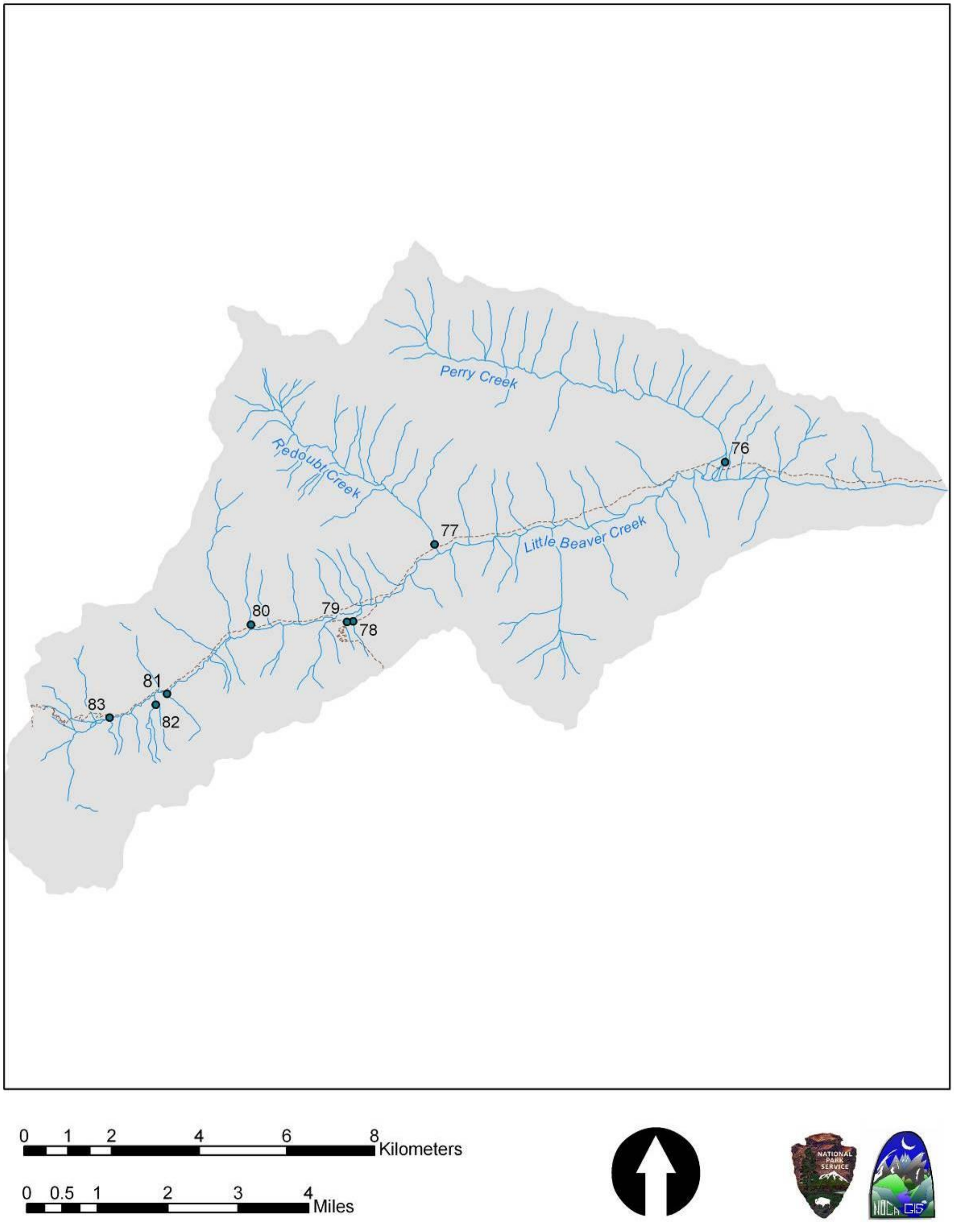
Appendix B (continued).

Table B3. Stream amphibian sample locations and landform characteristics within the Chilliwack watershed, NOCA (UTM, Zone 10, NAD 27).

Survey ID	Stream Name	Site #	Sample Date	Northing	Easting	Orographic Position	Ecoregion	Elevation (m)	Gradient Class (%)	Stream Order	Aspect (°from N)
10	Little Chilliwack	1	Aug-4-2003	5427676	616494	West	NC Lowland Forest	631	4-8	3	95
11	Little Chilliwack	2	Aug-5-2003	5426881	615769	West	NC Lowland Forest	757	4-8	3	40
12	T1 Little Chilliwack	1	Aug-5-2003	5427458	616045	West	NC Lowland Forest	657	>20	1	82
13	T2 Little Chilliwack	1	Aug-5-2003	5426995	615870	West	NC Lowland Forest	727	>20	1	37
14	T3 Little Chilliwack	1	Aug-6-2003	5426814	615695	West	NC Lowland Forest	760	>20	0.5	100
15	Chilliwack River	1	Aug-8-2003	5427344	616810	West	NC Lowland Forest	632	<1	4	20
16	T1 Lower Chilliwack	1	Aug-7-2003	5425782	618178	West	NC Lowland Forest	674	>20	3	130
17	Bear	1	Aug-7-2003	5424661	618127	West	NC Lowland Forest	668	>20	3	96
18	Indian	1	Aug-26-2003	5421251	617649	West	NC Lowland Forest	728	2-4	3	60
19	Brush	1	Aug-27-2003	5418206	615662	West	NC Highland Forest	822	8-20	3	35
20	Brush (Side Channel)	1	Aug-21-2003	5415666	616308	West	NC Highland Forest	921	2-4	3	10
21	Brush	2	Aug-21-2003	5414998	616594	West	NC Highland Forest	952	4-8	3	25
22	T1 Brush	1	Aug-19-2003	5414518	616655	West	NC Highland Forest	965	>20	0.5	40
23	Tapto	1	Aug-20-2003	5414382	618649	West	NC Subalpine/Alpine	1337	>20	1	145
24	Brush	3	Aug-20-2003	5414484	619179	West	NC Subalpine/Alpine	1409	>20	2	140
25	T2 Brush	1	Aug-20-2003	5414592	617492	West	NC Highland Forest	1078	>20	0.5	160
26	T2 Middle Chilliwack	1	Aug-26-2003	5420640	617219	West	NC Lowland Forest	722	>20	0.5	60
27	T3 Middle Chilliwack	1	Aug-27-2003	5419584	616229	West	NC Highland Forest	783	>20	1	55
28	T4 Middle Chilliwack	1	Aug-27-2003	5419439	616180	West	NC Highland Forest	791	>20	0.5	30
29	Easy	1	Aug-25-2003	5416028	613061	West	NC Highland Forest	823	4-8	2	30
30	T1 Upper Chilliwack	1	Aug-28-2003	5415874	612572	West	NC Highland Forest	870	>20	1	180
31	Copper	1	Aug-18-2003	5415100	610846	West	NC Highland Forest	944	>20	1	180
33	Chilliwack River	2	Aug-28-2003	5414814	611006	West	NC Highland Forest	899	2-4	3	120
34	Chilliwack River	3	Aug-29-2003	5415734	608308	West	NC Subalpine/Alpine	1337	4-8	1	38

Appendix B (continued).

Figure B4. Sample locations within the Little Beaver watershed. Sample numbers correspond to Table A4.



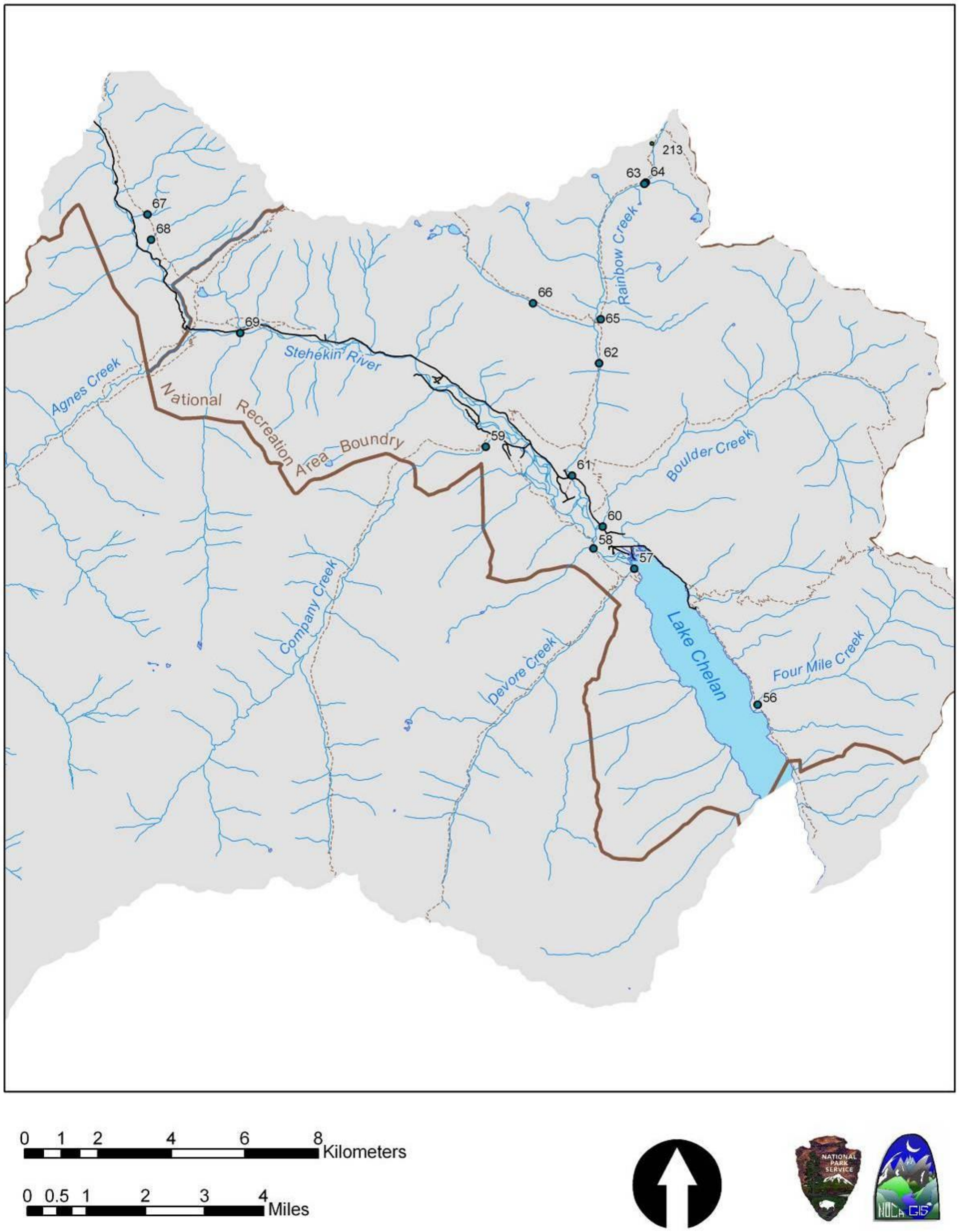
Appendix B (continued).

Table B4. Stream amphibian sample locations and landform characteristics within the Little Beaver watershed, NOCA (UTM, Zone 10, NAD 27).

Survey ID	Stream Name	Site #	Sample Date	Northing	Easting	Orographic Position	Ecoregion	Elevation (m)	Gradient Class (%)	Stream Order	Aspect (°from N)
76	Perry	1	Aug-23-2004	5420278	635941	East	NC Lowland Forest	624	8-20	3	173
77	Redoubt	1	Aug-24-2004	5418396	629304	East	NC Lowland Forest	676	2-4	3	128
78	T4 Little Beaver	1	Sep-1-2004	5416638	627441	East	NC Highland Forest	754	>20	1	32
79	T5 Little Beaver	1	Sep-1-2004	5416624	627300	East	NC Highland Forest	758	>20	1	10
80	T6 Little Beaver	1	Sep-14-2004	5416559	625101	East	NC Highland Forest	792	8-20	1	152
81	T1 Little Beaver	1	Aug-31-2004	5414980	623183	East	NC Lowland Forest	852	>20	1	34
82	T2 Little Beaver	1	Aug-31-2004	5414732	622925	East	NC Highland Forest	856	>20	2	26
83	Little Beaver	1	Sep-14-2004	5414438	621872	East	NC Highland Forest	915	4-8	3	64

Appendix B (continued).

Figure B5. Sample locations within the Lower Stehekin watershed. Sample numbers correspond to Table A5.



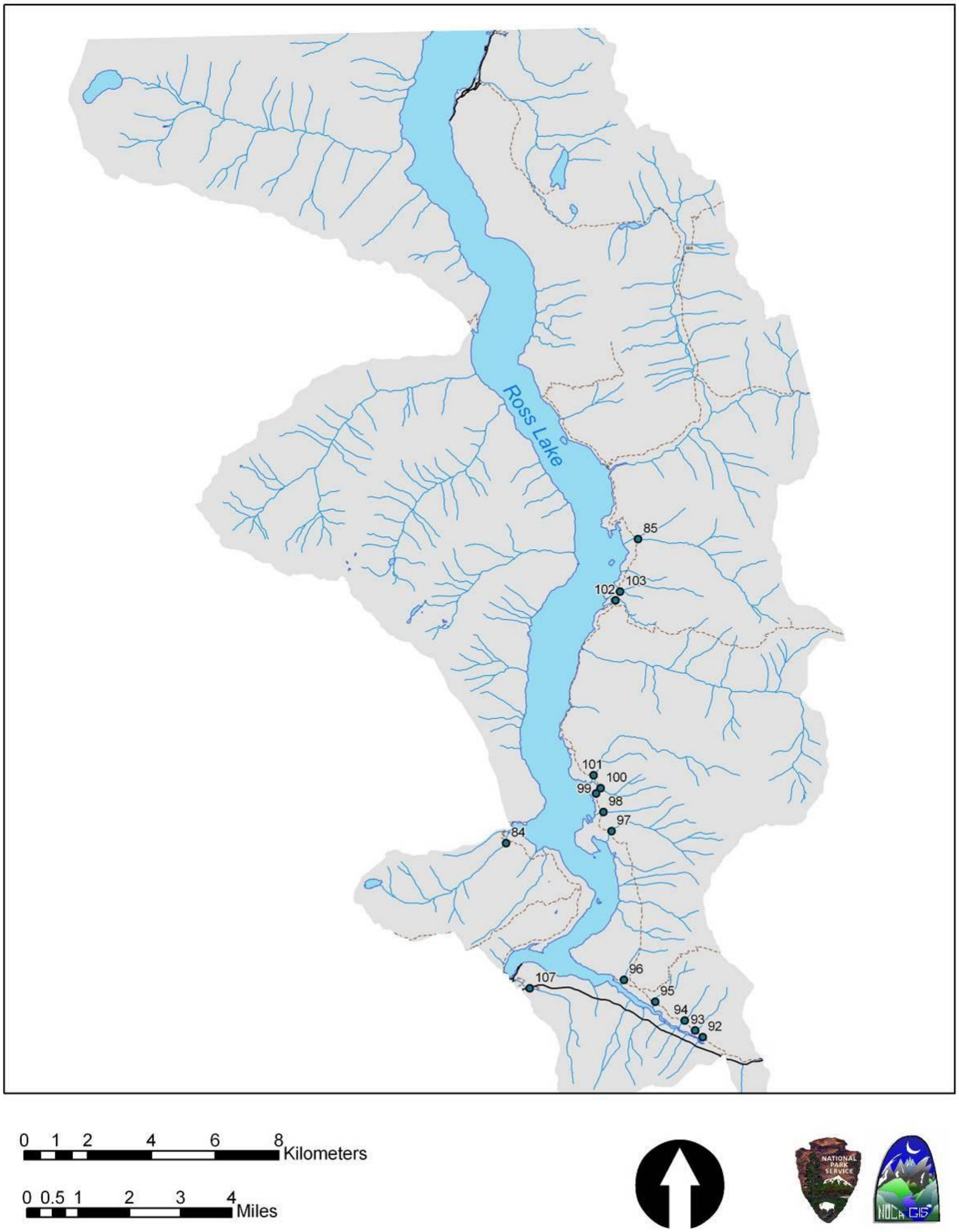
Appendix B (continued).

Table B5. Stream amphibian sample locations and landform characteristics within the Lower Stehekin watershed, NOCA (UTM, Zone 10, NAD 27).

Survey ID	Stream Name	Site #	Sample Date	Northing	Easting	Orographic Position	Ecoregion	Elevation (m)	Gradient Class (%)	Stream Order	Aspect (°from N)
56	Fourmile	1	July-29-2004	5350290	675683	East	Chelan Highlands	364	8-20	3	134
57	Devore	1	July-27-2004	5354012	672314	East	Chelan Highlands	335	4-8	3	52
58	Margerum	1	July-27-2004	5354568	671204	East	Chelan Highlands	340	>20	2	20
59	Company	1	July-26-2004	5357350	668264	East	Chelan Highlands	407	4-8	3	42
60	Boulder	1	July-28-2004	5355166	671456	East	Chelan Highlands	354	4-8	3	130
61	Rainbow	1	July-28-2004	5356560	670620	East	Chelan Highlands	369	2-4	3	158
62	Rainbow	2	Aug-4-2004	5359636	671354	East	Chelan Highlands	967	8-20	3	169
63	Rainbow	3	Aug-3-2004	5364549	672589	East	NC Highland Forest	1548	4-8	2	94
64	T1 Rainbow	1	Aug-3-2004	5364585	672631	East	NC Highland Forest	1550	8-20	1	120
65	Bench	1	Aug-3-2004	5360839	671406	East	Chelan Highlands	1170	>20	2	80
66	North Fork Rainbow	1	Aug-4-2004	5361281	669559	East	Chelan Highlands	1443	8-20	2	128
67	Buzzard	1	Aug-3-2004	5363713	659036	East	NC Highland Forest	582	8-20	2	67
68	McGregor	1	Aug-3-2004	5363016	659142	East	NC Highland Forest	561	8-20	2	124
69	Cabin	1	Aug-4-2004	5360464	661568	East	NC Highland Forest	450	>20	2	30

Appendix B (continued).

Figure B6. Sample locations within the Ross Lake watershed. Sample numbers correspond to Table A6.



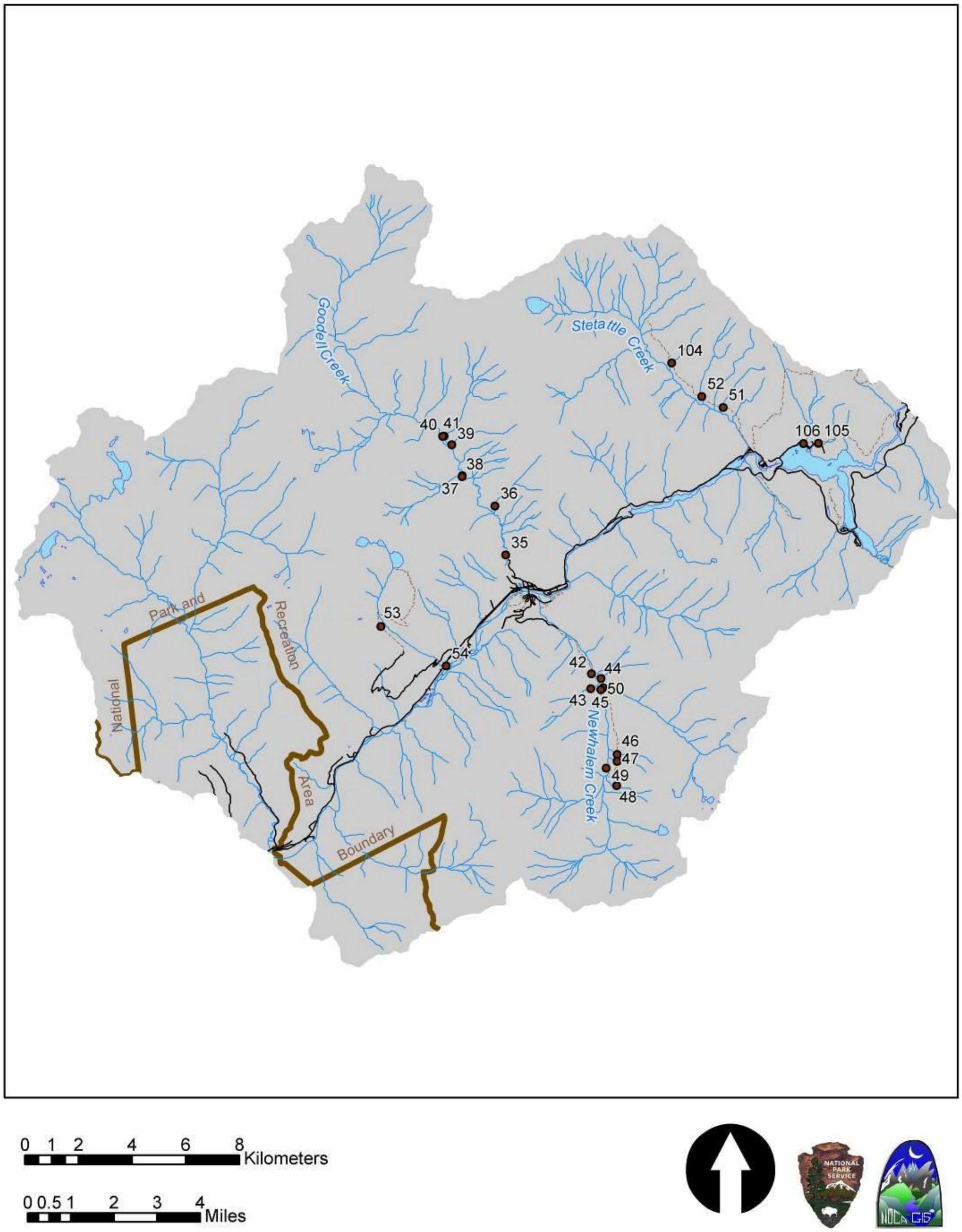
Appendix B (continued).

Table B6. Stream amphibian sample locations and landform characteristics within the Ross Lake watershed, NOCA (UTM, Zone 10, NAD 27).

Survey ID	Stream Name	Site #	Sample Date	Northing	Easting	Orographic Position	Ecoregion	Elevation (m)	Gradient Class (%)	Stream Order	Aspect (°from N)
84	Pierce	1	July-22-2004	5403444	642124	East	NC Lowland Forest	598	8-20	3	26
85	Dry	1	July-21-2004	5413033	646284	East	NC Lowland Forest	576	>20	3	76
92	T1 Ruby	1	July-7-2004	5397327	648314	East	NC Lowland Forest	593	>20	0.5	110
93	T2 Ruby	1	July-7-2004	5397536	648078	East	NC Lowland Forest	581	>20	1	108
94	T3 Ruby	1	July-8-2004	5397853	647752	East	NC Lowland Forest	606	>20	1	118
95	Lone Tree	1	July-8-2004	5398442	646817	East	NC Lowland Forest	575	>20	2	160
96	Hidden Hand	1	July-13-2004	5399134	645833	East	NC Lowland Forest	558	>20	1	133
97	Roland	1	July-19-2004	5403827	645444	East	NC Lowland Forest	554	>20	3	156
98	T1 Roland	1	July-20-2004	5404425	645190	East	NC Lowland Forest	564	>20	1	90
99	T2 Roland	1	July-20-2004	5405014	644958	East	NC Lowland Forest	557	>20	0.5	54
100	T3 Roland	1	July-20-2004	5405180	645101	East	NC Lowland Forest	558	>20	2	32
101	May	1	July-20-2004	5405592	644879	East	NC Lowland Forest	528	8-20	2	20
102	T1 Dry	1	July-21-2004	5411102	645572	East	NC Lowland Forest	561	>20	2	106
103	T2 Dry	1	July-21-2004	5411376	645716	East	NC Lowland Forest	561	>20	1	54
107	Happy	1	Sep-15-2004	5398872	642875	East	NC Lowland Forest	658	4-8	2	140

Appendix B (continued).

Figure B7. Sample locations within the Skagit/Diablo watershed. Sample numbers correspond to Table A7.



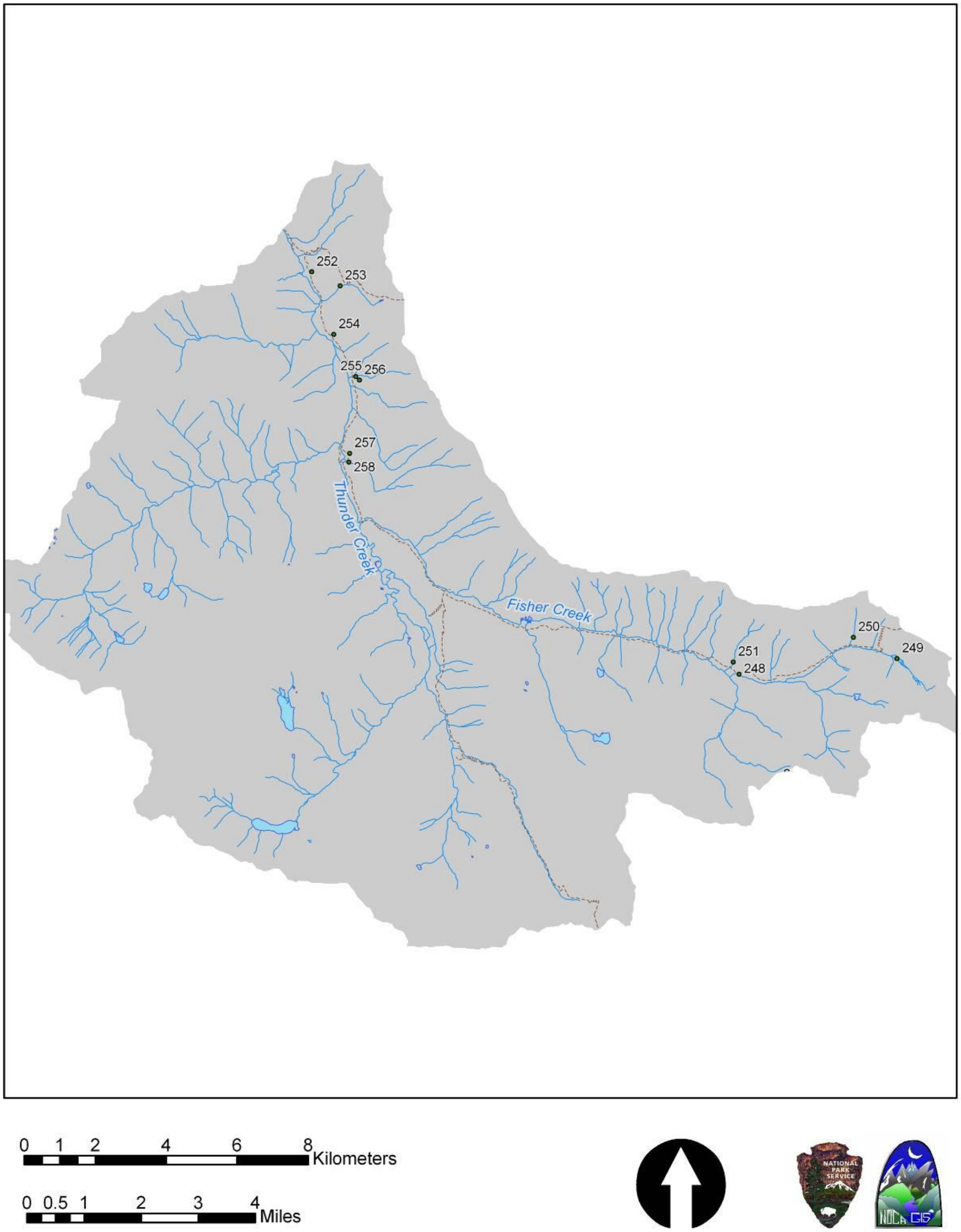
Appendix B (continued).

Table B7. Stream amphibian sample locations and landform characteristics within the Skagit/Diablo watershed, NOCA (UTM, Zone 10, NAD 27).

Survey ID	Stream Name	Site #	Sample Date	Northing	Easting	Orographic Position	Ecoregion	Elevation (m)	Gradient Class (%)	Stream Order	Aspect (°from N)
35	T1 Lower Goodell	1	Aug-11-2003	5393670	627231	West	NC Lowland Forest	184	>20	1	108
36	T2 Lower Goodell	1	Aug-12-2003	5395504	626837	West	NC Lowland Forest	303	>20	2	170
37	T3 Lower Goodell	1	Aug-13-2003	5396596	625610	West	NC Lowland Forest	302	8-20	2	70
38	Goodell	1	Sep-8-2003	5396628	625616	West	NC Lowland Forest	304	2-4	4	150
39	T4 Lower Goodell	1	Sep-10-2003	5397790	625228	West	NC Lowland Forest	354	>20	1	120
40	Terror	1	Sep-9-2003	5398110	624939	West	NC Lowland Forest	361	8-20	3	120
41	Goodell	2	Sep-10-2003	5398104	624884	West	NC Lowland Forest	365	1-2	3	140
42	T1 Lower Newhalem	1	July-23-2003	5389234	630437	West	NC Lowland Forest	382	>20	0.5	82
43	T2 Lower Newhalem	1	July-23-2003	5388684	630407	West	NC Lowland Forest	408	>20	2	50
44	T3 Lower Newhalem	1	July-28-2003	5389066	630791	West	NC Lowland Forest	407	>20	1	59
45	East Fork Newhalem	1	July-29-2003	5388712	630874	West	NC Lowland Forest	432	8-20	3	90
46	T1 Upper Newhalem	1	Sep-15-2003	5386224	631394	West	NC Lowland Forest	601	>20	1	104
47	T2 Upper Newhalem	1	Sep-16-2003	5385966	631394	West	NC Lowland Forest	608	>20	1	42
48	T3 Upper Newhalem	1	Sep-16-2003	5385058	631378	West	NC Lowland Forest	694	>20	1	52
49	T4 Upper Newhalem	1	Sep-17-2003	5385716	630984	West	NC Lowland Forest	520	>20	0.5	80
50	Newhalem	1	Sep-18-2003	5388642	630780	West	NC Lowland Forest	428	2-4	3	12
51	Bucket	1	Sep-22-2003	5399178	635349	West	NC Lowland Forest	439	>20	1	130
52	Camp Dayo	1	Sep-22-2003	5399592	634554	West	NC Lowland Forest	445	>20	2	80
53	T1 Thornton	1	Sep-2-2003	5391542	622482	West	NC Lowland Forest	824	>20	0.5	86
54	Thornton	1	Sep-3-2003	5389529	625017	West	NC Lowland Forest	124	8-20	1	122
104	T1 Stetattle	1	July-12-2004	5400837	633425	East	NC Lowland Forest	554	>20	1	172
105	T1 Diablo Lake	1	Sep-16-2004	5397838	638896	East	NC Lowland Forest	393	4-8	1	180
106	Sourdough	1	Sep-16-2004	5397831	638340	East	NC Lowland Forest	372	>20	2	156

Appendix B (continued).

Figure B8. Sample locations within the Thunder Creek watershed. Sample numbers correspond to Table A8.



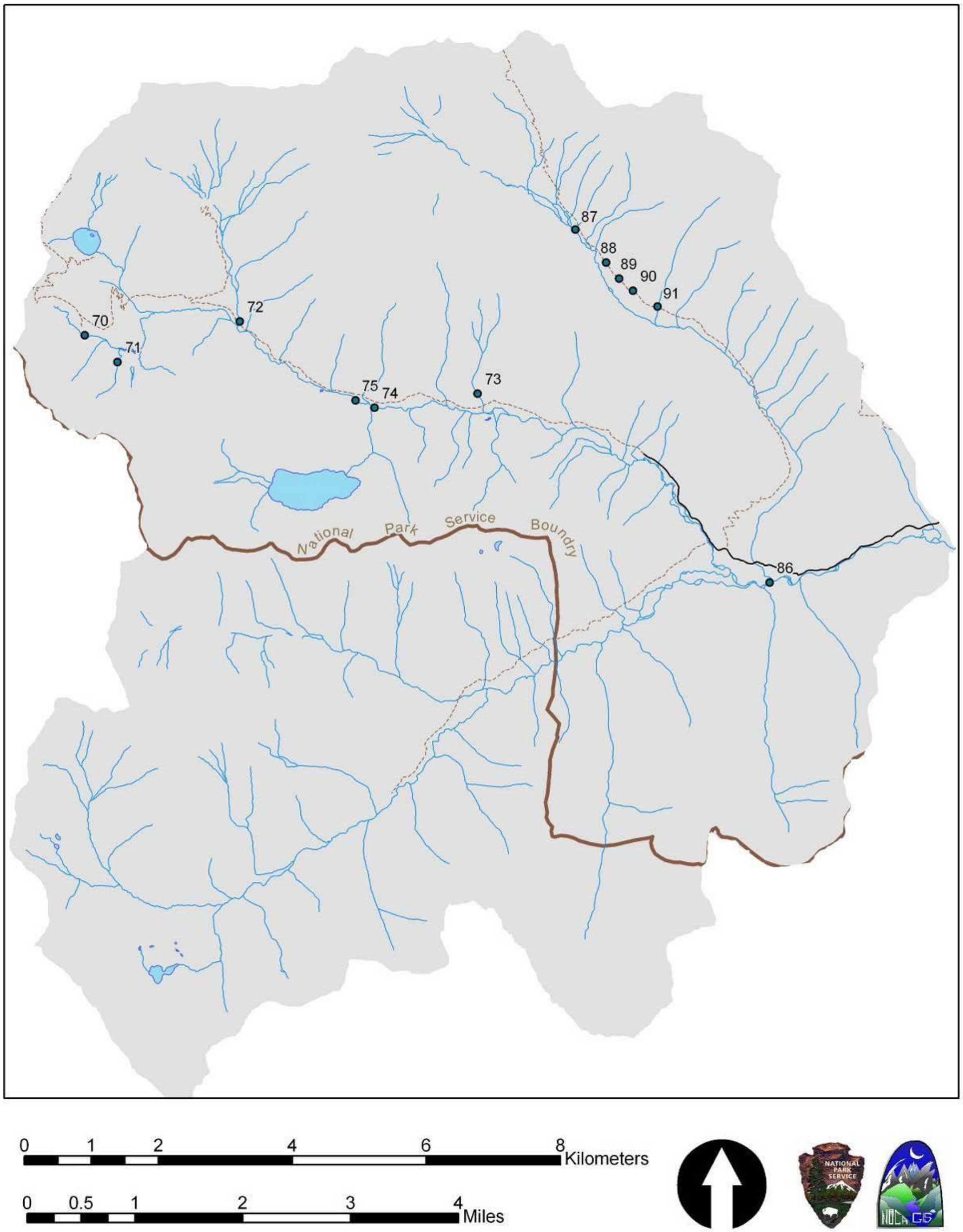
Appendix B (continued).

Table B8. Stream amphibian sample locations and landform characteristics within the Thunder Creek watershed, NOCA (UTM, Zone 10, NAD 27).

Survey ID	Stream Name	Site #	Sample Date	Northing	Easting	Orographic Position	Ecoregion	Elevation (m)	Gradient Class (%)	Stream Order	Aspect (°from N)
248	Fisher	1	July-21-1998	5380660	654550	East	NC Highland Forest	1183	2-4	3	90
249	Fisher	2	July-23-1998	5381100	659000	East	NC Highland Forest	1586	2-4	1	90
250	T1 Fisher	1	July-22-1998	5381700	657770	East	NC Highland Forest	1585	>20	1	180
251	T2 Fisher	1	July-21-1998	5381000	654380	East	NC Highland Forest	1219	>20	1	180
252	T1 Thunder	1	July-1-1998	5391990	642500	East	NC Lowland Forest	463	<1	1	90
253	T2 Thunder	1	June-18-1998	5391600	643300	East	NC Lowland Forest	707	>20	1	135
254	T3 Thunder	1	July-8-1998	5390230	643120	East	NC Lowland Forest	488	>20	1	135
255	T4 Thunder	1	July-7-1998	5389040	643740	East	NC Lowland Forest	549	>20	1	90
256	T5 Thunder	1	July-7-1998	5388940	643850	East	NC Lowland Forest	549	>20	2	45
257	T6 Thunder	1	June-25-1998	5386880	643570	East	NC Lowland Forest	585	2-4	1	90
258	T7 Thunder	1	June-26-1998	5386630	643550	East	NC Lowland Forest	597	2-4	2	45

Appendix B (continued).

Figure B9. Sample locations within the Upper Stehekin watershed. Sample numbers correspond to Table A9.



Appendix B (continued).

Table B9. Stream amphibian sample locations and landform characteristics within the Upper Stehekin watershed, NOCA (UTM, Zone 10, NAD 27).

Survey ID	Stream Name	Site #	Sample Date	Northing	Easting	Orographic Position	Ecoregion	Elevation (m)	Gradient Class (%)	Stream Order	Aspect (°from N)
70	Pelton	1	Aug-19-2004	5369216	644353	East	NC Highland Forest	1398	1-2	2	152
71	T1 Stehekin	1	Aug-17-2004	5368814	644846	East	NC Highland Forest	1405	>20	1	162
72	Basin	1	Aug-18-2004	5369422	646673	East	NC Highland Forest	954	>20	3	158
73	T1 Trapper Lake	1	Aug-19-2004	5368343	650226	East	NC Highland Forest	849	>20	2	34
74	Cottonwood	1	Aug-17-2004	5368132	648685	East	NC Highland Forest	836	4-8	2	8
75	Stehekin River	1	Aug-17-2004	5368242	648402	East	NC Highland Forest	837	2-4	4	100
86	Park	1	Aug-11-2004	5365516	654593	East	NC Highland Forest	677	4-8	3	154
87	Park	2	Aug-10-2004	5370799	651689	East	NC Highland Forest	1209	2-4	3	166
88	T1 Park	1	Aug-10-2004	5370307	652149	East	NC Highland Forest	1210	>20	0.5	152
89	T2 Park	1	Aug-11-2004	5370066	652344	East	NC Highland Forest	1203	>20	0.5	140
90	T3 Park	1	Aug-11-2004	5369882	652549	East	NC Highland Forest	1206	>20	0.5	114
91	T4 Park	1	Aug-11-2004	5369649	652917	East	NC Subalpine/Alpine	1220	>20	1	171

Appendix C. Hydrologic and Habitat Characteristics for Stream Amphibian Sample Sites

Table C1. Hydrologic characteristics for sample sites within the Big Beaver watershed. sd = standard deviation

Survey ID	Stream Name	Site #	Water Chemistry		Gradient (%)		Wetted Width (m)		Bankfull Width (m)		Water Depth (m)		Bankfull Depth (m)	
			Temperature (C)	Conductivity (µS)	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd
185	Luna	1	7	NA	2	0	9.8	0.6	12.0	0.9	0.34	0.11	NA	NA
186	T1 Big Beaver	1	11	13.1	15	5	1.5	0.5	2.8	0.6	0.13	0.09	NA	NA
187	Luna	2	6	17.9	5	0	9.2	3.1	9.9	3.0	0.22	0.09	NA	NA
188	T2 Big Beaver	1	14	NA	31	4	3.3	1.5	5.9	2.6	0.14	0.07	NA	NA
189	T3 Big Beaver	1	9	43	20	6	3.6	0.9	4.2	1.4	0.24	0.06	NA	NA
190	T4 Big Beaver	1	11	52.5	25	6	1.9	0.9	2.5	1.9	0.08	0.03	NA	NA
191	7 Mile	1	3	32.9	11	3	4.1	1.4	4.4	1.5	0.24	0.09	NA	NA
192	7 Mile	2	3	35	5	1	3.7	1.0	4.2	1.1	0.17	0.03	NA	NA
193	7 Mile	3	4	35.6	13	2	3.6	1.1	4.3	1.5	0.16	0.07	NA	NA
194	T1 7 Mile	1	7	36.1	20	2	2.1	1.3	3.0	1.6	0.09	0.04	NA	NA
195	39 Mile	1	8	55.2	18	8	4.2	1.4	6.1	1.6	0.21	0.06	NA	NA
196	T5 Big Beaver	1	9	110.2	19	5	1.6	0.5	1.8	0.6	0.10	0.05	NA	NA
197	T6 Big Beaver	1	13	80	17	3	2.6	0.9	3.8	2.3	0.12	0.02	NA	NA
198	Luna	2	3	20.6	24	9	6.3	1.8	6.9	1.8	0.28	0.08	NA	NA
199	Luna	3	3	7.4	4	1	6.5	2.9	7.3	3.2	0.21	0.10	NA	NA
200	T7 Big Beaver	1	10	66.7	10	5	1.3	0.4	1.5	0.6	0.05	0.03	NA	NA
201	T8 Big Beaver	1	10	49.1	38	3	3.9	1.6	4.6	2.5	0.07	0.03	NA	NA
202	T10 Big Beaver	1	11	28.8	22	3	4.0	1.5	5.0	1.8	0.17	0.05	NA	NA
203	T9 Big Beaver	1	11	NA	28	3	1.0	0.4	1.0	0.4	0.07	0.03	NA	NA
204	T11 Big Beaver	1	9	10.7	20	4	4.0	0.7	4.0	0.7	0.28	0.09	NA	NA
205	T12 Big Beaver	1	9	18.8	21	9	2.8	1.2	3.4	1.4	0.15	0.13	NA	NA
206	McMillan	1	6	15.4	2	1	3.9	1.7	4.0	1.6	0.18	0.15	NA	NA
207	T1 Luna	1	6	16.9	3	0	3.4	0.3	4.3	0.2	0.16	0.04	NA	NA
208	McMillan (Side Channel)	1	6	NA	3	2	3.2	1.1	3.4	1.3	0.26	0.08	NA	NA
209	T1 Luna Lake	1	6	4.6	15	12	4.9	2.8	11.7	7.2	0.06	0.02	NA	NA
210	T1 McMillan	1	16	NA	12	3	3.2	0.9	3.6	1.0	0.25	0.06	NA	NA
212	Big Beaver	1	7	14.3	2	1	5.6	2.1	7.0	2.3	0.26	0.10	NA	NA

Appendix C (continued).

Table C2. Hydrologic characteristics for sample sites within the Bridge Creek watershed. sd = standard deviation

Survey ID	Stream Name	Site #	Water Chemistry		Gradient (%)		Wetted Width (m)		Bankfull Width (m)		Water Depth (m)		Bankfull Depth (m)	
			Temperature (C)	Conductivity (µS)	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd
213	Rainbow	1	8	12.7	3	1	1.3	0.4	1.3	0.4	0.12	0.04	NA	NA
215	T1 North Fork Bridge	1	13	62.4	10	1	1.3	0.5	1.5	0.5	0.07	0.03	NA	NA
216	North Fork Bridge	1	11	15.1	3	0	10.5	2.1	11.1	3.4	0.34	0.10	NA	NA
217	T2 North Fork Bridge	1	14	45.9	10	6	0.8	0.2	0.8	0.2	0.04	0.01	NA	NA
218	Grizzly	1	7	19.4	4	1	9.4	3.7	12.5	7.2	0.24	0.10	NA	NA
219	Fisher	1	11	24.4	NA	NA	4.6	1.3	6.0	1.3	0.20	0.05	NA	NA
220	Fisher	2	13	28.8	11	1	2.4	1.2	3.6	1.4	0.07	0.04	NA	NA
221	Fisher	3	11	18.4	11	0	1.6	0.5	1.8	0.6	0.07	0.03	NA	NA
222	Grizzly	1	11	22.9	5	0	8.5	3.1	9.1	3.1	0.29	0.06	NA	NA
223	Grizzly	2	4	22.8	3	0	3.2	0.7	3.7	0.6	0.16	0.04	NA	NA
224	South Fork Bridge	1	8	20.2	2	0	5.9	2.4	7.6	3.4	0.26	0.14	NA	NA
225	T1 South Fork Bridge	1	6	10.5	7	1	0.9	0.4	1.0	0.4	0.07	0.03	NA	NA
226	T2 South Fork Bridge	1	4	12	6	1	1.1	0.5	1.1	0.5	0.07	0.03	NA	NA
227	T3 South Fork Bridge	1	3	14.4	14	9	1.7	1.0	2.6	2.1	0.06	0.01	NA	NA
228	T4 South Fork Bridge	1	6	11.1	1	0	6.8	2.4	5.0	1.2	0.44	0.09	NA	NA
229	T4 South Fork Bridge	2	6	11.5	3	2	1.4	0.5	1.4	0.5	0.10	0.04	NA	NA
230	Frisco	1	9	13.8	19	1	1.8	0.9	2.5	0.7	0.10	0.02	NA	NA
231	T1 Bridge	1	6	21.9	13	2	4.5	1.2	4.6	1.2	0.17	0.05	NA	NA
232	Bridge	1	10	38	2	0	14.5	1.5	16.6	1.6	0.33	0.05	NA	NA
233	Fireweed	1	3	23.9	3	0	1.6	0.5	1.9	0.8	0.08	0.04	NA	NA
234	East Fork Bridge	1	9	39.3	8	2	2.9	2.0	3.3	2.4	0.15	0.06	NA	NA
235	Stilleto	1	9	17.3	17	3	1.2	0.4	1.2	0.4	0.13	0.06	NA	NA
236	T1 East Fork Bridge	1	4	16.8	15	3	1.4	0.9	1.5	0.9	0.07	0.02	NA	NA
237	McAlester	1	7	37.9	5	1	6.0	2.2	6.6	2.1	0.20	0.07	NA	NA
238	T1 McAlester	1	4	50.8	7	1	1.0	0.2	1.0	0.2	0.05	0.02	NA	NA
239	T2 McAlester	1	4	NA	10	1	1.4	0.7	1.6	1.1	0.07	0.02	NA	NA
240	T4 Mc Alester	1	10	8.2	10	1	1.1	0.5	1.2	0.5	0.12	0.08	NA	NA
241	T3 Mc Alester	1	4	14.3	2	1	1.9	0.5	2.1	0.5	0.17	0.07	NA	NA
242	T2 Bridge	1	8	22	10	2	0.8	0.2	1.1	0.2	0.04	0.02	NA	NA
243	T4 Bridge	1	8	37.9	19	6	1.1	0.4	1.5	0.6	0.06	0.04	NA	NA
244	T3 Bridge	1	6	75.6	28	14	1.1	0.2	1.5	0.6	0.04	0.02	NA	NA
245	T6 Bridge	1	9	54.7	21	3	1.5	0.6	1.7	0.6	0.07	0.02	NA	NA
246	T5 Bridge	1	8	55.8	21	6	1.1	0.3	1.3	0.5	0.05	0.02	NA	NA
247	Bridge	2	8	33	3	1	9.7	1.6	11.3	1.7	0.33	0.04	NA	NA

Appendix C (continued).

Table C3. Hydrologic characteristics for sample sites within the Chilliwack watershed. sd = standard deviation

Survey ID	Stream Name	Site #	Water Chemistry		Gradient (%)		Wetted Width (m)		Bankfull Width (m)		Water Depth (m)		Bankfull Depth (m)	
			Temperature (C)	Conductivity (μS)	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd
10	LIttle Chilliwack	1	11.8	24.1	5	3	5.0	1.5	6.0	2.0	0.21	0.06	0.40	0.13
11	Little Chilliwack	2	11.1	32.7	4	2	10.9	2.5	12.6	2.3	0.41	0.15	0.68	0.15
12	T1 Little Chilliwack	1	12.2	58.1	13	7	1.1	0.4	1.8	0.7	0.04	0.02	0.29	0.09
13	T2 Little Chilliwack	1	10.1	27.3	27	6	0.8	0.5	1.9	0.6	0.04	0.02	0.58	0.16
14	T3 Little Chilliwack	1	12.9	43.9	25	11	1.1	0.7	1.2	0.3	0.02	0.01	0.23	0.13
15	Chilliwack River	1	9	27.1	1	<0	19.9	5.5	32.3	2.5	0.45	0.14	1.11	0.38
16	T1 Lower Chilliwack	1	17.1	42.1	16	<0	1.0	0.6	0.1	na	0.05	0.03	0.04	0.02
17	Bear	1	7.9	16	8	4	7.2	2.0	8.3	1.7	0.34	0.10	0.66	0.32
18	Indian	1	9.2	24.2	4	1	9.8	3.3	13.7	2.7	0.24	0.07	0.59	0.24
19	Brush	1	7.9	13.1	2	1	8.6	4.7	11.7	2.6	0.33	0.16	0.89	0.23
20	Brush (Side Channel)	1	10.2	18.8	2	1	2.1	0.5	2.5	0.3	0.12	0.07	0.28	0.05
21	Brush	2	8.1	20.9	4	2	8.3	3.4	25.7	9.8	0.22	0.09	0.70	0.31
22	T1 Brush	1	13.3	6	13	7	4.0	2.3	na	na	0.12	0.05	na	na
23	Tapto	1	13	16	16	14	2.5	1.3	6.0	2.2	0.06	0.05	0.69	0.20
24	Brush	3	6.4	66.5	9	6	1.3	0.7	10.6	1.7	0.16	0.18	0.97	0.37
25	T2 Brush	1	8.5	25.7	23	4	0.4	0.1	0.5	0.2	0.04	0.04	0.24	0.12
26	T2 Middle Chilliwack	1	8.5	22.4	31	9	1.4	0.4	1.7	0.4	0.02	0.02	0.29	0.04
27	T3 Middle Chilliwack	1	10.7	57.2	21	10	1.8	0.6	1.8	0.5	0.04	0.02	0.24	0.13
28	T4 Middle Chilliwack	1	11.6	28.8	25	7	0.8	0.4	1.4	0.4	0.06	0.05	0.22	0.14
29	Easy	1	10.9	12.7	3	2	5.5	2.4	11.1	2.9	0.14	0.03	0.62	0.25
30	T1 Upper Chilliwack	1	6	32.5	13	7	1.6	0.3	1.9	0.2	0.10	0.03	0.26	0.04
31	Copper	1	13.2	91.3	6	3	1.9	0.7	13.9	3.9	0.14	0.06	0.97	0.45
33	Chilliwack River	2	9.9	20.7	2	1	5.7	1.2	12.9	2.2	0.25	0.06	0.69	0.19
34	Chilliwack River	3	3.3	13.7	2	1	2.6	1.2	6.3	2.1	0.10	0.04	0.41	0.16

Table C4. Hydrologic characteristics for sample sites within the Little Beaver watershed. sd = standard deviation

Survey ID	Stream Name	Site #	Water Chemistry		Gradient (%)		Wetted Width (m)		Bankfull Width (m)		Water Depth (m)		Bankfull Depth (m)	
			Temperature (C)	Conductivity (μS)	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd
76	Perry	1	11.25	9	5	2	7.3	2.7	6.7	1.7	0.22	0.05	0.57	0.01
77	Redoubt	1	10.6	10	3	2	6.6	2.3	10.8	6.9	0.32	0.07	0.73	0.05
78	T4 Little Beaver	1	10.41	26	19	16	3.4	1.3	5.1	1.3	0.11	0.05	0.63	0.16
79	T5 Little Beaver	1	10.46	29	24	21	1.3	0.6	2.3	0.7	0.05	0.04	0.32	0.23
80	T6 Little Beaver	1	7.22	50	6	6	3.4	1.8	6.2	3.5	0.20	0.04	0.38	0.02
81	T1 Little Beaver	1	11.3	18	10	6	1.5	0.3	1.8	0.5	0.10	0.03	0.30	0.04
82	T2 Little Beaver	1	13.1	9	12	5	5.5	2.7	7.1	2.3	0.18	0.04	0.76	0.27
83	Little Beaver	1	6.2	33	3	1	11.1	2.9	10.5	0.9	0.45	0.07	0.74	0.17

Appendix C (continued).

Table C5. Hydrologic characteristics for sample sites within the Lower Stehekin watershed. sd = standard deviation

Survey ID	Stream Name	Site #	Water Chemistry		Gradient (%)		Wetted Width (m)		Bankfull Width (m)		Water Depth (m)		Bankfull Depth (m)	
			Temperature (C)	Conductivity (µS)	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd
56	Fourmile	1	14.9	66	10	5	4.4	1.6	5.3	0.7	0.18	0.07	0.45	0.09
57	Devore	1	13.18	50	4	2	6.7	3.8	7.3	0.9	0.24	0.08	0.57	0.18
58	Margerum	1	14.8	41	1	1	2.6	0.6	4.3	0.3	0.19	0.05	0.43	0.02
59	Company	1	11.8	45	8	6	8.5	1.5	11.4	1.5	0.47	0.10	0.82	0.13
60	Boulder	1	17.5	43	3	1	5.4	1.5	8.5	1.4	0.26	0.06	0.63	0.08
61	Rainbow	1	14.53	30	3	1	5.7	0.9	7.3	1.8	0.31	0.07	0.63	0.09
62	Rainbow	2	15.3	41	10	12	6.8	2.6	11.1	1.9	0.20	0.13	0.69	0.22
63	Rainbow	3	8.9	24	8	4	3.0	0.8	4.0	0.7	0.24	0.28	0.32	0.03
64	T1 Rainbow	1	11.8	38	6	4	1.8	0.3	2.6	0.4	0.07	0.03	0.26	0.09
65	Bench	1	13.4	36	20	12	2.3	0.7	3.5	0.7	0.10	0.06	0.45	0.05
66	North Fork Rainbow	1	10.6	25	6	3	4.4	2.2	6.7	0.6	0.16	0.04	0.57	0.11
67	Buzzard	1	7.4	47.2	5	3	1.9	0.4	2.0	0.2	0.06	0.02	0.16	0.05
68	McGregor	1	10.2	24.5	21	10	1.3	0.5	1.1	na	0.05	0.01	0.19	0.02
69	Cabin	1	11.9	42.7	8	8	5.8	2.2	6.8	1.0	0.22	0.07	0.52	0.11

Table C6. Hydrologic characteristics for sample sites within the Ross Lake watershed. sd = standard deviation

Survey ID	Stream Name	Site #	Water Chemistry		Gradient (%)		Wetted Width (m)		Bankfull Width (m)		Water Depth (m)		Bankfull Depth (m)	
			Temperature (C)	Conductivity (µS)	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd
84	Pierce	1	10.6	18.8	5	7	4.8	1.1	8.9	2.7	0.31	0.11	1.01	0.29
85	Dry	1	11.4	81.4	15	14	3.3	0.7	5.4	1.2	0.20	0.07	0.68	0.27
92	T1 Ruby	1	9.3	NA	15	9	0.9	0.5	0.9	0.1	0.02	0.02	0.18	0.07
93	T2 Ruby	1	10.1	NA	16	18	1.9	0.5	2.4	0.6	0.05	0.08	0.18	0.04
94	T3 Ruby	1	11	NA	24	15	1.6	0.6	2.5	0.2	0.08	0.07	0.33	0.05
95	Lone Tree	1	12.2	NA	18	12	2.2	1.0	4.0	0.3	0.13	0.04	0.43	0.09
96	Hidden Hand	1	8.87	NA	20	13	1.3	0.3	1.4	0.3	0.08	0.03	0.20	0.02
97	Roland	1	14.9	50.1	8	5	5.0	1.9	5.9	1.0	0.22	0.04	0.62	0.20
98	T1 Roland	1	10.3	109.3	18	17	1.3	0.3	1.8	0.2	0.08	0.03	0.24	0.06
99	T2 Roland	1	9	88.2	17	17	2.2	1.2	1.9	0.4	0.13	0.07	0.29	0.01
100	T3 Roland	1	10.6	93.3	10	7	1.8	0.3	2.0	0.4	0.09	0.07	0.22	0.04
101	May	1	9.8	11.6	4	1	5.3	1.2	6.6	1.4	0.29	0.06	0.63	0.12
102	T1 Dry	1	11.9	134.2	11	7	0.9	0.4	1.4	0.6	0.08	0.04	0.24	0.03
103	T2 Dry	1	10.1	113.2	28	20	1.3	0.4	2.2	0.3	0.11	0.06	0.38	0.17
107	Happy	1	7.9	14.2	2	0	4.2	0.5	4.6	0.8	0.27	0.09	0.30	0.06

Appendix C (continued).

Table C7. Hydrologic characteristics for sample sites within the Skagit/Diablo watershed. sd = standard deviation

Survey ID	Stream Name	Site #	Water Chemistry		Gradient (%)		Wetted Width (m)		Bankfull Width (m)		Water Depth (m)		Bankfull Depth (m)	
			Temperature (C)	Conductivity (µS)	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd
35	T1 Lower Goodell	1	7.5	40.3	3	3	1.3	0.4	1.7	0.7	0.04	0.02	0.15	0.04
36	T2 Lower Goodell	1	13.5	29.5	11	15	1.8	0.3	16.9	4.3	0.16	0.06	0.43	0.00
37	T3 Lower Goodell	1	7.3	16.2	10	5	4.7	2.1	6.3	2.5	0.25	0.08	0.69	0.10
38	Goodell	1	9.9	11.7	2	1	18.8	4.7	26.4	3.4	0.33	0.13	0.54	0.27
39	T4 Lower Goodell	1	11.9	42.1	6	5	2.6	1.2	6.5	1.0	0.11	0.07	0.49	0.10
40	Terror	1	8.2	10.1	4	1	7.7	2.7	9.5	2.5	0.36	0.12	0.67	0.17
41	Goodell	1	9.3	12.3	2	1	13.7	4.4	33.5	11.8	0.36	0.08	0.71	0.44
42	T1 Lower Newhalem	1	13.3	20.7	58	0	1.5	0.0	1.5		0.10	0.00	0.20	0.00
43	T2 Lower Newhalem	1	16.6	15.1	23	10	3.3	2.3	5.8	1.2	0.15	0.06	0.42	0.12
44	T3 Lower Newhalem	1	12.9	16.9	23	13	2.4	1.4	5.2	1.3	0.08	0.04	0.39	0.15
45	East Fork Newhalem	1	11.1	17.7	7	5	9.5	2.9	12.1	1.7	0.35	0.13	0.66	0.20
46	T1 Upper Newhalem	1	10.7	17.2	21	7	1.0	0.4	3.0	0.6	0.05	0.04	0.38	0.09
47	T2 Upper Newhalem	1	9.3	28.1	19	5	0.7	0.2	0.9	0.4	0.01	0.01	0.18	0.09
48	T3 Upper Newhalem	1	8.7	50.4	6	2	1.9	0.7	2.5	0.3	0.05	0.02	0.26	0.08
49	T4 Upper Newhalem	1	10.9	10.1	9	6	0.7	0.8	5.2	0.6	0.05	0.05	0.55	0.13
50	Newhalem	1	8.3	16.3	3	1	13.4	2.0	19.1	2.4	0.34	0.08	0.69	0.19
51	Bucket	1	11.2	84.6	17	11	1.0	0.4	5.4	2.0	0.02	0.03	0.56	0.15
52	Camp Dayo	1	12	84.9	5	3	1.3	0.9	6.9	1.2	0.15	0.08	0.42	0.18
53	T1 Thornton	1	13.6	34	12	14	3.9	1.1	4.3	1.8	0.13	0.04	0.47	0.07
54	Thornton	1	14	21.7	5	4	6.0	2.4	6.8	0.9	0.22	0.06	0.59	0.12
104	T1 Stetattle	1	13.34	NA	10	4	3.7	1.4	6.4	0.5	0.13	0.04	0.50	0.14
105	T1 Dialblo Lake	1	10.27	94	3	1	1.5	0.8	2.4	0.0	0.07	0.03	0.26	0.04
106	Sourdough	1	9.42	50	11	6	5.9	2.1	11.9	1.4	0.25	0.07	0.89	0.38

Appendix C (continued).

Table C8. Hydrologic characteristics for sample sites within the Thunder Creek watershed. sd = standard deviation

Survey ID	Stream Name	Site #	Water Chemistry		Gradient (%)		Wetted Width (m)		Bankfull Width (m)		Water Depth (m)		Bankfull Depth (m)	
			Temperature (C)	Conductivity (µS)	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd
248	Fisher	1	7	20.2	4	1	7.0	1.2	8.1	1.3	0.34	0.07	NA	NA
249	Fisher	2	7	12.19	1	1	4.9	1.0	4.9	1.0	0.21	0.05	NA	NA
250	T1 Fisher	1	15	37.5	16	3	1.6	0.4	2.4	0.5	0.07	0.02	NA	NA
251	T2 Fisher	1	18	35	14	1	2.1	0.9	3.2	0.9	0.06	0.02	NA	NA
252	T1 Thunder	1	12	55.3	13	4	1.9	0.7	2.4	0.6	0.15	0.05	NA	NA
253	T2 Thunder	1	8	38.4	10	2	1.6	0.4	2.7	0.7	0.11	0.03	NA	NA
254	T3 Thunder	1	12	30.4	14	2	1.3	0.7	2.3	0.8	0.06	0.02	NA	NA
255	T4 Thunder	1	12	58.4	9	1	0.9	0.5	1.8	0.2	0.08	0.07	NA	NA
256	T5 Thunder	1	13	55.6	10	1	1.8	0.5	2.0	0.5	0.10	0.05	NA	NA
257	T6 Thunder	1	12	53.7	3	1	1.8	0.4	2.0	0.3	0.16	0.05	NA	NA
258	T7 Thunder	1	8	43.3	10	3	3.0	1.3	3.1	1.3	0.23	0.06	NA	NA

Table C9. Hydrologic characteristics for sample sites within the Upper Stehekin watershed. sd = standard deviation

Survey ID	Stream Name	Site #	Water Chemistry		Gradient (%)		Wetted Width (m)		Bankfull Width (m)		Water Depth (m)		Bankfull Depth (m)	
			Temperature (C)	Conductivity (µS)	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd
70	Pelton	1	7.9	11	3	2	10.0	3.8	12.8	2.0	0.15	0.05	0.21	0.08
71	T1 Stehekin	1	16.8	78	29	20	1.5	0.7	5.4	2.0	0.06	0.04	0.55	0.14
72	Basin	1	12.19	13	6	4	10.7	4.8	11.9	1.7	0.28	0.05	0.81	0.09
73	T1 Trapper Lake	1	8.4	24	31	11	2.0	1.4	3.3	2.6	0.07	0.05	0.32	0.17
74	Cottonwood	1	17.5	35	11	16	5.6	1.4	7.3	2.7	0.30	0.18	0.80	0.07
75	Stehekin River	1	14.1	23	2	1	9.7	3.3	15.5	9.2	0.36	0.08	0.67	0.14
86	Park	1	13.05	30	3	2	8.1	2.5	14.0	6.2	0.36	0.06	0.71	0.24
87	Park	2	12	25	4	2	7.3	1.2	7.6	0.6	0.26	0.06	0.61	0.16
88	T1 Park	1	12.5	45	13	9	0.7	0.1	0.9	0.2	0.06	0.04	0.21	0.04
89	T2 Park	1	10.3	55	22	10	0.9	0.3	1.3	0.2	0.03	0.01	0.16	0.12
90	T3 Park	1	8.6	35	22	13	1.6	0.6	2.2	0.6	0.10	0.12	0.23	0.16
91	T4 Park	1	15.86	26	14	7	2.0	0.7	4.1	1.7	0.12	0.04	0.42	0.08

Appendix C (continued).

Table C10. Habitat characteristics for sample sites within the Big Beaver watershed.

Survey ID	Stream Name	Site #	% Canopy Cover		% Habitat Composition							% Instream Cover		
			mean	sd	Obscured	Cascade	Riffle	Pool	Tailout	Subsurface	Other	LWD	Org. Debris	Cut Bank
185	Luna	1	11	3	0	0	100	0	0	0	0	3	0	5
186	T1 Big Beaver	1	91	5	0	20	35	45	0	0	0	2	0	8
187	Luna	2	27	19	0	0	90	0	10	0	0	2	1	0
188	T2 Big Beaver	1	50	26	0	43	20	37	0	0	0	1	0	2
189	T3 Big Beaver	1	47	9	0	33	14	53	0	0	0	0	0	7
190	T4 Big Beaver	1	97	1	6	64	30	0	0	0	0	23	1	28
191	7 Mile	1	42	24	0	27	41	32	0	0	0	6	1	5
192	7 Mile	2	69	29	0	5	85	10	0	0	0	0	0	5
193	7 Mile	3	36	21	0	29	35	13	23	0	0	1	0	5
194	T1 7 Mile	1	7	16	5	4	50	42	0	0	0	2	0	5
195	39 Mile	1	90	11	0	42	39	16	3	0	0	4	0	7
196	T5 Big Beaver	1	93	5	0	20	60	20	0	0	0	12	0	64
197	T6 Big Beaver	1	85	13	0	69	11	20	0	0	0	3	0	16
198	Luna	2	15	3	0	65	0	35	0	0	0	0	0	0
199	Luna	3	0	0	0	35	23	19	23	0	0	0	0	0
200	T7 Big Beaver	1	95	3	0	0	50	50	0	0	0	13	8	50
201	T8 Big Beaver	1	41	15	0	100	0	0	0	0	0	0	0	0
202	T10 Big Beaver	1	75	20	0	79	7	14	0	0	0	11	1	5
203	T9 Big Beaver	1	96	3	0	10	80	10	0	0	0	8	0	75
204	T11 Big Beaver	1	65	18	2	95	0	4	0	0	0	1	1	18
205	T12 Big Beaver	1	93	13	0	40	20	40	0	0	0	18	0	15
206	McMillan	1	60	18	0	5	65	30	0	0	0	12	0	15
207	T1 Luna	1	88	15	0	0	100	0	0	0	0	9	0	10
208	McMillan (Side Channel)	1	89	8	0	0	85	15	0	0	0	4	1	25
209	T1 Luna Lake	1	3	3	0	46	41	8	0	0	5	0	0	0
210	T1 McMillan	1	24	35	0	72	10	0	18	0	0	1	2	5
212	Big Beaver	1	81	12	2	9	53	16	20	0	0	3	0	5

Appendix C (continued).

Table C11. Habitat characteristics for sample sites within the Bridge Creek watershed.

Survey ID	Stream Name	Site #	% Canopy Cover		% Habitat Composition							% Instream Cover		
			mean	sd	Obscured	Cascade	Riffle	Pool	Tailout	Subsurface	Other	LWD	Org. Debris	Cut Bank
213	Rainbow	1	27	16	0	11	89	0	0	0	0	0	3	76
215	T1 North Fork Bridge	1	91	13	0	8	40	14	38	0	0	14	15	47
216	North Fork Bridge	1	3	3	0	81	19	0	0	0	0	0	0	0
217	T2 North Fork Bridge	1	62	37	0	5	85	5	5	0	0	3	1	0
218	Grizzly	1	32	21	0	0	100	0	0	0	0	7	1	0
219	Fisher	1	66	21	0	26	70	4	0	0	0	0	0	10
220	Fisher	2	19	10	0	25	53	22	0	0	0	4	1	0
221	Fisher	3	4	5	0	9	60	22	10	0	0	9	6	15
222	Grizzly	1	65	7	0	87	10	3	0	0	0	1	0	20
223	Grizzly	2	38	36	0	0	80	0	20	0	0	14	5	45
224	South Fork Bridge	1	63	14	0	0	70	25	5	0	0	11	1	13
225	T1 South Fork Bridge	1	88	5	0	0	89	6	6	0	0	8	9	22
226	T2 South Fork Bridge	1	89	9	0	0	90	5	5	0	0	2	53	35
227	T3 South Fork Bridge	1	62	22	0	0	95	0	5	0	0	10	43	6
228	T4 South Fork Bridge	1	21	13	0	0	100	0	0	0	0	11	0	20
229	T4 South Fork Bridge	2	2	3	0	0	100	0	0	0	0	10	15	50
230	Frisco	1	11	15	0	32	58	10	0	0	0	1	4	10
231	T1 Bridge	1	12	12	0	50	50	0	0	0	0	3	3	30
232	Bridge	1	10	8	0	19	81	0	0	0	0	0	0	0
233	Fireweed	1	79	19	0	0	60	40	0	0	0	10	42	0
234	East Fork Bridge	1	90	11	0	0	81	19	0	0	0	19	11	15
235	Stilleto	1	60	12	0	40	50	10	0	0	0	13	4	15
236	T1 East Fork Bridge	1	38	18	0	20	52	24	4	0	0	2	12	15
237	McAlester	1	62	7	0	15	72	6	7	0	0	6	1	0
238	T1 McAlester	1	84	8	0	0	100	0	0	0	0	13	27	20
239	T2 McAlester	1	82	8	5	10	73	12	0	0	0	14	9	56
240	T4 Mc Alester	1	23	8	0	25	30	45	0	0	0	0	0	15
241	T3 Mc Alester	1	37	24	0	0	94	6	0	0	0	5	1	45
242	T2 Bridge	1	97	7	0	9	86	5	0	0	0	9	8	35
243	T4 Bridge	1	87	5	0	58	37	5	0	0	0	0	37	0
244	T3 Bridge	1	98	3	0	28	68	5	0	0	0	0	61	35
245	T6 Bridge	1	94	5	5	25	54	16	0	0	0	18	21	40
246	T5 Bridge	1	87	12	3	16	81	0	0	0	0	10	22	35
247	Bridge	2	39	8	0	0	100	0	0	0	0	1	0	0

Appendix C (continued).

Table C12. Habitat characteristics for sample sites within the Chilliwack watershed.

Survey ID	Stream Name	Site #	% Canopy Cover		% Habitat Composition							% Instream Cover		
			mean	sd	Obscured	Cascade	Riffle	Pool	Tailout	Subsurface	Other	LWD	Org. Debris	Cut Bank
10	LIttle Chilliwack	1	60	12	0	20	63	14	3	0	0	15	2	0
11	Little Chilliwack	2	64	15	1	30	33	22	15	0	0	0	5	2
12	T1 Little Chilliwack	1	99	2	3	35	39	22	0	0	0	19	15	7
13	T2 Little Chilliwack	1	68	8	13	22	1	27	0	36	0	5	18	0
14	T3 Little Chilliwack	1	83	15	2	39	19	18	0	2	20	2	35	12
15	Chilliwack River	1	24	11	0	0	78	22	0	0	0	17	10	0
16	T1 Lower Chilliwack	1	8	4	0	20	3	29	0	48	0	2	2	0
17	Bear	1	93	6	0	32	59	5	4	0	0	8	2	1
18	Indian	1	49	9	0	21	62	15	2	0	0	1	3	0
19	Brush	1	68	21	2	11	43	40	5	0	0	0	1	0
20	Brush (Side Channel)	1	91	11	0	0	35	46	0	20	0	3	2	3
21	Brush	2	25	20	0	50	50	0	0	0	0	2	1	0
22	T1 Brush	1	72	23	0	95	0	3	0	2	0	1	9	0
23	Tapto	1	69	9	0	46	28	18	1	7	0	0	3	0
24	Brush	3	17	33	2	16	27	19	0	36	0	0	0	2
25	T2 Brush	1	100	0	3	48	5	34	0	10	0	22	31	8
26	T2 Middle Chilliwack	1	98	3	23	61	5	12	0	0	0	20	25	15
27	T3 Middle Chilliwack	1	97	3	18	49	15	17	0	1	0	11	27	11
28	T4 Middle Chilliwack	1	95	6	26	35	0	24	0	15	0	24	14	3
29	Easy	1	33	28	2	7	67	25	0	0	0	8	6	2
30	T1 Upper Chilliwack	1	98	2	22	34	28	11	7	0	0	18	21	9
31	Copper	1	44	11	0	32	30	31	0	8	0	0	0	0
33	Chilliwack River	2	49	19	0	4	86	0	10	0	0	1	0	0
34	Chilliwack River	3	10	10	0	10	75	10	5	0	0	5	2	1

Table C13. Habitat characteristics for sample sites within the Little Beaver watershed.

Survey ID	Stream Name	Site #	% Canopy Cover		% Habitat Composition							% Instream Cover		
			mean	sd	Obscured	Cascade	Riffle	Pool	Tailout	Subsurface	Other	LWD	Org. Debris	Cut Bank
76	Perry	1	96	3	3	0	94	4	0	0	0	7	8	0
77	Redoubt	1	74	17	12	7	80	2	0	0	0	2	4	0
78	T4 Little Beaver	1	83	13	17	39	19	16	1	10	0	9	14	2
79	T5 Little Beaver	1	96	5	13	13	17	16	0	42	0	25	21	1
80	T6 Little Beaver	1	71	22	3	0	98	0	0	0	0	1	2	1
81	T1 Little Beaver	1	94	13	30	17	41	11	2	0	0	23	19	1
82	T2 Little Beaver	1	16	16	5	47	48	0	0	0	0	2	2	0
83	Little Beaver	1	2	4	0	20	80	0	0	0	0	0	0	0

Appendix C (continued).

Table C14. Habitat characteristics for sample sites within the Lower Stehekin watershed.

Survey ID	Stream Name	Site #	% Canopy Cover		% Habitat Composition							% Instream Cover		
			mean	sd	Obscured	Cascade	Riffle	Pool	Tailout	Subsurface	Other	LWD	Org. Debris	Cut Bank
56	Fourmile	1	92	10	5	39	33	21	3	0	0	4	5	1
57	Devore	1	85	18	0	0	87	13	1	0	0	1	1	0
58	Margerum	1	100	1	1	10	10	79	0	0	0	11	18	0
59	Company	1	83	11	0	19	44	35	2	0	0	0	1	1
60	Boulder	1	61	20	0	10	83	8	0	0	0	0	0	0
61	Rainbow	1	81	6	0	0	84	16	1	0	0	0	0	0
62	Rainbow	2	19	11	6	11	57	25	1	1	0	1	5	0
63	Rainbow	3	69	11	2	18	61	19	1	0	0	11	8	3
64	T1 Rainbow	1	88	5	3	2	42	52	2	0	0	2	9	1
65	Bench	1	87	14	11	31	4	49	2	3	0	8	5	0
66	North Fork Rainbow	1	77	9	3	3	48	41	4	1	0	1	8	0
67	Buzzard	1	99	1	12	3	54	28	3	1	0	8	7	7
68	McGregor	1	99	2	23	26	11	9	1	30	0	10	7	4
69	Cabin	1	95	4	0	6	69	24	2	0	0	0	1	0

Table B15. Habitat characteristics for sample sites within the Ross Lake watershed.

Survey ID	Stream Name	Site #	% Canopy Cover		% Habitat Composition							% Instream Cover		
			mean	sd	Obscured	Cascade	Riffle	Pool	Tailout	Subsurface	Other	LWD	Org. Debris	Cut Bank
84	Pierce	1	83	13	1	13	28	58	1	0	0	0	1	0
85	Dry	1	98	2	0	42	28	22	9	0	0	2	1	0
92	T1 Ruby	1	95	4	35	9	18	24	0	15	0	19	23	9
93	T2 Ruby	1	90	8	15	35	26	21	0	0	5	23	14	3
94	T3 Ruby	1	92	5	7	41	26	23	3	0	0	6	6	3
95	Lone Tree	1	96	6	5	36	29	23	2	6	0	11	10	2
96	Hidden Hand	1	98	2	11	39	33	18	1	0	0	4	14	9
97	Roland	1	89	9	0	20	50	15	16	0	0	4	3	1
98	T1 Roland	1	99	1	20	28	18	31	5	0	1	12	27	18
99	T2 Roland	1	98	1	35	39	14	8	4	2	0	16	30	13
100	T3 Roland	1	98	1	1	25	33	39	4	0	0	1	5	2
101	May	1	90	7	1	0	100	0	0	0	0	0	0	2
102	T1 Dry	1	98	1	2	17	17	56	2	7	0	7	4	0
103	T2 Dry	1	98	2	5	42	10	40	4	1	0	12	4	1
107	Happy	1	69	27	0	0	69	21	10	0	0	11	4	0

Appendix C (continued).

Table C16. Habitat characteristics for sample sites within the Skagit/Diablo watershed.

Survey ID	Stream Name	Site #	% Canopy Cover		% Habitat Composition							% Instream Cover		
			mean	sd	Obscured	Cascade	Riffle	Pool	Tailout	Subsurface	Other	LWD	Org. Debris	Cut Bank
35	T1 Lower Goodell	1	99	1	4	3	64	27	2	0	0	20	24	12
36	T2 Lower Goodell	1	53	9	0	8	19	37	6	31	0	0	0	0
37	T3 Lower Goodell	1	87	16	0	41	40	8	12	0	0	5	1	1
38	Goodell	1	38	23	0	18	77	5	0	0	0	0	0	0
39	T4 Lower Goodell	1	95	7	0	20	17	51	2	10	0	0	8	0
40	Terror	1	93	10	7	58	20	14	2	0	0	5	1	4
41	Goodell	1	24	9	0	10	80	10	0	0	0	2	0	0
42	T1 Lower Newhalem	1	100	0	20	60	0	10	5	5	0	50	5	0
43	T2 Lower Newhalem	1	65	20	0	51	14	32	0	2	0	0	0	0
44	T3 Lower Newhalem	1	94	3	3	24	22	27	4	22	0	9	5	1
45	East Fork Newhalem	1	74	11	0	16	39	40	5	0	0	6	4	2
46	T1 Upper Newhalem	1	100	0	12	41	9	37	1	1	0	6	22	4
47	T2 Upper Newhalem	1	99	1	22	53	7	19	0	0	0	16	27	6
48	T3 Upper Newhalem	1	98	1	9	24	37	29	2	0	0	14	21	1
49	T4 Upper Newhalem	1	75	24	2	14	12	18	1	55	0	2	6	0
50	Newhalem	1	60	14	0	0	92	8	0	0	0	0	1	0
51	Bucket	1	88	8	9	19	0	17	0	56	0	0	3	0
52	Camp Dayo	1	94	3	0	18	28	48	2	4	0	1	0	0
53	T1 Thornton	1	68	13	9	42	9	35	6	0	0	13	9	0
54	Thornton	1	57	39	0	20	55	15	11	0	0	1	0	1
104	T1 Stetattle	1	76	13	7	12	58	19	3	0	0	3	1	0
105	T1 Dialblo Lake	1	100	0	14	0	59	25	0	1	0	24	30	11
106	Sourdough	1	35	25	0	22	63	15	1	0	0	0	1	0

Appendix C (continued).

Table C17. Hydrologic characteristics for sample sites within the Thunder Creek watershed.

Survey ID	Stream Name	Site #	% Canopy Cover		% Habitat Composition							% Instream Cover		
			mean	sd	Obscured	Cascade	Riffle	Pool	Tailout	Subsurface	Other	LWD	Org. Debris	Cut Bank
248	Fisher	1	59	11	0	20	75	5	0	0	0	7	7	20
249	Fisher	2	0	0	0	0	100	0	0	0	0	1	1	20
250	T1 Fisher	1	0	0	0	100	0	0	0	0	0	0	2	5
251	T2 Fisher	1	93	3	0	75	10	15	0	0	0	2	8	0
252	T1 Thunder	1	100	0	0	25	28	35	12	0	0	3	3	26
253	T2 Thunder	1	99	1	0	0	70	30	0	0	0	8	2	10
254	T3 Thunder	1	100	1	0	71	24	5	0	0	0	7	8	0
255	T4 Thunder	1	100	0	0	27	32	34	7	0	0	2	12	5
256	T5 Thunder	1	98	2	0	48	18	30	4	0	0	10	8	20
257	T6 Thunder	1	99	3	7	0	79	9	5	0	0	8	2	55
258	T7 Thunder	1	97	3	0	46	32	0	22	0	0	2	6	25

Table C18. Habitat characteristics for sample sites within the Upper Stehekin watershed.

Survey ID	Stream Name	Site #	% Canopy Cover		% Habitat Composition							% Instream Cover		
			mean	sd	Obscured	Cascade	Riffle	Pool	Tailout	Subsurface	Other	LWD	Org. Debris	Cut Bank
70	Pelton	1	1	1	0	0	97	3	0	0	0	0	6	0
71	T1 Stehekin	1	24	27	6	37	16	38	4	1	0	0	5	0
72	Basin	1	2	4	3	20	78	0	0	0	0	0	1	0
73	T1 Trapper Lake	1	2	4	5	63	10	17	2	5	0	0	2	0
74	Cottonwood	1	47	26	2	27	72	0	0	0	0	3	6	0
75	Stehekin River	1	26	18	2	0	99	0	0	0	0	1	5	0
86	Park	1	31	13	0	0	86	14	0	0	0	0	0	0
87	Park	2	2	3	0	0	100	0	0	0	0	1	1	1
88	T1 Park	1	88	9	12	10	44	30	4	0	0	6	20	9
89	T2 Park	1	93	5	29	37	13	20	2	0	0	21	28	3
90	T3 Park	1	89	9	7	72	6	15	1	0	0	9	12	3
91	T4 Park	1	0	0	0	50	37	13	1	0	0	0	0	0

Appendix D. Amphibian Capture Information

Table D1. Amphibian capture and morphological data for the Big Beaver watershed.

Survey ID	Stream Name	Site #	Species	Age	Sex	Count	Total Length (mm)		Snout to Vent Length (mm)		Head Width (mm)		Hind Leg Length (mm)		Fore Leg Length (mm)	
							mean	sd	mean	sd	mean	sd	mean	sd	mean	sd
185	Luna	1	ASTR	L	U	1	42	na	na	na	12	na	na	na	na	na
187	Luna	2	ASTR	L	U	1	38	na	na	na	9	na	na	na	na	na
190	T4 Big Beaver	1	ASTR	A	M	1	na	na	30	na	na	na	35	na	20	na
194	T1 7 Mile	1	ASTR	L	U	10	42	4	na	na	9	1	na	na	na	na
195	39 Mile	1	ASTR	L	U	1	37	na	na	na	10	na	na	na	na	na
196	T5 Big Beaver	1	ASTR	L	U	3	32	1	na	na	8	0	na	na	na	na
197	T6 Big Beaver	1	ASTR	A	F	1	na	na	30	na	na	na	46	na	16	na
197	T6 Big Beaver	1	ASTR	L	U	2	30	na	na	na	7	na	na	na	na	na
200	T7 Big Beaver	1	ASTR	A	F	1	na	na	46	na	na	na	61	na	35	na
202	T10 Big Beaver	1	ASTR	L	U	8	37	6	na	na	9	2	3	na	na	na
202	T10 Big Beaver	1	ASTR	M	U	1	47	na	na	na	7	na	23	na	11	na
203	T9 Big Beaver	1	ASTR	A	F	1	na	na	47	na	na	na	60	na	25	na
203	T9 Big Beaver	1	ASTR	L	U	1	31	na	na	na	7	na	na	na	na	na
204	T11 Big Beaver	1	ASTR	L	U	3	41	14	na	na	10	4	11	na	na	na
205	T12 Big Beaver	1	ASTR	A	M	1	na	na	38	na	na	na	55	na	19	na
205	T12 Big Beaver	1	ASTR	L	U	7	32	2	na	na	8	1	na	na	na	na
210	T1 McMillan	1	ASTR	L	U	3	52	2	na	na	12	1	6	1	na	na
212	Big Beaver	1	ASTR	A	F	1	na	na	na	na	39	na	60	na	25	na

Table D2. Amphibian capture and morphological data for the Bridge Creek watershed.

Survey ID	Stream Name	Site #	Species	Age	Sex	Count	Total Length (mm)		Snout to Vent Length (mm)		Head Width (mm)		Hind Leg Length (mm)		Fore Leg Length (mm)	
							mean	sd	mean	sd	mean	sd	mean	sd	mean	sd
215	T1 North Fork Bridge	1	ASTR	M	U	2	48	na	18	na	8	na	20	na	10	na
220	Fisher	2	ASTR	A	F	1	na	na	23	na	na	na	na	na	na	na
232	Bridge	1	ASTR	L	U	1	34	na	na	na	9	na	na	na	na	na
234	East Fork Bridge	1	ASTR	L	U	7	41	9	na	na	9	2	5	3	na	na
234	East Fork Bridge	1	ASTR	M	U	1	50	na	18	na	13	na	10	na	na	na
235	Stilleto	1	ASTR	L	U	1	36	na	na	na	na	na	na	na	na	na
237	McAlester	1	ASTR	L	U	2	38	na	na	na	7	na	na	na	na	na
242	T2 Bridge	1	ASTR	M	U	1	na	na	22	na	na	na	33	na	14	na
245	T6 Bridge	1	ASTR	A	M	2	na	na	35	na	na	na	na	na	na	na
246	T5 Bridge	1	ASTR	A	F	2	na	na	na	na	na	na	na	na	na	na
247	Bridge	2	ASTR	L	U	1	52	na	na	na	13	na	na	na	na	na

Appendix D. (continued).

Table D3. Amphibian capture and morphological data for the Chilliwack watershed.

Survey ID	Stream Name	Site #	Species	Age	Sex	Count	Total Length (mm)		Snout to Vent Length (mm)		Head Width (mm)		Hind Leg Length (mm)		Fore Leg Length (mm)	
							mean	sd	mean	sd	mean	sd	mean	sd	mean	sd
10	LIttle Chilliwack	1	ASTR	L	U	8	40	7	na	na	10	2	na	na	na	na
10	LIttle Chilliwack	1	ASTR	M	U	1	49	na	21	na	na	na	10	na	6	na
11	Little Chilliwack	2	ASTR	L	U	23	34	6	na	na	8	2	na	na	na	na
11	Little Chilliwack	2	ASTR	M	U	2	47	na	19	na	9	na	10	na	7	na
12	T1 Little Chilliwack	1	PSRE	A	U	1	na	na	25	na	na	na	15	na	12	na
13	T2 Little Chilliwack	1	ASTR	A	M	1	na	na	45	na	na	na	40	na	25	na
13	T2 Little Chilliwack	1	ASTR	L	U	3	34	2	na	na	8	1	na	na	na	na
13	T2 Little Chilliwack	1	DITE	M	U	7	89	31	47	18	na	na	11	5	9	4
13	T2 Little Chilliwack	1	DITE	N	U	1	155	na	90	na	na	na	22	na	13	na
14	T3 Little Chilliwack	1	ASTR	L	U	1	38	na	na	na	9	na	na	na	na	na
14	T3 Little Chilliwack	1	DITE	L	U	1	55	na	na	na	na	na	5	na	5	na
16	T1 Lower Chilliwack	1	ASTR	L	U	23	33	4	na	na	8	1	na	na	na	na
16	T1 Lower Chilliwack	1	ASTR	M	U	7	34	6	18	1	na	na	11	3	6	1
17	Bear	1	ASTR	L	U	13	35	7	na	na	8	2	5	4	2	na
17	Bear	1	ASTR	M	U	4	45	2	18	1	11	1	11	1	5	1
18	Indian	1	ASTR	A	F	1	na	na	30	na	na	na	45	na	15	na
18	Indian	1	ASTR	L	U	14	35	8	na	na	9	2	3	1	na	na
18	Indian	1	ASTR	M	U	5	42	4	21	3	7	1	23	5	10	2
19	Brush	1	ASTR	A	F	1	na	na	26	na	na	na	29	na	12	na
19	Brush	1	ASTR	L	U	1	41	na	na	na	10	na	na	na	na	na
20	Brush (Side Channel)	1	ASTR	A	M	1	na	na	50	na	na	na	62	na	20	na
23	Tapto	1	ASTR	A	M	2	na	na	43	na	na	na	35	na	21	na
23	Tapto	1	ASTR	L	U	7	31	2	na	na	7	1	na	na	na	na
24	Brush	3	ASTR	L	U	16	34	6	na	na	8	2	4	na	na	na
25	T2 Brush	1	ASTR	A	F	2	na	na	37	na	na	na	36	na	16	na
26	T2 Middle Chilliwack	1	ASTR	L	U	1	34	na	na	na	9	na	na	na	na	na
27	T3 Middle Chilliwack	1	ASTR	L	U	1	36	na	na	na	8	na	na	na	na	na
27	T3 Middle Chilliwack	1	DITE	M	U	2	138	na	66	na	20	na	22	na	20	na
28	T4 Middle Chilliwack	1	ASTR	A	M	1	na	na	27	na	na	na	25	na	14	na
28	T4 Middle Chilliwack	1	ASTR	A	U	1	na	na	23	na	na	na	22	na	11	na
28	T4 Middle Chilliwack	1	DITE	M	U	2	57	na	29	na	6	na	5	na	6	na
29	Easy	1	ASTR	L	U	14	37	10	na	na	9	2	3	1	na	na
30	T1 Upper Chilliwack	1	ASTR	A	M	1	na	na	40	na	na	na	45	na	23	na
31	Copper	1	ASTR	A	M	1	na	na	36	na	na	na	34	na	20	na
31	Copper	1	ASTR	L	U	53	36	5	na	na	9	1	na	na	na	na
31	Copper	1	ASTR	M	U	1	39	na	17	na	na	na	22	na	9	na
31	Copper	1	ASTR	M	U	4	33	4	20	2	na	na	15	4	8	1
33	Chilliwack River	2	ASTR	A	F	4	na	na	22	1	na	na	30	4	12	2
33	Chilliwack River	2	ASTR	A	M	1	na	na	38	na	na	na	42	na	18	na
33	Chilliwack River	2	ASTR	L	U	32	36	6	na	na	9	2	7	na	na	na
33	Chilliwack River	2	ASTR	M	U	2	31	na	23	na	na	na	32	na	7	na
33	Chilliwack River	2	ASTR	M	U	6	28	5	22	3	na	na	31	6	11	3

Appendix D. (continued).

Table D4. Amphibian capture and morphological data for the Little Beaver watershed.

Survey ID	Stream Name	Site #	Species	Age	Sex	Count	Total Length (mm)		Snout to Vent Length (mm)		Head Width (mm)		Hind Leg Length (mm)		Fore Leg Length (mm)	
							mean	sd	mean	sd	mean	sd	mean	sd	mean	sd
78	T4 Little Beaver	1	ASTR	L	U	14	35	3	na	na	8	1	na	na	na	na
79	T5 Little Beaver	1	ASTR	L	U	4	38	1	na	na	9	1	na	na	na	na

Table D5. Amphibian capture and morphological data for the Lower Stehekin watershed.

Survey ID	Stream Name	Site #	Species	Age	Sex	Count	Total Length (mm)		Snout to Vent Length (mm)		Head Width (mm)		Hind Leg Length (mm)		Fore Leg Length (mm)	
							mean	sd	mean	sd	mean	sd	mean	sd	mean	sd
58	Margerum	1	RACA	A	U	2	na	na	45	na	na	na	93	na	24	na
63	Rainbow	3	ASTR	L	U	1	29	na	na	na	7	na	na	na	na	na
64	T1 Rainbow	1	ASTR	L	U	17	40	6	na	na	9	2	5	0	na	na
64	T1 Rainbow	1	ASTR	M	U	1	45	na	18	na	7	na	17	na	7	na
65	Bench	1	ASTR	L	U	6	38	8	na	na	9	2	5	na	na	na
66	North Fork Rainbow	1	ASTR	A	U	1	na	na	44	na	na	na	55	na	30	na
66	North Fork Rainbow	1	ASTR	L	U	3	34	2	na	na	8	1	na	na	na	na

Table D6. Amphibian capture and morphological data for the Ross Lake watershed.

Survey ID	Stream Name	Site #	Species	Age	Sex	Count	Total Length (mm)		Snout to Vent Length (mm)		Head Width (mm)		Hind Leg Length (mm)		Fore Leg Length (mm)	
							mean	sd	mean	sd	mean	sd	mean	sd	mean	sd
84	Pierce	1	PSRE	A	U	1	na	na	43	na	na	na	50	na	12	na
84	Pierce	1	ASTR	L	U	6	50	7	na	na	13	2	9	1	na	na
84	Pierce	1	ASTR	M	U	2	56	na	21	na	11	na	15	na	8	na
93	T2 Ruby	1	ASTR	A	U	1	na	na	na	na	na	na	na	na	na	na
93	T2 Ruby	1	ASTR	L	U	1	40	na	na	na	8	na	na	na	na	na
94	T3 Ruby	1	ASTR	L	U	4	40	1	na	na	11	1	na	na	na	na
95	Lone Tree	1	ASTR	A	U	1	na	na	30	na	na	na	na	na	na	na
95	Lone Tree	1	ASTR	L	U	2	41	na	na	na	12	na	na	na	na	na
100	T3 Roland	1	ASTR	A	M	1	na	na	36	na	na	na	45	na	20	na
100	T3 Roland	1	ASTR	A	U	1	na	na	25	na	na	na	32	na	14	na
100	T3 Roland	1	ASTR	L	U	1	39	na	na	na	9	na	na	na	na	na
102	T1 Dry	1	ASTR	L	U	1	43	na	na	na	9	na	na	na	na	na
107	Happy	1	ASTR	L	U	19	42	5	na	na	10	2	2	1	na	na

Appendix D. (continued).

Table D7. Amphibian capture and morphological data for the Skagit/Diablo watershed.

Survey ID	Stream Name	Site #	Species	Age	Sex	Count	Total Length (mm)		Snout to Vent Length (mm)		Head Width (mm)		Hind Leg Length (mm)		Fore Leg Length (mm)	
							mean	sd	mean	sd	mean	sd	mean	sd	mean	sd
35	T1 Lower Goodell	1	ASTR	A	M	1	na	na	40	na	na	na	35	na	15	na
35	T1 Lower Goodell	1	ASTR	A	U	1	na	na	40	na	na	na	na	na	na	na
36	T2 Lower Goodell	1	ASTR	A	F	1	na	na	50	na	na	na	50	na	17	na
36	T2 Lower Goodell	1	ASTR	A	M	1	na	na	30	na	na	na	33	na	14	na
36	T2 Lower Goodell	1	ASTR	L	U	50	45	4	na	na	11	1	na	na	na	na
36	T2 Lower Goodell	1	ASTR	M	U	1	41	na	22	na	na	na	23	na	8	na
36	T2 Lower Goodell	1	ASTR	M	U	3	56	3	20	2	na	na	20	4	9	3
36	T2 Lower Goodell	1	ASTR	M	U	5	47	8	23	1	na	na	26	5	12	2
37	T3 Lower Goodell	1	ASTR	L	U	3	37	3	na	na	10	2	4	na	na	na
38	Goodell	1	ASTR	L	U	2	50	na	na	na	12	na	na	na	na	na
38	Goodell	1	ASTR	M	U	3	36	6	21	2	na	na	20	3	10	1
39	T4 Lower Goodell	1	ASTR	A	M	1	na	na	20	na	na	na	34	na	9	na
39	T4 Lower Goodell	1	ASTR	L	U	18	42	2	na	na	10	2	2	0	na	na
39	T4 Lower Goodell	1	ASTR	M	U	1	21	na	19	na	na	na	28	na	10	na
39	T4 Lower Goodell	1	DITE	N	U	4	133	21	64	7	na	na	17	4	12	1
39	T4 Lower Goodell	1	DITE	N/M	U	2	102	na	51	na	na	na	14	na	10	na
40	Terror	1	ASTR	L	U	13	44	7	na	na	10	2	5	0	na	na
41	Goodell	2	ASTR	L	U	1	54	na	na	na	13	na	7	na	na	na
42	T1 Lower Newhalem	1	DITE	L	U	8	91	26	56	18	na	na	1	0	1	0
43	T2 Lower Newhalem	1	ASTR	L	U	70	35	5	na	na	8	2	10	na	na	na
43	T2 Lower Newhalem	1	DITE	L	U	1	81	na	na	na	na	na	14	na	12	na
43	T2 Lower Newhalem	1	ASTR	M	U	3	48	4	21	1	9	2	13	2	6	2
44	T3 Lower Newhalem	1	ASTR	A	F	1	na	na	21	na	na	na	31	na	7	na
44	T3 Lower Newhalem	1	ASTR	L	U	17	35	3	na	na	8	1	na	na	na	na
44	T3 Lower Newhalem	1	DITE	L	U	1	58	na	na	na	na	na	5	na	5	na
44	T3 Lower Newhalem	1	ASTR	M	U	2	81	na	41	na	na	na	59	na	36	na
44	T3 Lower Newhalem	1	DITE	M	U	5	100	21	58	11	na	na	12	5	9	3
44	T3 Lower Newhalem	1	RAAU	M	U	1	na	na	20	na	na	na	na	na	na	na
44	T3 Lower Newhalem	1	DITE	N	U	1	179	na	99	na	13	na	24	na	20	na
45	East Fork Newhalem	1	ASTR	L	U	8	36	8	na	na	8	2	na	na	na	na
45	East Fork Newhalem	1	DITE	L	U	2	42	na	na	na	10	na	4	na	4	na
45	East Fork Newhalem	1	DITE	N	U	1	158	na	87	na	na	na	28	na	17	na
46	T1 Upper Newhalem	1	DITE	M	U	1	87	na	46	na	na	na	18	na	16	na
47	T2 Upper Newhalem	1	DITE	L	U	1	60	na	na	na	na	na	7	na	5	na
48	T3 Upper Newhalem	1	DITE	L	U	2	64	na	na	na	na	na	9	na	7	na
50	Newhalem	1	ASTR	L	U	4	47	2	na	na	11	1	4	1	na	na
51	Bucket	1	ASTR	L	U	25	43	4	na	na	10	1	3	0	na	na
52	Camp Dayo	1	ASTR	A	M	1	na	na	36	na	na	na	31	na	12	na
52	Camp Dayo	1	ASTR	L	U	56	40	6	na	na	10	2	na	na	na	na
53	T1 Thronton	1	ASTR	A	M	1	na	na	42	na	na	na	41	na	21	na
53	T1 Thronton	1	ASTR	L	U	8	37	3	na	na	9	1	na	na	na	na
53	T1 Thronton	1	DITE	M	U	2	113	na	64	na	na	na	18	na	16	na
104	T1 Stetattle	1	ASTR	L	U	1	41	na	na	na	15	na	na	na	na	na
104	T1 Stetattle	1	ASTR	M	U	1	52	na	17	na	13	na	11	na	na	na
105	T1 Diablo Lake	1	ASTR	L	U	1	40	na	na	na	9	na	na	na	na	na

Appendix D. (continued).

Table D8. Amphibian capture and morphological data for the Thunder Creek watershed.

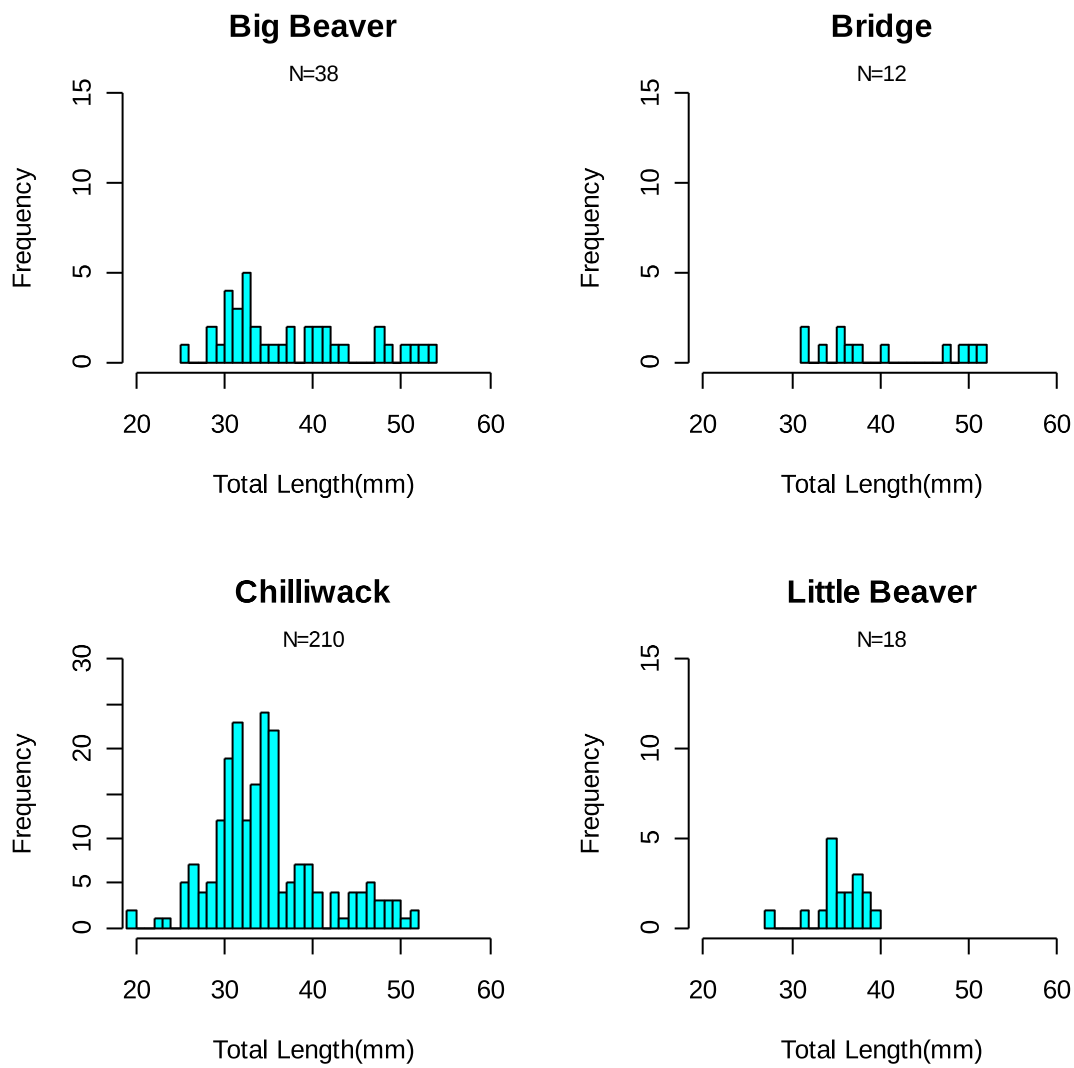
Survey ID	Stream Name	Site #	Species	Age	Sex	Count	Total Length (mm)		Snout to Vent Length (mm)		Head Width (mm)		Hind Leg Length (mm)		Fore Leg Length (mm)	
							mean	sd	mean	sd	mean	sd	mean	sd	mean	sd
248	Fisher	1	ASTR	L	U	3	49	2	na	na	12	2	na	na	na	na
248	Fisher	1	ASTR	M	U	4	54	1	na	na	12	2	19	5	9	1
249	Fisher	2	ASTR	L	U	11	30	9	na	na	7	2	11	na	na	na
250	T1 Fisher	1	ASTR	L	U	15	38	8	na	na	9	2	2	na	na	na
251	T2 Fisher	1	ASTR	A	U	1	na	na	44	na	na	na	55	na	20	na
251	T2 Fisher	1	ASTR	L	U	28	33	3	na	na	8	1	na	na	na	na
252	T1 Thunder	1	ASTR	A	U	1	na	na	27	na	na	na	41	na	17	na
252	T1 Thunder	1	ASTR	L	U	7	38	6	na	na	9	1	na	na	na	na
253	T2 Thunder	1	ASTR	L	U	10	37	6	na	na	8	2	5	1	na	na
254	T3 Thunder	1	ASTR	L	U	3	36	8	na	na	8	2	9	na	na	na
255	T4 Thunder	1	ASTR	L	U	1	38	na	na	na	8	na	na	na	na	na
256	T5 Thunder	1	ASTR	L	U	5	33	3	na	na	8	1	na	na	na	na
258	T7 Thunder	1	ASTR	L	U	11	42	8	na	na	10	3	8	na	na	na
258	T7 Thunder	1	ASTR	M	U	3	52	2	na	na	13	2	13	2	na	na

Table D9 Amphibian capture and morphological data for the Upper Stehekin watershed.

Survey ID	Stream Name	Site #	Species	Age	Sex	Count	Total Length (mm)		Snout to Vent Length (mm)		Head Width (mm)		Hind Leg Length (mm)		Fore Leg Length (mm)	
							mean	sd	mean	sd	mean	sd	mean	sd	mean	sd
71	T1 Stehekin	1	ASTR	L	U	1	44	na	na	na	11	na	na	na	na	na
86	Park	1	RACA	A	U	3	na	na	54	2	na	na	88	11	21	1
88	T1 Park	1	ASTR	A	F	1	na	na	30	na	na	na	49	na	13	na
88	T1 Park	1	ASTR	A	M	2	na	na	39	na	na	na	54	na	26	na
88	T1 Park	1	ASTR	L	U	11	33	4	na	na	8	2	na	na	na	na
89	T2 Park	1	ASTR	A	F	1	na	na	37	na	na	na	50	na	20	na
90	T3 Park	1	ASTR	A	M	1	na	na	40	na	na	na	54	na	26	na
90	T3 Park	1	ASTR	L	U	3	35	3	na	na	8	1	na	na	na	na

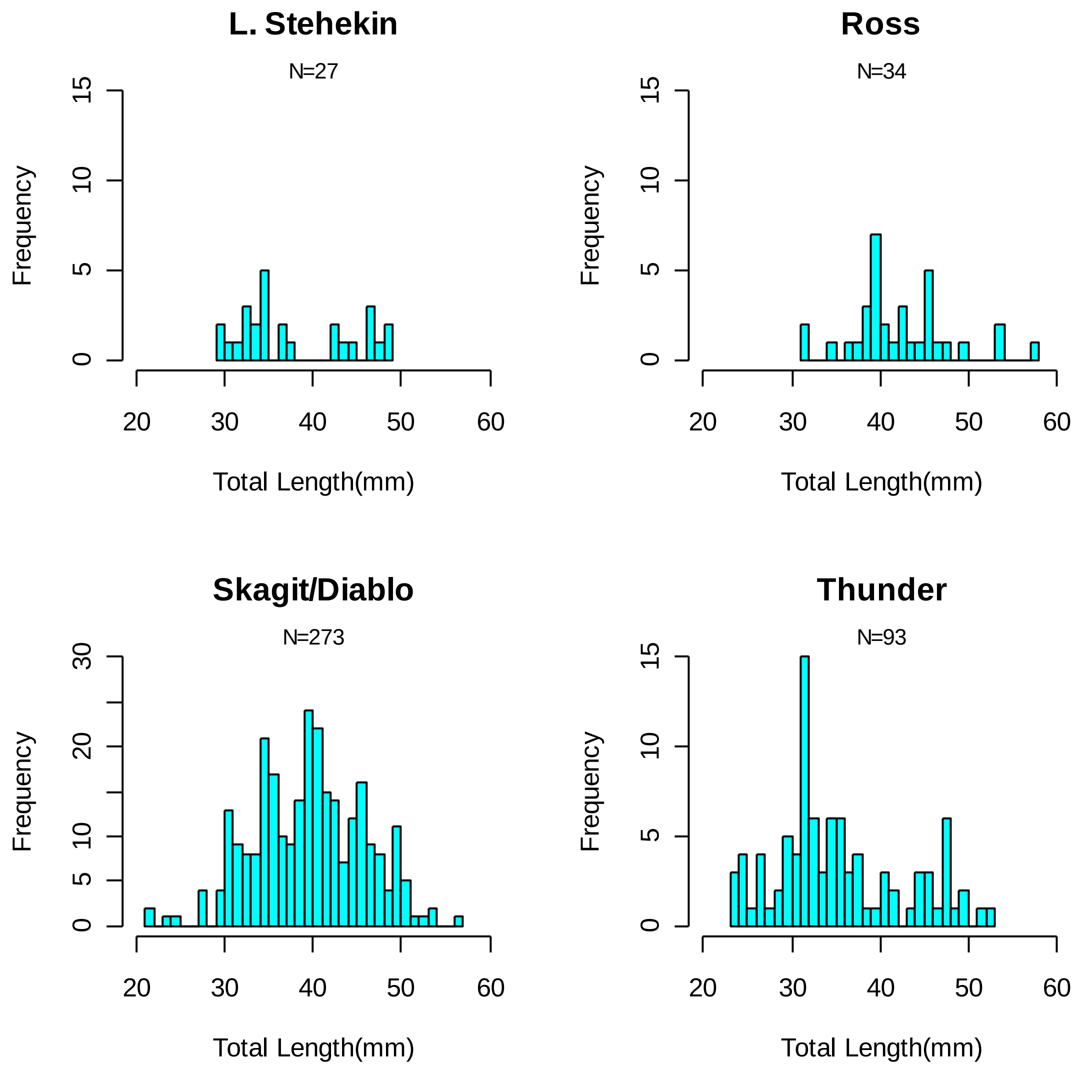
Appendix D. (continued).

Figure D1. Total length distributions for Ascaphus truei tadpoles in the Big Beaver, Bridge Creek, Chilliwack and Little Beaver watersheds.



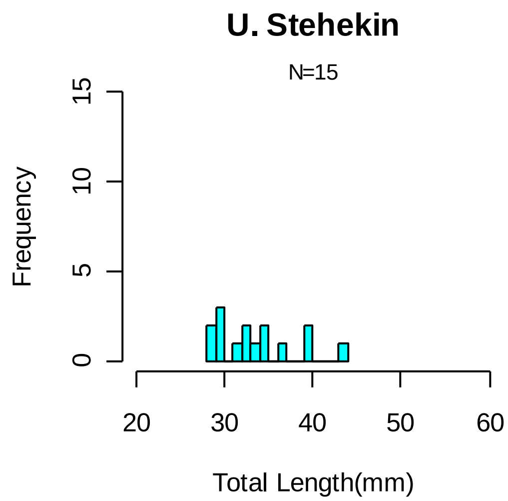
Appendix D. (continued).

Figure D2. Total length distributions for Ascaphus truei tadpoles in the Lower Stehekin, Ross Lake, Skagit/Diablo and Thunder Creek watersheds.



Appendix D. (continued).

Figure D3. Total length distributions for Ascaphus truei tadpoles in the Upper Stehekin watershed.



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