Assess Current and Potential Salmonid Production in Rattlesnake Creek Associated with Restoration Efforts

US Geological Survey Reports

Annual Report
2002 - 2003

DOE/BP-00005068-2

December 2003

This Document should be cited as follows:

Connolly, Patrick, "Assess Current and Potential Salmonid Production in Rattlesnake Creek Associated with Restoration Efforts; US Geological Survey Reports", 2002-2003 Annual Report, Project No. 200102500, 188 electronic pages, (BPA Report DOE/BP-00005068-2)

Bonneville Power Administration
P.O. Box 3621
Portland, OR 97208

This report was funded by the Bonneville Power Administration (BPA), U.S. Department of Energy, as part of BPA's program to protect, mitigate, and enhance fish and wildlife affected by the development and operation of hydroelectric facilities on the Columbia River and its tributaries. The views in this report are the author's and do not necessarily represent the views of BPA.

Assess Current and Potential Salmonid Production in Rattlesnake Creek Associated with Restoration Efforts

2002 Annual Report
(Contract year: May 2002—April 2003)

December 2003

Editor:
Patrick J. Connolly
Research Fishery Biologist

U.S. Geological Survey
Western Fisheries Research Center
Columbia River Research Laboratory
5501-a Cook-Underwood Road
Cook, WA 98605

Prepared for:
Bonneville Power Administration
Division of Fish and Wildlife
COTR: John Baugher
P.O. Box 3621
Portland, OR 97208-3621

BPA Project Number: 2001-025-00
Account Number: 003882
Contract Number: 00005068

Table of Contents

Page

Executive Summary iii

Report A: Characterization of Flow, Temperature, Habitat Conditions, and Fish Populations in the Rattlesnake Creek Watershed A-1
by M. Brady Allen, Patrick J. Connolly, and Kyle Martens

Report B: Instream PIT-Tag Detection System B-1
by Ian G. Jezorek and Patrick J. Connolly

Executive Summary

This project was designed to document existing habitat conditions and fish populations within the Rattlesnake Creek watershed (White Salmon River subbasin, Washington) before major habitat restoration activities are implemented and prior to the reintroduction of salmon and steelhead above Condit Dam. Returning adult salmon *Oncorhynchus* spp. and steelhead *O. mykiss* have not had access to Rattlesnake Creek since 1913. An assessment of resident trout populations should serve as a good surrogate for evaluation of factors that would limit salmon and steelhead production in the watershed.

Personnel from United States Geological Survey's Columbia River Research Laboratory (USGS-CRRL) attend to three main objectives of the Rattlesnake Creek project. The first is to characterize stream and riparian habitat conditions. This effort includes measures of water quality, water quantity, stream habitat, and riparian conditions. The second objective is to determine the status of fish populations in the Rattlesnake Creek drainage. To accomplish this, we derived estimates of salmonid population abundance, determined fish species composition, assessed distribution and life history attributes, obtained tissue samples for genetic analysis, and assessed fish diseases in the watershed. The third objective is to use the collected habitat and fisheries information to help identify and prioritize areas in need of restoration. As this report covers the second year of at least a three-year study, it is largely restricted to describing our efforts and findings for the first two objectives.

Large woody debris (LWD) was low in frequency in all areas that we surveyed. Water temperatures were above the preferred range for rainbow trout throughout much of

the summer in 2002, as they were in 2001, particularly in the section immediately above the confluence with Indian Creek (rkm 0.8). Because of lack of large trees, particularly conifers, in the riparian zone, adequate shading and LWD are likely to continue to be limited in the near future.

Although fish habitat was degraded, we found a relatively robust population of rainbow trout in Rattlesnake Creek, with several pools containing more than 18 age-1 rainbow trout. All reaches appeared to have some successful reproduction, with age-0 trout collected in every reach. The reach below the lowermost waterfall appears to have substantially more age-0 trout. The riffles in many sections were nearly dry during summer of both 2001 and 2002, which provided little habitat for older fish. Longnose dace were very abundant in all Rattlesnake Creek reaches. In the two reaches where longnose dace were sampled (rkm 0.2-1.3, 7.2-7.8), their biomass was nearly double the salmonid biomass.

The lower waterfalls on Rattlesnake Creek (3.6 m height at rkm 2.4) appear to be a barrier to resident fish. Lamprey and cutthroat trout were not found above these falls. Only rainbow trout, longnose dace, and shorthead sculpin were found above and below the lower waterfalls. Indian Creek had even fewer species than Rattlesnake Creek, with cutthroat trout dominating the assemblage. Another set of two falls occurs at rkm 17 that are each over 22 m in height. These upper falls are certainly fish barriers, and we have not found evidence of fish occurring above these falls to date.

The Lower Columbia River Fish Health Center found heavy infections of diagenic trematodes and suspect cases of BKD in some of the rainbow trout tested. Longnose dace tested positive for BKD and some sculpin were suspected of being

infected with BKD, but in general both species appeared healthy. There will be additional disease samples in 2003, so we will track the changes in disease presence and severity across time and among reaches.

We conducted extensive PIT-tagging efforts in the Rattlesnake Creek watershed and the mainstem White Salmon River. To accomplish this, we cooperated with the U.S. Forest Service and National Marine Fisheries Service (NMFS), with each providing matching funds to enhance the effort. Over 877 PIT tags were inserted in fish in the White Salmon River and Rattlesnake Creek watersheds during 2002, adding to the 633 that were PIT-tagged in 2001. We continued to partner with NMFS to maintain and upgrade an instream PIT-tag detector system in lower Rattlesnake Creek (rkm 0.3), near its confluence with the White Salmon River. The detector became operational in August 2001. With additional tagging and detection efforts in 2003, we will continue to assess patterns of habitat use and population links between the Rattlesnake Creek watershed and the White Salmon River.

During redd surveys, we observed large rainbow trout on redds. These fish were much larger than those we observed during our population survey work in the summer months. As validated by our PIT-tagging efforts and the PIT-tag detector deployed in lower Rattlesnake Creek, it appears that a number of large rainbow trout that reside in the White Salmon River for most of the year, migrate up Rattlesnake Creek for spawning on an annual basis. This documents an important life history linkage for rainbow trout between the mainstem White Salmon River and one of its largest tributaries, Rattlesnake Creek. It demonstrates that these rainbow trout are good surrogates for estimating

Rattlesnake Creek's potential productivity for steelhead if and when reintroduced above Condit Dam.

Report A: Characterization of Flow, Temperature, Habitat Conditions, and Fish Populations in the Rattlesnake Creek Watershed

Prepared by:
M. Brady Allen
Fishery Biologist

Patrick J. Connolly
Research Fishery Biologist

Kyle Martens
Fishery Biologist

U.S. Geological Survey
Western Fisheries Research Center
Columbia River Research Laboratory
5501-a Cook-Underwood Road
Cook, WA 98605

In: **Connolly, P.J., editor. Assess Current and Potential Salmonid Production in Rattlesnake Creek Associated with Restoration Efforts**

2002 Annual Report
(Contract year: May 2002—April 2003)

December 2003

Prepared for:
Bonneville Power Administration
Division of Fish and Wildlife
COTR: John Baugher
P.O. Box 3621
Portland, OR 97208-3621

BPA Project Number: 2001-025-00
Account Number: 003882
Contract Number: 00005068

List of Tables

Table 1. Locations of reach surveys....A-38

Table 2. Reach survey summary....A-39

Table 3. Location of thermographs....A-40

Table 4. Number of days in 2001 and 2002 when maximum temperature exceeded 16, 18, and 20 and monthly maximum....A-41

Table 5. Number of days per month in 2002 when maximum temperature exceeded 16, 18, and 20 and monthly maximum....A-42

Table 6. Locations of flow measurements....A-43

Table 7. Location of fish sampling sites and number of PIT tags deployed....A-44

Table 8. Presence and absence of fish species by reach....A-45

Table 9. Location, length, area, and percent habitat type of select reaches in Rattlesnake Creek....A-46

Table 10. Comparison between the number of trout caught on the first pass and the population estimate for the pools of Rattlesnake Creek....A-47

Table 11. Delimits of size and age classes of salmonids....A-48

List of Figures

Figure 1. Rattlesnake Creek watershed....A-49

Figure 2. Locations of reach surveys and thermograph sites....A-50

Figure 3. Locations of fish sampling and flow sites....A-51

Figure 4a-f. Summary of reach survey data for each reach of Rattlesnake Creek....A-52

Figure 5a-f. Summary of adjacent and outer riparian vegetation in each reach of Rattlesnake Creek....A-58

Figure 6. Mean canopy cover of each reach in Rattlesnake Creek....A-64

Figure 7a-c. Visual estimates of canopy cover averaged over 100 m for each reach of Rattlesnake Creek....A-65

Figure 8. Daily maximum water temperatures from October 2001 to September 2002....A-68

Figure 9. Monthly mean water temperatures during July and August 2001 and 2002....A-69

Figure 10. Diel water temperature fluctuation....A-70

Figure 11. Flow at four sites from January through December 2002....A-71

Figure 12. Flow at two sites from June through November 2001 and 2002....A-72

Figure 13. Fish population and biomass in lower Rattlesnake Creek for 2001 and 2002....A-73

Figure 14. Fish population and biomass for each reach sampled in 2002....A-74

Figure 15. Use of habitat types by age-0 and age-1 and older trout in the LRAT and MRAT reaches....A-75

Figure 16a-g. Comparison of salmonid population and biomass in pools in each reach of Rattlesnake Creek....A-76

Figure 17a-g. Length frequency of trout from each reach sampled in 2002....A-83

Figure 18. Length and weight of recaptured PIT-tagged fish in the LRAT reach of Rattlesnake Creek 2001 and 2002....A-90

List of Appendix Tables

Appendix Table 1a-9a. Population estimate of salmonids by habitat type for each reach sampled in the Rattlesnake Creek watershed during 2002. ....A-91

Appendix Table 1b-9b. Number and biomass of salmonids by habitat type for each reach sampled in the Rattlesnake Creek watershed during 2002. ……....A-91

Appendix Table 10a-g. Comparison of salmonids collected on the first electrofishing pass to the multiple-pass population estimate in each reach sampled in the Rattlesnake Creek watershed during 2002. ....A-110

Appendix Table 11a-19a. Number of salmonids in the pools of each reach sampled in the Rattlesnake Creek watershed during 2002. ....…A-118

Appendix Table 11b-19b. Biomass of salmonids in the pools of each reach sampled in the Rattlesnake Creek watershed during 2002. ....A-118

Appendix Table 20. Fish health results from the U.S. Fish and Wildlife Service's Lower Columbia River Fish Health Center for longnose dace, shorthead sculpin, rainbow trout, and cutthroat trout...A-138

Introduction

This project was designed to address a unique opportunity to document existing habitat conditions and fish populations within the Rattlesnake Creek watershed (White Salmon River subbasin, Washington) before major habitat restoration activities are implemented in response to the reintroduction of salmon and steelhead above Condit Dam. Returning adult salmon *Oncorhynchus* spp. and steelhead *O. mykiss* have not had access to Rattlesnake Creek since 1914. An assessment of resident trout populations should serve as a good surrogate for evaluation of factors that would limit salmon and steelhead production in the watershed.

Before the construction of Condit Dam in 1913 on the mainstem White Salmon River (at river km 5.1), Rattlesnake Creek (a principal tributary of the White Salmon River at river km 13.8) was likely a productive stream for anadromous salmon, steelhead, and cutthroat trout *O. clarki* (Western Watershed Analysts 1997). With the proposed removal of Condit Dam scheduled for 2006, or at least a retrofit to provide upstream fish passage, Rattlesnake Creek has high potential to support reintroduced or naturally colonizing populations of anadromous salmon and steelhead, but this potential is currently limited by existing habitat conditions (Haring 2003).

As noted in previous reports on the Rattlesnake Creek watershed (Stampfli 1994; Western Watershed Analysts 1997; Rawding 2000; Haring 2003), fish habitat has been severely degraded by a number of land-use activities in the watershed. These reports indicated fish habitat conditions in Rattlesnake Creek are compromised by high stream temperatures, low summer flows, lack of woody debris, and lack of riparian vegetation.

Personnel from United States Geological Survey's Columbia River Research Laboratory (USGS-CRRL) attend to three main objectives within the BPA-funded Rattlesnake Creek project. The first is to characterize stream and riparian habitat conditions. This effort includes measures of water quality, water quantity, stream habitat, and riparian conditions. The second objective is to determine the status of fish populations in the Rattlesnake Creek watershed. To accomplish this, we derived estimates of salmonid population abundance, determined fish species composition, assessed distribution and life history attributes, obtained tissue samples for future genetic analysis, and assessed fish diseases in the watershed. The third objective is to use the collected habitat and fisheries information to help identify and prioritize areas in need of restoration.

As this report covers the second year of at least a three-year study, the data collected are partial and the results presented are preliminary. Efforts and results covered by this report include reach-scale habitat surveys (hereafter referred to as "reach surveys"), stream temperature, flow, and fish population information that we gathered at key sites within the Rattlesnake Creek subbasin. This report covers the portion of the work completed under Task 1*a* of Objective 1 (water quantity, stream habitat and riparian conditions) and Tasks 2*a*, 2*b*, and 2*c* of Objective 2 as stated in the Statement of Work submitted in May 2001 by the USGS-CRRL. This report presents our findings from the data we collected through fall 2002.

We used results from habitat surveying, temperature profiling, and flow monitoring to characterize physical habitat conditions and their variation among and within streams of the watershed. Habitat characterization in concert with efforts to assess

the fish populations will allow us to assess potential rearing conditions for salmon and steelhead within the watershed. These data should help prioritize sites in need of restoration.

Study Area

The Rattlesnake Creek watershed covers 143 km^2 and supports a third-order stream system with the largest tributary watersheds being the second order systems of Mill and Indian creeks (Figure 1). Rattlesnake Creek enters the White Salmon River at river kilometer (rkm) 13.8, near the town of Husum. Elevations range from 114 m at the mouth of Rattlesnake Creek, which is at the watershed's western boundary, to 927 m at ridge tops near its eastern edge. The watershed's climate is temperate with 75 to 85% of the annual precipitation occurring between October and March. The average annual precipitation at the western downstream end of the watershed is about 127 cm and decreases to about 80 cm in the eastern upstream extension of the watershed (Western Watershed Analysts 1997). Due to the relatively low elevation of the watershed, precipitation in the winter is largely delivered as rain in the lower elevations and as rain or snow in the higher elevations.

There are two sets of waterfalls in Rattlesnake Creek. The lower set of falls, at rkm 2.4, has three individual drops, with the middle one being the largest (about 3.6 m total height, but with a step and 1.5 m deep pocket at 2.1 m). It is most likely a barrier to the resident fish, but may not have been a barrier to salmon and steelhead. Reiser and

Peacock (1985) reported a maximum jumping height of 3.3 m for steelhead, and 2.4 m for chinook salmon. The upper falls, at rkm 17, has two separate drops of about 22 - 25 m each that is certainly a fish barrier.

Indian Creek is a tributary entering at rkm 0.8 of Rattlesnake Creek. There is a culvert approximately 0.1 km from the mouth of Indian Creek that may be a resident fish barrier. Mill Creek is a tributary entering at rkm 14 of Rattlesnake Creek.

We divided the drainage into four reaches based on geomorphology and potential fish barriers (Figure 1). The lowermost reach (LRAT) starts at the mouth of Rattlesnake Creek and extends upstream about 2.4 km to the lower set of waterfalls. We had permission to sample 1,100 m at the downstream end of this reach and 440 m at the upstream end of the reach. The next reach (BRAT) is confined by canyon walls and extends from above the lower falls for about 2.5 km to the start of a much less confined stream. We had permission to sample on five adjacent sections in this reach totaling 2,440 m. The middle reach (MRAT) is a less constrained alluvial reach that extends 5.3 km between two confined reaches. We had permission to sample on a private landowners section totaling 1,240 m and on Department of Natural Resources (DNR) land totaling 580 m. The uppermost reach (URAT) starts at the base of a canyon and extends about 7 km to the base of the upper falls. We had permission to sample the full length of this reach. We had permission to sample two sections of Indian Creek, with the lower section (LIND) being 800-m long and the upper section (MIND) being 880-m long. The two sections were defined by landowner boundaries, but they also constituted parts of two separate reaches defined by their geomorphology.

Methods

Habitat Surveys

To conduct habitat surveys at the reach scale, we walked the stream channel and performed a series of measurements at 20-m intervals. At each 20-m interval, we measured stream width and took a densitometer reading from the stream center. Within each 20-m interval, we measured stream gradient using an Abney level, and we counted boulders (diameter $\geq$ 0.5 m), pools, and pieces of large woody debris (LWD). We classified LWD as conifer or hardwood and tallied pieces into four size classes by length (L) and diameter (D) (L > 5 m with D = 0.3-0.6 m; L > 5 m with D > 0.6 m; L 1-5 m, with D = 0.3-0.6 m; and L 1-5 m with D > 0.6 m). We measured maximum depth in each pool and estimated percent cover for each pool. We also estimated percent spawning area and percent canopy closure within each of these 20-m intervals. Data on pool depth and cover were not analyzed at the time of this report and were not included.

At 100-m intervals, we characterized riparian vegetation within a 10-m x 10-m transect and we assessed channel confinement. Within a transect, we documented dominate species of riparian vegetation. Channel confinement was assessed from estimates of distance to terraces and hill slopes.

Temperature

Personnel from the Underwood Conservation District (UCD) maintained a network of eight thermographs in the Rattlesnake Creek watershed from June 2001 through the present. Sites were chosen to provide thorough coverage of the watershed

(Figure 2). All thermograph units deployed and maintained by UCD personnel were Optic StowAway thermograph devices from Onset Computer Corporation (OCC). Prior to deployment, the units were tested for accuracy and adequacy of response time to change in temperature as per instructions from OCC's operating manual.

Thermographs recorded temperature every two hours. Temperature data were downloaded in October 2001, May 2002, October 2002, and will continue to be downloaded twice a year (spring and fall). To minimize time out of water and missed readings, downloads occurred in the field with use of an OCC optic shuttle. However, the thermographs were removed from the stream, for up to a week, to be re-calibrated annually. We calculated the daily mean temperature as the mean of the 12 daily readings. We derived the daily minimum and maximum temperatures from the minimum and maximum reading of the 12 daily readings.

Flow

Personnel from CRRL established four flow-monitoring stations in the Rattlesnake Creek subbasin (Figure 3). These stations consisted of a site in the lower Rattlesnake Creek (LRAT), a site in Rattlesnake Creek above the Indian Creek confluence (RAIN), a site in the middle section of Rattlesnake Creek within DNR land (MRAT), and site in the middle section of Indian Creek within DNR land (MIND). These stations were visited about every two weeks during June through October. In addition, occasional attempts were made to measure flow at LRAT throughout the winter of 2002–2003.

Stream flow was measured following the protocol of Bain and Stevenson (1999). This protocol entailed anchoring a measuring tape perpendicular to stream flow and recording the distance at the left and right wetted edge. We measured water depth and water velocity with a Marsh-McBirney flow meter at a minimum of 10 (usually about 20) intervals along the measuring tape. Because water depths were always less than 1 m, water velocities were measured at 60% of the depth at each interval. The flow at each interval was computed using the equation:

$$Q_n = d_n \times \left(\frac{b_{n+1} - b_{n-1}}{2} \right) \times v_n$$

Where Q_n = discharge at interval *n*, d_n = depth at interval *n*, b_n = distance along the tape measure from the left wetted edge to point *n*, and v_n = mean velocity of interval *n*. Total flow was calculated by summing the flow of each interval.

Fish

To obtain estimates of salmonid population, density, and biomass, we first conducted intensive habitat surveys of sampling sections, generally following Bisson et al. (1982) for declaring habitat types. Habitat surveys were performed by measuring the length, width, average depth, and maximum depth of each habitat type (e.g., pools, glides, and riffles) from the start to the end of a fish-sampling site, usually within a few days of fish sampling. For pools, we estimated the percent cover and types of cover (e.g., substrate, undercut bank, instream and overhead wood). In sections of the LRAT, BRAT, MRAT, and LIND reaches, we electrofished a systematic sample of habitat units within strata of habitat types. Habitat units chosen for sampling were blocked off with nets to

insure no movement into or out of the unit during sampling. During 2001, we noted that longnose dace *Rhinichthys cataractae* were highly abundant in Rattlesnake Creek, and we decided to more accurately assess their abundance in 2002. In the MRAT and LRAT reaches, population estimates for longnose dace were conducted during our efforts to gain salmonid population estimates. A backpack electrofisher was used to conduct two or more passes under the removal-depletion methodology (Zippin 1956; Bohlin et al. 1982; White et al. 1982). The field guides of Connolly (1996) were used to insure a controlled level of precision in the population estimate (CV < 25% for age-0; CV < 12.5% for age-1 or older trout) was achieved within each sampling unit for each age group considered (two age groups for salmonids, one age group for longnose dace). These methods were chosen specifically to minimize the number of units sampled by electrofishing and to minimize the number of electrofishing passes conducted. This approach serves to lessen the chance that individual fish will be exposed to potentially harmful effects of electrofishing while insuring a high degree of precision in our estimates.

In addition to the stratified systematic sampling described above, a less intensive method that we termed "index shocking" was used in other sections sampled for fish. The same intensive habitat survey was conducted as described in the population estimate sampling. We then restricted our sampling to pools. One pass was conducted (upstream and back) with no block nets in place. This method allowed us to sample lengths of stream more quickly, while providing information on the fish population within pools and giving us the ability to measure, weigh, insert PIT tags, and recapture previously PIT-tagged fish.

Captured fish were anesthetized with the lightest possible dose of MS-222 before handling and were released to their approximate point of capture after handling. The exception to this protocol was when a fish died before or during handling. These mortalities were given to the U.S. Fish and Wildlife Service's Lower Columbia River Fish Health Center (LCRFHC) for disease profiling. All fish captured were measured for fork length to the nearest mm, weighed to the nearest 0.01 g, and inspected for external signs of disease. Scale samples were collected from fish measuring 70 – 100 mm and over 150 mm to estimate age classes. Because of the difficulty identifying rainbow trout from cutthroat trout when the fork length was less than 80 mm, all those collected below this size were simply called "trout". All trout above this size were identified as either rainbow trout or cutthroat trout, and if the fish had hybrid characteristics, it was typically classified as a rainbow trout for our population estimates. In order to track movements, growth, and survival of the trout, we inserted PIT tags (12 mm; 134.2 kHz) in most of the trout that exceeded 80 mm in fork length.

In each reach, a small caudal fin clip was collected for genetic analysis from the first 50 trout and any subsequent cutthroat trout that exceeded 70 mm. These tissue samples were stored in a 1.5 ml vial with 90% ethanol. A portion of the samples have been sent to USGS's Alaska Science Center - Biological Science Office for genetic analysis as part of a related study by the U. S. Forest Service. The results of the genetic analysis have not been received to date.

The fish provided to the LCRFHC were given a rigorous inspection for disease. Diseases screened at the LCRFHC by testing or microscopic observations included bacterial (bacterial kidney disease, coldwater disease, columnaris, emphysematous

putrefactive disease, furunculosis, enteric redmouth), viral (infectious pancreatic necrosis, infectious hematopoietic necrosis, viral hemorrhagic septicemia), and parasitic agents (whirling disease, *Ceratomyxa*, digenetic trematodes, *Myxobolus kisutchi, Myxidium minteri, Hexamita, Gyrodactulus, Scyphidia, Heteropolaria*). During fish collections, all salmonids over 80 mm fork length were visually observed for the presence and severity of black spot (*Neascus).*

Spawning surveys were conducted from 29 March 2002 until no new redds were observed for two consecutive weeks which occurred by 9 May 2002. The LRAT reach was surveyed once a week, with MIND and MRAT surveyed every other week. These reaches were visually surveyed, and when redds or spawning fish were seen, we recorded and flagged the location, measured the redd (length, width, depth), estimated dominant and subdominant substrate size, approximate redd age, and recorded the size and species of fish if observed on the redd. To reduce observer error, the same person was involved in all surveys.

To evaluate the distribution of rainbow trout among habitat types, we used Vanderploeg and Scavia's (1979) electivity index. Potential values of this index range between -1 and 1. Values near zero represent a distribution of trout biomass (g) that was proportional with the available area (m^2) of the habitat type. Strongly negative values represent a relatively low use of that habitat type, and strongly positive values represent relatively high use of that habitat type.

Results

Habitat Surveys

Reach surveys were completed on 4.1 km of stream in 2001 and 8.0 km of stream in 2002. The remainder of the stream that we gained permission to sample will be surveyed in 2003. The locations of these reach surveys are shown in Figure 2, and described in Table 1. The average gradient of each reach ranged from 1.3 to 2.7% in Rattlesnake Creek, 2.8% in LIND and 4.7% in MIND (Table 2). Mill Creek had the highest average gradient at 8.1%. In mainstem Rattlesnake Creek, the mean number of pools per 100 m ranged from a low of 1.6 in the URAT reach to a high of 2.8 in the LRAT reach. The tributaries had a higher frequency of pools than the mainstem with 2.7 pools per 100 m in the MIND reach and 3.4 pools per 100 m in both LIND and LMIL reaches. The number of boulders varied from 10 per 100 m at MRAT to 241 per 100 m at LRAT.

The amount of coniferous LWD was low (0.1 pieces per 100 m or fewer in mainstem Rattlesnake Creek, and 0.2 to 0.7 pieces per 100 m in the tributaries). Hardwood LWD was more abundant at 0.2 to 0.6 pieces per 100 m in mainstem reaches and 0.2 to 1.1 pieces per 100 m in the tributaries. Conifer and hardwood "KEY" pieces (defined as pieces 5 m or longer in length and 0.6 m or larger in diameter) were rare, with 0.4 pieces per 100 m or fewer in all surveyed reaches of Rattlesnake Creek and its tributaries (Figures 4a-4d). Of the mainstem reaches, MRAT reach had the most LWD with 1.1 pieces (conifer and hardwood combined) per 100 m, of which 0.4 per 100 m were KEY pieces. There was mostly hardwood LWD in MIND and LIND, with pieces

of coniferous LWD limited to the upstream sections (Figure 4e). Lower Mill Creek (LMIL) had more coniferous LWD per 100 m than any other reach (Table 2), but it had only one KEY piece, which was a conifer (Figure 4f).

The adjacent (0 to 3 m from bankfull width) riparian vegetation on Rattlesnake Creek was dominated by 15 to 40-cm red alder trees (Figures 5a-5f). There were few transects with conifers as the dominant tree type within the adjacent zone in any of the reaches, however conifers tended to dominate in the higher gradient reaches of the tributaries (LMIL and MIND; Figures 5e and 5f).

Hardwoods dominated most outer riparian (3 to 10 m from bankfull width) stands, particularly in the MRAT and URAT reaches, and there were many transects where there were no trees contributing to a canopy layer within the outer riparian zone. Where conifers dominated the canopy in the outer riparian zone, such as in BRAT and MIND, they tended to be small young trees.

Mean canopy cover was lowest in the BRAT reach and highest in the tributaries, particularly in the MIND reach (Figure 6). The mean densiometer measurement was typically higher than the visual estimate and had higher standard deviation. Mean visual estimates of canopy cover in the mainstem Rattlesnake Creek ranged from a low of 30% in the BRAT reach to a high of 67% in the MIND reach. Estimates using a densiometer ranged from a low of 36% in the BRAT reach to a high of 73% in the MIND reach. Mean canopy cover at 100-m intervals in mainstem reaches of Rattlesnake Creek were typically under 60%, but some 20-m intervals exceeded 80% cover, especially in the tributaries (Figures 7a – 7c).

Temperature

In the second week of June 2001, UCD placed eight thermographs throughout the Rattlesnake Creek watershed (Table 3, Figure 2). Data from these thermographs were retrieved in early October 2001, and the thermographs remained in place to collect temperature information. The thermographs were downloaded again in May 2002 and removed from their sites for about one week to calibrate. They were then redeployed and downloaded at the end of September 2002. The analysis in this report covers data collected from June 2001 through September 2002, primarily concentrating on the summer months.

The Rattlesnake mainstem site above Indian Creek (RAIN) consistently had the highest daily maximum temperature compared with the other mainstem sites (Figure 8). This site also had the highest mean temperature of any of the mainstem sites during July (19.1 °C) and August (17.5 °C; Figure 9). This was warmer than the July mean temperature experienced in 2001 (18.3 °C) and cooler than August 2001 (18.4 °C). The coolest mainstem site was the one located highest up the drainage (URAT). This site had the coolest mean temperatures during July (15.5 °C) and August (14.4 °C; Figure 9) and had the lowest daily maximum from June through October (Figure 8). There was a period in late-July when there was a temperature shift at the TOML site (see Figure 2 for location) compared to the other thermograph sites. During that period, it was the coolest site and remained the coolest through mid-September (Figure 8). This was a similar trend as seen in 2001, although TOML was the coolest site for only a week in August 2001.

The rate of warming can be determined by looking at the slope of the lines in Figure 9. The mean water temperature increased at a consistent rate from URAT to MRAT in both July (0.32 °C/ km) and August (0.32 °C/ km), even with the cooling influence of Mill Creek (LMIL). However, in both months but particularly August, the monthly mean temperature at the TOML site (13.7 °C) was much cooler than the upstream site (17.2 °C; MRAT). The highest rate of warming (0.80 °C/ km) was in August from TOML to the RAIN thermograph site, due to the unusually low mean temperature at TOML (13.7 °C). The highest rate of cooling (-1.07 °C/ km) was in August from the RAIN site to the LRAT site, possibly due to the cooling influence of the surface and hyporheic flow from Indian Creek.

During June through September of 2001 and 2002, we recorded many daily water temperatures that exceeded 16 °C at all the mainstem Rattlesnake Creek sites and Indian Creek (Table 4). Only Mill Creek did not exceed 16 °C in 2001 or 2002. This 16 °C limit has been set by the Washington Department of Ecology (Washington Department of Ecology, November 18 1997, Chapter 173-201A, Water Quality Standards for the Surface Waters of the State of Washington) as an indicator of stream health. By comparing either the number of days exceeding 16 °C, 18 °C, and 20 °C or the annual maximum temperature, 2002 was a warmer summer than 2001 (Table 4). In 2002, the warmest month was July, which had water temperatures above 16 °C nearly every day at all mainstem sites (Table 5). The highest temperature recorded was 24.1 °C, which was at Rattlesnake Creek just above the confluence of Indian Creek (RAIN). This maximum temperature was higher than that reported in 2001 (23.2 °C). This site also recorded temperatures higher than 20 °C for more than half of July, as did LRAT, MRAT, and

BUPC. The mainstem location with the lowest maximum temperatures, in the upper canyon below the waterfalls (URAT, Table 4), still had many days with temperatures above those preferred by salmonids.

July was the month with the highest temperature and the most diel water temperature range measured on the hottest day at all sites (Figure 10), where as June was the hottest month in 2001. The water warmed 4 °C over the course of the day on June 27, 2002 (June's warmest day) at URAT. Several other sites ranged 3.87 °C in July (BUPC, MRAT, and RAIN). The diel temperature range was greater in June 2001 at 5.5 °C. Indian Creek, with a July diel range of 3.54 °C, had daily fluctuations similar to Rattlesnake Creek. Mill Creek, with a diel range of 1.05 °C, had much more stable temperatures. This trend was similar on the hottest day in June, August, and September 2002 (Figure 10), as well as the trends observed in 2001. The temperature shift at the TOML site is particularly striking, with large diel change in June and July, and then small diel change in August and September. Most mainstem sites on August 16th had diel fluctuation of at least 3 °C, while the TOML site fluctuated 0.61 °C on that day.

Flow

Four flow measurement sites were sampled in 2002, with three sites on Rattlesnake Creek and one on Indian Creek (Table 6, Figure 3). After June, flow was measured every two weeks until late October. In addition, flows at LRAT and MIND were measured during high flow events in the winter and early spring. During a high flow event on 14 January 2002, the flow at LRAT measured 160.3 cfs (Figure 11). Flow on Indian Creek on 10 January 2002 was 19.5 cfs. We observed higher peak flows but

they could not be measured due to personnel safety concerns. The lowest flows in 2002 were recorded on August 23rd with MRAT at 0.07 cfs, RAIN at 0.19 cfs, LRAT at 0.29 cfs, and Indian Creek at 0.01 cfs. Rattlesnake Creek dropped to base summer flow by early August (Figure 11). Base flows were lower in 2002 than in 2001 (Figure 12). The lowest flows in 2001 for Rattlesnake Creek were recorded on July 26th: 0.08 cfs at MRAT, 0.28 at RAIN, and 0.6 cfs at LRAT. As expected, the flows increased over the late fall and winter, associated with rainfall.

During July through October 2002, the upper falls (rkm 17) had no surface flow over the lip of the falls; however, the water flowed from the plunge pool at the bottom of the falls throughout the summer. Many of the riffles between pools had no surface flow from July through October.

Fish

A total of 5.4 km on Rattlesnake Creek, 0.9 km on Indian Creek and 0.7 km on Mill Creek were sampled for fish during summer 2002 (Table 7, Figure 3). This compares with a total of 3.2 km on Rattlesnake Creek and 0.5 km on Indian Creek sampled for fish during summer 2001. In conjunction with fish sampling for population estimates, 751 PIT tags were deployed, including 659 in mainstem Rattlesnake Creek, 72 in Indian Creek, and 20 in Mill Creek (Table 7). In 2001, 544 PIT tags were deployed in mainstem Rattlesnake Creek and 30 PIT tags were deployed in Indian Creek. Ninety-three PIT-tagged trout were recaptured in 2002.

We found six fish species in our sampling areas in 2002 (Table 8): rainbow trout, cutthroat trout, longnose dace, shorthead sculpin *Cottus confusus*, brook lamprey

Lampetra richardsoni, and one brook trout *Salvelinus fontinalis*. Crayfish were present and often abundant in all reaches, and one Pacific giant salamander *Dicamptodon tenebrosus* was collected in the BRAT reach. All of the six fish species were found in the LRAT reach. Cutthroat trout, brook trout and brook lamprey were not collected in reaches above the lower falls, which includes BRAT, MRAT, URAT and Mill Creek. Brook trout, lamprey, and longnose dace were all absent from the lower (LIND) and middle (MIND) sections of Indian Creek.

In Indian Creek, the age-1 or older salmonid population was dominated by cutthroat trout in the LIND reach (81%) and the MIND reach (95%). Only 1 rainbow trout (FL, 88 mm), versus 20 cutthroat trout, that were 80 mm or longer were collected in the MIND reach (all trout < 80 mm were identified only as trout). Because the LIND reach was sampled for a population estimate and the MIND reach was sampled for an "index", these proportions may not be representative. The MIND reach was above two culverts and above a section of creek that we lacked permission to sample.

We sampled one reach, LRAT, for a population estimate in both 2001 and 2002. One clear difference is the change in the age-1 or older rainbow trout and age-1 or older cutthroat trout. The number and biomass of these age-1 or older trout decreased substantially from 2001 to 2002 (Figure 13). Differences between years for age-0 trout were not as clear, given the overlap of errors of estimation.

During 2001 fish sampling efforts, we noted the abundant dace population, so in 2002 in conjunction with our trout sampling efforts, we sampled the dace population to derive population estimates in the LRAT (limited to the LRAT1 section) and MRAT (limited to the MRAT2 section) reaches. We found that the dace biomass (LRAT = 3.14

g/m^2, MRAT = 5.26 g/m^2) was nearly double the salmonid biomass (LRAT = 1.94 g/ m^2, MRAT = 2.71 g/m^2) in both reaches (Figure 14, Appendix Tables 1b, 3b, 6b, and 7b). Numerically the salmonid (0.60 fish/ m^2) and dace (0.66 fish/ m^2) populations were similar in the LRAT reach, but in the MRAT reach, dace (1.32 fish/ m^2) were nearly six times more abundant than salmonids (0.23 fish/ m^2). In LRAT, the salmonid population was three times higher, but the dace population was about half, of that in MRAT. The LRAT reach had a much larger population of age-0 trout (0.55 trout/ m^2) compared with MRAT (0.17 trout/ m^2; Figure 14, Appendix Tables 1-9). The contribution of age-0 dace was very limited according to length-frequency graphs. With age-0 trout excluded, the number of age-1 or older salmonids in LRAT (0.05 trout/ m^2) and MRAT (0.06 trout/ m^2) were nearly identical. Compared to these age-1 or older salmonid populations, the dace population (trout/ m^2) was over 10 times higher in LRAT and over 20 times higher in MRAT.

Habitat surveys done prior to fish sampling showed that 39% of Rattlesnake Creek is composed of low gradient riffles with the remainder of the creek composed of glides (14%), shallow pools (26%), and deep pools (18%, Table 9). Vanderploeg and Scavia's (1979) electivity index, E*, indicated that the fish were less abundant in riffles than could be explained by the availability of that habitat type (Figure 15). Appendix Tables 1-9 document the number and biomass of trout and dace in each habitat type, as well as the amount of each habitat type available, for our 2002 sampling effort.

Although we refrained from a formal analysis of pattern of pools and fish numbers, thinking that it would be best reserved after additional data are collected in 2003, we do present this information graphically. Figure 16 shows the distribution and

maximum depth of pools, as well as the number and biomass of age-0 and age-1 or older trout in those pools, for all reaches sampled in 2002. There appears to be little relationship between pool area or pool depth and salmonid biomass of the pool. The amount and type of cover in each pool may have a large influence on salmonid biomass. These relationships will be analyzed and more fully addressed in the 2003 report.

To develop an index for our single-pass shocking method, we compared the number of fish collected on the first pass to a population estimate resulting from multiple passes (Table 10, Figures 16a-f, Appendix Tables 10a-g). Within individual habitat units, our efficiency on the first pass during multiple-pass sampling ranged from 16% to 100% for age-0 trout and 50% to 100% for age-1 or older trout when at least one fish was caught on the first pass (Table 10, Appendix Tables 10a-g). On average, we collected 89% (SD = 14) of age-0 fish and 90% (SD = 15) of age-1 or older fish on the first pass when 1 to 10 fish were caught on the first pass. When no fish were collected on the first pass, we typically collected zero fish (81% of the time) on subsequent passes, but never more than two fish of any single age class and species on subsequent passes. When more than 10 fish were caught on the first pass, our efficiency on the first pass averaged 65% (SD=19) for age-0 fish and 74% (SD=15) for age-1 or older fish.

The index shocking method was used in the LRAT2, BRAT1, BRAT3, BRAT5, MRAT1, URAT, MILL and MIND sections. Figures 16a-g and Appendix Tables 11-19 show the distribution of pools and the number and biomass of age-0 and age-1 or older trout in those pools sampled in each reach. This method, although less thorough than the multiple-pass method, allowed us to sample a larger area more quickly and increased our ability to recapture PIT-tagged fish to detect movement and measure growth of specific

fish. Sampling in subsequent years will allow us to track changes in the fish distribution and individual fish growth within and among these reaches.

The maximum fork length recorded for an age-0 trout was 95 mm (collected 16 October 2002 from the MRAT1 section, Table 11). The maximum fork length for an age-0 trout in 2001 was 92 mm from the BRAT reach. The minimum length of an age-1 fish on Rattlesnake Creek was 88 mm in mid July 2002 on the MRAT2 section. In 2001, the minimum length of an age-1 fish on Rattlesnake Creek was 78 mm in the LRAT reach in August. The tributaries had smaller fish with a maximum age-0 trout fork length of 65 mm in both Mill and Indian creeks. In 2001, Indian Creek also had smaller fish with the maximum age-0 fish measuring 55 mm. Ages were determined with length-frequency analysis (Figures 17a-g) and by aging scales from those fish near the estimated fork-length limits for each age. Because of the difficulty differentiating between rainbow and cutthroat trout that are smaller than 80 mm, we did not estimate the maximum length of age-0 cutthroat trout in LRAT.

During our fish sampling efforts, we recaptured 93 trout that had been previously PIT tagged (23 in LRAT, 59 in BRAT, 8 in MRAT, 3 in MIND), which does not include detections of fish on the instream PIT-tag detection system (for these, see Report B of this report). In the LRAT1 section, length and weight of recaptured PIT-tagged fish at initial tagging to the time of recapture showed measurable growth had occurred for individual trout from July 2001 to July 2002 (Figure 18), but few fish showed growth over the summer months, from July 2002 to October 2002. We plan to more fully analyze these growth data in 2003, when more data are available.

Fish were submitted to the LCRFHC for disease assessments from 4 reaches and 13 separate sampling dates in 2002 (Appendix Table 20). A total of 112 rainbow trout, 43 shorthead sculpin, and 24 longnose dace were submitted from the LRAT reach; 15 rainbow trout were submitted from the BRAT reach; 24 rainbow trout, 50 longnose dace and 1 shorthead sculpin were submitted from the MRAT reach; and 10 cutthroat trout were submitted from the LIND reach. In general, the longnose dace appeared to be in good health with some suspected or confirmed presence of bacterial kidney disease (BKD), *Renibacterium salmoninarum,* and a few fish with aeromonas. The sculpin were also generally in good health, with some suspected presence of BKD. The rainbow trout sampled in June appeared relatively healthy but some had suspect cases of BKD, low levels of the parasite *Trichodina* on the skin, and high levels of the parasite *Nanophyetus* in the hind-gut. The fish collected in September had higher levels of *Nanophyetus* than those collected earlier in the season, but they were also collected from a different reach confounding comparisons. About 90% of the trout submitted to the LCRFHC were age-0, so the sample size for age-1 or older fish was small. Black spot, caused by the parasite *Neascus,* was regularly seen by USGS personnel on salmonids and longnose dace in every reach.

Spawning surveys were conducted from 29 March 2002 to 9 May 2002. During the first few surveys, the water turbidity and high flow made redd detection difficult. As flows subsided and the water cleared, the dark substrate color and lack of algae on the submerged rocks continued to make redd identification difficult. Therefore, only definitive redds and fish seen exhibiting spawning behavior are reported here. New redds or fish with spawning behavior were observed from 5 April 2002 to 26 April 2002.

During that time, water temperatures were between 7 °C and 10 °C. Two redds and four fish (all less than 300 mm total length) were seen during the bi-monthly surveys in the MRAT2 section. During the bi-monthly surveys in the MIND reach, seven new redds and six spawning fish (100-130 mm total length) were observed. During weekly surveys on the LRAT1 section, 8 new redds and 11 fish with spawning behavior were observed. Several trout (300 – 500 mm total length), much larger than those handled during our surveys in the summer, were observed and documented in spawning areas, or on redds in the lower LRAT reach.

Discussion

Large wood and pools were low in frequency throughout the system. Similar to what others have concluded about habitat conditions on Rattlesnake Creek (Western Watershed Analysts 1997; Stampfli 1994; Rawding 2000), these factors indicate degraded fish habitat conditions in Rattlesnake Creek. Our reach surveys showed that the MRAT reach had the highest amount of LWD with 0.7 pieces per 100 m that were at least 0.3-m diameter and 5-m long. The minimum amount of LWD that NMFS (1996) recommend for a stream to be described as "properly functioning" is 1.24 pieces per 100 m (NMFS 1996). However, NMFS defined LWD as pieces with a 0.3-m diameter and 10.4-m length. Therefore, the reach with the most LWD in Rattlesnake Creek had about half of the recommended minimum using our more liberal classification of LWD. In 2003, we plan to re-survey all the reaches for LWD and measure the length and width of each piece within the bankfull width. With each piece's length and width, we can

directly compare LWD amounts to other studies and prescriptions that use different definitions and classifications.

There were fewer pools in the drainage than the recommended minimum. For a stream of its size, a recommended minimum is 3.5 pools per 100 m (Overton et al. 1997; Platts et al. 1983). The reaches of Rattlesnake Creek that we surveyed ranged from 46% to 80% of this standard. Bisson and Sedell (1984) observed elongated riffles and a reduction in the number of pools in streams where LWD quantities were low. This condition and process appears to fit Rattlesnake Creek.

Our riparian canopy survey showed that most of the Rattlesnake Creek was dominated by small-diameter red alder. There appears to be limited potential for recruitment of LWD large enough to persist, particularly coniferous LWD, in the near future. Likely a result of low levels instream LWD, the creek channel has limited spawning gravels and few high-quality rearing pools for fish (see Johnson et al. 1985 as referenced in Meehan 1991). The small-diameter deciduous trees do not likely provide adequate shading, as discussed below.

Water temperatures in Rattlesnake Creek are a concern because they were regularly above the preferred range for rainbow trout throughout the summer of 2001 and 2002, particularly in the section above the confluence with Indian Creek. These high temperatures combined with low base flows could make summer a stressful and potentially lethal time for trout in Rattlesnake Creek. Water from the plateau above the upper waterfall, when flowing, was warm upon entering the fish bearing sections of Rattlesnake Creek. Water in the upper canyon had daily maximum temperatures that were above 16 °C in over half of the days in July and August. These warm temperatures

coincided with very low flows (<0.3 cfs at LRAT). Optimum feeding temperature for rainbow trout is between 13 °C and 16 °C (Cherry et al. 1975; Kaya 1977). As water temperatures increase beyond about 15 °C, metabolic costs escalate rapidly and available food resources support progressively lower densities of juvenile salmonids (Li et al. 1995). At temperatures above 20 °C, rainbow trout can experience high metabolic demands and stress, which can lead to suppressed growth and increased early mortality (Hokanson 1977; Nielsen et al. 1994). At temperatures above 24 °C, high mortalities can occur (Cherry et al. 1975), with the upper incipient lethal temperature reported as 25.6 °C (Bidgood and Berst 1969; Hokanson 1977). Rattlesnake Creek approached lethal temperatures with the highest temperature recorded of 24.1°C just above the confluence with Indian Creek.

The thermograph site above the confluence with Indian Creek (RAIN) recorded the warmest water temperatures found throughout the summer of 2001 and 2002. There were many long shallow glides that were exposed to the sun in the BRAT and LRAT reaches, between the TOML and RAIN thermograph sites. However, the temperatures were reduced below the Indian Creek confluence (LRAT), probably due to the surface and hyporheic inflow from Indian Creek. The lack of sufficient canopy shade (ranging from 30% to 67%) likely exacerbates this water temperature problem. There were no areas surveyed on mainstem Rattlesnake Creek that approached 90% shading, the recommended level by Western Watershed Analysts (1997).

The water in Mill Creek (rkm 14) was substantially cooler than Rattlesnake Creek or Indian Creek (rkm 0.8). Mill Creek had some of the highest riparian shade and had low diel temperature variation. Stream temperatures can be affected by characteristics

such as ambient air temperature, water velocity, flow, depth, riparian canopy cover, and groundwater inflow. Although Mill Creek and Indian Creek have similar amounts of shading, Mill Creek has a higher elevation (360 m at mouth) than Indian Creek (128 m at mouth), which may be a primary explanatory factor.

Water temperatures at the TOML site were particularly interesting because this site was cooler than the sites either upstream or downstream in both 2001 and 2002. This may be due to groundwater inflow or pool stratification. This thermograph site was at the downstream end of a 5-km long alluvial reach and just upstream from the more confined BRAT reach. Bounded alluvial valley segments have been associated with increased groundwater inflow (Baxter et al. 1999; Stanford and Ward 1993). In streams with higher than optimal temperatures, salmonids have been shown to use thermal refugia such as coldwater patches created by groundwater seeps, springs, and thermal stratification within stream channels (Nielsen et al. 1994; Ebersole 2001).

The lower waterfalls on Rattlesnake Creek appear to be an upstream passage barrier to resident fish. Lamprey and cutthroat trout were not found above these falls. Only rainbow trout, longnose dace, and shorthead sculpin were found above and below the lower waterfall. Anticipated aditional data gathering and analysis of PIT-tag recaptures and the genetic samples may help us assess whether the fish above and below this barrier are distinct populations. Cutthroat trout dominated the assemblage in Indian Creek. The proportion of rainbow trout to cutthroat trout was higher in the LIND reach compared to the MIND reach of Indian Creek, therefore there is a lower potential for introgression of rainbow trout into the cutthroat trout population in the upper reaches of Indian Creek. The MIND reach was above two culverts and a section of creek that we

lacked permission to sample. One brook trout was collected on 15 October 2002 in the LRAT1 section of Rattlesnake Creek. Brook trout are known to inhabit the White Salmon basin, and we believe this fish may have been on a spawning migration (brook trout are fall spawners). We have not collected any age-0 brook trout throughout two years of intensive sampling, so we do not believe there is a reproducing population of brook trout in Rattlesnake Creek.

Although fish habitat was degraded, we found a relatively robust population of rainbow trout in Rattlesnake Creek, with several pools containing more than 18 age-1 rainbow trout. All reaches seemed to have some successful reproduction, with age-0 trout collected in every reach. In 2001 and 2002, there was a higher proportion of age-1 or older trout compared to age-0 trout in pools in the LRAT reach. The higher number of age-0 trout in the LRAT reach may be due to some trout in the White Salmon River using lower Rattlesnake Creek as a spawning tributary (see Report B of this report). An additional year of spawning surveys and PIT-tag recaptures will help determine the significance of what appears to be a potadromous spawning population.

The riffles in many sections were nearly dry throughout the summer and did not provide much habitat for bigger fish. As shown in Vanderploeg and Scavia's (1979) electivity index, E*, both the age-0 and age-1 or older trout tended to avoid the riffles in favor of pools and glides, particularly in the MRAT reach (Figure 15). This is likely due to the lack of pockets deep enough to hold trout in the riffles of this reach. Longnose dace, however, were found in high abundance in nearly all reaches and habitat types of the stream. Dace can be direct competitors with rainbow trout for food (Scott and Crossman, 1998), although they may serve as prey for the large trout. Because the dace

biomass was nearly double the salmonid biomass in the reaches where dace were sampled, they are likely having an interactive effect on the salmonid population.

In some reaches, a single pass 'index' electrofishing method was used to more quickly sample lengths of stream while providing information on the fish population within pools. To gauge our efficiency, we compared the number of fish collected on the first pass to our population estimates. With an experienced electrofishing crew, we typically collected most of the trout on the first pass. Our efficiency appeared to be highest when a pool contained between 1 and 10 fish for any given species and age class, but then the pass-removal estimators may not perform well at these low population levels (Connolly 1996). Factors that might influence the efficiency of the first pass are substrate size, pool width and depth, instream cover, and overhead cover (Kruse et. al 1998). Because most of the pools in Rattlesnake Creek were relatively shallow and lacked cover for fish, we believe our efficiency was more consistent than it might be in streams with more structure. Although block nets were in place during the multiple pass efforts, but not in our single-pass efforts, we reasoned that the first pass for each of these efforts should be comparable enough to derive a population index for the one-pass efforts. We plan to continue to explore this efficiency issue with future sampling efforts.

Over 600 PIT tags in 2001 and nearly 900 PIT tags in 2002 were inserted in fish from the mainstem White Salmon River and the Rattlesnake Creek watershed. Several of those fish were recaptured in 2002, and we anticipate substantially more recaptured fish in future years as more PIT tags are deployed throughout the watershed. In 2002, the length and weight of the recaptured fish in the LRAT1 section showed annual growth, but a lack of growth during the summer months. High metabolic costs due to higher than

optimal temperatures may be a factor limiting growth in the summer. We will have opportunities to look at growth, movement, and life history attributes of individual fish when more of these PIT-tagged fish are recaptured in future sampling years. We will continue to monitor the remote PIT-tag reader at the mouth of Rattlesnake Creek (see report B), and the PTAGIS database will be queried for any detections downstream in the Columbia River.

Results from disease profiling provided by U. S. Fish and Wildlife Service's Lower Columbia River Fish Health Center indicate that longnose dace and shorthead sculpin were relatively healthy. Most trout were healthy, but some individuals had heavy infections of diagenic trematodes and BKD. Black spot infections were common in the longnose dace and trout handled by USGS personnel. There are a variety of chemical, physical, biological, and ecological parameters that influence a fish population's ability to withstand disease (Snieszko, 1974). The elevated parasitic infections of these fish may be due to increased stress during times of high temperature and low flow. Disease can directly influence success of reproduction, performance, susceptibility to predation, and other critical factors required for the survival of a species (Hedrick, 1998). There will be additional disease samples in 2003, and we will track the changes in disease presence and severity over time and among reaches.

During redd surveys, we observed large rainbow trout on redds. These fish were much larger than those we observed during our population survey work in the summer months. These large rainbow trout are believed to be fish from the White Salmon River that use Rattlesnake Creek for spawning. Report B of this report includes additional

information about the use of lower Rattlesnake Creek for spawning by White Salmon River rainbow trout.

Acknowledgements

We would like to thank many people who assisted us with this project. Jim Petersen served as the Project Leader and helped with the administration and planning of the project. We thank Ian Jezorek as a crew leader, and Jodi Charrier, Joe Feldhaus, Sarah Rose, Brien Rose, and Chris Schafer for performing data collection and data entry. Thanks to many CRRL employees who helped intermittently with our fish sampling. Steve Stampfli, Roz Plumb, and Jim White of Underwood Conservation District provided the thermograph data reported here and served as great sources of historical information in the watershed. Ken Lujan and Susan Gutenberger of the USFWS's Lower Columbia River Fish Health Center provided the fish health profiles. Many private landowners granted us permission to sample on their property and they deserve large thanks for the inconvenience and hospitality. Without their help, this project would not be possible. Greg Morris of Yakama Nation's Fisheries Program continued to help us understand what is going on in areas of the watershed that we do not have access to. Thanks to John Baugher, our BPA Contracting Officer Technical Representative.

References

Bain, M. B., and N. J. Stevenson. 1999. Aquatic habitat assessment: common methods. American Fisheries Society, Bethesda, Maryland.

Baxter, C. V., C. A. Frissell, and F. R. Hauer. 1999. Geomorphology, logging roads, and the distribution of bull trout spawning in a forested river basin: implications for management and conservation. Transactions of the American Fisheries Society 128:854-867.

Bidgood, B. F., and A. H. Berst. 1969. Lethal temperatures for Great Lakes rainbow trout. Journal of the Fisheries Research Board of Canada 26:456-459.

Bisson, P. A., J. L. Nielsen, R. A. Palmason, and L. E. Grove. 1982. A system of naming habitat types in small streams, with examples of habitat utilization by salmonids during low streamflow. Pages 62-73 *in* N.B. Armantrout. 1982. Acquisition and utilization of aquatic habitat inventory information symposium. American Fisheries Society, Western Division, Bethesda, MD.

Bisson, P. A., and J. R. Sedell. 1984. Salmonid populations in streams in clearcut vs. old-growth forests of western Washington. Pages 121-129 *in* Meehan et al. 1984. Proceedings, fish and wildlife relationships in old-growth forests symposium. American Institute of fishery Research Biologists, Asheville, N. C.

Bohlin, T. 1982. The validity of the removal method for small populations -- consequences for electrofishing practice. Institute of Freshwater Research Drottningholm Report 60:15-18.

Cherry, D. S., K. L. Dickson, and J. Cairns, Jr. 1975. Temperatures selected and avoided by fish at various acclimation temperatures. Journal of the Fisheries Research Board of Canada 32:485-491.

Connolly, P. J. 1996. Resident cutthroat trout in the central Coast Range of Oregon: logging effects, habitat associations, and sampling protocols. Doctoral dissertation. Oregon State University, Corvallis.

Ebersole, J. L., W. J. Liss, and C. A. Frissel. 2001. Relationship between stream temperature, thermal refugia and rainbow trout *Oncorhynchus mykiss* abundance in arid-land streams in the northwestern United States. Ecology of Freshwater Fish 10:1-10.

Johnson, R. R., C. D. Ziebell, D. R. Patton, P. F. Folliott, and R. H. Hamre, *Technical coordinators*. 1985. Riparian ecosystems and their management: reconciling conflicting uses. U. S. Forest Service General Technical Report RM-120.

Haring, D. 2003. White Salmon River watershed addendum to Wind/ White Salmon water resource inventory area 29 salmonid limiting factor analysis (originally issued July 1999). Washington Conservation Commission, Olympia, Washington.

Hedrick, R. P. 1998. Relationships of the host, pathogen, and environment: implications for diseases of cultured and wild fish populations. Journal of Aquatic Animal Health 10:107-111.

Hokanson, K. E., C. F. Kleiner, and T. W. Thorslund. 1977. Effects of constant temperatures and diel temperature fluctuations on specific growth and mortality rates and yield of juvenile rainbow trout, *Salmo gairdneri*. Journal of Fisheries Research Board of Canada. 34:639-648.

Kaya, C. M., L. R. Kaeding, and D. E. Burkhalter. 1977. Use of a cold-water refuge by rainbow and brown trout in a geothermally heated stream. Progressive Fish-Culturist 39:37-39.

Kruse, C. G., W. A. Hubert, and F. J. Rahel. 1998. Single-pass electrofishing predicts trout abundance in mountain streams with sparse habitat. North American Journal of Fisheries Management 18:940-946.

Li, H. W., G. A. Lamberti, T. N. Pearsons, C. K. Tait, and J. L. Li. 1995. Cumulative impact of riparian disturbances in small streams of the John Day Basin, Oregon. Transactions of the American Fisheries Society 123:627-640.

Meehan, W. R. editor. 1991. Influences of forest and rangeland management on salmonid fishes and their habitats. American Fisheries Society Special Publication 19.

Nielsen, J. L., T. E. Lisle, and V. Ozaki. 1994. Thermally stratified pools and their use by steelhead in northern California streams. Transactions of the American Fisheries Society 123:613-626.

NMFS (National Marine Fisheries Service). 1996. Making Endangered Species Act determinations of effect for individual of grouped actions at the watershed scale. The National Marine Fisheries Service Environmental and Technical Services Division, Habitat Conservation Branch, Seattle, WA.

Overton, C. K., S. P. Wollrab, B. C. Roberts, and M. A. Radko. 1997. R1/R4 (Northern/Intermountain Regions) fish and fish habitat standard inventory procedures handbook. USDA Forest Service General Technical Report INT-GTR-345, Ogden, UT.

Platts, W. S., W. F. Megahan, and G. W. Minshall. 1983. Methods for evaluating stream, riparian, and biotic conditions. USDA Forest Service General Technical Report INT-138, Ogden, UT.

Rawding, D. 2000. White Salmon River subbasin summary. Draft. June 30, 2000. Prepared for: Northwest Power Planning Council, Portland, OR.

Reiser, D. W., and R. T. Peacock. 1985. A technique for assessing upstream fish passage problems at small-scale hydropower developments. Pages 423-432 *in* F. W. Olson, R. G. White, and R. H. Hamre, editors. Symposium of small hydropower and fisheries. American Fisheries Society, Western Division, Bethesda, Maryland.

Rosgen, D. L. 1994. A classification of natural rivers. Elsevier Science, B. V. Amsterdam. Catena 22:169-199.

Scott, W. B., and E. J. Crossman. 1998. Freshwater Fishes of Canada. Galt House Publications, Oakville, Ontario, Canada.

Snieszko, S. F. 1974. The effects of environmental stress on outbreaks of infectious diseases of fishes. Journal of Fish Biology 6:197-208.

Stampfli, S. M. 1994. White Salmon River Basin assessment and watershed enhancement project- basin water quality investigation report. Underwood Conservation District, White Salmon, WA.

Stanford, J. A., and J. V. Ward. 1993. An ecosystem perspective of alluvial rivers: connectivity and the hyporheic corridor. Journal of the North American Benthological Society 12:48-62.

Vanderploeg, H. A., and D. Scavia. 1979. Two electivity indices for feeding with special reference to zooplankton grazing. Journal of the Fisheries Research Board of Canada 36:362-365.

Western Watershed Analysts. 1997. Panakanic Watershed Analysis. Champion Pacific Timberlands, Inc.

White, G. C., D. R. Anderson, K. P. Burnham, and D. L. Otis. 1982. Capture-recapture and removal methods for sampling closed populations. No. LA-8787-NERP, UC-11. Los Alamos National Laboratory, Los Alamos, New Mexico.

Zippin, C. 1956. An evaluation of the removal method of estimating animal populations. Biometrics 12:163-189.

Table 1. Locations of reach surveys (rapid-reach type) conducted within the Rattlesnake Creek watershed in 2001 and 2002. Coordinates were obtained from a hand-held Global Positioning System using North American Datum 1927. Sites are listed from upstream to downstream within a watershed.

Watershed Site	Survey year	Start point distance from from mouth (km)	Length of survey (km)	Coordinates at start		Coordinates at end	
				Northing	Easting	Northing	Easting
Rattlesnake Creek							
URAT	2002	10.8	3.6	5078524	624154	RNO[a]	
MRAT 2	2001	7.2	0.6	5076347	622077	5076668	622403
MRAT 1	2002	6.0	1.2	RNO		5076351	622064
BRAT 5	2002	4.3	0.5	5074092	620731	RNO	
BRAT 3 and 4	2001	3.3	1.0	5074176	620038	5074390	620640
BRAT 2	2002	2.9	0.4	5073959	619687	5074176	620038
BRAT 1	2001	2.4	0.5	5073738	619276	5074077	619658
LRAT 2	2002	2.0	0.4	RNO		5073743	619284
LRAT 1	2001	0.2	1.1	5072424	617997	RNO	
Mill Creek							
LMIL	2002	0.0	1.0	5079735	626489	5079033	627106
Indian Creek							
MIND	2001	2.2	0.9	5071551	620085	5071699	620025
LIND	2002	0.1	0.8	5072713	618456	RNO	

[a] Reading not obtainable (RNO) because of topography of basin.

Table 2. Reach survey data for streams within the Rattlesnake Creek watershed. Sites are listed from upstream to downstream within a watershed.

Watershed Reach	Survey Date (mm/yy)	Surveyed length Start –	End	Length (m)	Rosgen (1994) channel type	Stream width (m)	Stream gradient (%)	Number per 100m in reach length[a] Pools	Boulders	CLW	HLW	KEY
Rattlesnake Creek												
URAT	07/02	10800	14400	3600	B, F	4.3	1.6	1.6	45	0.1	0.2	0.2
MRAT		5950	7770	1820	C	6.4	1.5	2.2	10	0.1	0.6	0.4
	06/01	7190	7770	580								
	06/02	5950	7190	1240								
BRAT		2400	4840	2440	B, A	5.4	1.3	2.1	84	0.1	0.3	0.0
	08/02	4340	4840	500								
	8/01-7/02[b]	2400	4340	1940								
LRAT		200	2400	1540[c]	B	6.1	2.7	2.8	241	0.0	0.4	0.2
	07/02	1960	2400	440								
	07/01	200	1300	1100								
Mill Creek												
LMIL	08/02	0	1000	1000	A	2.2	8.1	3.4	79	0.7	0.2	0.1
Indian Creek												
MIND	07/01	2200	3080	880	B	2.0	4.7	2.7	101	0.2	1.1	0.3
LIND	06/02	100	900	800	B	2.6	2.8	3.4	10	0.3	0.5	0.2

[a] CLW = Conifer large woody debris ≥1 m length and ≥ 0.3 m diameter; HLW = Hardwood large woody debris ≥ 1 m length and ≥ 0.3 m diameter; KEY = "Key pieces" conifer and hardwood large woody debris ≥ 5 m length and ≥ 0.6 m diameter.
[b] 440 m section of land not surveyed in 2001 was surveyed in July 2002 after landowner permission was granted.
c 650 m section of stream has not been surveyed due to lack of landowner permission.

Table 3. Locations of thermographs deployed and maintained by Underwood Conservation District within the Rattlesnake Creek watershed. Sites are listed from upstream to downstream within a subbasin. For additional information on thermograph locations see Figure 2.

Watershed Subwatershed	Code	Coordinates Northing	Easting	Elevation (m)	Distance upstream from mouth (km)	Date Start dd/mm/yy	End[1] dd/mm/yy
Upper Rattlesnake Creek	URAT	5081213	628410	457	16.9	07/06/01	02/10/02
Mill Creek	LMIL	5079549	626619	396	0.2	08/06/01	27/09/02
Upper Rattlesnake Creek below canyon	BUPC	5078753	624011	292	11.3	08/06/01	24/09/02
Middle Rattlesnake Creek	MRAT	5076576	622218	250	7.7	08/06/01	24/09/02
Tomlin property	TOML	5074768	620819	226	5.6	07/06/01	24/09/02
Lower Rattlesnake above Indian Creek	RAIN	5072747	618418	131	0.8	07/06/01	24/09/02
Indian Creek	LIND	5072689	618451	131	0.0	07/06/01	24/09/02
Lower Rattlesnake Creek	LRAT	5072419	617933	122	0.1	07/06/01	24/09/02

[1]Thermographs were removed from about 16 May through 24 May 2002 for calibration.

Table 4. Number of days when maximum water temperature exceeded 16, 18, and 20 °C, and yearly maximum water temperature recorded at locations in the Rattlesnake Creek watershed[a]. Thermograph locations are listed from upstream to downstream. Refer to Table 3 and Figure 2 for additional site information.

Site	RKM	Number of days ≥ 16°C		Number of days ≥ 18°C		Number of days ≥ 20°C		Maximum (°C)	
		2001	2002	2001	2002	2001	2002	2001	2002
Mainstem									
URAT	16.9	47	59	15	22	0	2	19.5	20.3
BUPC	11.3	81	80	48	50	16	19	21.4	22.4
MRAT	7.7	87	91	51	62	11	27	21.7	22.3
TOML	5.6	78	56	23	31	0	6	19.5	21.3
RAIN	0.8	103	101	72	72	38	39	23.2	24.1
LRAT	0.1	97	96	57	62	10	25	21.1	23.5
Tributaries									
LMIL	0.1	0	0	0	0	0	0	15.7	15.4
LIND	0.0	85	86	41	54	9	14	20.8	21.8

[a]Thermograph data includes from about 07 June 2001 through 16 May 2002, and 24 May through 23 September 2002.

Table 5. Number of days per month when maximum water temperature exceeded 16, 18, and 20 °C and the monthly maximum water temperature recorded at locations in the Rattlesnake Creek watershed during 2002. Locations are listed from upstream to downstream. Refer to Table 3 and Figure 2 for additional site information.

Site	RKM	Number of days ≥ 16°C				Number of days ≥ 18°C				Number of days ≥ 20°C				Maximum (°C)			
		Jun	Jul	Aug	Sep	Jun	Jul	Aug	Sep[a]	Jun	Jul	Aug	Sep[a]	Jun	Jul	Aug	Sep[a]
Mainstem																	
URAT	16.9	13	27	18	1	1	20	1	0	0	2	0	0	18.1	20.3	18.1	16.5
BUPC	11.3	13	29	30	8	2	24	22	2	0	16	3	0	19.3	22.4	20.3	18.7
MRAT	7.7	17	31	31	12	8	24	27	3	1	21	5	0	20.0	22.3	20.7	19.2
TOML	5.6	23	31	0	0	13	18	0	0	2	4	0	0	20.3	21.3	15.7	15.0
RAIN	0.8	24	31	31	13	15	27	27	3	5	22	12	0	21.9	24.1	21.4	19.7
LRAT	0.1	23	31	31	10	15	27	17	3	5	20	0	0	21.6	23.5	19.3	18.7
Tributaries																	
LMIL	0.1	0	0	0	0	0	0	0	0	0	0	0	0	13.7	15.4	14.4	14.0
LIND	0.0	17	31	30	8	9	24	19	2	0	14	0	0	20.0	21.8	20.0	18.7

[a]Temperature data includes through 23 September 2002

Table 6. Locations of flow measurements taken within the Rattlesnake Creek watershed[a]. Coordinates were obtained from a hand-held global positioning system (GPS) using North American Datum 1927. Sites are listed from upstream to downstream within the watershed.

Watershed Site	Coordinates Northing	Coordinates Easting	Elevation (ft)	Distance upstream of mouth (km)	Year Sampled 2001	Year Sampled 2002
Rattlesnake Creek						
URAT - upper DNR[b]	5081436	628496	1,500	16.9	Y[c]	N
URAT - lower SDS[d]	5078524	624154	900	11.2	Y	Y[e]
MRAT - DNR	5076614	622231	820	7.7	Y	Y
LRAT - above Indian Cr.	5072742	618411	430	0.8	Y	Y
LRAT - lower	5072429	671898	400	0.1	Y	Y
Mill Creek						
LMIL - DNR	5079664	626548	1,300	0.1	Y[f]	N
Indian Creek						
MIND - middle	5071671	620054	730	2.2	Y	Y
LIND - lower	5072687	618423	430	0.0	Y[c]	N

[a] Flows taken approximately once every two weeks from June through October unless noted otherwise.
[b] DNR = Department of Natural Resources.
[c] Flow measured only on 06/07/01.
[d] SDS= land owned by SDS Lumber Company
[e] Flow measured only on 10/22/02.
[f] Flow measured only on 06/08/01.

Table 7. Locations of fish surveys conducted within the Rattlesnake Creek watershed in 2002. Population and index electrofishing methods were used to estimate populations and were associated with habitat (rapid reach type) surveys. Population surveys (PS) used a systematic sample of habitat units within different habitat types (e.g., pool, glide, riffle) and multiple pass, removal- depletion electrofishing with block nets. Index shocking sampled only pool habitats, and one pass was conducted (upstream and back) with no block nets. Additional fish collections were conducted without a population estimate or habitat survey (FCNP). Coordinates were obtained from a hand-held global positioning system using North American Datum 1927. Sites are listed from upstream to downstream within a watershed.

Watershed Site	Fish survey method and length surveyed	Start point distance from mouth (km)	Coordinates at start point Northing	Coordinates at start point Easting	Coordinates at end point Northing	Coordinates at end point Easting	Number of 134.2 kHz PIT tags deployed[a]
Rattlesnake Creek							
URAT	Index, 500m; FCNP	11.2	5078524	624154	RNO[b]		38
URAT	FCNP	10.8	5078870	624283	RNO		13
MRAT 2	PS, 580	7.1	5076154	621933	5076658	622395	33
MRAT 1	Index, 310; FCNP	5.9	RNO		5076351	622064	53
BRAT 5	Index, 520 m	4.5	5074092	620731	RNO		78
BRAT 4	PS, 500 m	3.9	RNO		5074461	620696	65
BRAT 3	Index, 500 m	3.4	5074170	620064	RNO		98
BRAT 2	PS, 460 m	3.0	5073959	619687	5074176	620038	58
BRAT 1	Index, 500 m	2.5	5073735	619295	5074077	619861	49
LRAT 2	Index, 400 m	2.1	RNO		5073743	619284	50
LRAT 1	PS, 1100 m; FCNP	0.2	5072427	617875	5073242	618451	124
Mill Creek							
UMIL	Index, 179 m; FCNP	2.6	RNO		RNO		8
LMIL	Index, 527 m	0.0	5079735	626489	RNO		12
Indian Creek							
MIND	Index, 117 m	2.2	5071656	620064	RNO		15
LIND	PS, 812 m	0.1	5072713	618456	RNO		57
						Total	**751**

[a]Fish tagged were limited to rainbow trout and cutthroat trout with fork length of 80 mm or longer
[b]RNO = Reading not obtainable because of topography of basin.

Table 8. Presence and absence of the fish species found in the Rattlesnake Creek watershed by U.S. Geological Survey personnel, 2002. Sites are listed in an upstream to downstream pattern. P = present, A = absent.

Watershed Site	Rainbow trout	Cutthroat trout	Brook trout	Longnose dace	Shorthead sculpin	Brook lamprey
Rattlesnake Creek						
URAT	P	A	A	P	P	A
MRAT	P	A	A	P	P	A
BRAT	P	A	A	P	P	A
LRAT	P	P	P	P	P	P
Mill Creek						
UMIL	P	A	A	A	A	A
LMIL	P	A	A	A	P	A
Indian Creek						
MIND	P	P	A	A	P	A
LIND	P	P	A	A	P	A

Table 9. Location, length, area, and percent of each habitat type from surveyed locations in the Rattlesnake Creek watershed, 2002. Shallow pools were defined as having a depth of ≤90cm for Rattlesnake Creek and ≤60cm for tributary streams. Percent habitat was calculated using area. Backwater pools and side-channels were not included in total survey length, but were included for total surface area.

Watershed Site	Start Distance from Mouth (km)	Total Survey Length (m)	Total Surface Area (m^2)	Habitat Type (%) Back Water Pool	Glide	Shallow Pool	Deep Pool	High Gradient Riffle	Low Gradient Riffle	Side Channel	Step
Rattlesnake Creek											
LRAT 1	0.2	1082	7,037	0[a]	6	21	14	4	54	0[a]	0[a]
LRAT 2[b]	2.0	431	2,873	1	12	34	7	1	39	4	2
LRAT		**1,513**	**9,910**	**0[a]**	**8**	**24**	**12**	**3**	**50**	**1**	**1**
BRAT 1	2.4	539	3,053	0	34	35	1	1	29	0	0
BRAT 2	2.9	466	2,682	0	40	18	12	0	30	0	0
BRAT 3	3.4	497	3,032	0[a]	10	24	43	0	16	7	0[a]
BRAT 4	4.4	560	2,995	0	26	8	36	0	30	0	0[a]
BRAT 5	4.9	520	2,896	0	4	37	27	0	28	4	0[a]
BRAT		**2,582**	**14,658**	**0[a]**	**22**	**25**	**24**	**0[a]**	**26**	**2**	**0[a]**
MRAT 1	6.0	299	2,181	2	5	22	32	0	39	0	0
MRAT 2[c]	7.2	594	3,029	1	2	36	11	0	48	2	0
MRAT		**893**	**5,210**	**2**	**3**	**30**	**19**	**0**	**45**	**1**	**0[a]**
URAT	10.8	550	2,607	1	13	29	5	0[a]	52	0	0
Rattlesnake Overall		**5,538**	**32,385**	**1**	**14**	**26**	**18**	**1**	**39**	**2**	**0[a]**
Indian Creek											
LIND	0.1	812	1,886	0	5	11	3	0	78	3	0
Mill Creek											
LMIL[c]	0.0	527	1,229	0	9	18	3	17	47	5	0[a]

[a] Habitat type present, but consisted of < 0.5% of surveyed habitat area.
[b] Waterfalls consisted of 1% of surveyed habitat area.
[c] Stream was subterranean, but consisted of < 0.5% of total survey length.

Table 10. Comparison between the number of trout caught on the first pass and the population estimate, using multiple pass removal-depletion electrofishing with block nets for the pools in Rattlesnake and Indian creeks, 2002. The number of pools sampled are indicated in parentheses. Case 1 = no fish caught on the first pass; Case 2 = one to ten fish caught on the first pass; Case 3 = eleven or more fish caught on the first pass. Age-0 trout are primarily rainbow trout (RBT) unless noted to be primarily cutthroat trout (CTT). SD = standard deviation.

		Mean percent of the population estimate caught on the first pass					
		Age-0			Age-1 or older		
Watershed Site	Species	Case 1	Case 2	Case 3	Case 1	Case 2	Case 3
Rattlesnake Creek							
LRAT1	RBT	-	-	57 (8)	-	74 (5)	70 (3)
LRAT1	CTT	-	-	-	80 (5)	100 (3)	-
BRAT2	RBT	0 (1)	90 (5)	61 (1)	-	84 (7)	-
BRAT4	RBT	-	88 (2)	76 (4)	0 (1)	79 (5)	-
MRAT2	RBT	-	80 (3)	72 (4)	-	89 (5)	81 (2)
Indian Creek							
LIND	RBT	-	-	-	100 (4)	100 (7)	-
LIND	CTT	100 (5)	93 (6)	-	-	97 (11)	-
Overall Mean (weighted by the number of pools)		83 (SD=37)	89 (SD=14)	65 (SD=19)	80 (SD=40)	90 (SD=15)	74 (SD=15)

Table 11. Delimits of age classes of rainbow trout (RBT) and cutthroat trout (CTT) in Rattlesnake Creek and its tributaries during summer 2002. Sites are listed in an upstream to downstream pattern within the watershed. See Figure 3 and Table 6 for information on fish sampling sites. Age classes were estimated by length-frequency analysis and verified by aging scales. FL= fork length.

Watershed Site	Date	Length of stream surveyed (km)	Start point distance from mouth (km)	Species	Max FL age 0	Min FL age 1
Rattlesnake Creek						
URAT	01 Oct 02-03 Oct 02	0.5	12.0	RBT	90	100
MRAT 2	16 Jul 02-19 Jul 02	0.5	7.2	RBT	78	88
MRAT 1	16 Oct 02	0.3	6.0	RBT	95	105
BRAT 5	18 Sept 02-23 Sep 02	0.5	4.4	RBT	88	100
BRAT 3 and 4	10 Sept 02-11 Sep 02	1.0	3.4	RBT	90	98
BRAT 2	04 Sept 02-06 Sept 02	0.5	2.9	RBT	90	100
BRAT 1	28 Aug 02-29 Aug 02	2.4	0.5	RBT	85	95
LRAT 2	27 Aug 02	0.4	2.0	RBT	80	90
LRAT 1	25 Jun 02-02 Jul 02	1.1	0.2	RBT	87	89
Mill Creek						
LMIL	10 Oct 02	0.5	0.0	RBT	65	100
Indian Creek						
MIND	19 Aug 02	0.1	2.4	CTT	65	88
LIND	20 Aug 02-22 Aug 02	0.8	0.1	CTT	79	80
LIND	20 Aug 02-22 Aug 02	0.8	0.1	RBT	79	80

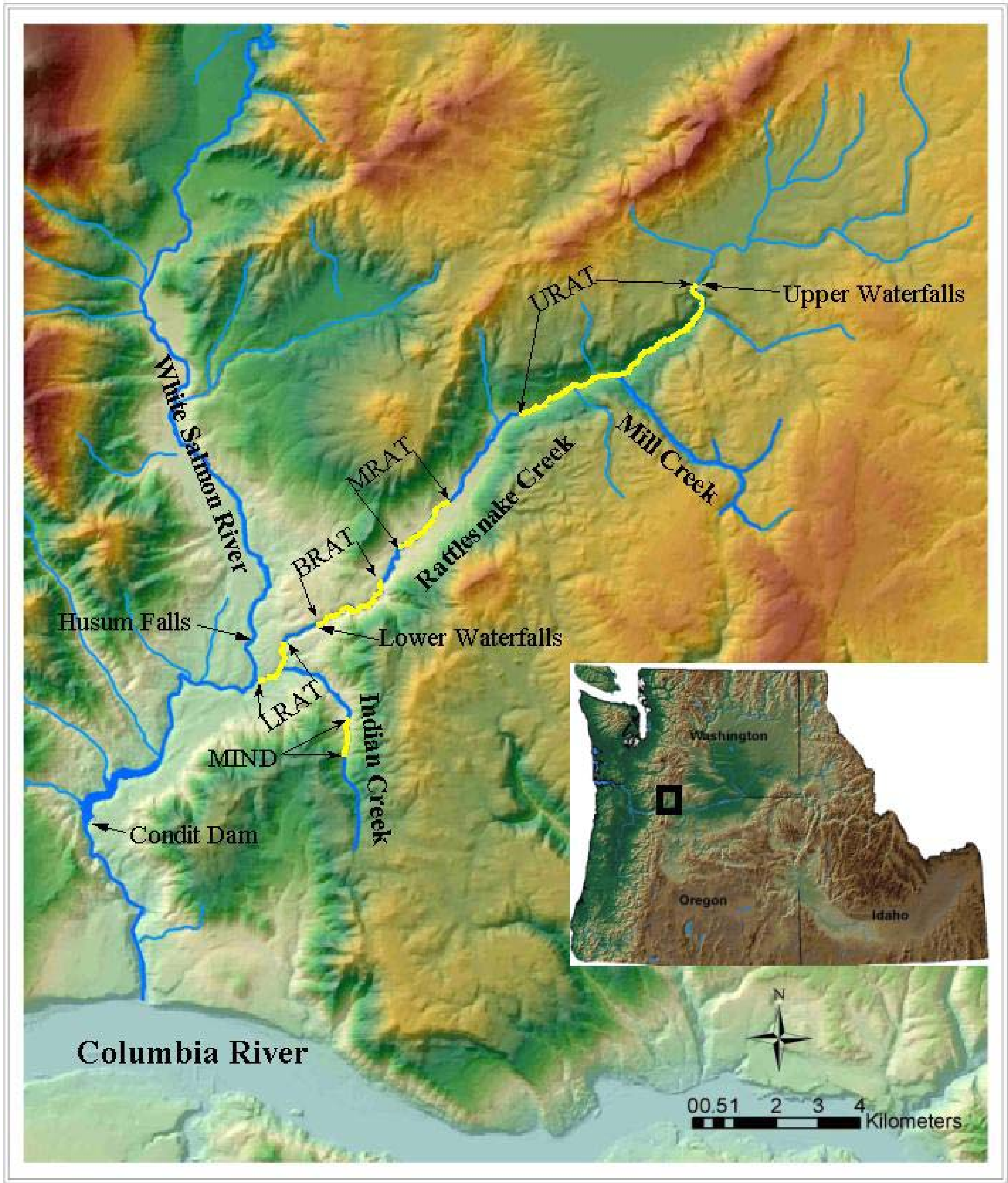


Figure 1. Location of Rattlesnake Creek, WA and study reaches within the Columbia River Gorge. Study reaches are: LRAT = lower Rattlesnake Creek below lower waterfall; BRAT = lower Rattlesnake Creek above lower waterfall; MRAT = middle Rattlesnake Creek; URAT = upper Rattlesnake Creek to upper waterfall

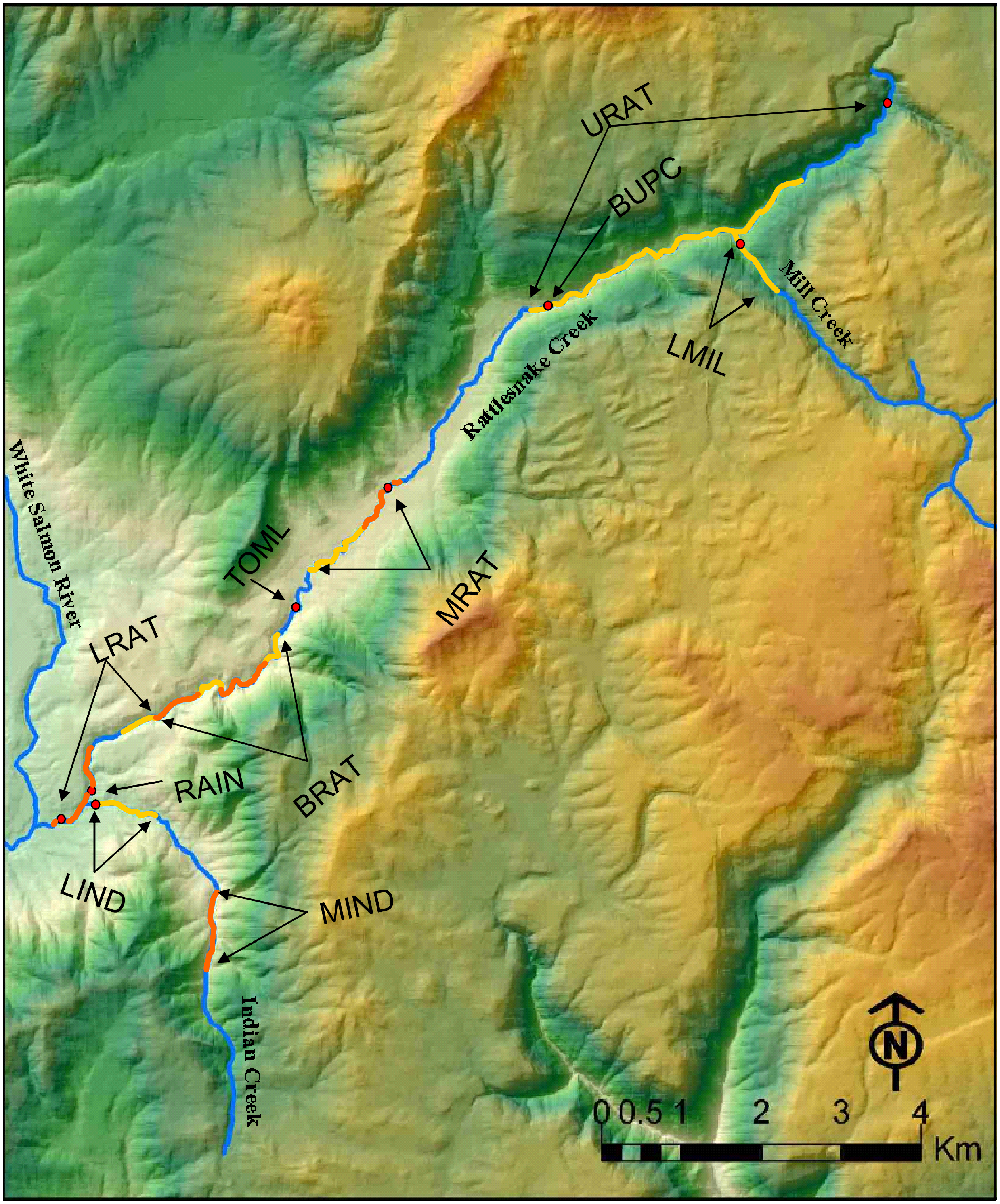


Figure 2. Locations of reach surveys and thermograph sites within the Rattlesnake Creek watershed, 2002. ▬ = Location of reach surveys in 2001. ▬ = Location of reach surveys in 2002. ● = Location of thermograph sites. See Table 1 for additional information on reach survey sites. Table 3 provides additional information on thermograph sites.

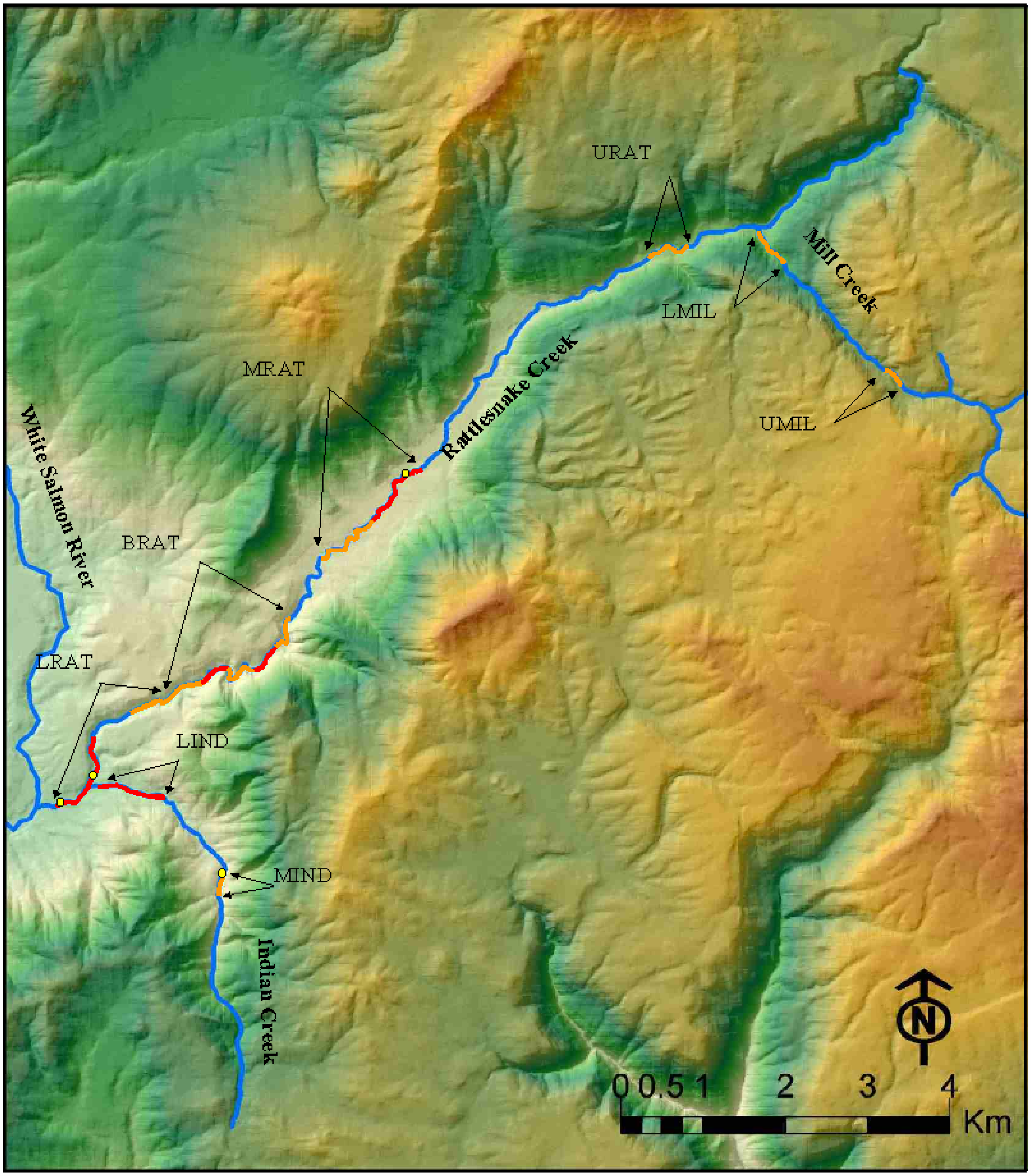


Figure 3. Locations of fish sampling and flow sites within the Rattlesnake Creek watershed, 2002. ○ = Flow measurement locations. ▬ = Locations of population surveys (used a systematic sample of habitat units within different habitat types (e.g., pool, glide, riffle) with multiple pass, removal- depletion electrofishing with block nets). ▬ = Locations of index shocking (only pool habitats were sampled, one pass was conducted (upstream and back) with no block nets). Additional fish collections conducted without a population estimate or habitat survey were not shown. Additional information on flow measurement locations is provided in Table 6. Table 7 provides additional information on fish sampling sites.

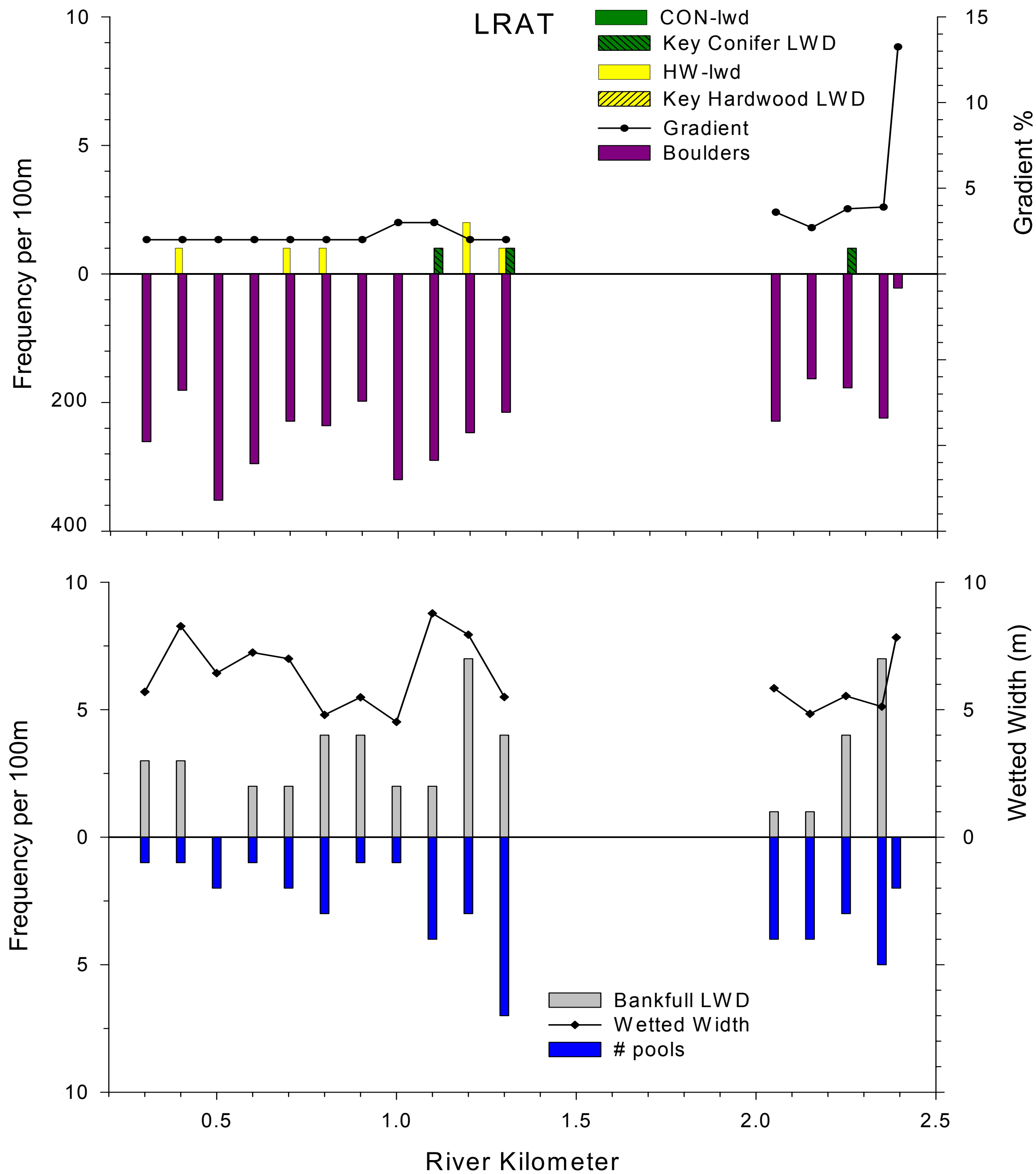


Figure 4a. Reach survey data in 100 m intervals from the LRAT reach of Rattlesnake Creek (rkm 0.2 – 1.3 and rkm 1.9-2.4). Top graph shows the total number per 100 m of coniferous and deciduous large woody debris (LWD; >1 m long and >30 cm diameter) key LWD pieces (>5 m long and >60 cm diameter), boulders, and the average gradient. Bottom graph shows the total number of bankfull LWD, pools, and the average wetted width of the stream.

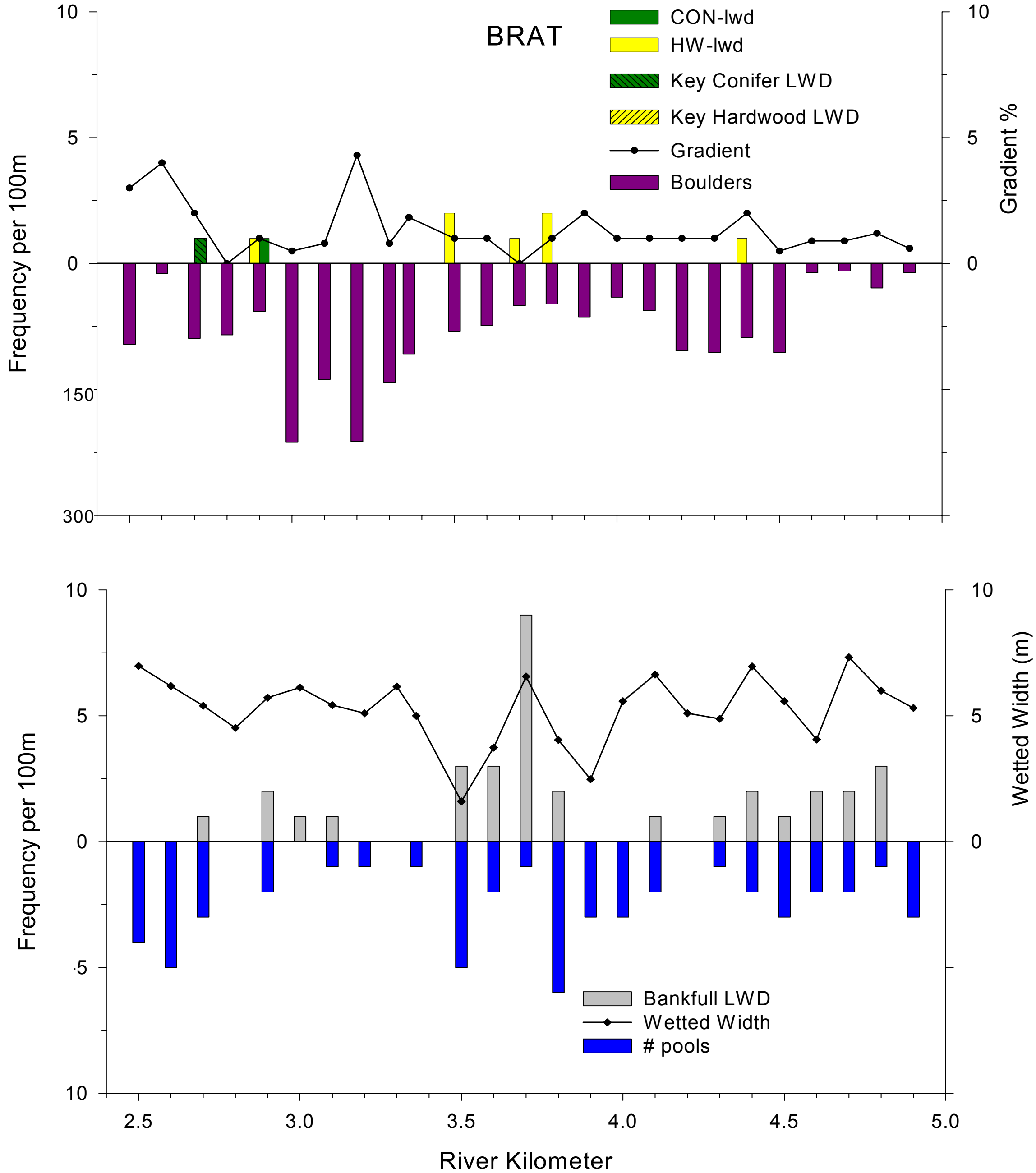


Figure 4b. Reach survey data in 100 m intervals from the BRAT reach of Rattlesnake Creek (rkm 2.4 – 4.8). Top graph shows the total number per 100 m of coniferous and deciduous large woody debris (LWD; >1 m long and >30 cm diameter) key LWD pieces (>5 m long and >60 cm diameter), boulders, and the average gradient. Bottom graph shows the total number of bankfull LWD, pools, and the average wetted width of the stream.

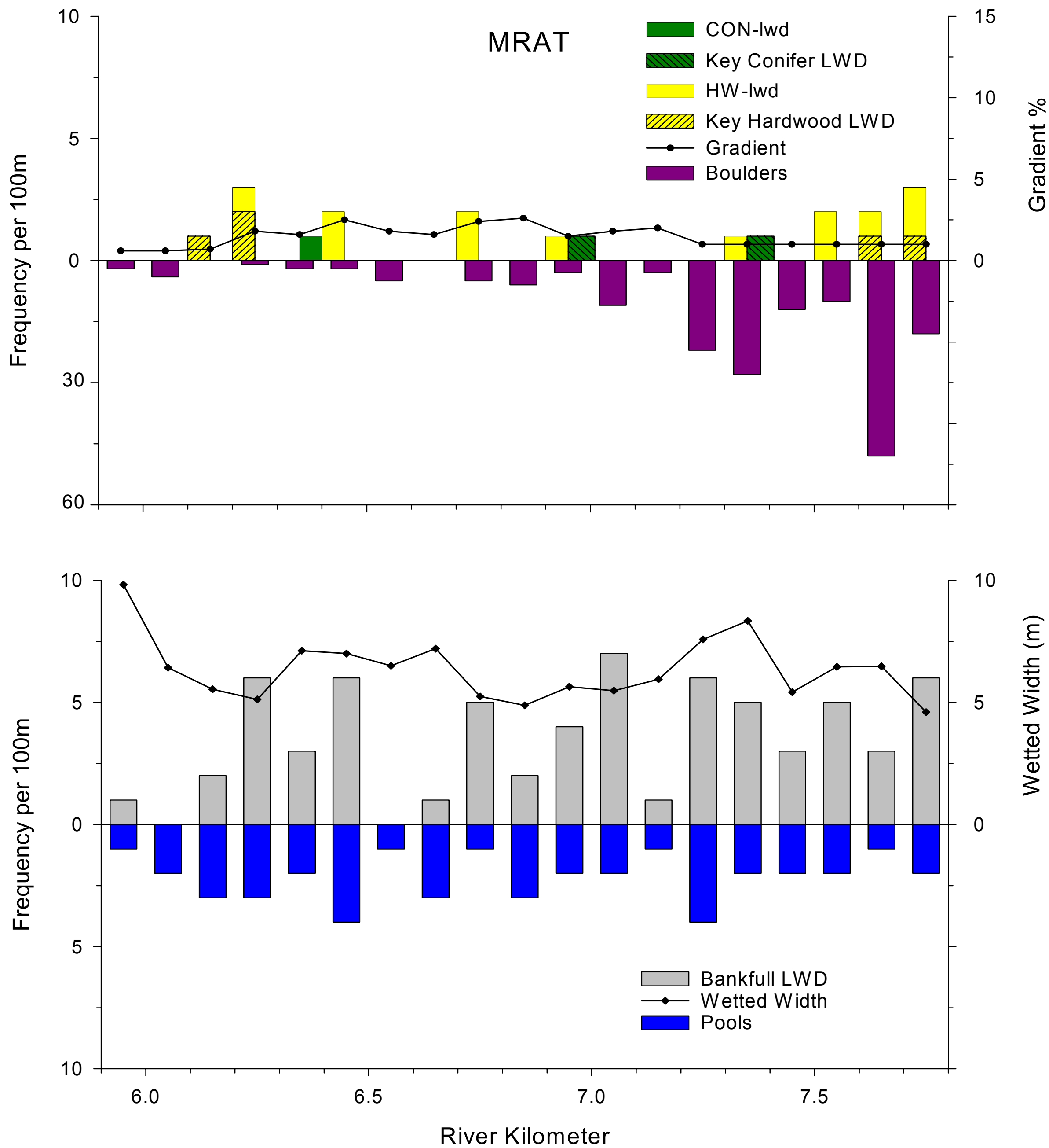


Figure 4c. Reach survey data in 100 m intervals from the MRAT reach of Rattlesnake Creek (rkm 6.0 – 7.8). Top graph shows the total number per 100 m of coniferous and deciduous large woody debris (LWD; >1 m long and >30 cm diameter) key LWD pieces (>5 m long and >60 cm diameter), boulders, and the average gradient. Bottom graph shows the total number of bankfull LWD, pools, and the average wetted width of the stream.

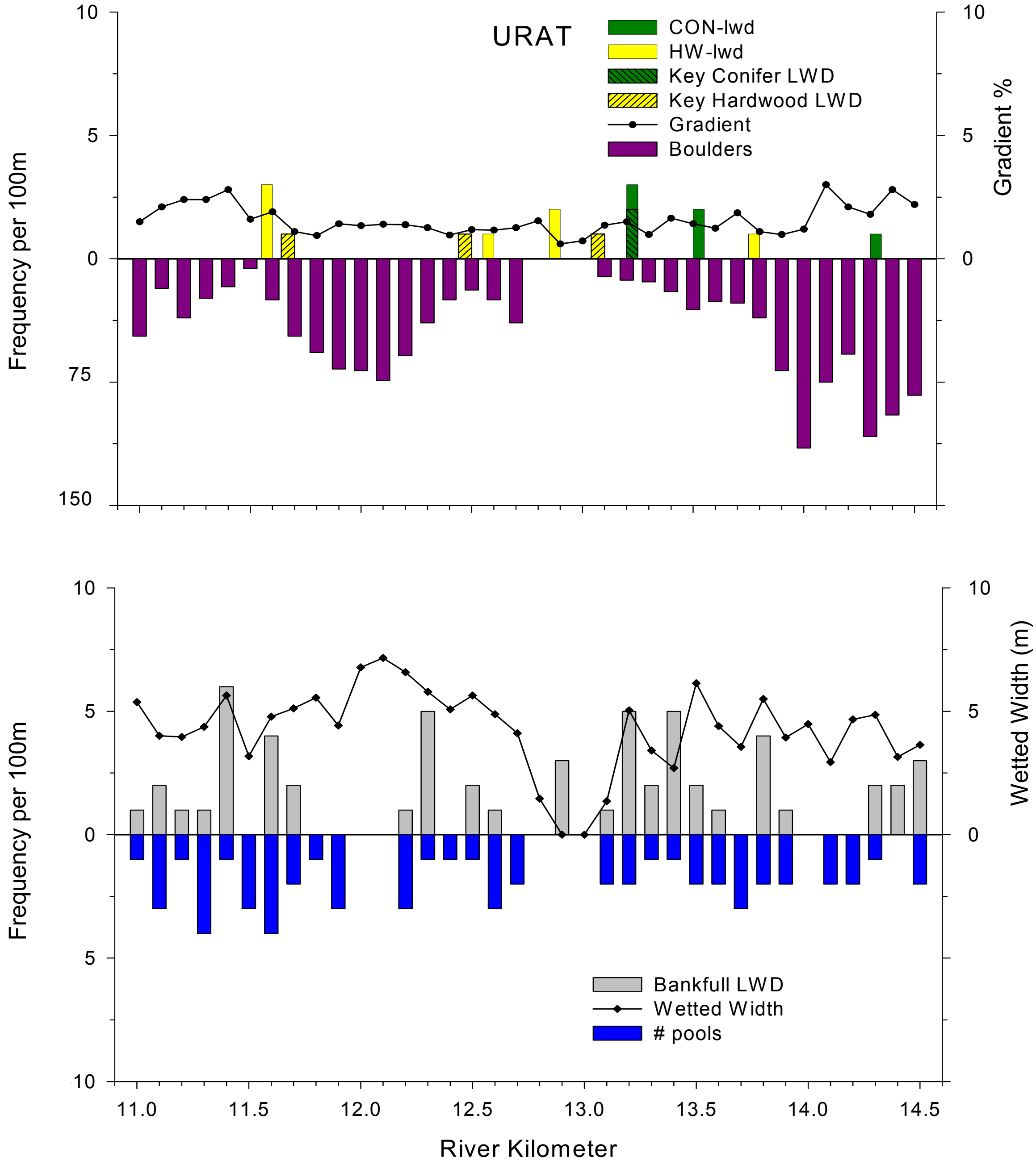


Figure 4d. Reach survey data in 100 m intervals from the URAT reach of Rattlesnake Creek (rkm 10.8 – 14.4). Top graph shows the total number per 100 m of coniferous and deciduous large woody debris (LWD; >1 m long and >30 cm diameter) key LWD pieces (>5 m long and >60 cm diameter), boulders, and the average gradient. Bottom graph shows the total number of bankfull LWD, pools, and the average wetted width of the stream.

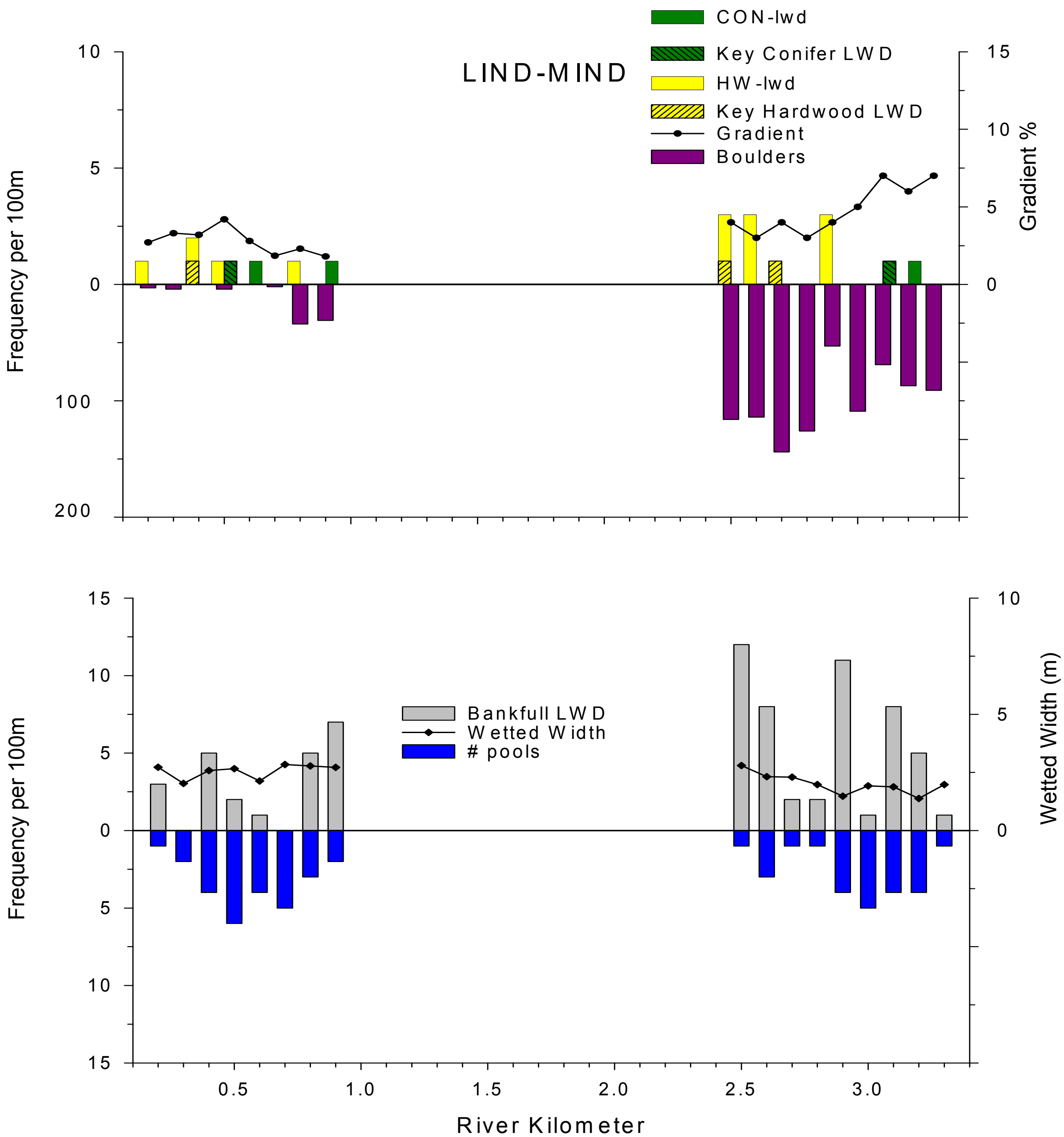


Figure 4e. Reach survey data in 100 m intervals from Indian Creek (LIND; rkm 0.1-0.9 and MIND; rkm 2.4-3.3). Top graph shows the total number per 100 m of coniferous and deciduous large woody debris (LWD; >1 m long and >30 cm diameter) key LWD pieces (>5 m long and >60 cm diameter), boulders, and the average gradient. Bottom graph shows the total number of bankfull LWD, pools, and the average wetted width of the stream.

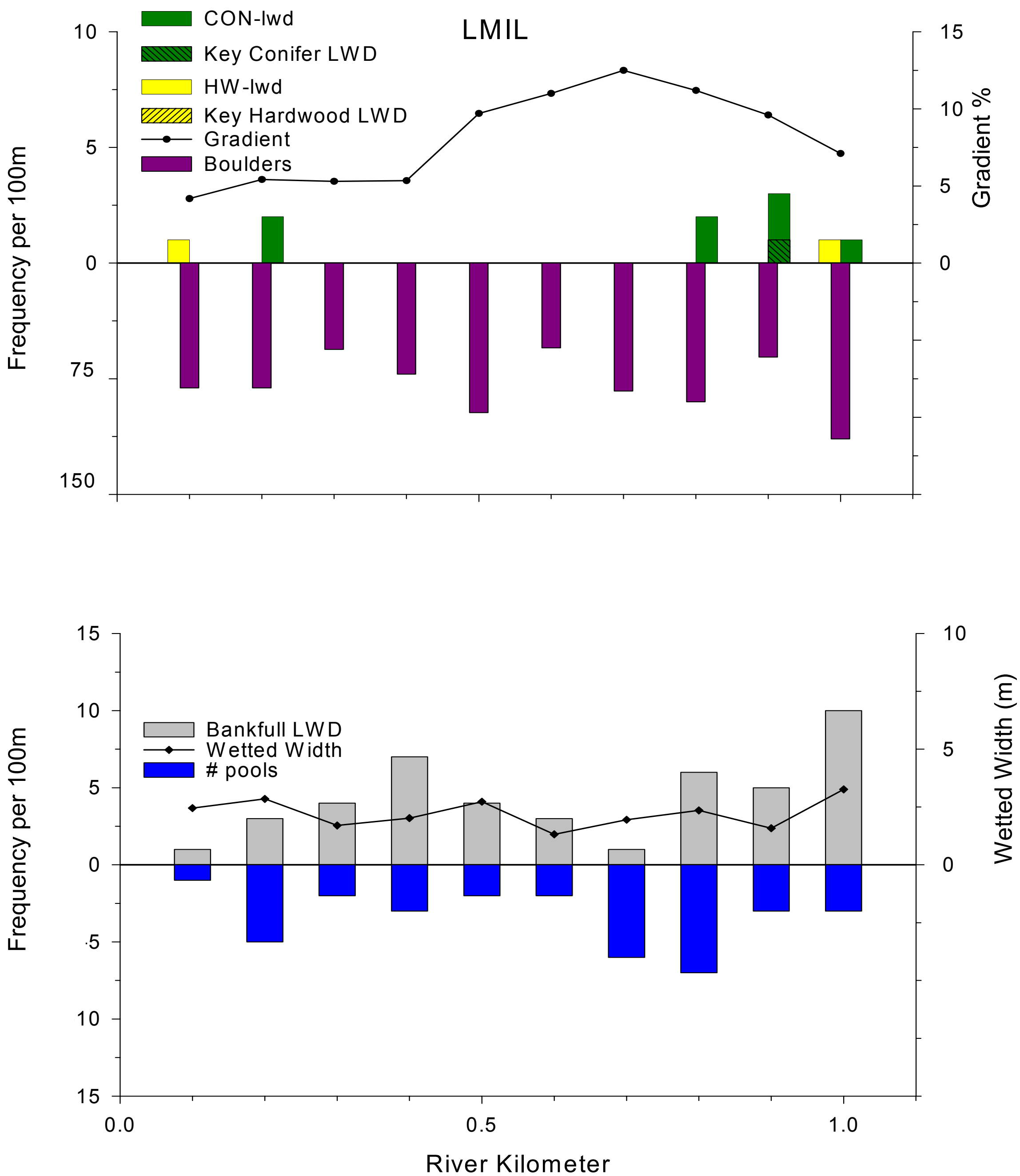


Figure 4f. Reach survey data in 100 m intervals from lower Mill Creek (rkm 0.0 - 1.0) a tributary of Rattlesnake Creek. Top graph shows the total number per 100 m of coniferous and deciduous large woody debris (LWD; >1 m long and >30 cm diameter) key LWD pieces (>5 m long and >60 cm diameter), boulders, and the average gradient. Bottom graph shows the total number of bankfull LWD, pools, and the average wetted width of the stream.

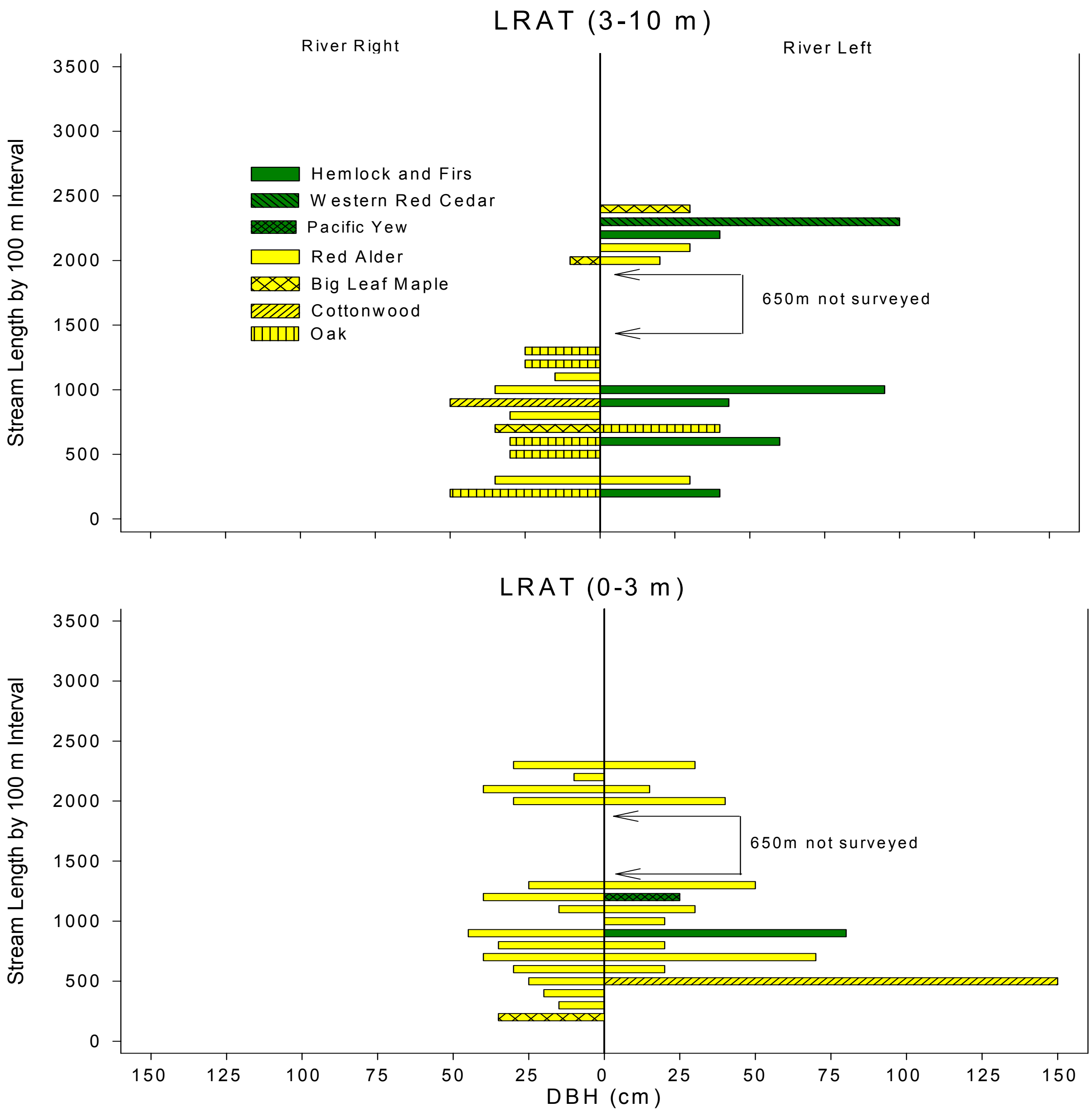


Figure 5a. Characterization of outer (3-10 m from bankfull) and adjacent (0-3 m from bankfull) riparian vegetation in lower Rattlesnake Creek (LRAT; rkm 0.2-2.4). The diameter at breast height (DBH) of the dominant tree type within a 10-m section at each 100-m transect is shown. Blanks indicate the lack of canopy-height trees (approx. >3 m tall) within the 10-m section.

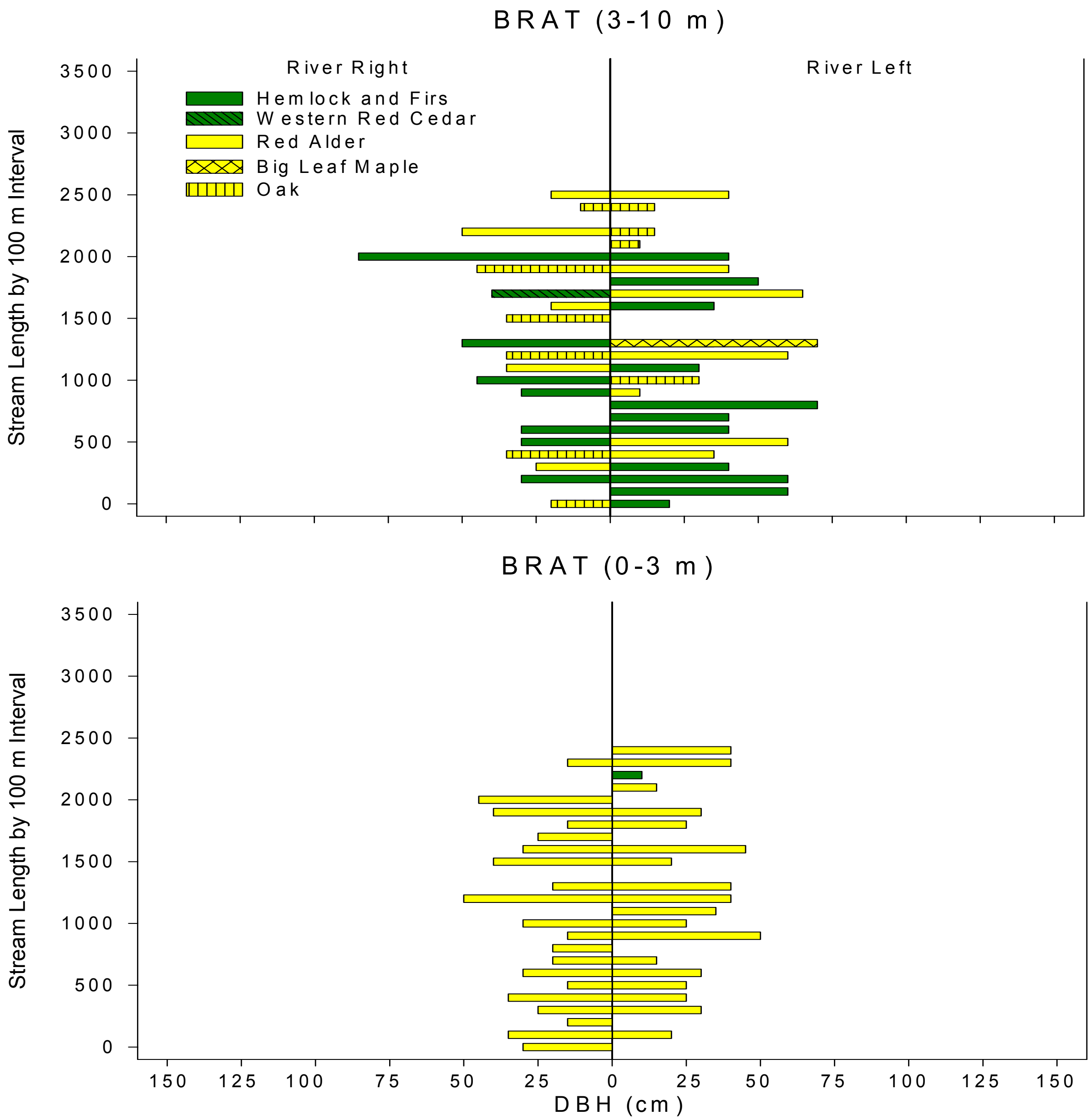


Figure 5b. Characterization of outer (3-10 m from bankfull) and adjacent (0-3 m from bankfull) riparian vegetation in the BRAT reach of Rattlesnake Creek (rkm 2.4-4.9). The diameter at breast height (DBH) of the dominant tree type within a 10-m section at each 100-m transect is shown. Blanks indicate the lack of canopy-height trees (approx. >3 m tall) within the 10-m section.

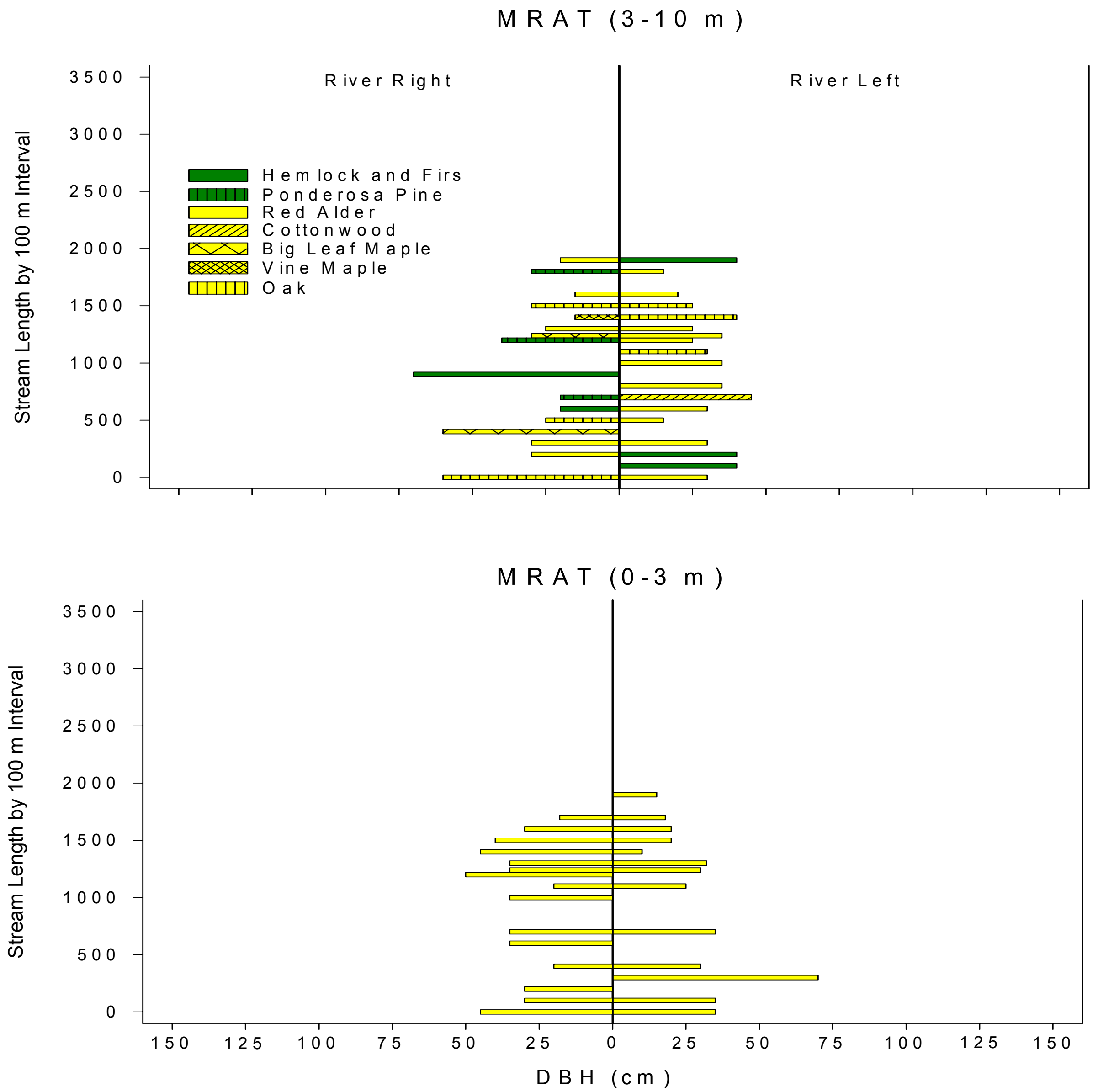


Figure 5c. Characterization of outer (3-10 m from bankfull) and adjacent (0-3 m from bankfull) riparian vegetation in middle Rattlesnake Creek (MRAT; rkm 6.0-7.8). The diameter at breast height (DBH) of the dominant tree type within a 10-m section at each 100-m transect is shown. Blanks indicate the lack of canopy-height trees (approx. >3 m tall) within the 10-m section.

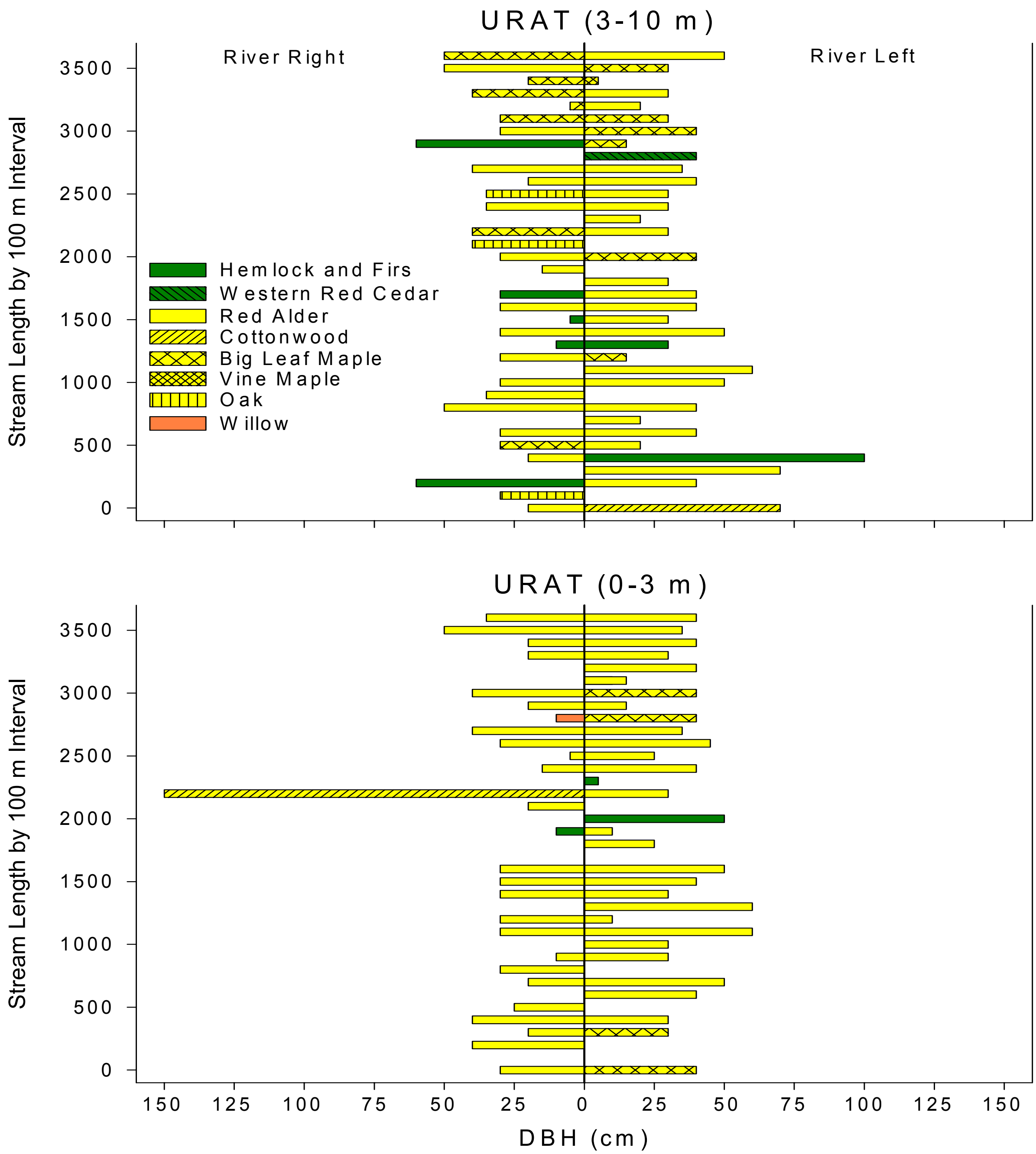


Figure 5d. Characterization of outer (3–10 m from bankfull) and adjacent (0-3 m from bankfull) riparian vegetation in upper Rattlesnake Creek (URAT; rkm 10.8-14.4). The diameter at breast height (DBH) of the dominant tree type within a 10-m section at each 100-m transect is shown. Blanks indicate the lack of canopy-height trees (approx. >3 m tall) within the 10-m section.

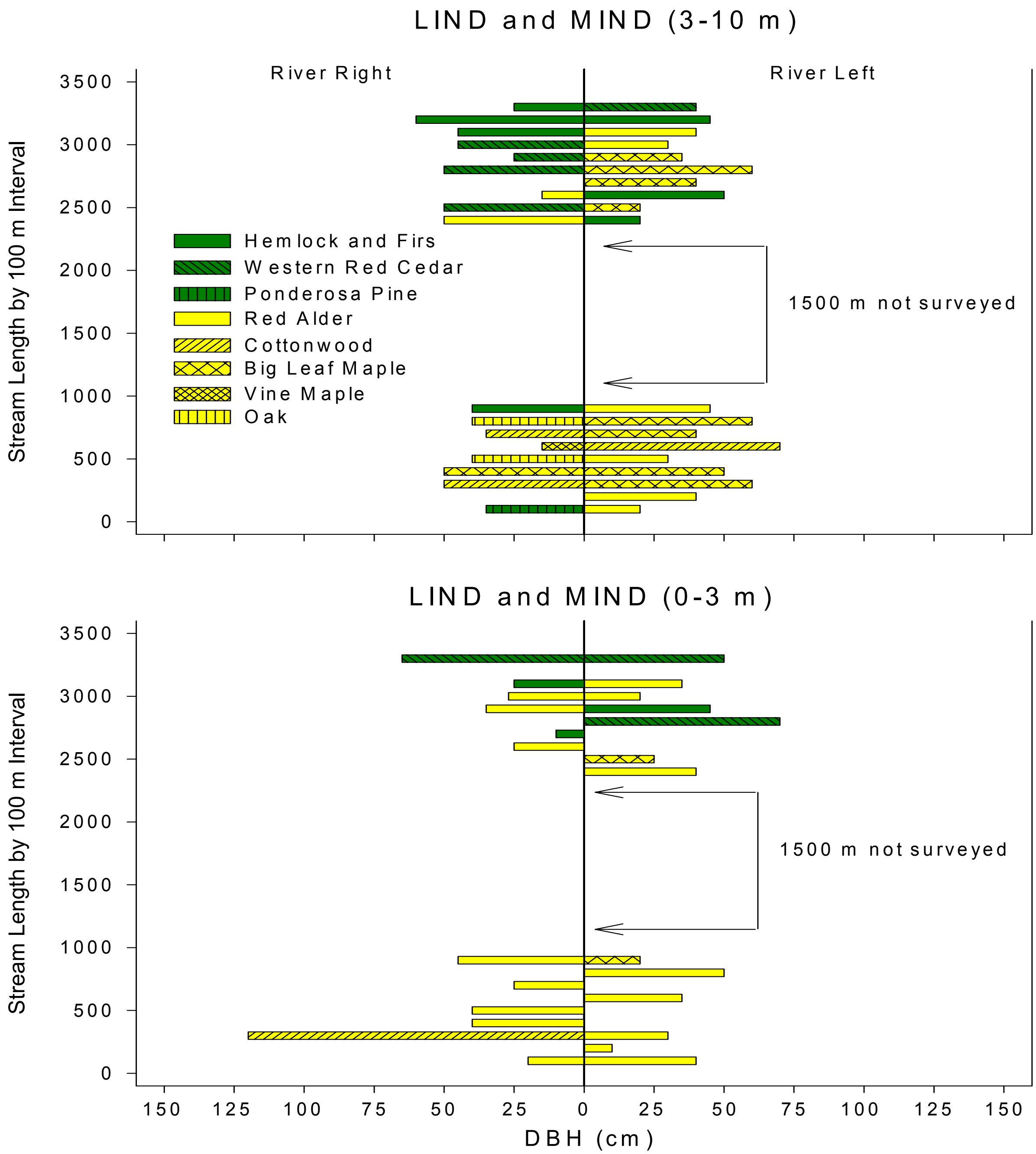


Figure 5e. Characterization of outer (3-10 m from bankfull) and adjacent (0-3 m from bankfull) riparian vegetation in Indian Creek (LIND and MIND; rkm 0.1-3.3), a tributary to Rattlesnake Creek. The diameter at breast height (DBH) of the dominant tree type within a 10-m section at each 100-m transect is shown. Blanks indicate the lack of canopy-height trees (approx. >3 m tall) within the 10-m section.

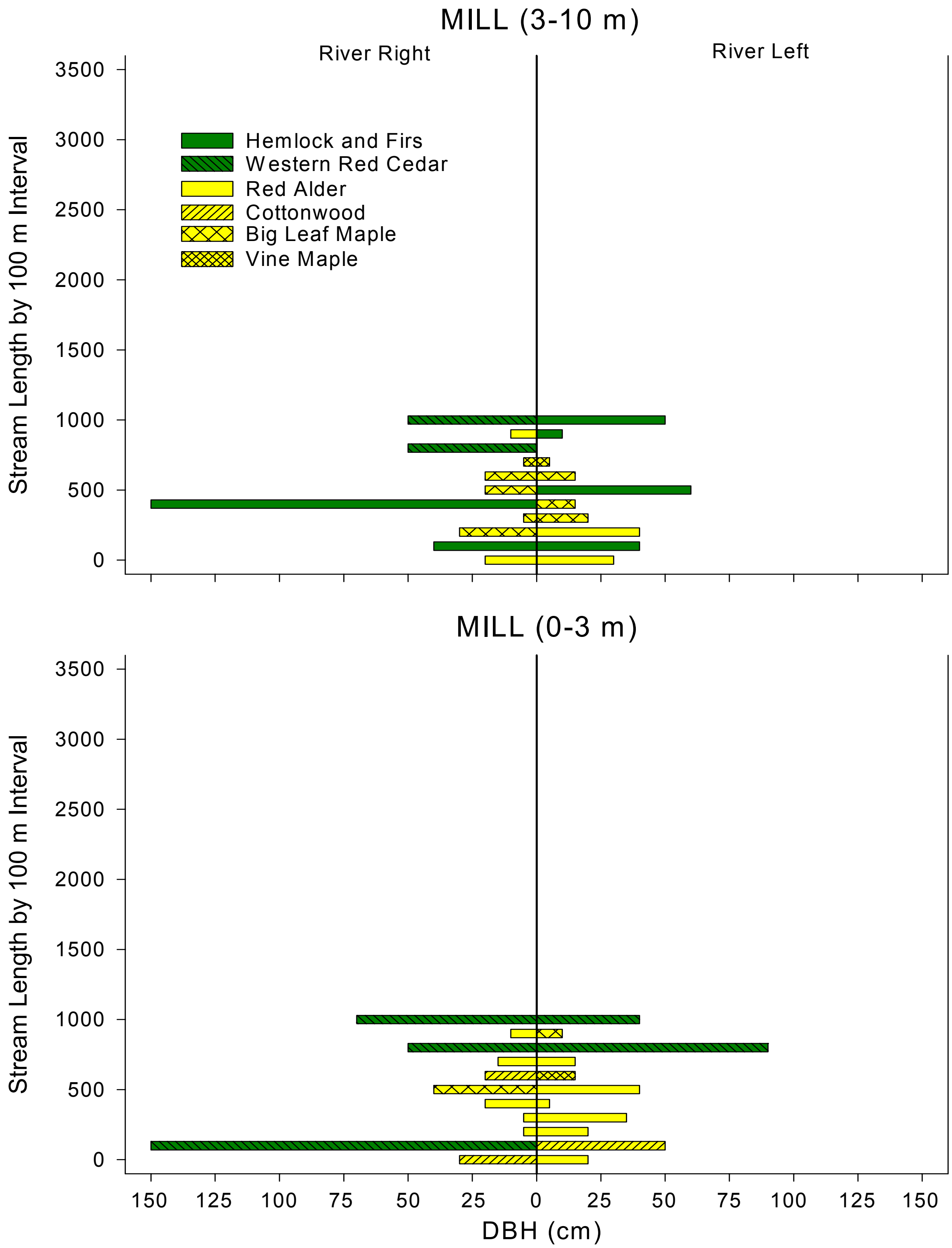


Figure 5f. Characterization of outer (3-10 m from bankfull) and adjacent (0-3 m from bankfull) riparian vegetation in lower Mill Creek (LMIL; rkm 0-1.0), a tributary to Rattlesnake Creek. The diameter at breast height (DBH) of the dominant tree type within a 10-m section at each 100-m transect is shown. Blanks indicate the lack of canopy-height trees (approx. >3 m tall) within the 10-m section.

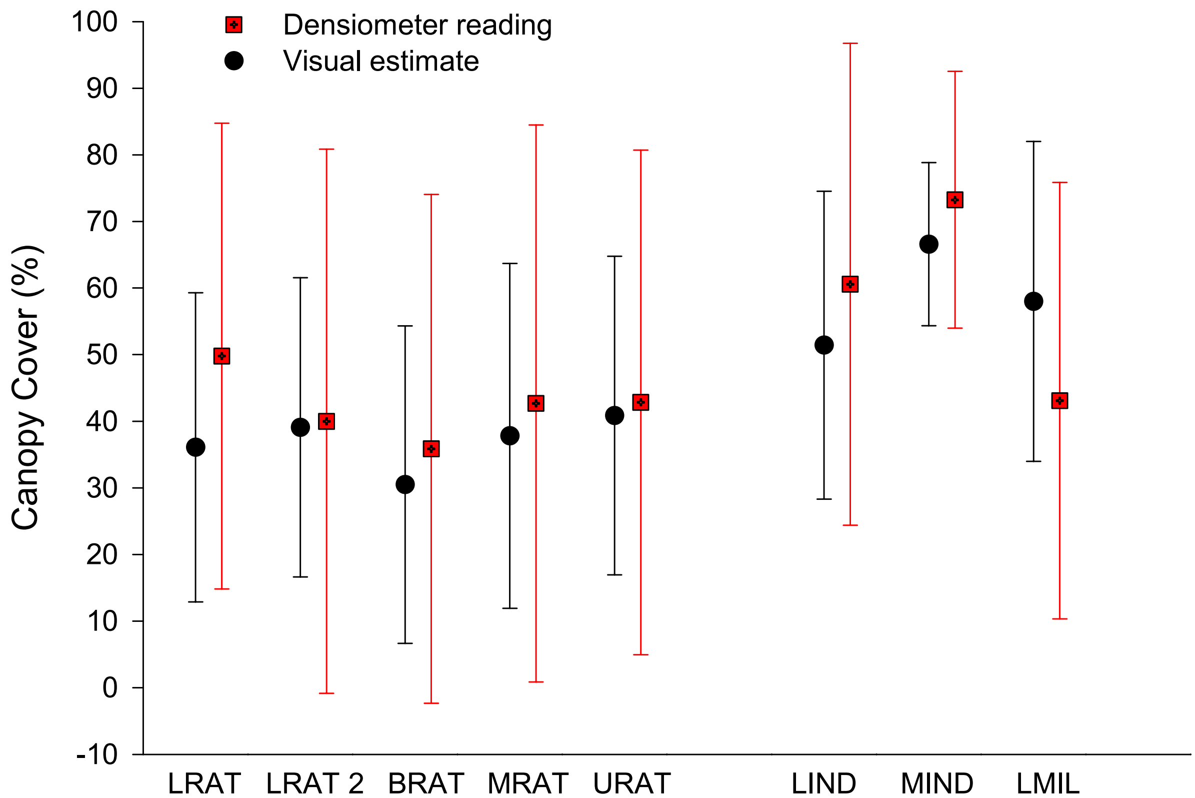
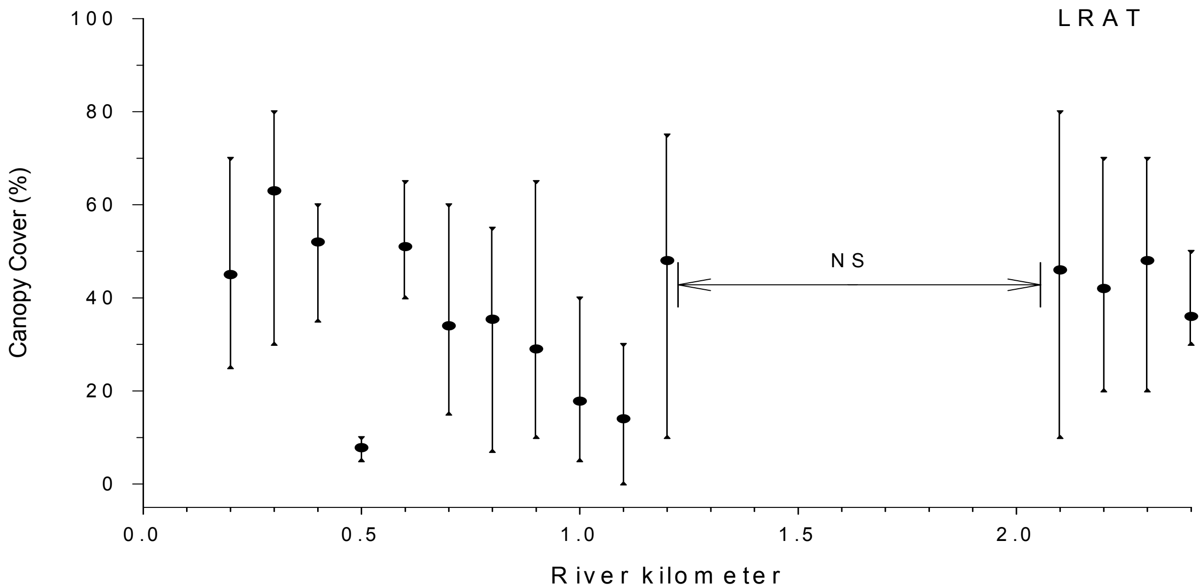


Figure 6. Mean canopy shade of each reach in 2001 and 2002. Measurements were made by visual estimates and densiometer every 20 m; error bars indicate standard deviation for 20-m intervals in each reach.



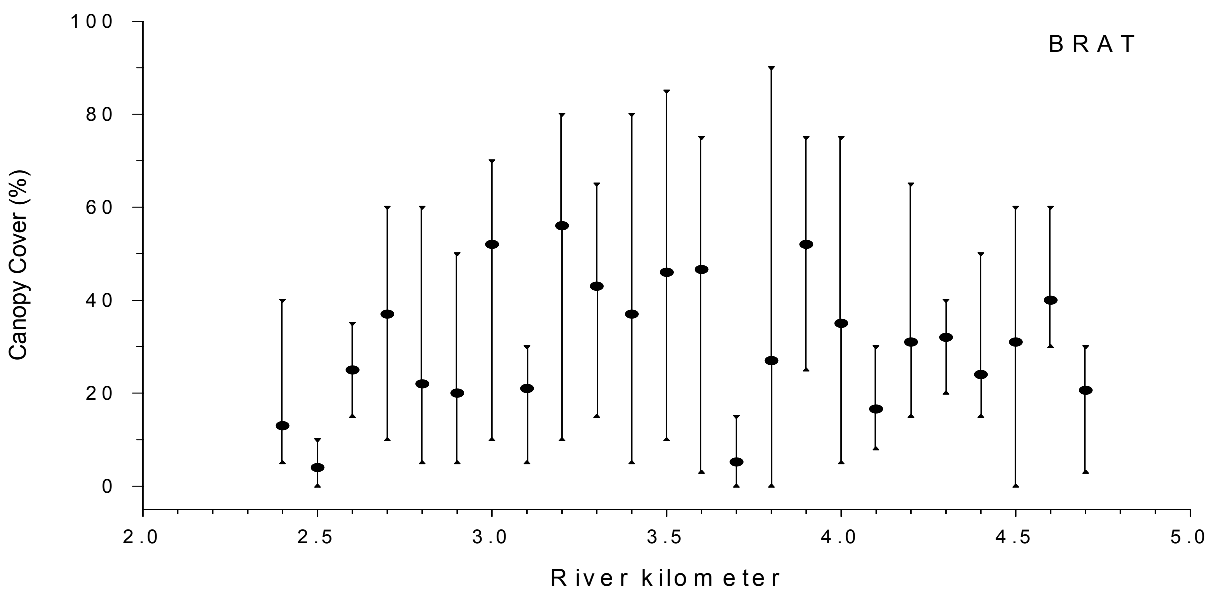
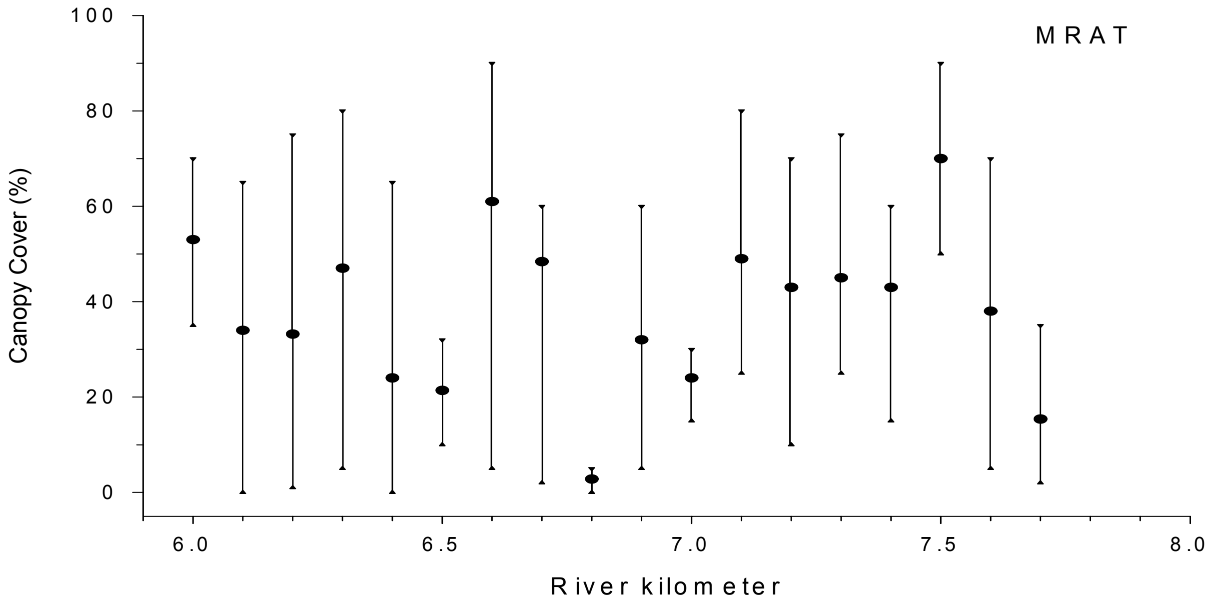


Figure 7a. Visual estimates of canopy shade in the LRAT (rkm 0.2-2.4) and BRAT (rkm 2.4-4.9) reaches of Rattlesnake Creek. Measurements were recorded every 20 m and averaged over 100 m. Maximum, mean, and minimum canopy shade estimates are shown for each 100-m transect. NS = not sampled.



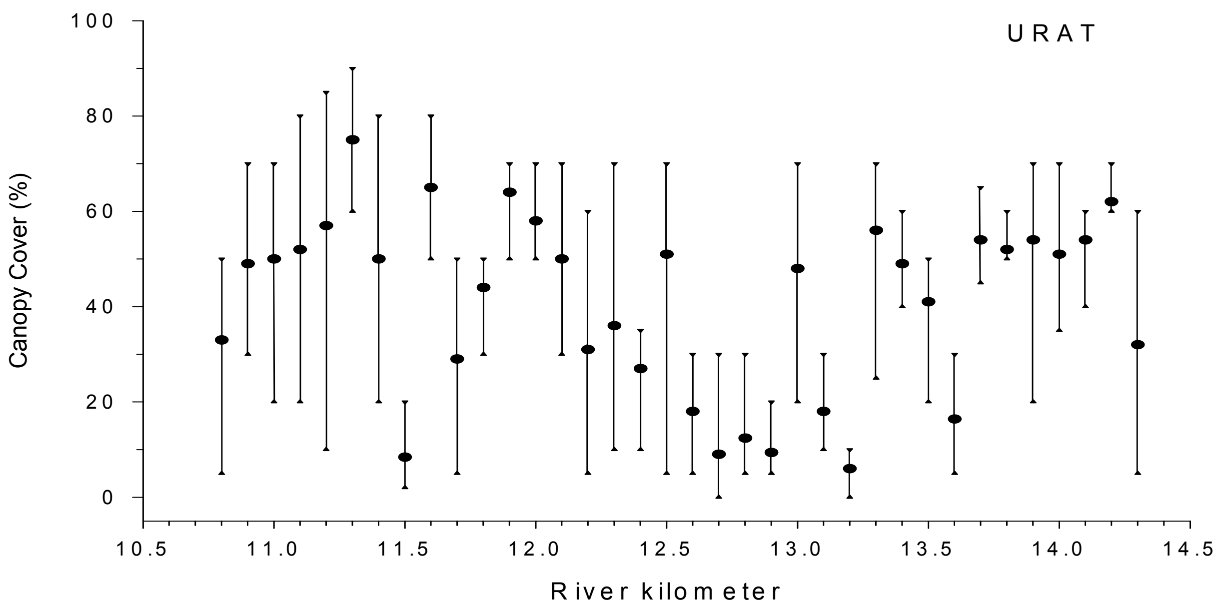
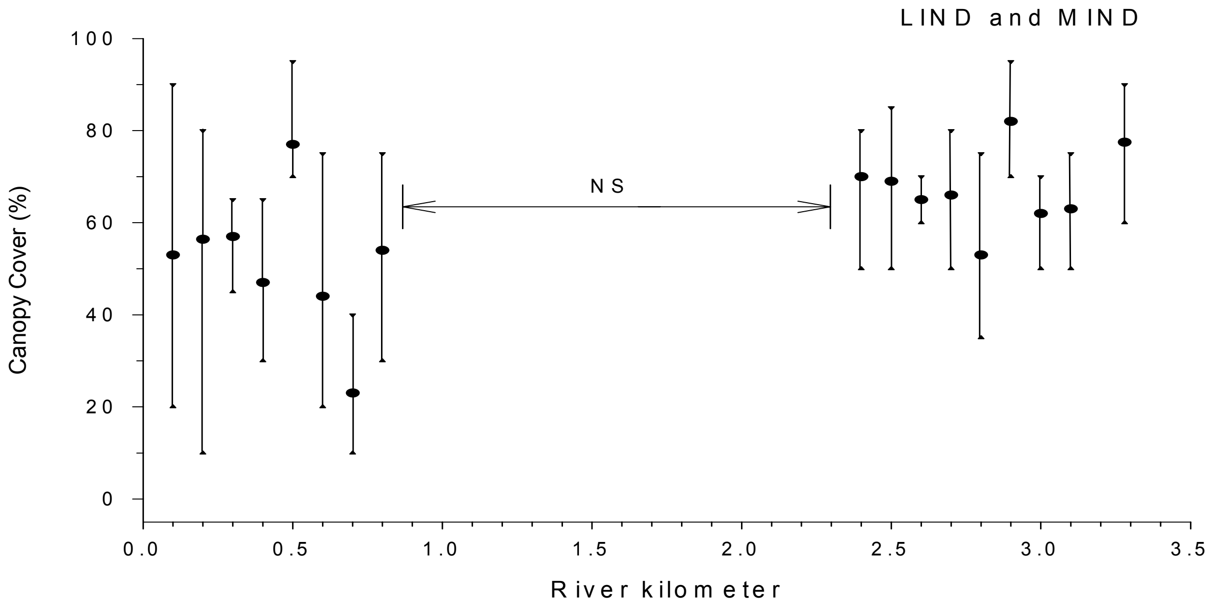


Figure 7b. Visual estimates of canopy shade in the MRAT (rkm 6.0-7.8) and URAT (rkm 10.8-14.4) reaches of Rattlesnake Creek. Measurements were recorded every 20 m and averaged over 100 m. Maximum, mean, and minimum canopy shade estimates are shown for each 100-m transect.



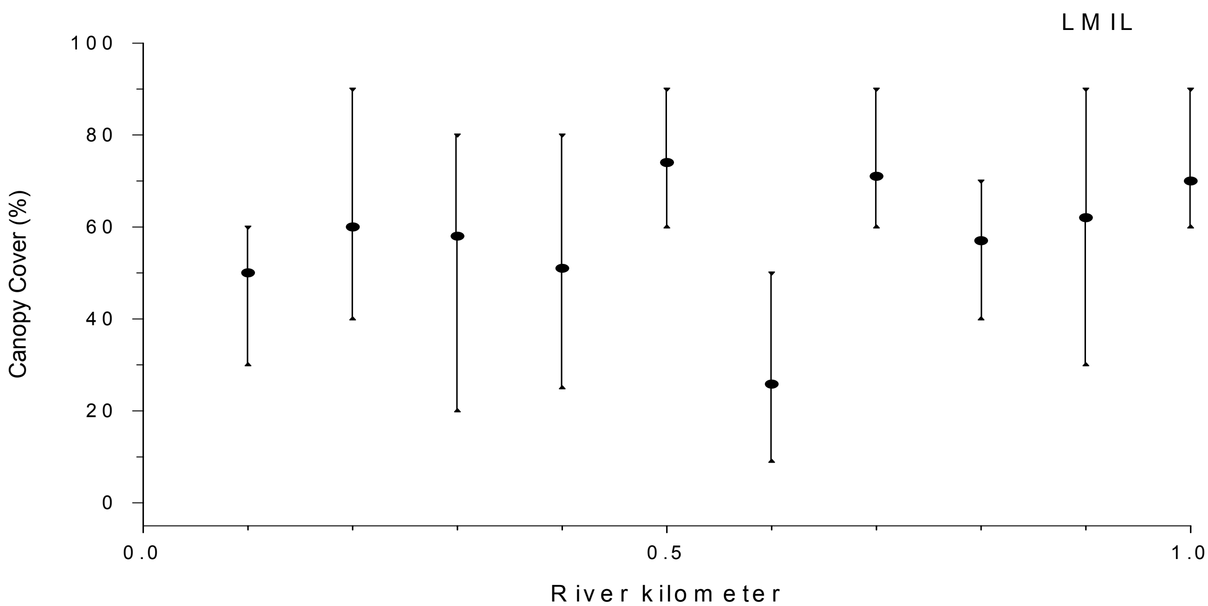


Figure 7c. Visual estimates of canopy shade in reaches of Indian creek (rkm 0.1-3.3), and Mill creek (rkm 0.0-1.0), tributaries to Rattlesnake Creek. Measurements were recorded every 20 m and averaged over 100 m. Maximum, mean, and minimum canopy shade estimates are shown for each 100-m transect. NS = not sampled.

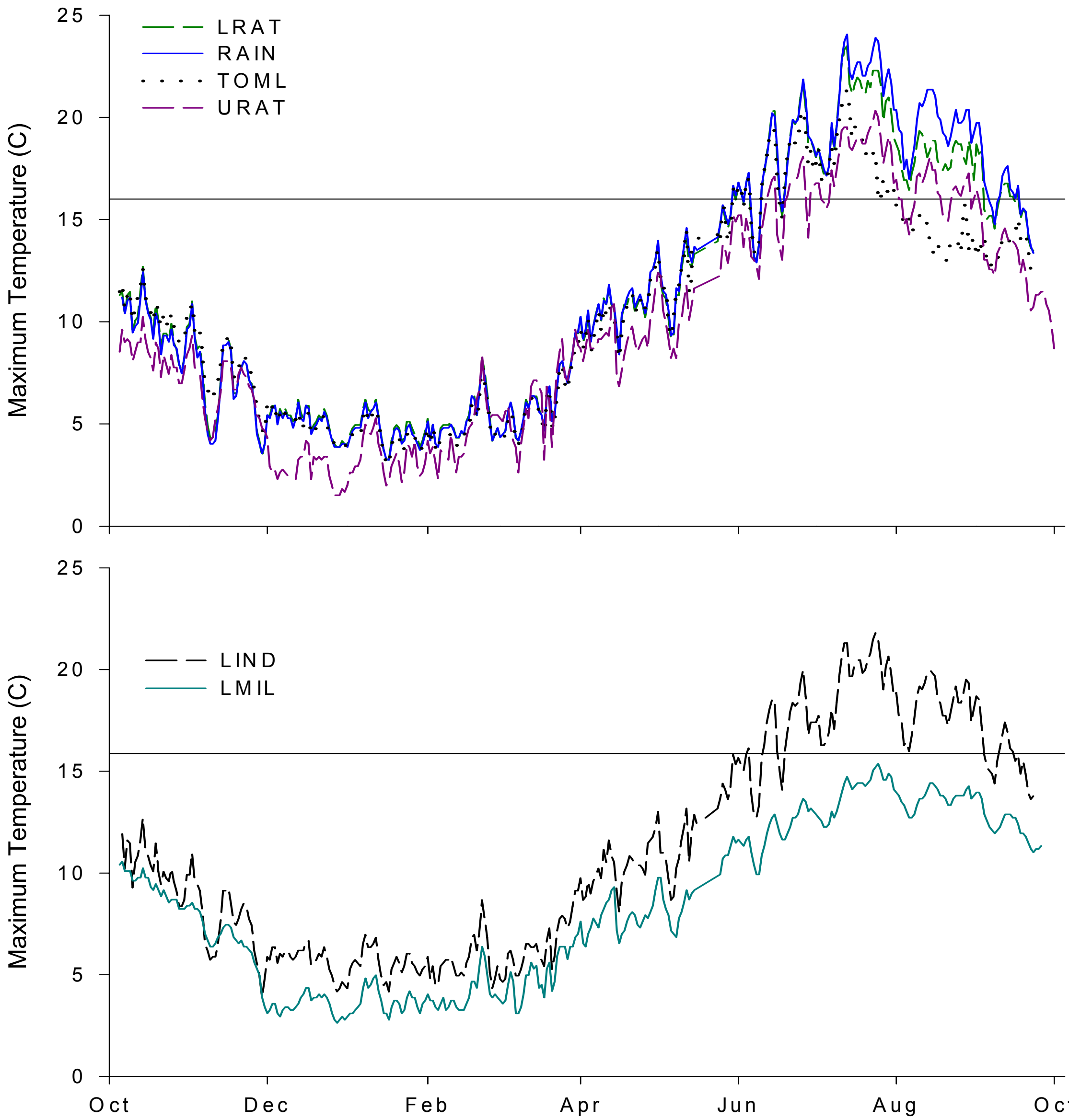


Figure 8. Daily maximum temperatures at six sites in Rattlesnake Creek from October 4, 2001 to September 24, 2002. Thermograph sites are mapped on Figure 2, and coordinates and elevation are provided in Table 3. The line at 16 C marks the maximum surface water temperature standard set by the Washington Department of Ecology (Chapter 173-201A, Nov. 18, 1997, Water Quality Standards for the Surface Waters of the State of Washington).

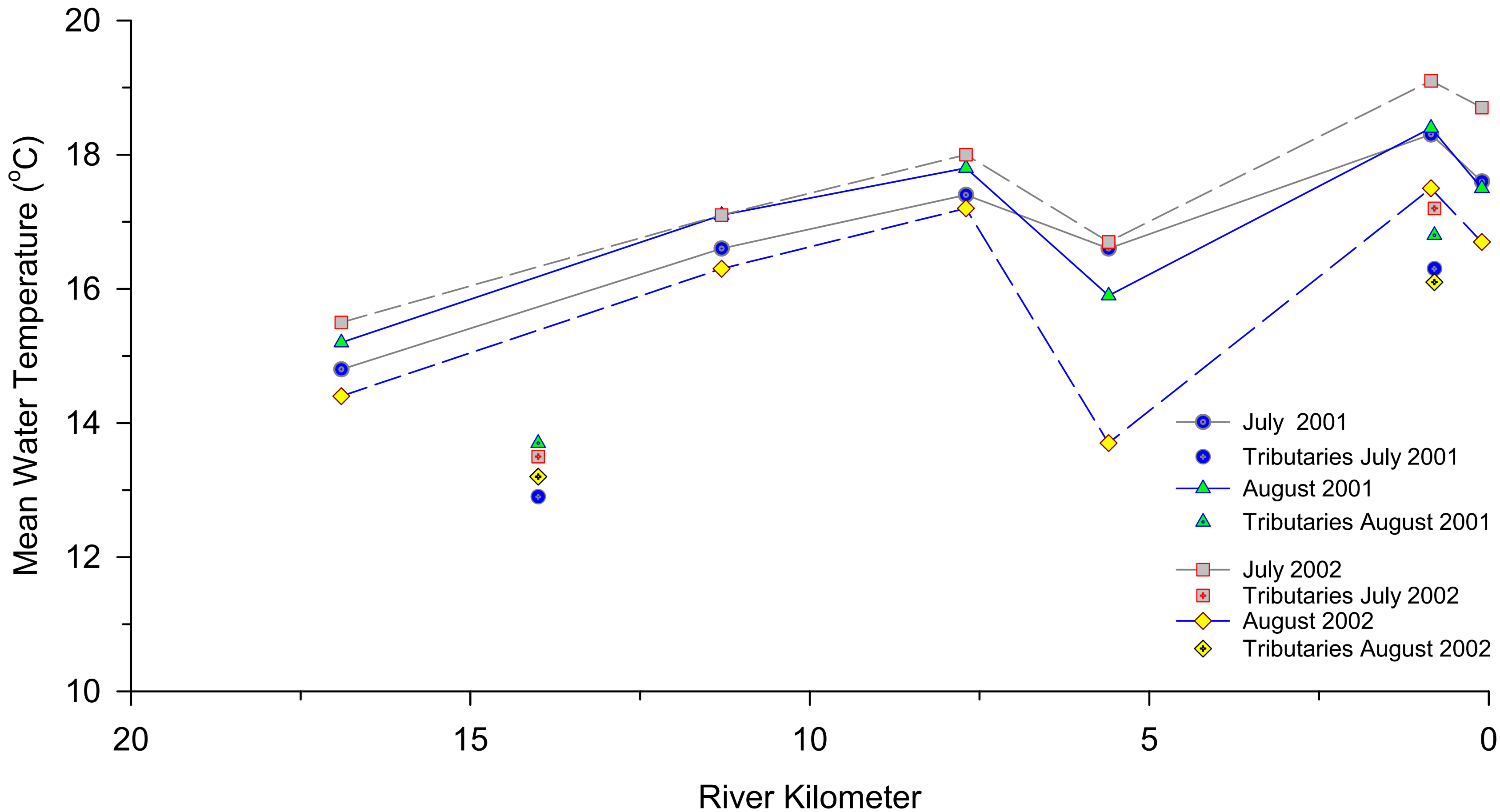


Figure 9. Mean water temperature during July and August of 2001 and 2002 in the mainstem Rattlesnake Creek and its tributaries. Sites, from left to right, are shown from upstream to downstream. River kilometer zero is the mouth of Rattlesnake Creek. Figure 2 is a map of thermograph locations, and additional information on thermograph coordinates, elevations and start and end dates are provided in Table 3.

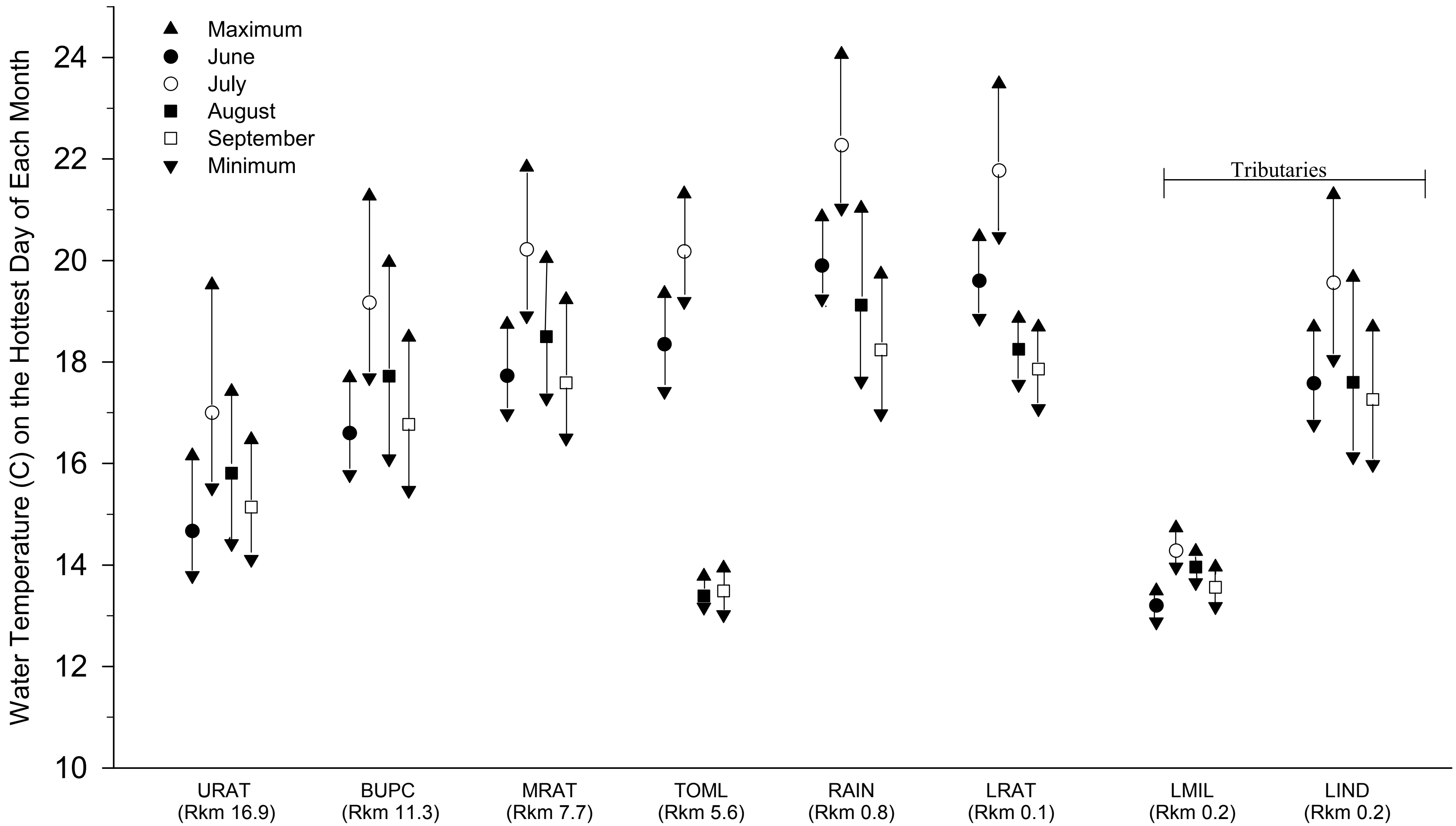


Figure 10. Dates chosen had the warmest single day water temperature for each month at most sites in 2002 (June 27, July 13, August 16, and September 1). For additional thermograph information, Figure 2 shows thermograph locations. Thermograph coordinate elevations, start dates, and end dates are provided in Table 3. Mill Creek enters Rattlesnake Creek at rkm 14, Indian creek enters at rkm 0.8.

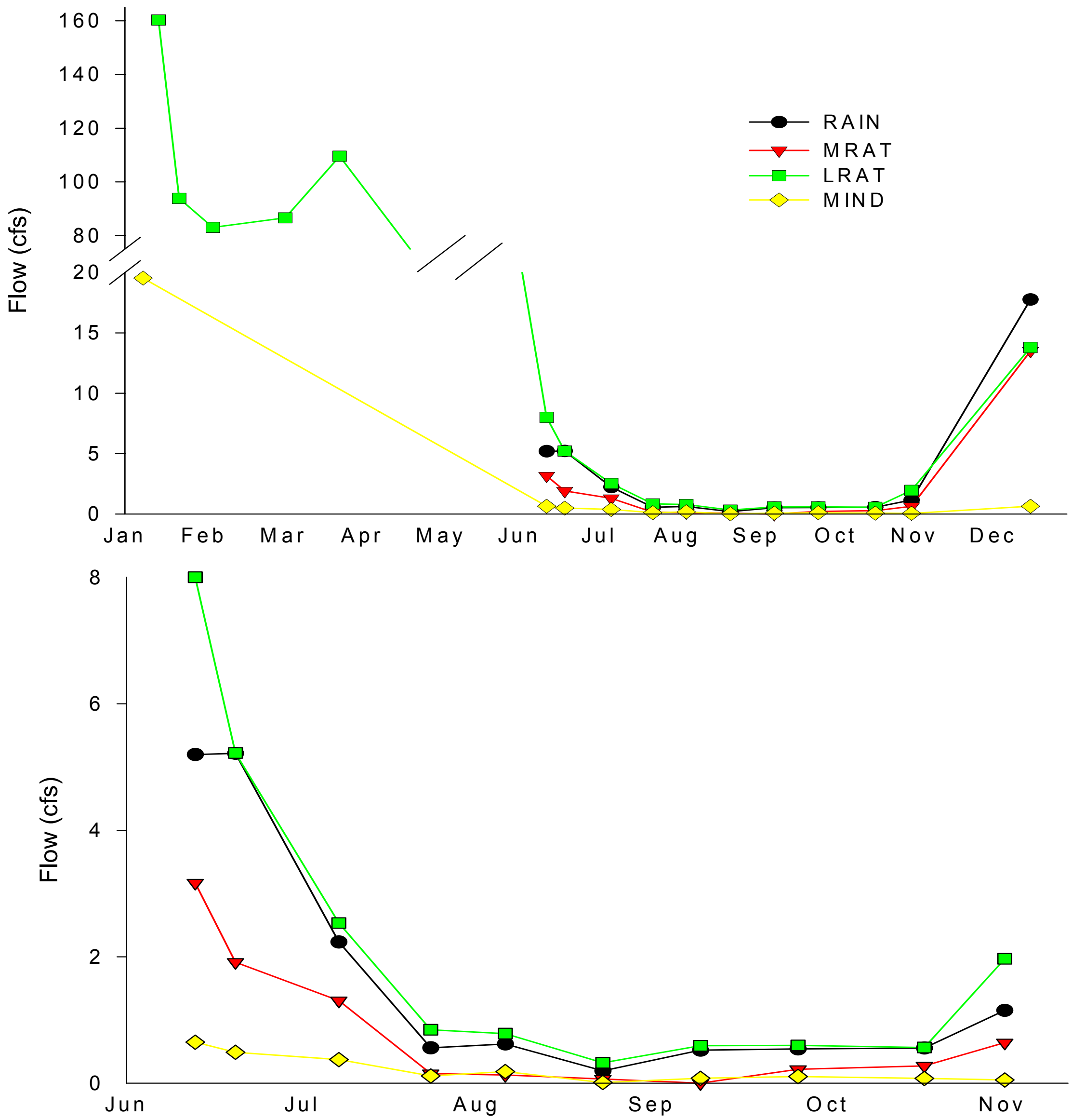


Figure 11. Flow measured at three sites on Rattlesnake Creek (LRAT, rkm 0.2; RAIN, rkm 0.8; MRAT, rkm 7.7) and one site on Indian Creek (MIND, rkm 2.2). The top graph shows flow measurements collected from January - December 2002. The bottom graph shows low flows from June – November 2002. For information on flow measurement locations, see Table 6 and Figure 3.

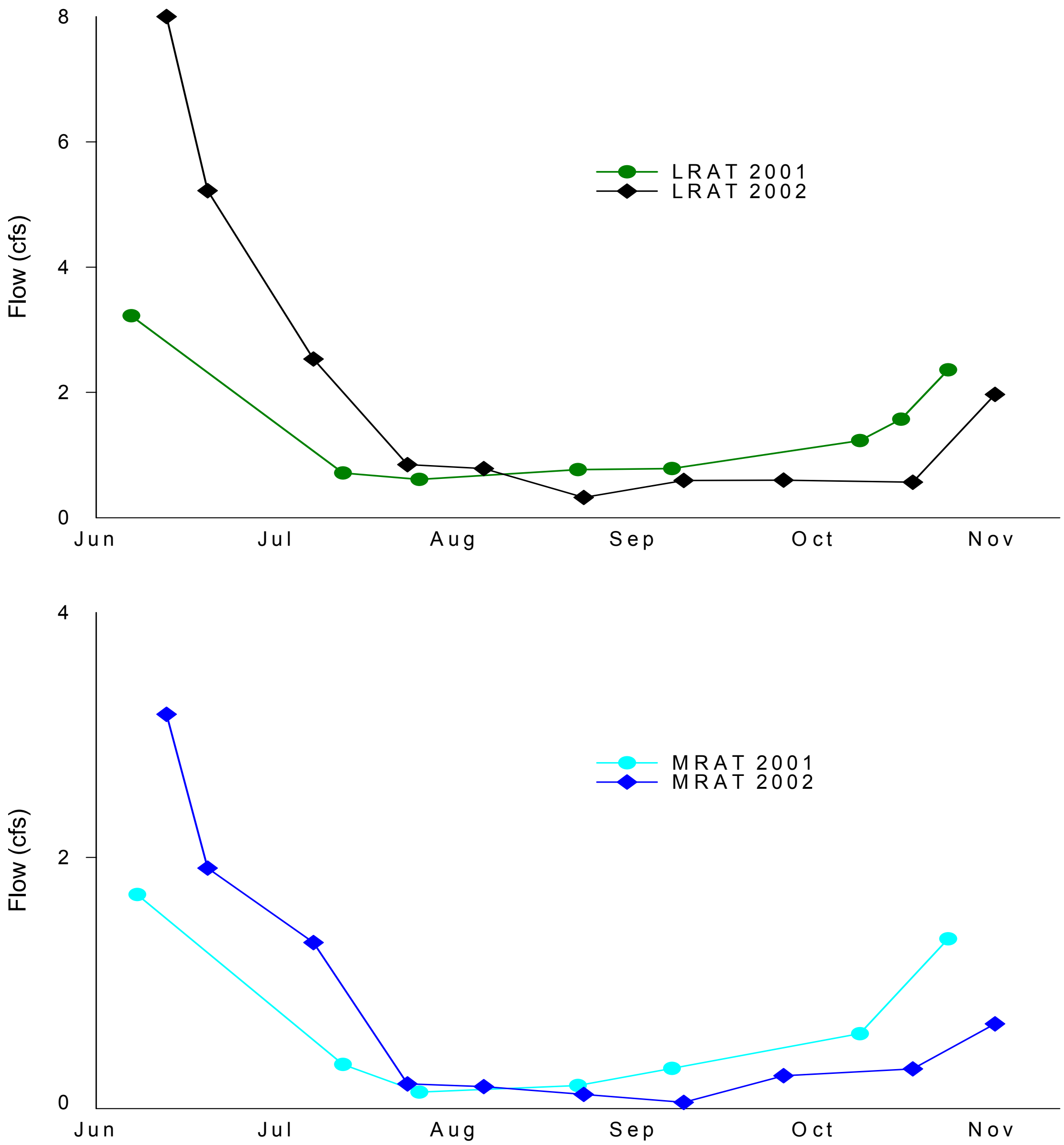


Figure 12. Flow for LRAT (rkm 0.2) and MRAT (rkm 7.7) from June – November, 2001-2002. For information on flow measurement locations, see Table 6 and Figure 3.

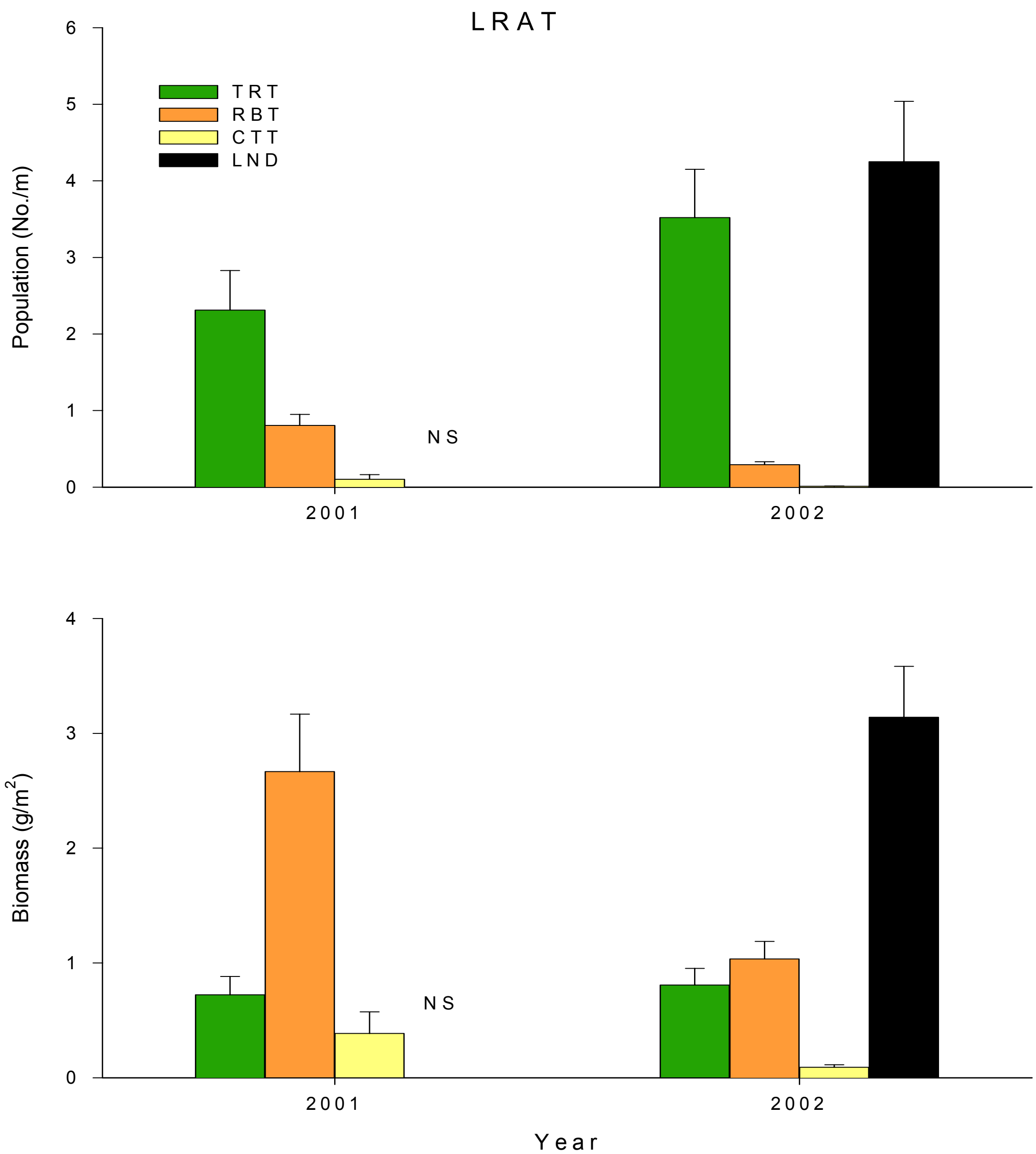


Figure 13. Comparison of fish population and biomass estimates in lower Rattlesnake creek (LRAT; rkm 0.2-1.3). Salmonids <80 mm long were considered trout (TRT). Rainbow trout (RBT) and cutthroat trout (CTT) were collected in 2001 and 2002. Longnose dace (LND) were not sampled (NS) in 2001, but were in 2002. Error bars represent 2 SE, which is approximately a 95 % confidence interval.

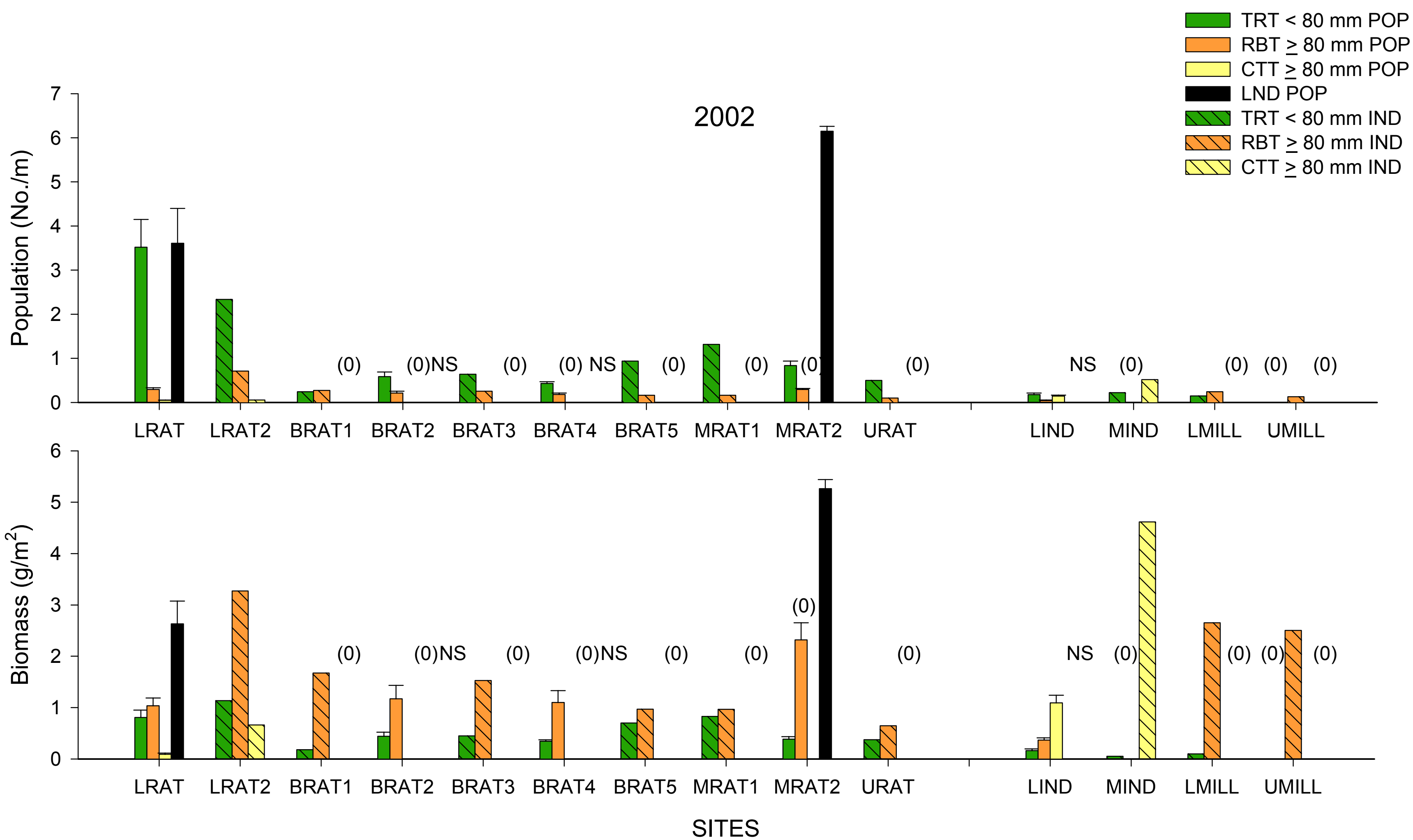


Figure 14. Population (POP) and Index (IND) electrofishing population and biomass estimates (with 1 SE bars for population estimates) of rainbow trout (RBT), cutthroat trout (CTT), and longnose dace (LND) found in Rattlesnake Creek watershed, 2002. Stream codes are: LRAT = section 1 of lower Rattlesnake Cr., LRAT2 = Rattlesnake Cr. below 1st waterfall, BRAT1 = Rattlesnake Cr. above falls, BRAT2 = Rattlesnake Cr. 500 m above falls, BRAT3 = Rattlesnake Cr. 1000 m above falls, BRAT4 = Rattlesnake Cr. 1500 m above falls, BRAT5 = Rattlesnake Cr. 2000 m above falls, MRAT1 = Rattlesnake Cr rkm 5.6-7.2, MRAT2 = Rattlesnake Cr. rkm 7.2-7.8, URAT = Rattlesnake Cr. rkm 10.8-14.4, LIND = Indian Cr. 100 m above mouth, MIND = Indian Cr. rkm 2.4-3.3, LMILL = Mill Cr. 0-1000 m, UMILL = Mill Cr. rkm 2.6-3.0. Additional information on stream code locations are provided on Figure 3 and Table 7.

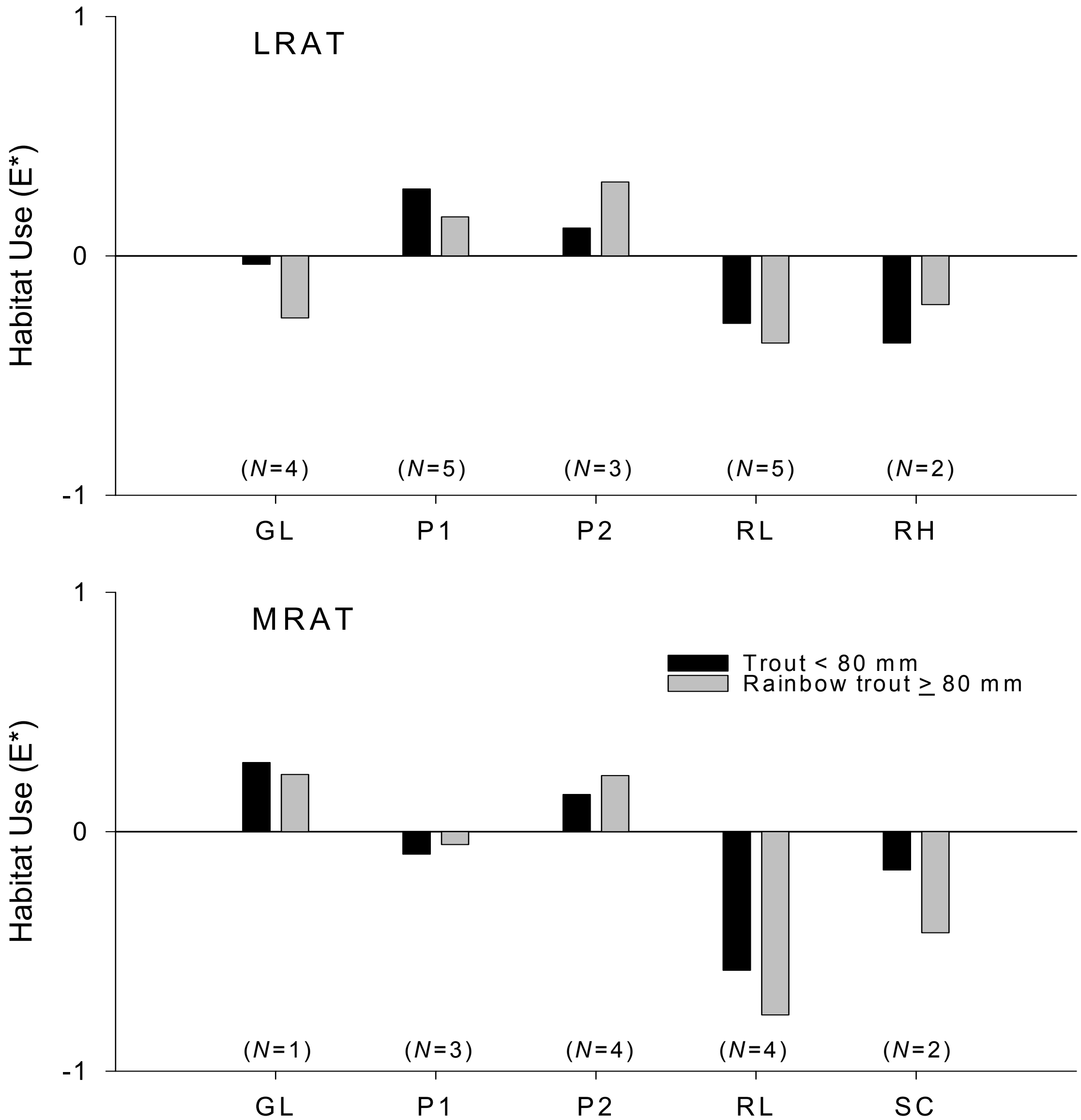


Figure 15. Use of habitat types by trout and rainbow trout in the LRAT1 (rkm 0.2-1.3) and MRAT2 (rkm 7.2-7.8) sections of Rattlesnake Creek during 2002. Vanderploeg and Scavia's (1979) electivity index, E*, was used to calculate habitat use based on fish biomass per m^2. Strongly positive values represent high use relative to the availability of a habitat type while strongly negative values represent low use. GL=glides, P1= pools <90 cm maximum depth for LRAT1 and <80 cm for MRAT2, P2=pools ≥ 90 cm maximum depth for LRAT1 and ≥80 cm for MRAT2, RL=low gradient riffles, RH=high gradient riffles, SC=side channel.

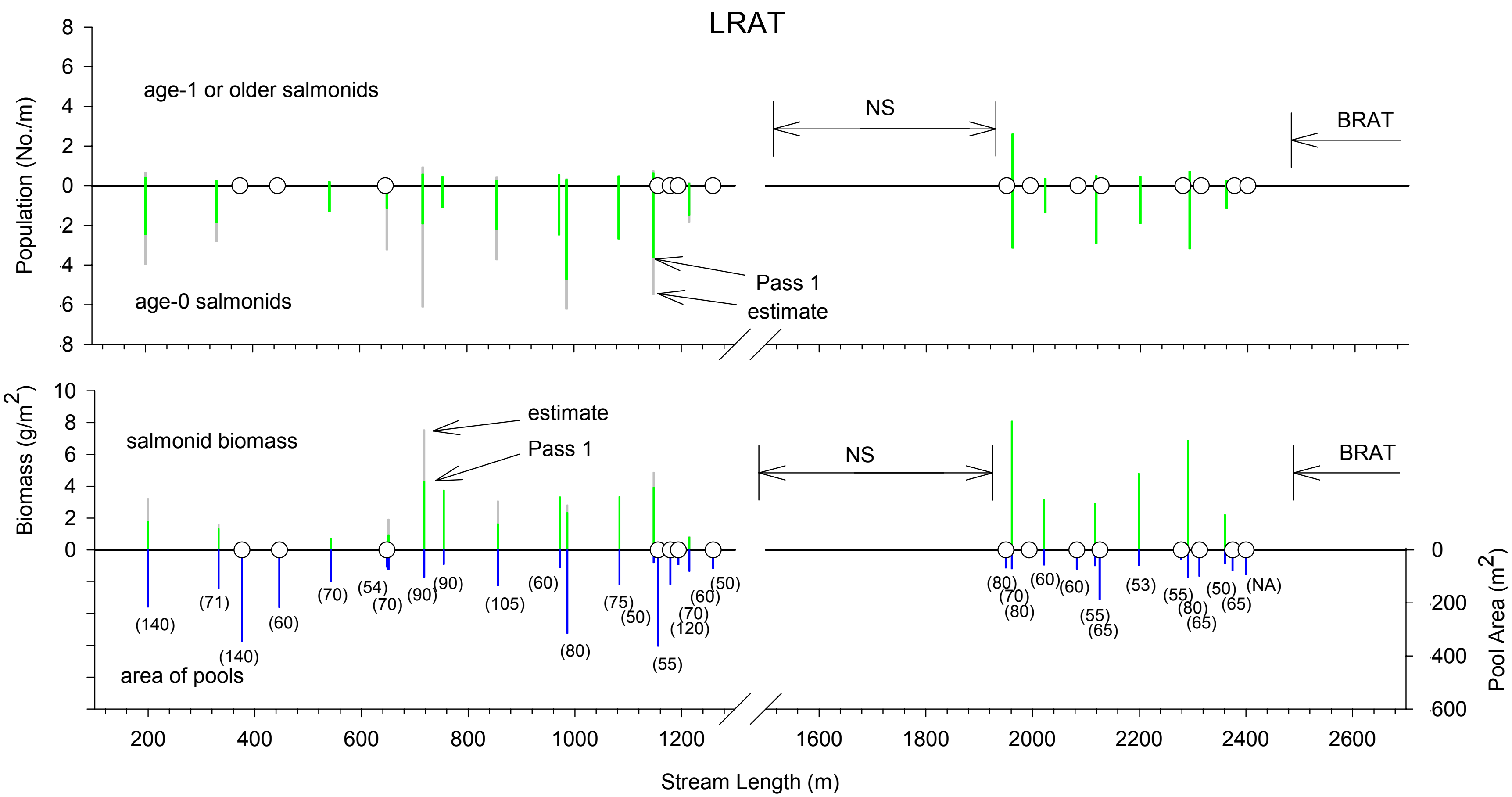


Figure 16a. Comparison of salmonid population and biomass in the pools (n=33) of lower Rattlesnake Creek (LRAT; rkm 0.2-1.3 and 1.9-2.4). Section 1 (200 m to 1300 m) was sampled using multiple pass, removal-depletion electrofishing with blocknets. Section 2 (1950 m to 2400 m) was sampled using one pass electrofishing without blocknets. The upper graph shows fish per meter of age-0 trout and age-1 or older trout after the first electrofishing pass and the estimated total population from multiple passes (2-5). The lower graph shows biomass (g/m^2) of all salmonids after the first pass and the estimated biomass from multiple passes, and the area (m^2) of pools in the stream section. Maximum depth (cm) is noted in parentheses below each pool. o = pools not sampled for fish (n=15).

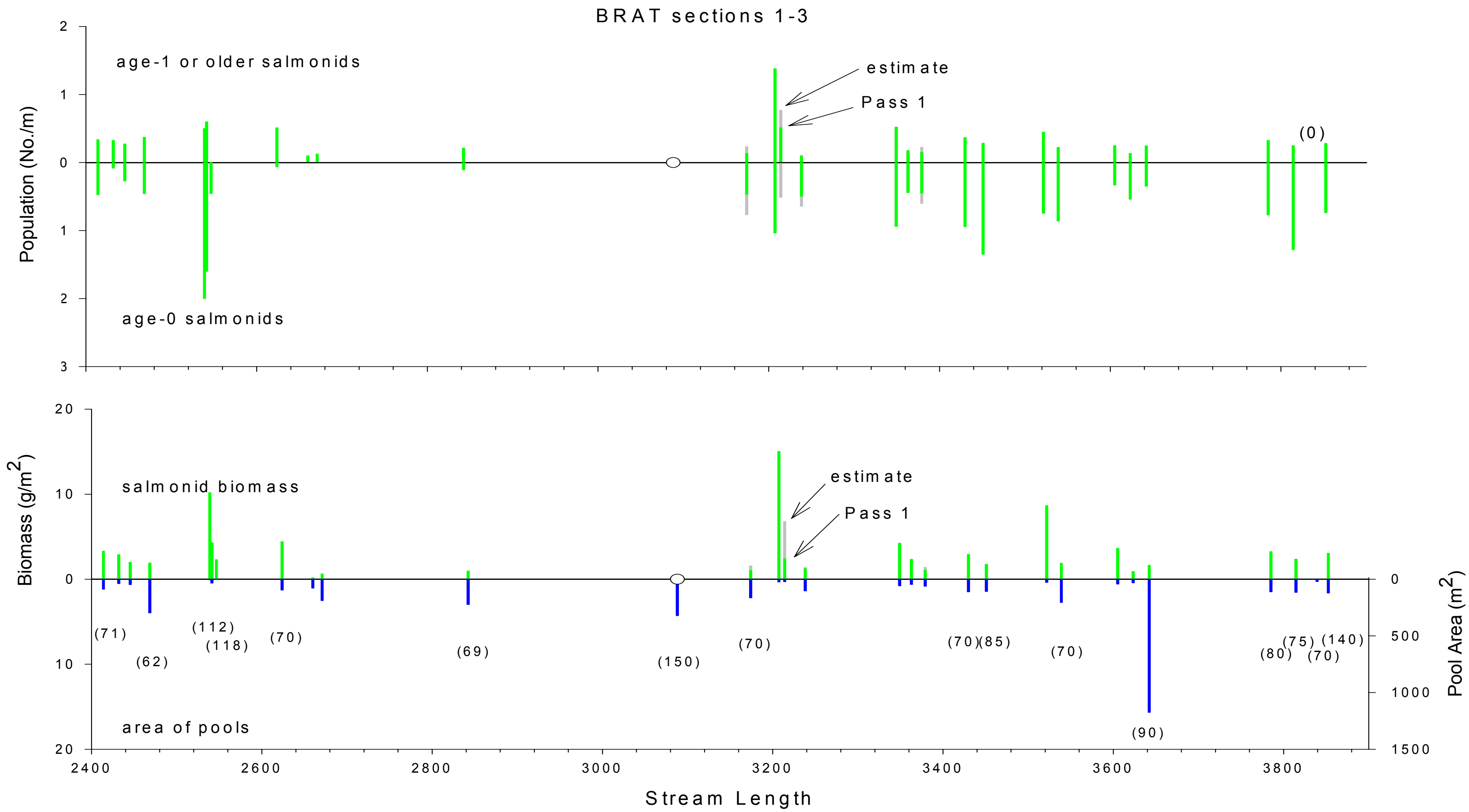


Figure 16b. Comparison of salmonid population and biomass in pools (n=17) in section 1,2 and 3 of the BRAT reach of Rattlesnake Creek (rkm 2.4-3.8). Section 2 (2,900 m to 3,340 m) was sampled using multiple pass, removal-depletion electrofishing with blocknets. Sections 1 (2,400 m to 2,900 m) and 3 (3,340 m to 3,840 m) were sampled using one pass electrofishing without blocknets. The upper graph shows fish per meter of age-0 trout and age-1 or older trout after the first electrofishing pass and the estimated total population from multiple passes (2-5). The lower graph shows biomass (g/m^2) of all salmonids after the first pass and the estimated biomass from multiple passes, and the area (m^2) of pools in the stream section. Maximum depth (cm) is noted in parentheses below each pool greater than 40 cm deep. o = pools not sampled for fish (n=1).

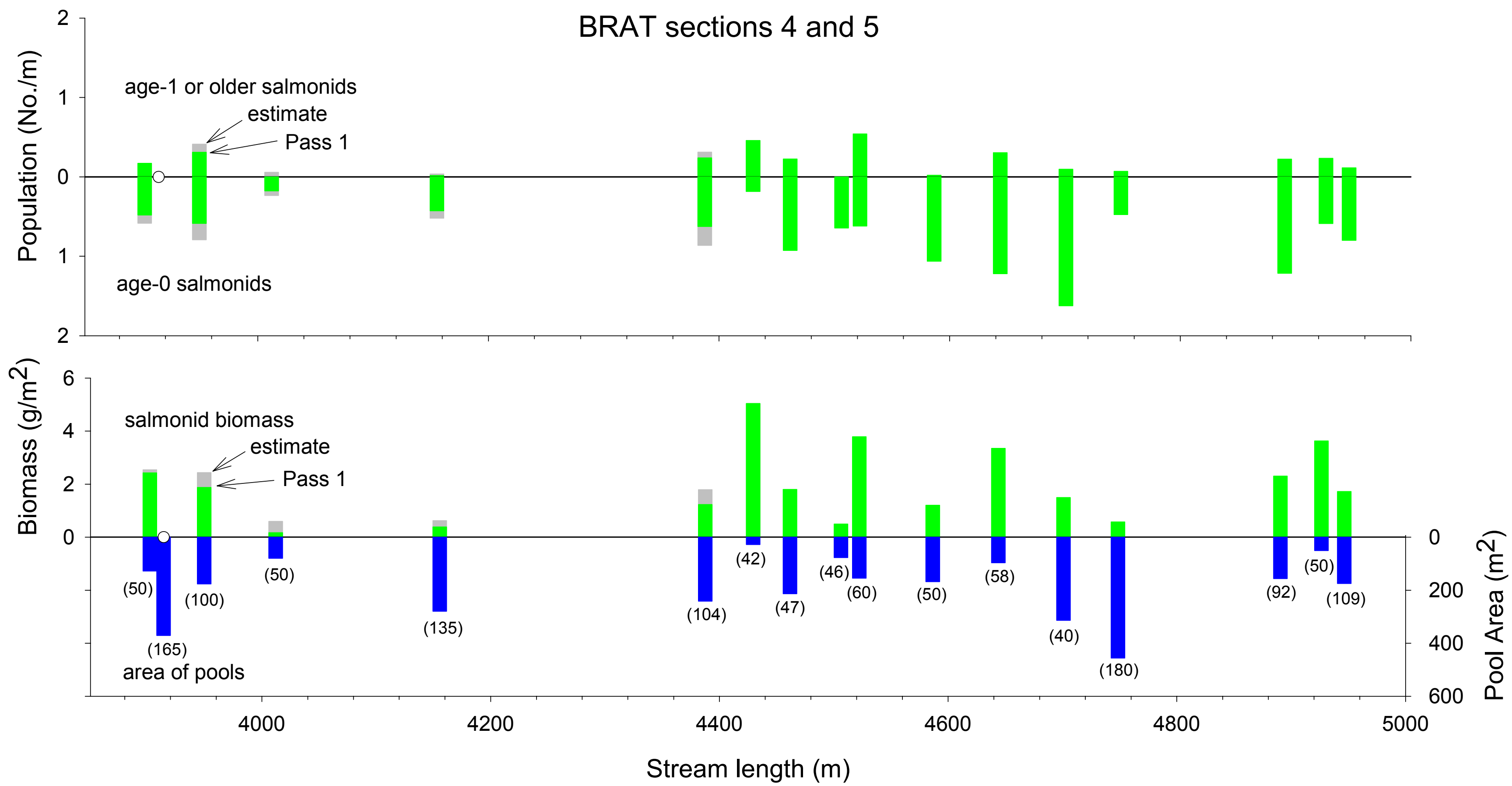


Figure 16c. Comparison of salmonid population and biomass in pools (n=17) in section 4 and 5 of the BRAT reach of Rattlesnake Creek (rkm 3.8-4.8). Section 4 (3,840 m to 4,340 m) was sampled using multiple pass, removal-depletion electrofishing with blocknets. Section 5 (4,340 m to 4,840 m) was sampled using one pass electrofishing without blocknets. The upper graph shows fish per meter of age-0 trout and age-1 or older trout after the first electrofishing pass and the estimated total population from multiple passes (2-5). The lower graph shows biomass (g/m^2) of all salmonids after the first pass and the estimated biomass (g/m^2) from multiple passes, and the area (m^2) of pools in the stream section. Maximum depth (cm) is noted in parentheses below each pool.
o = pools not sampled for fish (n=1).

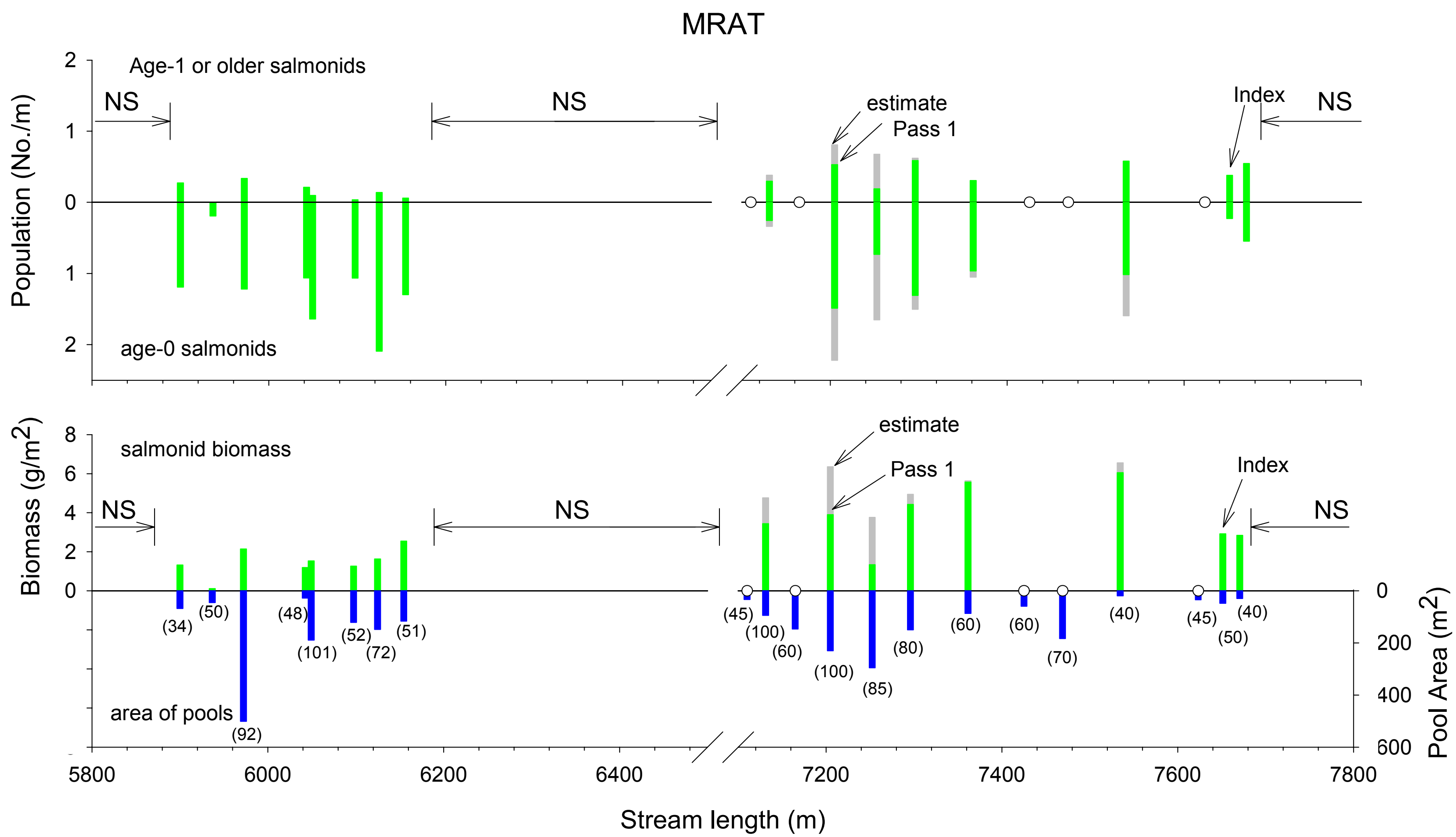


Figure 16d. Comparison of salmonid population and biomass in pools (n=21) of the middle Rattlesnake Creek (MRAT: rkm 5.9-6.2 and 7.2-7.8). Section 1 (5,950 m to 6,200 m) was sampled using one pass electrofishing without blocknets. Section 2 (7,190 m to 7,770 m) was sampled using multiple pass, removal-depletion electrofishing with blocknets. The upper graph shows fish per meter of age-0 trout and age-1 or older trout after the first electrofishing pass and the estimated total population from multiple passes (2-5). The lower graph shows biomass (g/m^2) of all salmonids after the first pass and the estimated biomass (g/m^2) from multiple passes, and the area (m^2) of pools in the stream section. Maximum depth (cm) is noted in parentheses below each pool. o = pools not sampled for fish (n=5).

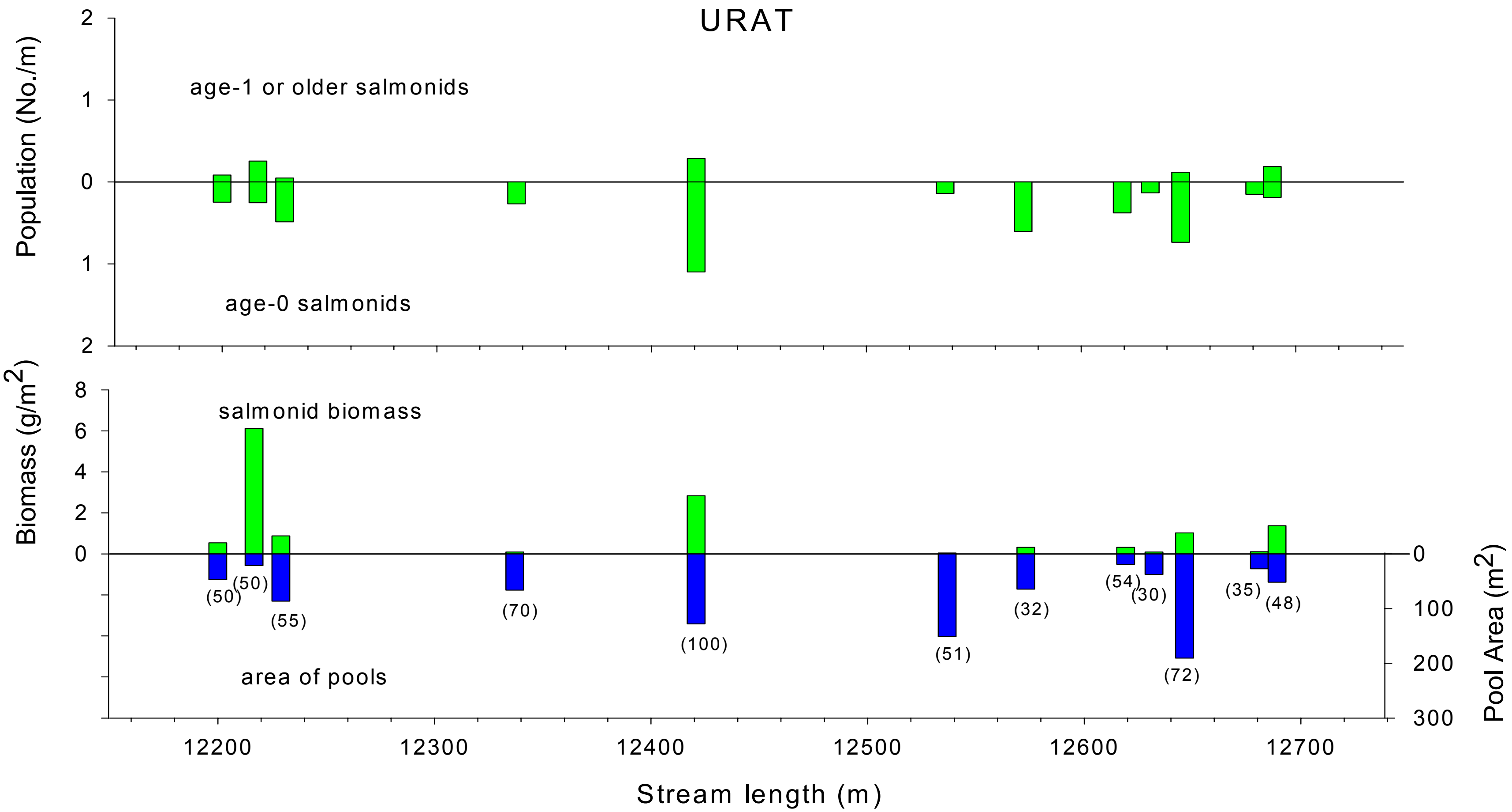


Figure 16e. Comparison of salmonid population and biomass in pools (n=12) of upper Rattlesnake Creek (URAT; rkm 12.2 -12.7). Upper Rattlesnake Creek was sampled using one pass electrofishing without blocknets. The upper graph shows fish per meter of age-0 trout and age-1 or older trout after the first electrofishing pass. The lower graph shows biomass (g/m^2) of all salmonids after the first pass, and the area (m^2) of pools in the stream section. Maximum depth (cm) is noted in parentheses below each pool. All pools in the reach were sampled for fish.

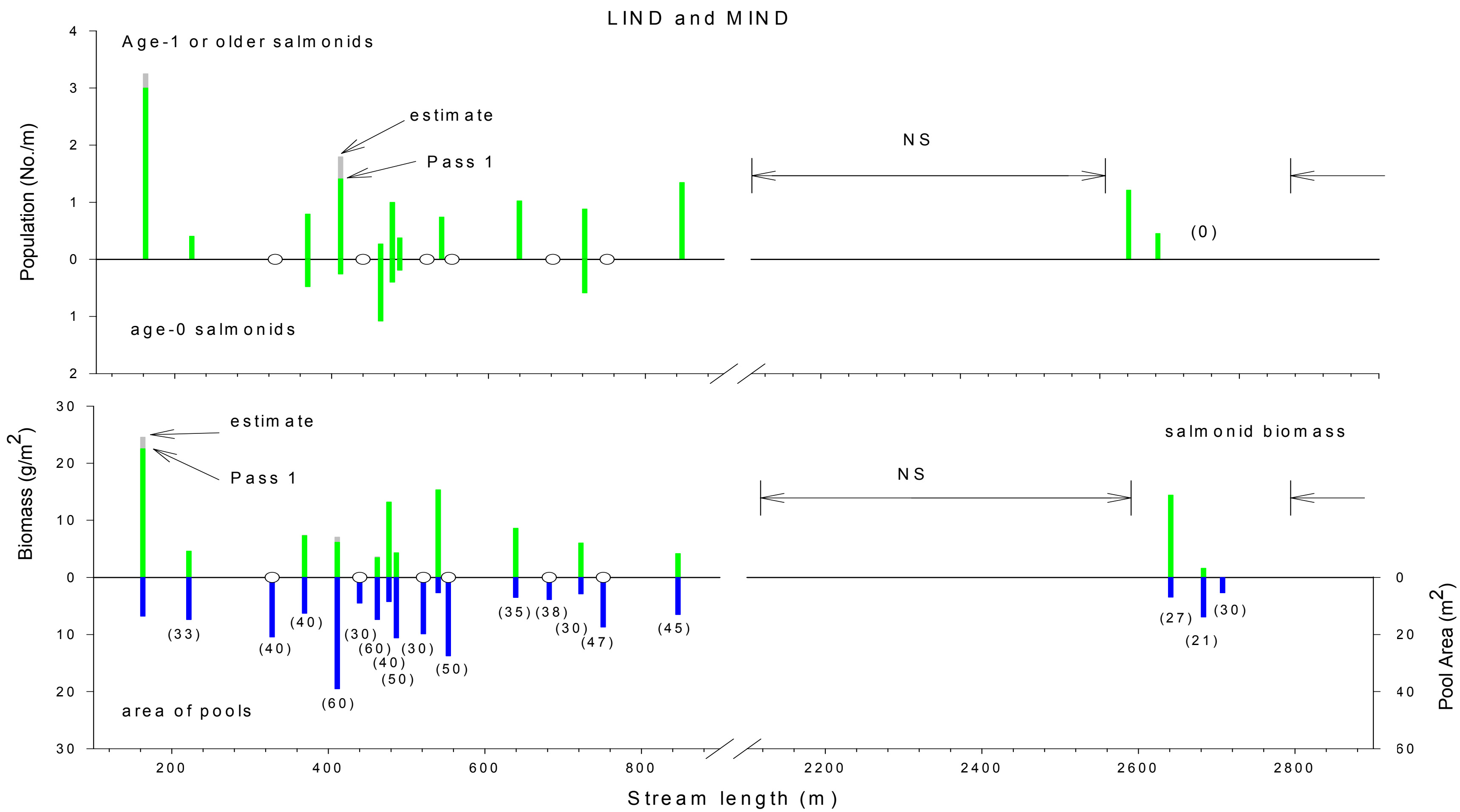


Figure 16f. Comparison of salmonid population and biomass in pools (n=17) of Indian Creek (rkm 0.1-0.9 and 2.4-2.5). The lower Indian Creek section (LIND, 100 m to 900 m) was sampled using multiple pass, removal-depletion electrofishing with blocknets. The middle Indian Creek section (MIND, 2,600 m to2,800 m) was sampled using one pass electrofishing without blocknets. The upper graph shows fish per meter of age-0 trout and age-1 or older trout after the first electrofishing pass and the estimated total population from multiple passes (2-5). The lower graph shows biomass (g/m^2) of all salmonids after the first pass and the estimated biomass from multiple passes, and the area (m^2) of pools in the stream section. Maximum depth (cm) is noted in parentheses below each pool. o = pools not sampled for fish (n=1).

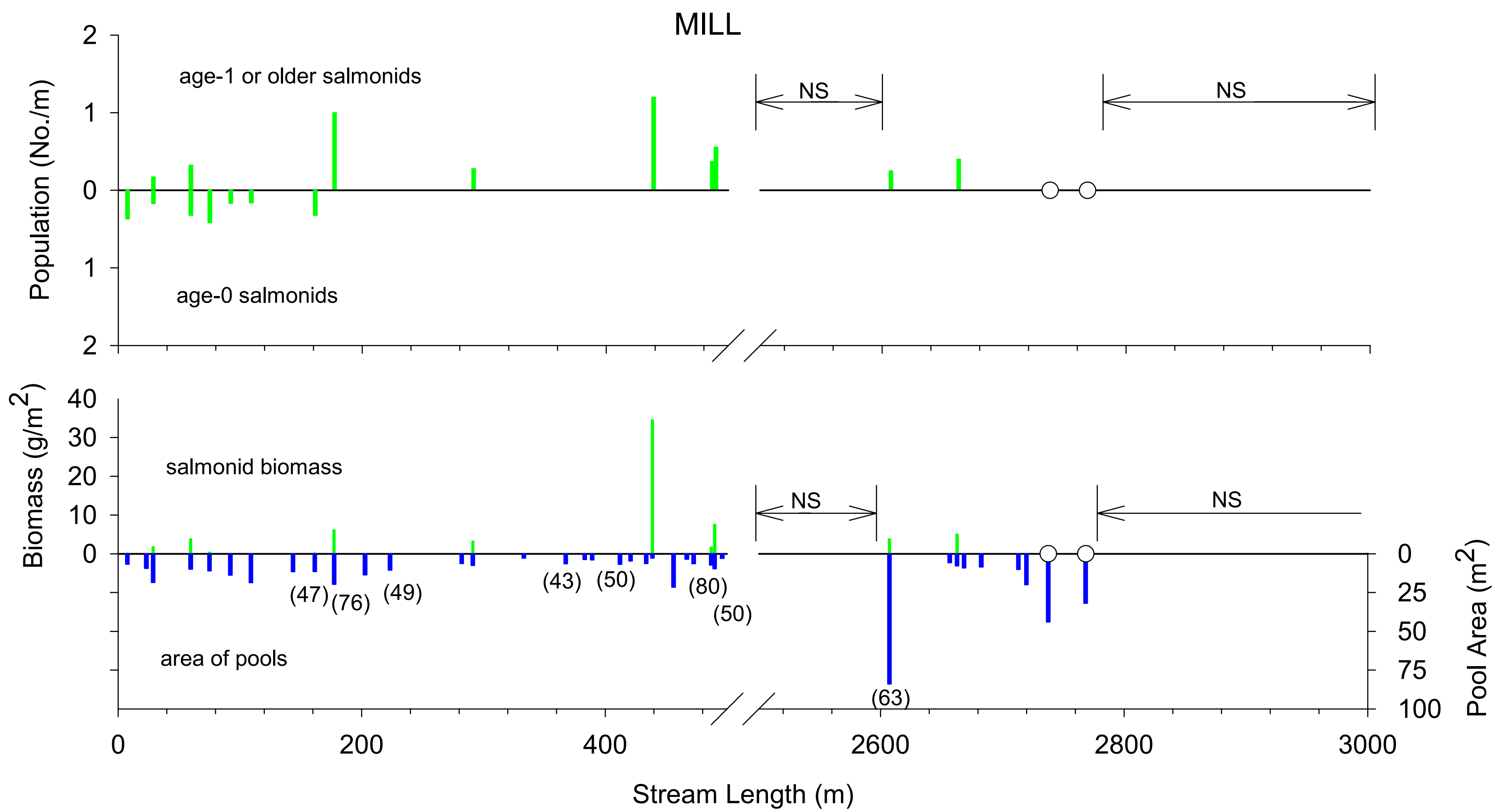


Figure 16g. Comparison of salmonid population and biomass in pools (n=36) of Mill Creek (rkm 0.0-1.0 and 2.6-2.8). Mill Creek was sampled using one pass electrofishing without blocknets. The upper graph shows fish per meter of age-0 trout and age-1 or older trout. The lower graph shows biomass (g/m^2) of all salmonids, and the area (m^2) of pools in the stream section. Maximum depth (cm) is noted in parentheses below for each pool over 40 cm. o = pools not sampled for fish (n=2).

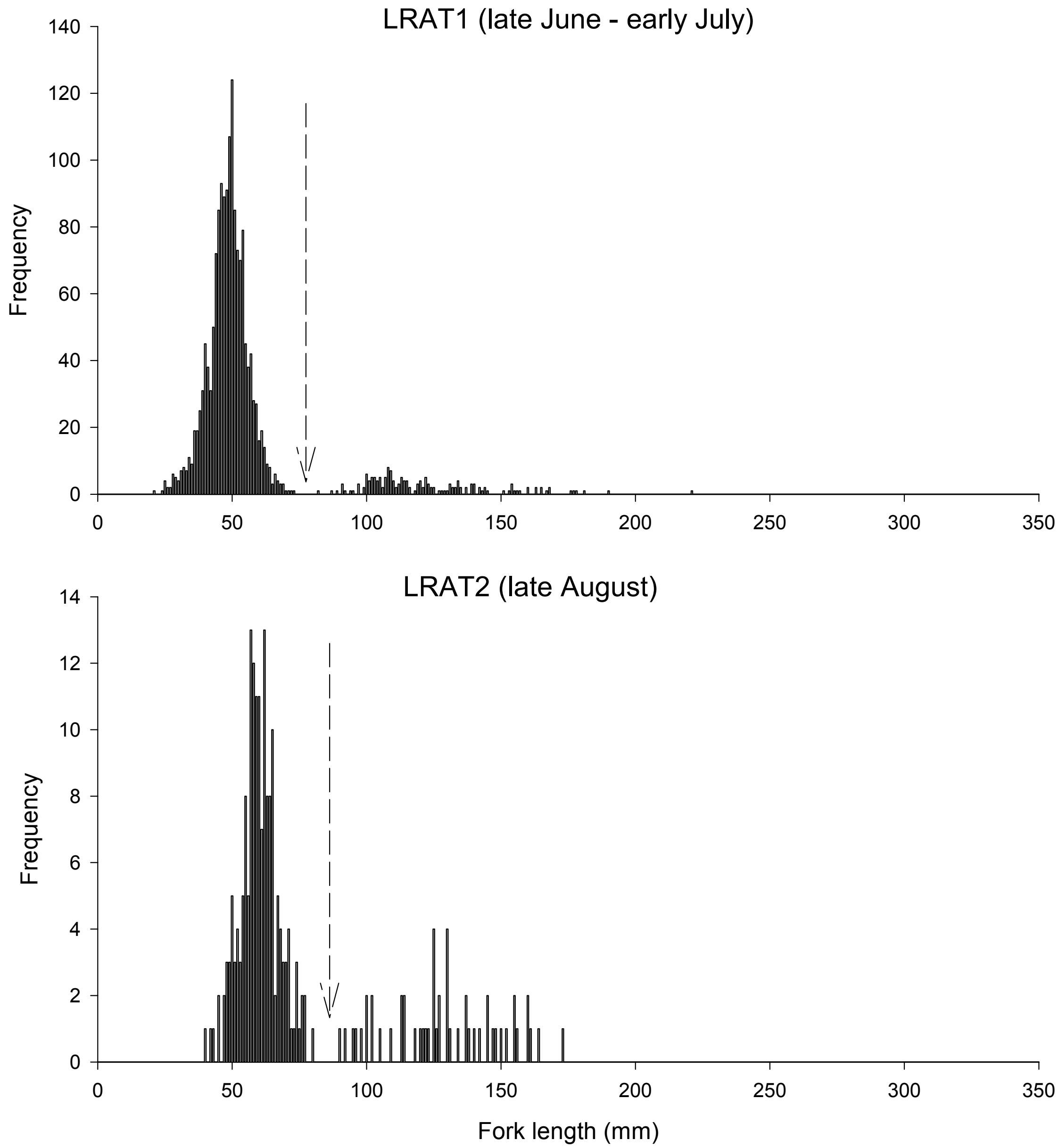


Figure 17a. Length frequency in 1-mm increments of rainbow trout sampled in section 1 (rkm 0.2-1.3) and section 2 (rkm 1.9-2.4) of the LRAT reach of Rattlesnake Creek. The arrow indicates the break between age-0 and age-1 or older fish. This break was verified by aging fish by scales on either side of the break.

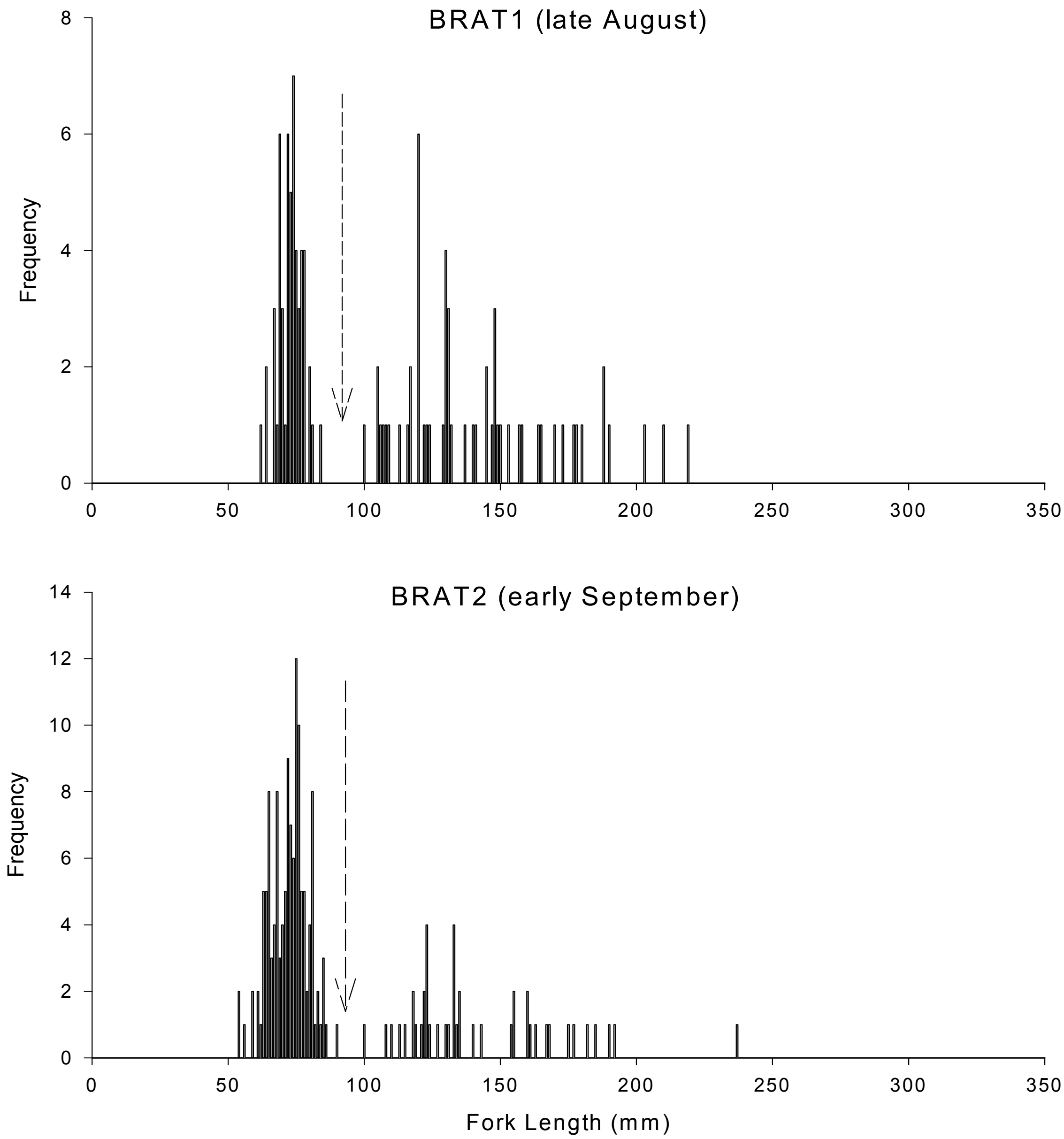


Figure 17b. Length frequency in 1-mm increments of rainbow trout sampled in section 1 (rkm 2.4-2.9) and section 2 (rkm 2.9-3.4) of the BRAT reach of Rattlesnake Creek. The arrow indicates the break between age-0 and age-1 or older fish. This break was verified by aging fish by scales on either side of the break.

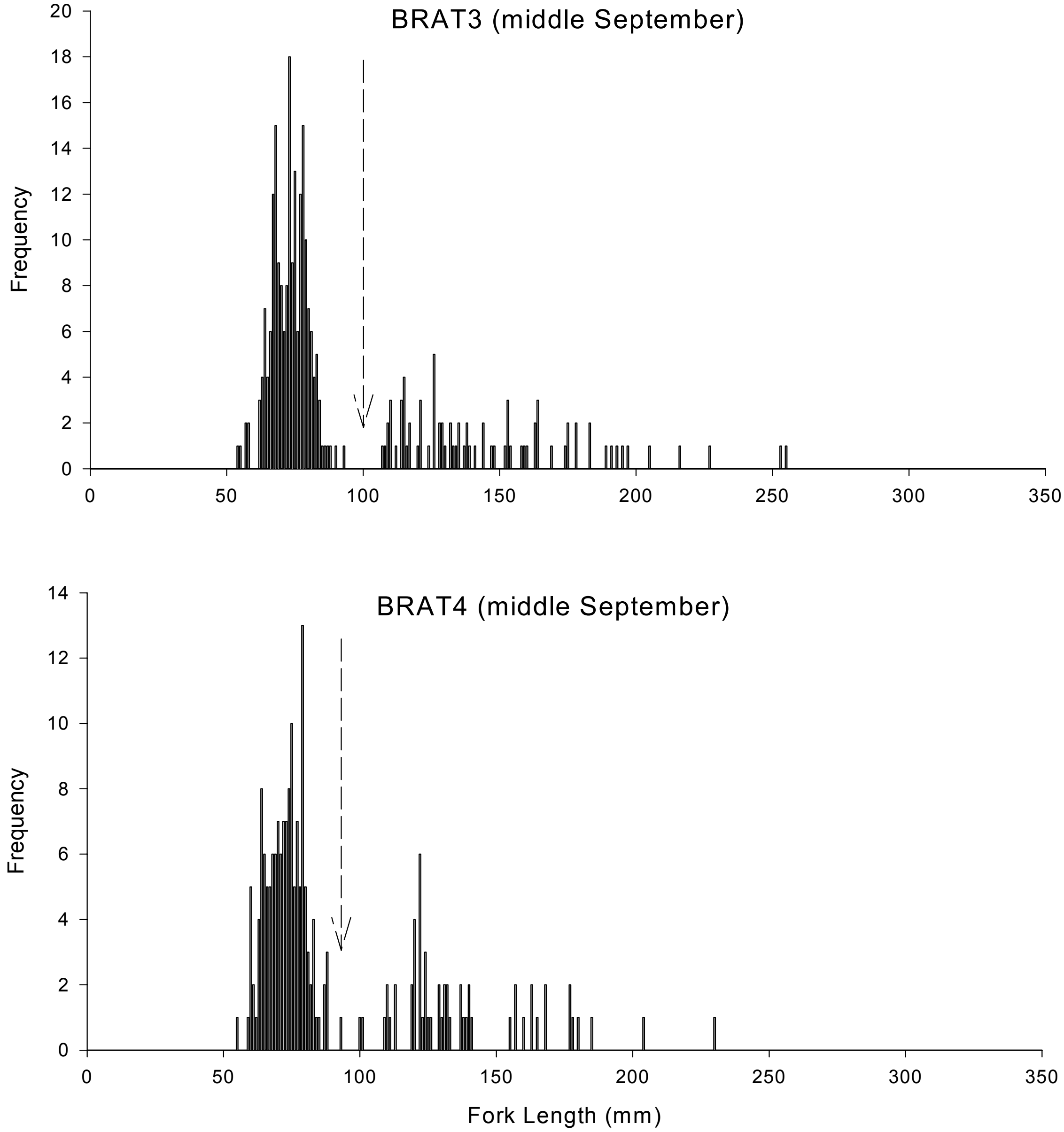


Figure 17c. Length frequency in 1-mm increments of rainbow trout sampled in section 3 (rkm 3.3-3.8) and section 4 (rkm 3.8-4.3) of the BRAT reach of Rattlesnake Creek. The arrow indicates the break between age-0 and age-1 or older fish. This break was verified by aging fish by scales on either side of the break.

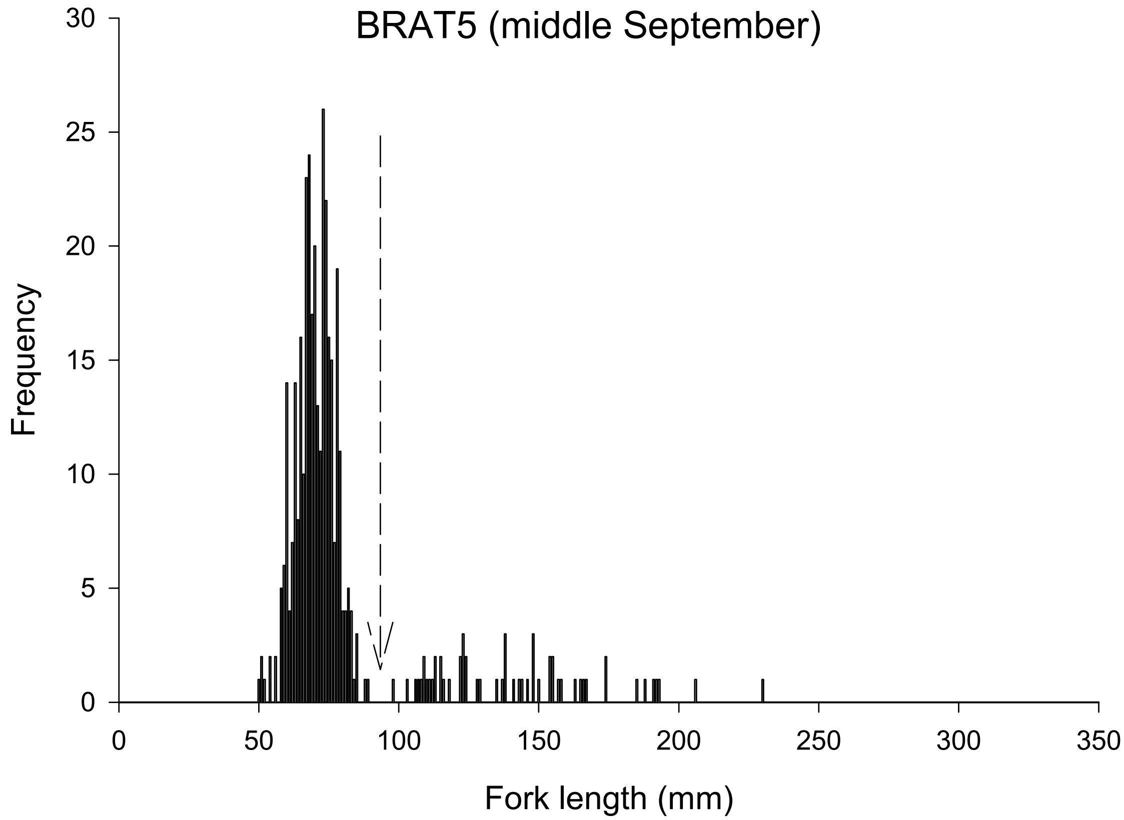


Figure 17d. Length frequency in 1-mm increments of rainbow trout sampled in section 5 (rkm 4.3-4.8) of the BRAT reach of Rattlesnake Creek. The arrow indicates the break between age-0 and age-1 or older fish. This break was verified by aging by fish scales on either side of the break.

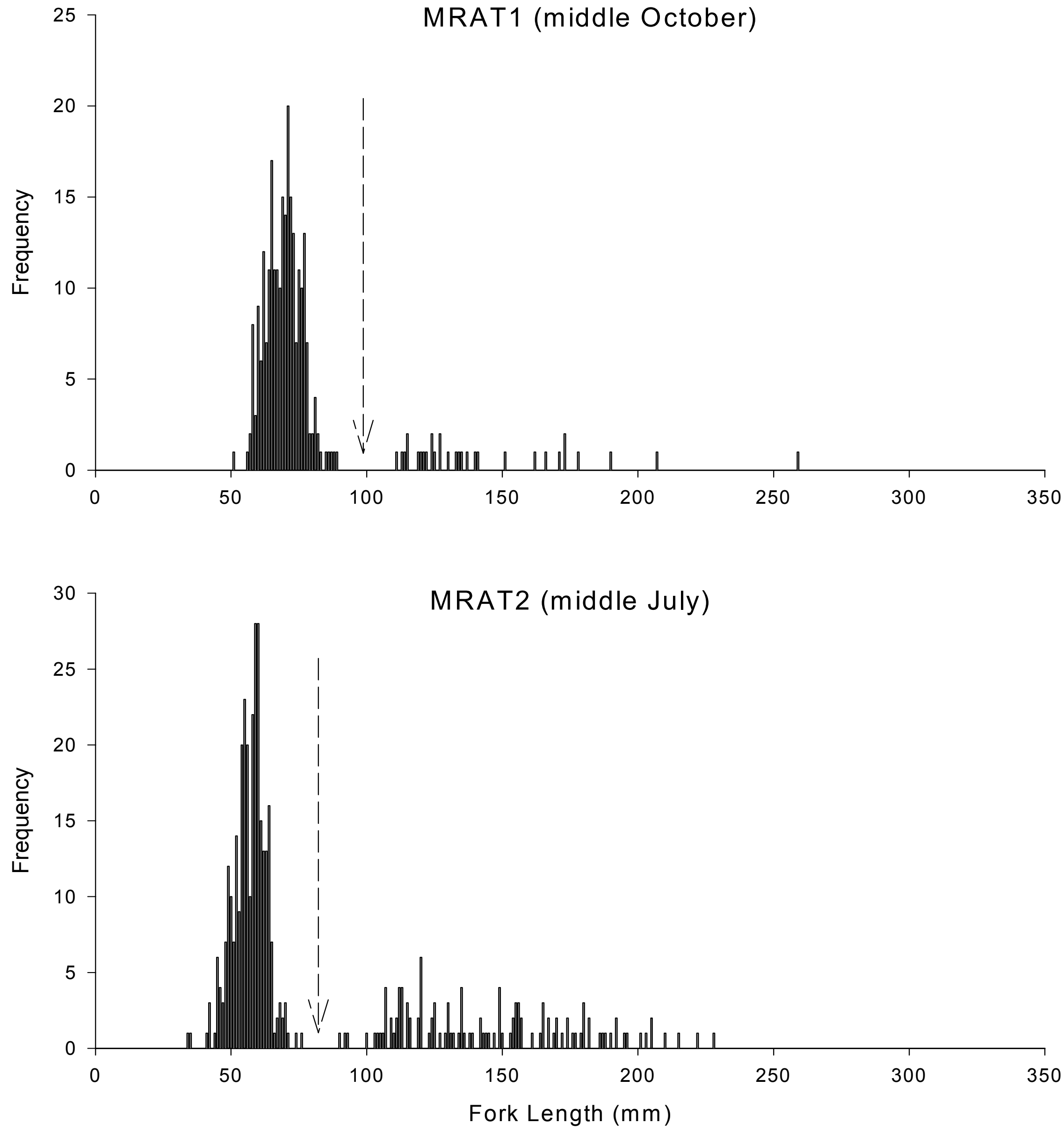
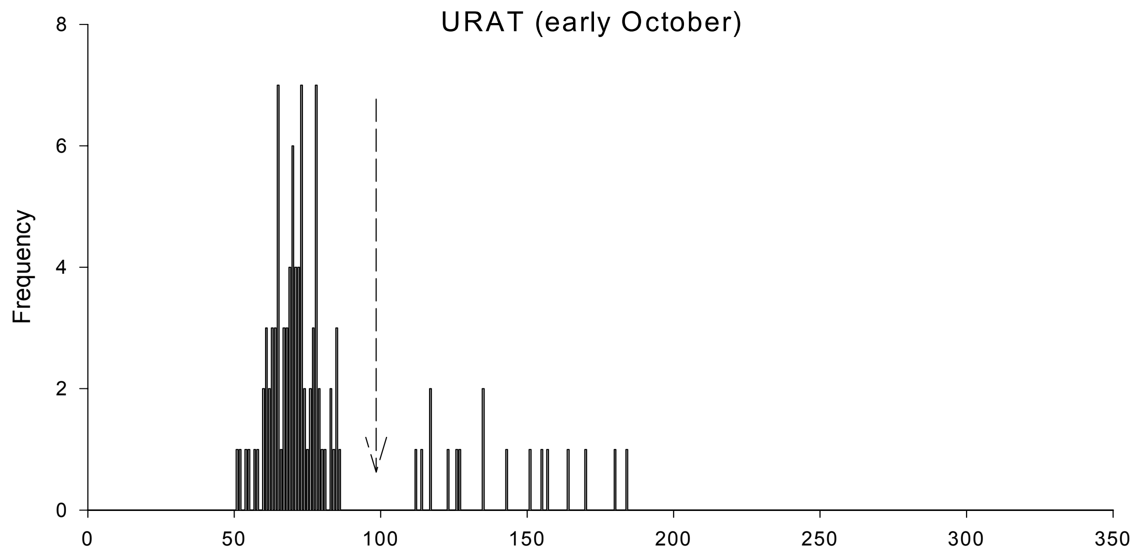


Figure 17e. Length frequency in 1-mm increments of rainbow trout sampled in section 1 (rkm 6.0-7.2) and section 2 (rkm 7.2-7.8) of the MRAT reach of Rattlesnake Creek. The arrow indicates the break between age-0 and age-1 or older fish. This break was verified by aging fish by scales on either side of the break.



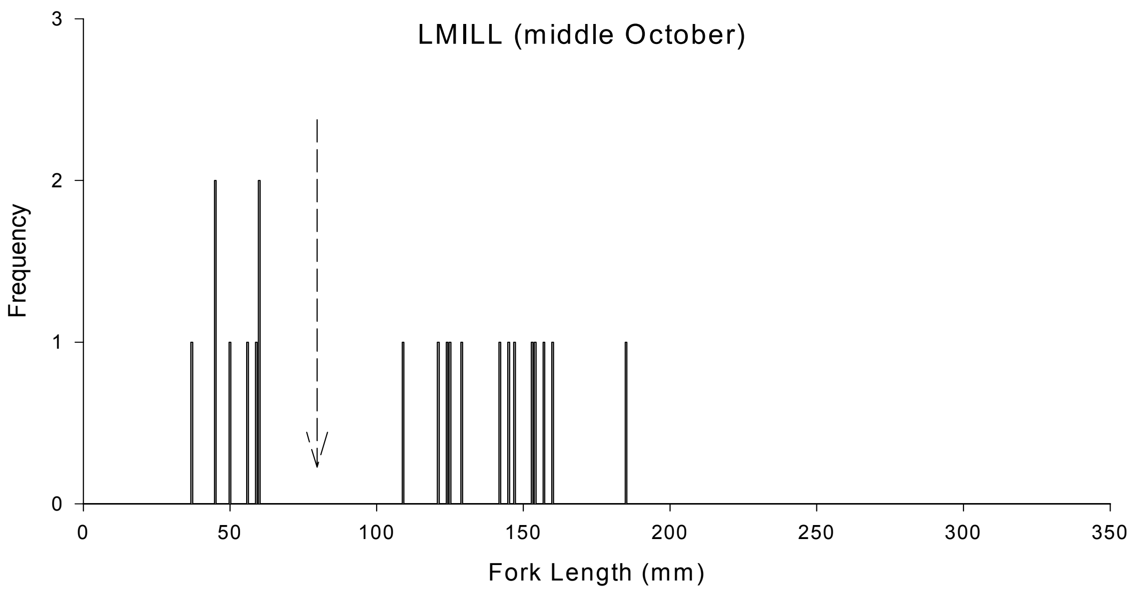


Figure 17f. Length frequency in 1-mm increments of rainbow trout sampled in the URAT reach of Rattlesnake Creek (rkm 10.8-11.8) and the LMil reach of Mill Creek (0.0-0.5) of the Rattlesnake Creek watershed. The arrow indicates the break between age-0 and age-1 or older fish. This break was verified by aging fish by scales on either side of the break.

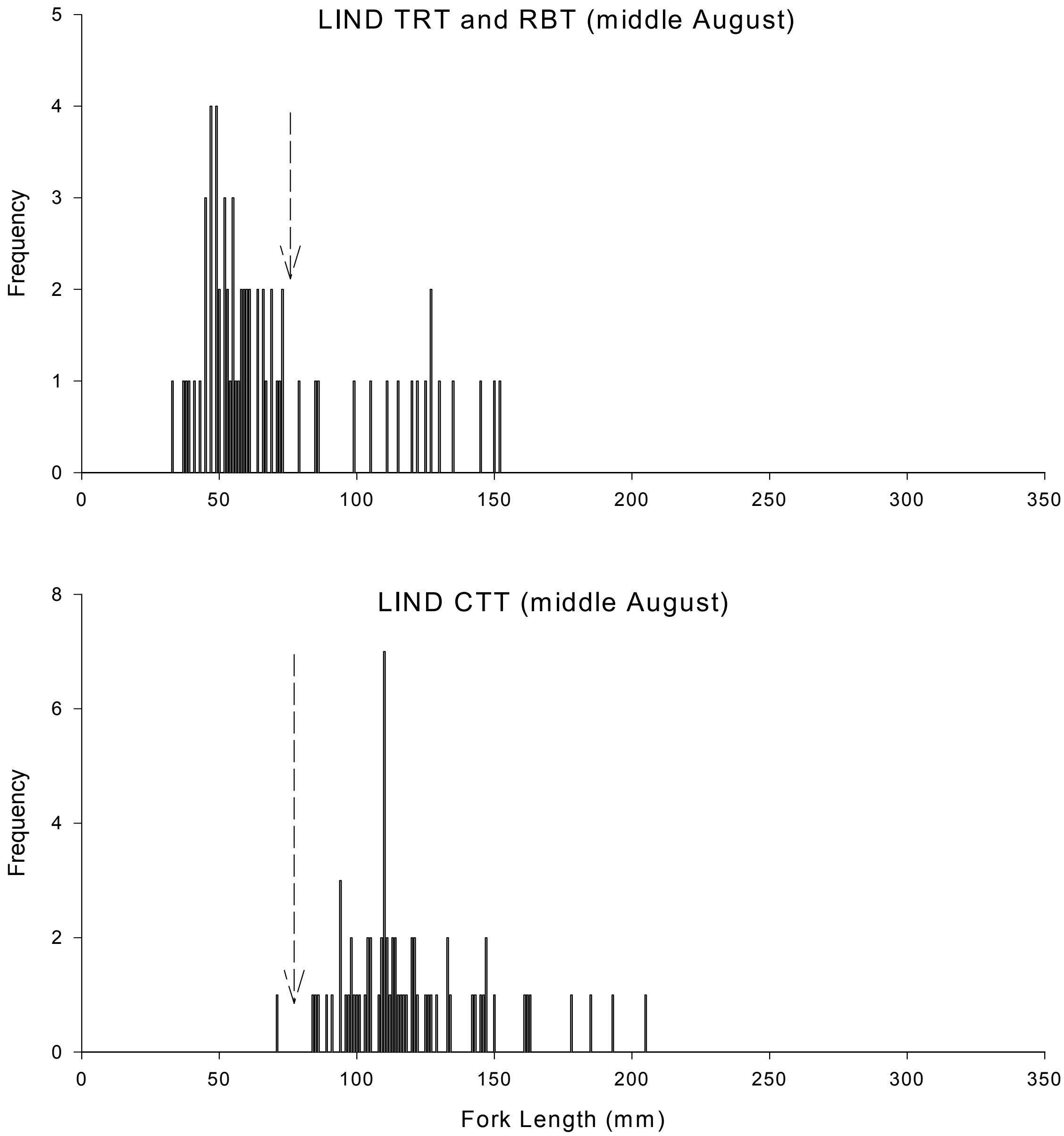


Figure 17g. Length frequency in 1-mm increments of trout (TRT), rainbow trout (RBT), and cutthroat trout (CTT) sampled in the LIND reach (rkm 0.0-0.9) of Indian Creek of the Rattlesnake Creek watershed. The arrow indicates the break between age-0 and age-1 or older fish. This break was verified by aging fish by scales on either side of the break.

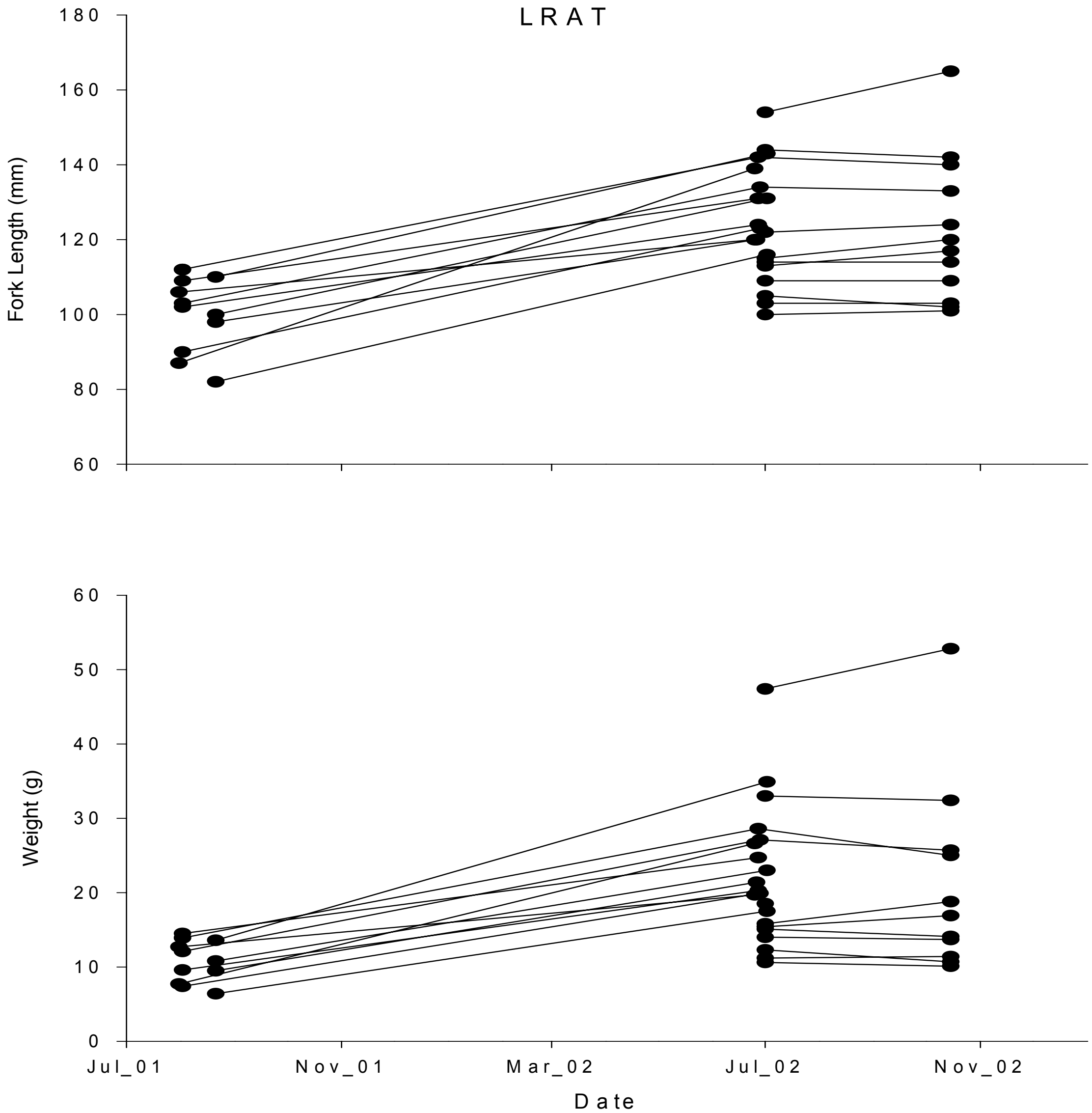


Figure 18. Length (mm) and weight (g) of PIT tagged fish within lower Rattlesnake Creek (LRAT; rkm 0.2-1.3) at initial tagging and at each time of recapture.

Appendix Tables

Appendix Tables 1a-9b. Population and biomass estimates of fish by habitat type for the sections of Rattlesnake Creek where multiple pass, removal-depletion electrofishing was performed.

Appendix Table 1a. Population estimate of age-0 trout and age-1 or older rainbow trout by habitat type for the LRAT1 section of Rattlesnake Creek (rkm 0.2-1.3). A systematic sample of habitat units within different habitat types (e.g., pool, glide, riffle) was chosen for multiple pass, removal-depletion electrofishing with block nets. Habitat Types are: GL = glide, P1 = shallow pools (<90 cm), P2 = deep pools (≥ 90 cm), RH = high gradient riffles, and RL = low gradient riffles. $\hat{N}$ = estimated population size, $\hat{B}$ = biomass estimate (g), T = total, CV = coefficient of variation.

Habitat type	Total length (m) (% of total)	Total area (m^2) (% of total)	Age-0 trout				Age-1 or older rainbow trout			
			$\hat{N}_i$ (% $\hat{N}_T$)	CV_i	$\hat{B}_i$ (% $\hat{B}_T$)	CV_i	$\hat{N}_i$ (% $\hat{N}_T$)	CV_i	$\hat{B}_i$ (% $\hat{B}_T$)	CV_i
GL	75.8 (7)	452 (6)	253 (7)	3.1	339 (6)	3.7	20 (6)	0.0	326 (4)	0.0
P1	236.8 (22)	1,455 (21)	1,523 (40)	39.1	2,249 (40)	39.3	101 (31)	28.5	2,394 (33)	31.8
P2	160.7 (15)	984 (14)	708 (19)	19.5	1,078 (19)	21.6	96 (30)	13.3	2,191 (30)	13.4
RH	41.5 (4)	272 (4)	83 (2)	2.4	131 (2)	2.4	10 (3)	4.5	250 (3)	4.5
RL	568.9 (52)	3,830 (55)	1,258 (33)	24.9	1,872 (33)	23.0	94 (29)	27.9	2,098 (29)	33.3
Total	1,083.7 (100)	6,993 (100)	3,825 (101)		5,669 (100)		321 (99)		7,259 (99)	

Appendix Table 1b. Number and biomass (g) of age-0 trout and age-1 or older rainbow trout by habitat type for the LRAT1 section of Rattlesnake Creek (rkm 0.2-1.3). A systematic sample of habitat units within different habitat types (e.g., pool, glide, riffle) was chosen for multiple pass, removal- depletion electrofishing with block nets. Habitat types are: GL = glide, P1 = shallow pools (<90 cm), P2 = deep pools (≥ 90 cm), RH = high gradient riffles, and RL = low gradient riffles. SE = standard error.

Habitat type	Age-0 trout				Age-1 or older rainbow trout			
	no./m (SE)	no./m^2 (SE)	g/m (SE)	g/m^2 (SE)	no./m (SE)	no./m^2 (SE)	g/m (SE)	g/m^2 (SE)
GL	3.34 (0.10)	0.56 (0.02)	4.47 (0.17)	0.75 (0.03)	0.26 (0.00)	0.04 (0.00)	4.30 (0.00)	0.72 (0.00)
P1	6.43 (2.51)	1.05 (0.41)	9.50 (3.73)	1.55 (0.61)	0.43 (0.12)	0.07 (0.02)	10.11 (3.21)	1.65 (0.52)
P2	4.41 (0.86)	0.72 (0.10)	6.71 (1.45)	1.10 (0.24)	0.60 (0.08)	0.10 (0.01)	13.63 (1.82)	2.23 (0.30)
RH	2.00 (0.00)	0.31 (0.00)	3.16 (0.08)	0.48 (0.01)	0.24 (0.01)	0.04 (0.00)	6.01 (0.27)	0.92 (0.04)
RL	2.21 (0.14)	0.33 (0.08)	3.29 (0.76)	0.49 (0.11)	0.16 (0.05)	0.02 (0.01)	3.69 (1.23)	0.55 (0.18)
Mean	3.52	0.55	5.22	0.81	0.29	0.05	6.68	1.04

Appendix Table 2a. Population estimate of age-1 or older cutthroat trout by habitat type for the LRAT1 section of Rattlesnake Creek (rkm 0.2-1.3). A systematic sample of habitat units within different habitat types (e.g., pool, glide, riffle) was chosen for multiple pass, removal-depletion electrofishing with block nets. Habitat Types are: GL = glide, P1 = shallow pools (<90 cm), P2 = deep pools (≥ 90 cm), RH = high gradient riffles, and RL = low gradient riffles. $\hat{N}$ = estimated population size, $\hat{B}$ = biomass estimate (g), T = total, CV = coefficient of variation.

Habitat type	Total length (m) (% of total)	Total area (m^2) (% of total)	Age-1 or older cutthroat trout			
			$\hat{N}_i$ (% $\hat{N}_T$)	CV_i	$\hat{B}_i$ (% $\hat{B}_T$)	CV_i
GL	75.8 (7)	452 (6)	2 (15)	0.0	99 (15)	0.0
P1	236.8 (22)	1,455 (21)	3 (23)	80.2	45 (7)	80.2
P2	160.7 (15)	984 (14)	8 (62)	17.7	504 (78)	28.2
RH	41.5 (4)	272 (4)	0 (0)	0.0	0 (0)	0.0
RL	568.9 (52)	3,830 (55)	0 (0)	0.0	0 (0)	0.0
Total	1,083.7 (100)	6,993 (100)	13 (100)		648 (100)	

Appendix Table 2b. Number and biomass (g) of age-1 or older cutthroat trout by habitat type for the LRAT1 section of Rattlesnake Creek (rkm 0.2-1.3). A systematic sample of habitat units within different habitat types (e.g., pool, glide, riffle) was chosen for multiple pass, removal- depletion electrofishing with block nets. Habitat types are: GL = glide, P1 = shallow pools (<90 cm), P2 = deep pools (≥ 90 cm), RH = high gradient riffles, and RL = low gradient riffles. SE = standard error.

Habitat Type	Age-1 or older cutthroat trout			
	no./m (SE)	no./m^2 (SE)	g/m (SE)	g/m^2 (SE)
GL	0.03 (0.00)	0.004 (0.00)	1.31 (0.00)	0.22 (0.00)
P1	0.01 (0.01)	0.002 (0.00)	0.19 (0.15)	0.03 (0.03)
P2	0.05 (0.01)	0.01 (0.00)	3.13 (0.88)	0.51 (0.14)
RH	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)
RL	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)
Mean	0.01	0.002	0.60	0.09

Appendix Table 3a. Population estimate of longnose dace by habitat type for the LRAT1 section of Rattlesnake Creek (rkm 0.2-1.3). A systematic sample of habitat units within different habitat types (e.g., pool, glide, riffle) was chosen for multiple pass, removal-depletion electrofishing with block nets. Habitat Types are: GL = glide, PL = pools, RH = high gradient riffles, and RL = low gradient riffles. $\hat{N}$ = estimated population size, $\hat{B}$ = biomass estimate (g), T = total, CV = coefficient of variation.

Habitat type	Total length (m) (% of total)	Total area (m^2) (% of total)	Longnose dace			
			$\hat{N}_i$ (% $\hat{N}_T$)	CV_i	$\hat{B}_i$ (% $\hat{B}_T$)	CV_i
GL	75.8 (7)	452 (6)	284 (6)	7.1	1,163 (5)	6.7
PL	397.5 (37)	2,439 (35)	1,230 (27)	28.6	7,108 (32)	34.9
RL	610.4 (56)	4,102 (59)	3,107 (67)	25.2	13,764 (62)	13.5
Total	1,083.7 (100)	6,993 (100)	4,621 (100)		22,035 (99)	

Appendix Table 3b. Number and biomass (g) of longnose dace by habitat type for the LRAT1 section of Rattlesnake Creek (rkm 0.2-1.3). A systematic sample of habitat units within different habitat types (e.g., pool, glide, riffle) was chosen for multiple pass, removal- depletion electrofishing with block nets. Habitat types are: GL = glide, PL= pools, RH = high gradient riffles, and RL = low gradient riffles. SE = standard error.

Habitat type	Longnose dace			
	no./m (SE)	no./m^2 (SE)	g/m (SE)	g/m^2 (SE)
GL	3.75 (0.27)	0.63 (0.04)	15.34 (1.02)	2.57 (0.17)
PL	3.09 (0.88)	0.50 (0.14)	17.88 (6.23)	2.91 (1.02)
RL	5.09 (1.28)	0.76 (0.19)	22.55 (3.04)	3.36 (0.45)
Mean	4.25	0.66	20.28	3.14

Appendix Table 4a. Population estimates of age-0 trout and age-1or older rainbow trout by habitat type for the BRAT2 section of Rattlesnake Creek (rkm 2.9-3.4). A systematic sample of habitat units within different habitat types (e.g., pool, glide, riffle) was chosen for multiple pass, removal-depletion electrofishing with block nets. Habitat Types are: GL = glide, PG = pools with glide characteristics, PS = scour pools, and RL = low gradient riffles. $\hat{N}$ = estimated population size, $\hat{B}$ = biomass estimate (g), T = total, CV = coefficient of variation.

Habitat type	Total length (m) (% of total)	Total area (m^2) (% of total)	Age-0 trout				Age-1 or older rainbow trout			
			$\hat{N}_i$ (% $\hat{N}_T$)	CV_i	$\hat{B}_i$ (% $\hat{B}_T$)	CV_i	$\hat{N}_i$ (% $\hat{N}_T$)	CV_i	$\hat{B}_i$ (% $\hat{B}_T$)	CV_i
GL	180.9 (39)	1,071 (40)	143 (53)	25.3	634 (53)	26.6	37 (37)	41.8	1,220 (39)	47.3
PG	54.4 (12)	270 (10)	35 (13)	3.1	151 (13)	3.4	12 (12)	0.0	434 (14)	0.0
PS	80.9 (17)	532 (20)	41 (15)	31.2	198 (17)	26.3	24 (24)	12.7	830 (26)	15.2
RL	149.4 (32)	809 (30)	53 (19)	56.0	200 (17)	61.0	27 (27)	41.6	666 (21)	54.5
Total	465.6 (100)	2,682 (100)	272 (100)		1,183 (100)		100 (100)		3,150 (100)	

Appendix Table 4b. Number and biomass (g) of age-0 trout and age-1 or older rainbow trout by habitat type for the BRAT2 section of Rattlesnake Creek (rkm 2.9-3.4). A systematic sample of habitat units within different habitat types (e.g., pool, glide, riffle) was chosen for multiple pass, removal- depletion electrofishing with block nets. Habitat types are: GL = glide, PG = pools with glide characteristics, PS = scour pools, and RL = low gradient riffles. SE = standard error.

Habitat type	Age-0 trout				Age-1 or older rainbow trout			
	no./m (SE)	no./m^2 (SE)	g/m (SE)	g/m^2 (SE)	no./m (SE)	no./m^2 (SE)	g/m (SE)	g/m^2 (SE)
GL	0.79 (0.20)	0.13 (0.03)	3.51 (0.93)	0.59 (0.16)	0.20 (0.08)	0.03 (0.01)	6.75 (3.19)	1.14 (0.54)
PG	0.64 (0.02)	0.13 (0.00)	2.78 (0.09)	0.56 (0.02)	0.22 (0.00)	0.04 (0.00)	7.97 (0.00)	1.60 (0.00)
PS	0.51 (0.16)	0.08 (0.02)	2.45 (0.64)	0.37 (0.10)	0.30 (0.04)	0.05 (0.01)	10.26 (1.56)	1.56 (0.20)
RL	0.36 (0.20)	0.07 (0.04)	1.34 (0.82)	0.25 (0.15)	0.18 (0.07)	0.03 (0.01)	4.46 (2.43)	0.82 (0.45)
Mean	0.59	0.10	2.54	0.44	0.21	0.04	6.76	1.17

Appendix Table 5a. Population estimate of age-0 trout and age-1 or older rainbow trout by habitat type for the BRAT4 section of Rattlesnake Creek (rkm 4.4-4.9)). A systematic sample of habitat units within different habitat types (e.g., pool, glide, riffle) was chosen for multiple pass, removal-depletion electrofishing with block nets. Habitat Types are: GL = glide, P1 = shallow pools (<100 cm), P2 = deep pools (≥ 100 cm), and RL = low gradient riffles. $\hat{N}$ = estimated population size, $\hat{B}$ = biomass estimate (g), T = total, CV = coefficient of variation.

Habitat type	Total length (m) (% of total)	Total area (m^2) (% of total)	Age-0 trout				Age-1 or older rainbow trout			
			$\hat{N}_i$ (% $\hat{N}_T$)	CV_i	$\hat{B}_i$ (% $\hat{B}_T$)	CV_i	$\hat{N}_i$ (% $\hat{N}_T$)	CV_i	$\hat{B}_i$ (% $\hat{B}_T$)	CV_i
GL	159.9 (29)	784 (26)	61 (25)	28.3	238 (23)	29.5	25 (25)	30.0	1,080 (15)	36.7
P1	57.0 (10)	236 (8)	24 (10)	6.0	121 (12)	6.0	11 (11)	0.0	400 (59)	0.0
P2	177.5 (32)	1,070 (36)	115 (48)	7.5	508 (49)	4.7	37 (37)	19.9	881 (11)	18.6
RL	164.4 (29)	902 (30)	42 (17)	19.2	173 (17)	17.4	29 (29)	48.6	637 (15)	56.8
Total	558.8 (100)	2,992 (100)	242 (100)		1,040 (101)		102 (100)		2,998 (100)	

Appendix Table 5b. Number and biomass (g) of age-0 trout and age-1 or older rainbow trout by habitat type for the BRAT4 section of Rattlesnake Creek (rkm 4.4-4.9). A systematic sample of habitat units within different habitat types (e.g., pool, glide, riffle) was chosen for multiple pass, removal- depletion electrofishing with block nets. Habitat types are: GL = glide, P1 = shallow pools (<100 cm), P2 = deep pools (≥ 100 cm), and RL = low gradient riffles. SE = standard error.

Habitat type	Age-0 trout				Age-1 or older rainbow trout			
	no./m (SE)	no./m^2 (SE)	g/m (SE)	g/m^2 (SE)	no./m (SE)	no./m^2 (SE)	g/m (SE)	g/m^2 (SE)
GL	0.38 (0.11)	0.08 (0.02)	1.49 (0.44)	0.30 (0.09)	0.15 (0.05)	0.03 (0.01)	6.75 (2.48)	1.38 (0.51)
P1	0.42 (0.03)	0.10 (0.01)	2.12 (0.13)	0.51 (0.03)	0.19 (0.00)	0.05 (0.00)	7.02 (0.00)	1.69 (0.00)
P2	0.65 (0.05)	0.11 (0.01)	2.86 (0.13)	0.47 (0.20)	0.21 (0.04)	0.03 (0.01)	4.96 (0.92)	0.82 (0.15)
RL	0.26 (0.05)	0.05 (0.01)	1.05 (0.18)	0.19 (0.03)	0.18 (0.09)	0.03 (0.02)	5.70 (3.23)	1.04 (0.59)
Mean	0.43	0.08	1.86	0.35	0.18	0.03	5.89	1.10

Appendix Table 6a. Population estimate of age-0 trout and age-1 or older rainbow trout by habitat type for the MRAT2 section of Rattlesnake Creek (rkm 7.2-7.8). A systematic sample of habitat units within different habitat types (e.g., pool, glide, riffle) was chosen for multiple pass, removal-depletion electrofishing with block nets. Habitat Types are: GL = glide, P1 = shallow pools (<80 cm), P2 = deep pools (≥ 80 cm), RL = low gradient riffles, and SC = side channels. $\hat{N}$ = estimated population size, $\hat{B}$ = biomass estimate (g), T = total, and CV = coefficient of variation.

Habitat type	Total length (m) (% of total)	Total area (m^2) (% of total)	Age-0 trout				Age-1 or older rainbow trout			
			$\hat{N}_i$ (% $\hat{N}_T$)	CV_i	$\hat{B}_i$ (% $\hat{B}_T$)	CV_i	$\hat{N}_i$ (% $\hat{N}_T$)	CV_i	$\hat{B}_i$ (% $\hat{B}_T$)	CV_i
GL	20.9 (3)	54 (2)	26 (5)	0.0	61 (5)	0.0	10 (6)	0.0	272 (4)	0.0
P1	163.1 (26)	640 (21)	114 (22)	39.5	283 (24)	42.1	42 (24)	21.0	1,811 (26)	45.8
P2	146.1 (23)	815 (27)	255 (50)	14.7	595 (51)	13.5	106 (60)	10.9	4,191 (60)	11.3
RL	272.5 (43)	1,471 (49)	106 (21)	18.2	215 (18)	15.5	17 (10)	49.1	652 (9)	47.4
SC	25.0 (4)	49 (2)	9 (2)	0.0	18 (2)	0.0	3 (2)	0.0	99 (1)	0.0
Total	627.6 (99)	3,029 (100)	510 (100)		1,172 (100)		178 (102)		7,026 (100)	

Appendix Table 6b. Number and biomass (g) of age-0 trout and age-1 or older rainbow trout by habitat type for the MRAT2 section of Rattlesnake Creek (rkm 7.2-7.8). A systematic sample of habitat units within different habitat types (e.g., pool, glide, riffle) was chosen for multiple pass, removal- depletion electrofishing with block nets. Habitat types are: GL = glide, P1 = shallow pools (<80 cm), P2 = deep pools (≥ 80 cm), RL = low gradient riffles, and SC = side channels. SE = standard error.

Habitat type	Age-0 trout				Age-1 or older rainbow trout			
	no./m (SE)	no./m^2 (SE)	g/m (SE)	g/m^2 (SE)	no./m (SE)	no./m^2 (SE)	g/m (SE)	g/m^2 (SE)
GL	1.24 (0.00)	0.48 (0.00)	2.92 (0.00)	1.12 (0.00)	0.48 (0.00)	0.18 (0.00)	13.00 (0.00)	5.00 (0.00)
P1	0.70 (0.28)	0.18 (0.07)	1.73 (0.73)	0.44 (0.19)	0.26 (0.05)	0.07 (0.01)	11.10 (5.09)	2.83 (1.30)
P2	1.75 (0.26)	0.31 (0.05)	4.07 (0.55)	0.73 (0.10)	0.73 (0.08)	0.13 (0.01)	28.69 (3.25)	5.14 (0.58)
RL	0.39 (0.07)	0.07 (0.01)	0.79 (0.12)	0.15 (0.02)	0.06 (0.03)	0.01 (0.01)	2.39 (1.13)	0.44 (0.21)
SC	0.36 (0.00)	0.19 (0.00)	0.73 (0.00)	0.38 (0.00)	0.12 (0.00)	0.06 (0.00)	3.97 (0.00)	2.04 (0.00)
Mean	0.84	0.17	1.92	0.39	0.29	0.06	11.53	2.32

Appendix Table 7a. Population estimate of longnose dace by habitat type for the MRAT2 section of Rattlesnake Creek (rkm 7.2 -7.8). A systematic sample of habitat units within different habitat types (e.g., pool, glide, riffle) was chosen for multiple pass, removal-depletion electrofishing with block nets. Habitat Types are: GL = glide, PL = pools, and RL = low gradient riffles. $\hat{N}$ = estimated population size, $\hat{B}$ = biomass estimate (g), T = total, CV = coefficient of variation.

Habitat type	Total length (m) (% of total)	Total area (m^2) (% of total)	Longnose dace			
			$\hat{N}_i$ (% $\hat{N}_T$)	CV_i	$\hat{B}_i$ (% $\hat{B}_T$)	CV_i
GL	20.9 (3)	54 (2)	390 (10)	4.0	1,725 (11)	4.0
PL	309.2 (51)	1,455 (49)	2,380 (60)	27.0	10,873 (69)	42.7
RL	272.5 (45)	1,471 (49)	1,176 (30)	5.6	3,091 (20)	16.7
Total	602.6 (99)	2,980 (100)	3,946 (100)		15,688 (100)	

Appendix Table 7b. Number and biomass (g) of longnose dace by habitat type for the MRAT2 section of Rattlesnake Creek (rkm 7.2 -7.8). A systematic sample of habitat units within different habitat types (e.g., pool, glide, riffle) was chosen for multiple pass, removal- depletion electrofishing with block nets. Habitat types are: GL = glide, PL= pools, and RL = low gradient riffles. SE = standard error.

Habitat type	Longnose dace			
	no./m (SE)	no./m^2 (SE)	g/m (SE)	g/m^2 (SE)
GL	18.66 (0.74)	7.18 (0.29)	82.52 (3.28)	31.74 (1.26)
PL	7.70 (2.10)	1.64 (0.45)	35.16 (15.01)	7.47 (3.19)
RL	4.32 (0.24)	0.80 (0.45)	11.34 (1.89)	2.10 (0.35)
Mean	6.48	1.32	25.76	5.26

Appendix Table 8a. Population estimate of age-0 trout and age-1 or older cutthroat trout by habitat type; for lower Indian Creek (LIND, rkm 0.1-0.9). A systematic sample of habitat units within different habitat types (e.g., pool, glide, riffle) was chosen for multiple pass, removal-depletion electrofishing with block nets. Habitat Types are: GL = glide, P1 = shallow pools (<60 cm), P2 = deep pools (≥ 60 cm), RL = low gradient riffles, and SC = side channels. $\hat{N}$ = estimated population size, $\hat{B}$ = biomass estimate (g), T = total, CV = coefficient of variation.

Habitat type	Total length (m) (% of total)	Total area (m^2) (% of total)	Age-0 trout				Age-1 or older cutthroat trout			
			$\hat{N}_i$ (% $\hat{N}_T$)	CV_i	$\hat{B}_i$ (% $\hat{B}_T$)	CV_i	$\hat{N}_i$ (% $\hat{N}_T$)	CV_i	$\hat{B}_i$ (% $\hat{B}_T$)	CV_i
GL	46.2 (5)	90 (5)	28 (19)	17.5	55 (18)	29.6	32 (27)	29.9	490 (24)	41.6
P1	94.6 (11)	203 (11)	18 (12)	27.7	39 (12)	28.2	52 (44)	12.8	871 (42)	12.6
P2	19.2 (2)	67 (4)	10 (7)	0.0	23 (7)	0.0	24 (20)	4.2	539 (26)	3.6
RL	652.0 (76)	1,468 (78)	84 (58)	30.2	180 (58)	31.9	11 (9)	90.6	168 (8)	90.6
SC	50.2 (6)	61 (3)	6 (4)	23.6	14 (4)	30.7	0 (0)	0.0	0 (0)	0.0
Total	862.2 (100)	1,889 (101)	146 (100)		311 (99)		119 (100)		2,067 (100)	

Appendix Table 8b. Number and biomass (g) of age-0 trout and age-1 or older cutthroat trout by habitat type for lower Indian Creek (LIND, rkm 0.1-0.9). A systematic sample of habitat units within different habitat types (e.g., pool, glide, riffle) was chosen for multiple pass, removal- depletion electrofishing with block nets. Habitat types are: GL = glide, P1 = shallow pools (<84 cm), P2 = deep pools (≥ 84 cm), RL = low gradient riffles, and SC = side channels. SE = standard error.

Habitat type	Age-0 trout				Age-1 or older cutthroat trout			
	no./m (SE)	no./m^2 (SE)	g/m (SE)	g/m^2 (SE)	no./m (SE)	no./m^2 (SE)	g/m (SE)	g/m^2 (SE)
GL	0.61 (0.11)	0.31 (0.05)	1.19 (0.35)	0.61 (0.18)	0.69 (0.21)	0.36 (0.11)	10.60 (4.41)	5.45 (2.27)
P1	0.19 (0.050	0.09 (0.02)	0.41 (0.12)	0.19 (0.05)	0.55 (0.07)	0.26 (0.03)	9.21 (1.16)	4.29 (0.54)
P2	0.52 (0.00)	0.15 (0.00)	1.18 (0.00)	0.34 (0.00)	1.25 (0.05)	0.36 (0.01)	28.07 (1.01)	8.00 (0.29)
RL	0.13 (0.04)	0.06 (0.02)	0.28 (0.09)	0.12 (0.04)	0.02 (0.02)	0.01 (0.01)	0.26 (0.23)	0.11 (0.10)
SC	0.12 (0.03)	0.10 (0.02)	0.27 (0.08)	0.22 (0.07)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)
Mean	0.18	0.08	0.38	0.16	0.15	0.06	2.55	1.09

Appendix Table 9a. Population estimate age-1 or older rainbow trout by habitat type for lower Indian Creek (LIND; rkm 0.1-0.9). A systematic sample of habitat units within different habitat types (e.g., pool, glide, riffle) was chosen for multiple pass, removal-depletion electrofishing with block nets. Habitat Types are: GL = glide, P1 = shallow pools (<60 cm), P2 = deep pools (≥ 60 cm), RH = high gradient riffles, and RL = low gradient riffles. $\hat{N}$ = estimated population size, $\hat{B}$ = biomass estimate (g), T = total, and CV = coefficient of variation.

Habitat type	Total length (m) (% of total)	Total area (m^2) (% of total)	Age-1 or older rainbow trout			
			$\hat{N}_i$ (% $\hat{N}_T$)	CV_i	$\hat{B}_i$ (% $\hat{B}_T$)	CV_i
GL	46.2 (5)	90 (5)	4 (12)	40.8	106 (15)	48.8
P1	94.6 (11)	203 (11)	14 (26)	32.2	290 (42)	37.6
P2	19.2 (2)	67 (4)	5 (40)	0.0	101 (14)	0.0
RL	652.0 (76)	1,468 (78)	11 (22)	90.6	201 (29)	90.6
SC	50.2 (6)	61 (3)	0 (0)	0.0	0 (0)	0.0
Total	862.2 (100)	1,889 (101)	34 (100)		698 (100)	

Appendix Table 9b. Number and biomass (g) of age-1 or older rainbow trout by habitat type for lower Indian Creek (LIND; rkm 0.1-0.9). A systematic sample of habitat units within different habitat types (e.g., pool, glide, riffle) was chosen for multiple pass, removal- depletion electrofishing with block nets. Habitat types are: GL = glide, P1 = shallow pools (<60 cm), P2 = deep pools (≥ 60 cm), RH = high gradient riffles, and RL = low gradient riffles. SE = standard error.

Habitat type	Age-1 or older rainbow trout			
	no./m (SE)	no./m^2 (SE)	g/m (SE)	g/m^2 (SE)
GL	0.09 (0.04)	0.04 (0.02)	2.28 (1.11)	1.17 (0.57)
P1	0.15 (0.05)	0.07 (0.02)	3.06 (1.15)	1.43 (0.54)
P2	0.26 (0.00)	0.07 (0.00)	5.26 (0.00)	1.50 (0.00)
RL	0.02 (0.02)	0.01 (0.01)	0.31 (0.28)	0.14 (0.12)
SC	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)
Mean	0.04	0.02	0.86	0.38

Appendix Tables 10a-10g. Comparison between the number of trout caught on the first pass and the population estimate, using multiple pass removal-depletion electrofishing, for the pools of Rattlesnake Creek during 2002.

Appendix Table 10a. Comparison between the number of rainbow trout caught on the first pass and the population estimate, using multiple pass removal-depletion electrofishing with block nets, for each pool on lower Rattlesnake Creek (LRAT, rkm 0.2-1.2). Case 1 = no fish caught on the first pass; Case 2 = one to ten fish caught on the first pass; Case 3 = eleven or more fish caught on the first pass.

Habitat unit number	Age-0 trout			Age-1 or older trout		
	Pass 1	Population estimate (SE)	Percent of estimate	Pass 1	Population estimate (SE)	Percent of estimate
1	76	122 (0.5)	62	12	19 (0.0)	63
5	39	59 (5.4)	66	5	6 (0.8)	83
15	15	97 (132.1)	16	3	5 (0.0)	83
19	43	137 (127.6)	31	11	19 (0.0)	58
25	56	95 (2.0)	59	7	10 (0.0)	70
29	236	311 (7.2)	76	15	17 (0.7)	88
34	29	44 (0.0)	66	5	6 (0.0)	83
43	27	33 (1.0)	82	1	2 (0.0)	50
Total	521	898		59	84	
Mean	65	112	57 (SD=21.0)	7.4	10.5	76 (SD=13.2)
Case 1			-			-
Case 2			-			74 (n=5)
Case 3			57 (n = 8)			70 (n=3)

Appendix Table 10b. Comparison between the number of cutthroat trout caught on the first pass and the population estimate, using multiple pass removal-depletion electrofishing with block nets, for each pool on lower Rattlesnake Creek (LRAT, rkm 0.2-1.2). See appendix table 10a for information on age-0 trout. Case 1 = no fish caught on the first pass; Case 2 = one to ten fish caught on the first pass; Case 3 = eleven or more fish caught on the first pass.

Habitat unit number	Age-1 or older trout		
	Pass 1	Population estimate (SE)	Percent of estimate
1	1	1 (0.0)	100
5	0	0 (0.0)	100
15	0	0 (0.0)	100
19	2	2 (0.0)	100
25	0	1 (0.0)	0
29	0	0 (0.0)	100
34	0	0 (0.0)	100
43	1	1 (0.0)	100
Total	4	5	
Mean	0.5	0.6	88 (SD=33.1)
Case 1			80 (n=5)
Case 2			100 (n=3)
Case 3			-

Appendix Table 10c. Comparison between the number of rainbow trout caught on the first pass and the population estimate, using multiple pass removal-depletion electrofishing with block nets, for each pool on the BRAT2 section of Rattlesnake Creek (rkm 2.9-3.4). Case 1 = no fish caught on the first pass; Case 2 = one to ten fish caught on the first pass; Case 3 = eleven or more fish caught on the first pass.

Habitat unit number	Age-0 trout			Age-1 or older trout		
	Pass 1	Population estimate (SE)	Percent of estimate	Pass 1	Population estimate (SE)	Percent of estimate
15	14	23 (0.0)	61	4	7 (0.0)	57
17	6	6 (0.0)	100	8	8 (0.0)	100
19	0	2 (0.0)	0	2	3 (0.0)	67
23	10	13 (1.1)	77	2	2 (0.0)	100
30	9	9 (0.0)	100	5	5 (0.0)	100
32	5	5 (0.0)	100	2	2 (0.0)	100
34	6	8 (0.0)	75	2	3 (0.0)	67
Total	50	66		25	30	
Mean	7.1	9.4	73 (SD=49.5)	3.6	4.3	84 (SD=49.5)
Case 1			0 (n=1)			-
Case 2			90 (n=5)			84 (n=7)
Case 3			61 (n=1)			-

Appendix Table 10d. Comparison between the number of rainbow trout caught on the first pass and the population estimate, using multiple pass removal-depletion electrofishing with block nets, for each pool on the BRAT4 section of Rattlesnake Creek (rkm 4.4 - 4.9). Case 1 = no fish caught on the first pass; Case 2 = one to ten fish caught on the first pass; Case 3 = eleven or more fish caught on the first pass.

Habitat unit number	Age-0 trout			Age-1 or older trout		
	Pass 1	Population estimate (SE)	Percent of estimate	Pass 1	Population estimate (SE)	Percent of estimate
1	14	18 (1.4)	78	5	5 (0.0)	100
3	17	22 (0.4)	73	9	13 (0.0)	69
5	3	4 (0.0)	75	0	1 (0.0)	0
13	23	28 (0.6)	82	1	2 (0.0)	50
26	26	36 (2.9)	72	10	13 (1.1)	77
28	2	2 (0.0)	100	5	5 (0.0)	100
Total	85	110		30	39	
Mean	14.2	18.3	81 (SD=37.3)	5.0	6.5	66 (SD=47.1)
Case 1			-			0 (n=1)
Case 2			88 (n=2)			79 (n=5)
Case 3			76 (n=4)			-

Appendix Table 10e. Comparison between the number of rainbow trout caught on the first pass and the population estimate, using multiple pass removal-depletion electrofishing with block nets, for each pool on the MRAT2 section of Rattlesnake Creek (rkm 7.2 - 7.8). Case 1 = no fish caught on the first pass; Case 2 = one to ten fish caught on the first pass; Case 3 = eleven or more fish caught on the first pass.

Habitat unit number	Age-0 trout			Age-1 or older trout		
	Pass 1	Population estimate (SE)	Percent of estimate	Pass 1	Population estimate (SE)	Percent of estimate
4	6	8 (0.0)	75	7	9 (0.0)	78
8	59	88 (1.9)	67	21	32 (0.5)	66
10	27	61 (3.8)	44	7	25 (3.8)	66
12	40	47 (1.4)	85	18	19 (0.3)	95
14	22	24 (0.5)	92	7	7 (0.0)	100
20	7	11 (0.0)	64	4	4 (0.0)	100
28	3	3 (0.0)	100	3	3 (0.0)	100
Total	164	242		67	99	
Mean	23.4	34.6	75 (SD=35.0)	9.6	14.1	86 (SD=49.5)
Case 1			-			-
Case 2			80 (n=3)			89 (n=5)
Case 3			72 (n=4)			81 (n=2)

Appendix Table 10f. Comparison between the number of rainbow trout caught on the first pass and the population estimate, using multiple pass removal-depletion electrofishing with block nets, for each pool on lower Indian Creek (LIND, rkm 0.1 – 0.9), a tributary to Rattlesnake Creek. See appendix table 10g for information on age-0 trout. Case 1 = no fish caught on the first pass; Case 2 = one to ten fish caught on the first pass; Case 3 = eleven or more fish caught on the first pass.

Habitat unit number	Age-1 or older trout		
	Pass 1	Population estimate (SE)	Percent of estimate
2	3	3 (0.0)	100
6	1	1 (0.0)	100
14	0	0 (0.0)	100
16	1	1 (0.0)	100
26	1	1 (0.0)	100
28	2	2 (0.0)	100
30	3	3 (0.0)	100
34	0	0 (0.0)	100
42	0	0 (0.0)	100
48	0	0 (0.0)	100
54	1	1 (0.0)	100
Total	12	12	
Mean	1.1	1.1	100 (SD=0.0)
Case 1			100 (n=4)
Case 2			100 (n=7)
Case 3			-

Appendix Table 10g. Comparison between the number of cutthroat trout caught on the first pass and the population estimate, using multiple pass removal-depletion electrofishing with block nets, for each pool on lower Indian Creek (LIND, rkm 0.1 – 0.9), a tributary to Rattlesnake Creek. Case 1 = no fish caught on the first pass; Case 2 = one to ten fish caught on the first pass; Case 3 = eleven or more fish caught on the first pass.

Habitat unit number	Age-0 trout			Age-1 or older trout		
	Pass 1	Population estimate (SE)	Percent of estimate	Pass 1	Population estimate (SE)	Percent of estimate
2	0	0 (0.0)	100	9	10 (0.0)	90
6	0	0 (0.0)	100	2	2 (0.0)	100
14	2	3 (0.0)	67	5	5 (0.0)	100
16	2	2 (0.0)	100	10	13 (0.0)	77
26	7	8 (0.0)	88	1	1 (0.0)	100
28	2	2 (0.0)	100	3	3 (0.0)	100
30	2	2 (0.0)	100	1	1 (0.0)	100
34	0	0 (0.0)	100	2	2 (0.0)	100
42	0	0 (0.0)	100	4	4 (0.0)	100
48	2	2 (0.0)	100	3	3 (0.0)	100
54	0	0 (0.0)	100	6	6 (0.0)	100
Total	17	19		46	50	
Mean	1.5	1.7	96 (SD=38.6)	4.2	4.5	97 (SD=38.6)
Case 1			100 (n=5)			-
Case 2			93 (n=6)			97 (n=11)
Case 3			-			-

Appendix Tables 11a-9b Number and biomass of trout per meter in each section of Rattlesnake Creek where pools were sampled using one-pass electrofishing during summer 2002. .

Appendix Table 11a. Number of rainbow trout per pool in the LRAT2 section of Rattlesnake Creek (rkm 1.95) during summer 2002. Pools were sampled using one-pass electrofishing.

Unit number	Distance from start (m)	Pool length (m)	Sampled (Y/N)	Age-0 rainbow trout				Age-1 or older rainbow trout			
				Total	no./m	no./m^2	no./m^3	Total	no./m	no./m^2	no./m^3
2	11.4	9.2	Y	29	3.15	0.41	1.02	24	2.61	0.34	0.85
11	72.0	11.0	Y	15	1.36	0.26	0.66	4	0.36	0.07	0.17
15	167.1	7.9	Y	23	2.91	0.39	1.55	4	0.51	0.07	0.27
19	249.3	13.1	Y	25	1.91	0.42	1.33	6	0.46	0.10	0.32
29	341.6	20.7	Y	66	3.19	0.64	1.16	15	0.72	0.14	0.26
33	410.8	11.3	Y	13	1.15	0.26	0.85	3	0.27	0.06	0.20

Appendix Table 11b. Biomass (g) of rainbow tout per pool in the lower Rattlesnake Creek (LRAT 2, rkm 1.95) during summer 2002. Pools were sampled using one-pass electrofishing.

Unit number	Distance from start (m)	Pool length (m)	Sampled (Y/N)	Age-0 rainbow trout				Age-1 or older rainbow trout			
				Biomass (g)	g/m	g/m^2	g/m^3	Biomass (g)	g/m	g/m^2	g/m^3
2	11.4	9.2	Y	69.14	7.52	0.98	2.44	503.85	54.77	7.11	17.78
11	72.0	11.0	Y	44.10	4.01	0.77	1.93	135.84	12.35	2.37	5.94
15	167.1	7.9	Y	59.21	7.49	1.00	4.00	113.16	14.32	1.91	7.64
19	249.3	13.1	Y	55.85	4.26	0.95	2.96	226.98	17.33	3.85	12.03
29	341.6	20.7	Y	194.94	9.42	1.88	3.42	517.36	24.99	5.00	9.09
33	410.8	11.3	Y	32.69	2.89	0.64	2.14	79.08	7.00	1.56	5.18

Appendix Table 12a. Number of rainbow trout per pool in the BRAT1 section (rkm 2.4) of Rattlesnake Creek during summer 2002. Pools were sampled using one-pass electrofishing.

Unit number	Distance from start (m)	Pool length (m)	Sampled (Y/N)	Age-0 rainbow trout				Age-1 or older rainbow trout			
				Total	no./m	no./m^2	no./m^3	Total	no./m	no./m^2	no./m^3
4	14.0	14.8	Y	7	0.47	0.08	0.26	5	0.34	0.06	0.19
6	32.0	12.3	Y	1	0.08	0.03	0.10	4	0.33	0.10	0.41
8	45.5	11.0	Y	3	0.27	0.06	0.25	3	0.27	0.06	0.25
12	68.5	35.0	Y	16	0.46	0.05	0.22	13	0.37	0.04	0.17
19	138.9	2.0	Y	4	2.00	0.80	2.67	1	0.50	0.20	0.67
21	141.4	5.0	Y	8	1.60	0.23	0.38	3	0.60	0.09	0.14
23	146.7	2.2	Y	1	0.45	0.45	0.45	0	0.00	0.00	0.00
28	223.8	15.7	Y	1	0.06	0.01	0.02	8	0.51	0.08	0.17
30	259.9	10.0	Y	0	0.00	0.00	0.00	1	0.10	0.01	0.05
32	270.9	40.2	Y	0	0.00	0.00	0.00	5	0.12	0.03	0.09
37	442.4	37.8	Y	4	0.11	0.02	0.05	8	0.21	0.04	0.10

Appendix Table 12b. Biomass (g) of rainbow tout per pool in the BRAT1 section (rkm 2.4) of Rattlesnake Creek during summer 2002. Pools were sampled using one-pass electrofishing.

Unit number	Distance from start (m)	Pool length (m)	Sampled (Y/N)	Age-0 rainbow trout				Age-1 or older rainbow trout			
				Biomass (g)	g/m	g/m^2	g/m^3	Biomass (g)	g/m	g/m^2	g/m^3
4	14.0	14.8	Y	28.36	1.92	0.32	1.06	265.40	17.93	2.99	9.96
6	32.0	12.3	Y	4.43	0.36	0.11	0.45	109.23	8.88	2.78	11.10
8	45.5	11.0	Y	10.69	0.97	0.23	0.90	83.17	7.56	1.76	7.03
12	68.5	35.0	Y	71.03	2.03	0.24	0.95	497.75	14.22	1.67	6.69
19	138.9	2.0	Y	16.93	8.46	3.39	11.29	34.04	17.02	6.81	22.69
21	141.4	5.0	Y	38.39	7.68	1.10	1.83	112.62	22.52	3.22	5.36
23	146.7	2.2	Y	5.06	2.30	2.30	2.30	0.00	0.00	0.00	0.00
28	223.8	15.7	Y	5.78	0.37	0.06	0.12	418.10	26.63	4.37	8.73
30	259.9	10.0	Y	0.00	0.00	0.00	0.00	13.07	1.31	0.17	0.67
32	270.9	40.2	Y	0.00	0.00	0.00	0.00	117.26	2.92	0.62	2.07
37	442.4	37.8	Y	17.65	0.46	0.08	0.21	194.16	5.14	0.87	2.35

Appendix Table 13a. Number of rainbow trout per pool in the BRAT3 section (rkm 3.4) of Rattlesnake Creek during summer 2002. Pools were sampled using one-pass electrofishing.

Unit number	Distance from start (m)	Pool length (m)	Sampled (Y/N)	Age-0 rainbow trout				Age-1 or older rainbow trout			
				Total	no./m	no./m^2	no./m^3	Total	no./m	no./m^2	no./m^3
3	24.9	19.1	Y	18	0.94	0.16	0.41	7	0.37	0.06	0.16
5	46.0	14.1	Y	19	1.35	0.18	0.51	4	0.28	0.04	0.11
15	116.8	6.7	Y	5	0.75	0.17	0.69	3	0.45	0.10	0.42
17	134.0	36.0	Y	31	0.86	0.15	0.50	8	0.22	0.04	0.13
21	200.2	12.1	Y	4	0.33	0.09	0.47	3	0.25	0.07	0.35
23	218.4	7.4	Y	4	0.54	0.13	0.64	1	0.14	0.03	0.16
25	237.3	117.5	Y	41	0.35	0.03	0.09	29	0.25	0.02	0.06
28	380.1	24.6	Y	19	0.77	0.17	0.49	8	0.33	0.07	0.21
30	409.5	24.2	Y	31	1.28	0.27	1.07	6	0.25	0.05	0.21
32	434.4	10.5	Y	0	0.00	0.00	0.00	0	0.00	0.00	0.00
34	447.6	28.5	Y	21	0.74	0.17	0.29	8	0.28	0.07	0.11

Appendix Table 13b. Biomass (g) of rainbow tout per pool in the BRAT3 section (BRAT, rkm 3.4) of Rattlesnake Creek during summer 2002. Pools were sampled using one-pass electrofishing.

Unit number	Distance from start (m)	Pool length (m)	Sampled (Y/N)	Age-0 rainbow trout				Age-1 or older rainbow trout			
				Biomass (g)	g/m	g/m^2	g/m^3	Biomass (g)	g/m	g/m^2	g/m^3
3	24.9	19.1	Y	91.18	4.77	0.82	2.06	231.68	12.13	2.09	5.23
5	46.0	14.1	Y	84.22	5.97	0.79	2.25	102.91	7.30	0.96	2.74
15	116.8	6.7	Y	15.67	2.34	0.54	2.18	77.30	34.87	8.11	32.43
17	134.0	36.0	Y	153.34	4.26	0.75	2.49	233.60	6.49	1.14	3.79
21	200.2	12.1	Y	17.46	1.44	0.41	2.06	136.83	11.31	3.23	16.15
23	218.4	7.4	Y	15.21	2.06	0.49	2.45	12.91	1.74	0.42	2.08
25	237.3	117.5	Y	202.18	1.72	0.17	0.43	1720.72	14.64	1.46	3.66
28	380.1	24.6	Y	88.28	3.59	0.80	2.28	272.09	11.06	2.46	7.02
30	409.5	24.2	Y	135.93	5.62	1.17	4.68	138.50	5.72	1.19	4.77
32	434.4	10.5	Y	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
34	447.6	28.5	Y	131.50	4.61	1.07	1.79	242.36	8.50	1.98	3.30

Appendix Table 14a. Number of rainbow trout per pool in the BRAT5 section (rkm 4.4) of Rattlesnake Creek during summer 2002. Pools were sampled using one-pass electrofishing.

Unit number	Distance from start (m)	Pool length (m)	Sampled (Y/N)	Age-0 rainbow trout				Age-1 or older rainbow trout			
				Total	no./m	no./m^2	no./m^3	Total	no./m	no./m^2	no./m^3
1	0	35.6	Y	33	0.93	0.15	0.86	8	0.22	0.04	0.86
3	44.6	15.5	Y	10	0.65	0.13	0.54	0	0.00	0.00	0.54
5	60.6	25.8	Y	16	0.62	0.10	0.30	14	0.54	0.09	0.29
11	124.9	48.0	Y	51	1.06	0.30	1.08	1	0.02	0.01	1.08
13	182.2	26.2	Y	32	1.22	0.33	0.92	8	0.31	0.08	0.92
17	239.2	41.3	Y	67	1.62	0.21	0.76	4	0.10	0.01	0.76
19	286.8	57.0	Y	27	0.47	0.06	0.07	4	0.07	0.01	0.07
23	428.9	31.3	Y	38	1.21	0.24	0.64	7	0.22	0.04	0.64
25	464.7	17.0	Y	10	0.59	0.20	0.65	4	0.24	0.08	0.65
27	484.7	35.0	Y	28	0.80	0.16	0.33	4	0.11	0.02	0.33

Appendix Table 14b. Biomass (g) of rainbow tout per pool in the BRAT5 section (rkm 4.4) of Rattlesnake Creek during summer 2002. Pools were sampled using one-pass electrofishing.

Unit number	Distance from start (m)	Pool length (m)	Sampled (Y/N)	Age-0 rainbow trout				Age-1 or older rainbow trout			
				Biomass (g)	g/m	g/m^2	g/m^3	Biomass (g)	g/m	g/m^2	g/m^3
1	0	35.6	Y	169.64	4.77	0.79	4.41	215.64	6.06	1.01	5.61
3	44.6	15.5	Y	38.38	2.48	0.50	2.06	0.00	0.00	0.00	0.00
5	60.6	25.8	Y	75.85	2.94	0.49	1.40	510.36	19.78	3.30	9.42
11	124.9	48.0	Y	183.17	3.82	1.09	3.89	18.93	0.39	0.11	0.40
13	182.2	26.2	Y	129.98	4.96	1.34	3.72	194.49	7.42	2.01	5.57
17	239.2	41.3	Y	278.59	6.75	0.89	3.17	188.93	4.57	0.60	2.15
19	286.8	57.0	Y	101.40	1.78	0.22	0.28	160.51	2.82	0.35	0.44
23	428.9	31.3	Y	163.84	5.23	1.05	2.76	196.29	6.27	1.25	3.30
25	464.7	17.0	Y	46.72	2.75	0.92	3.05	138.16	8.13	2.71	9.03
27	484.7	35.0	Y	118.80	3.39	0.68	1.41	182.35	5.21	1.04	2.17

Appendix Table 15a. Number of rainbow trout per pool in the MRAT1 section (rkm 6.0) of Rattlesnake creek during summer 2002. Pools were sampled using one-pass electrofishing.

Unit number	Distance from start (m)	Pool length (m)	Sampled (Y/N)	Age-0 rainbow trout				Age-1 or older rainbow trout			
				Total	no./m	no./m^2	no./m^3	Total	no./m	no./m^2	no./m^3
1	0.0	10.9	Y	13	1.19	0.19	0.69	3	0.28	0.04	0.16
2.1	36.8	10.3	Y	2	0.19	0.04	0.11	0	0.00	0.00	0.00
5	72.2	53.3	Y	65	1.22	0.13	0.22	18	0.34	0.04	0.06
7	142.6	4.7	Y	5	1.06	0.18	0.60	1	0.21	0.04	0.12
9	149.4	30.5	Y	50	1.64	0.26	0.40	3	0.10	0.02	0.02
11	197.5	26.3	Y	28	1.06	0.23	0.75	1	0.04	0.01	0.27
13	224.8	21.5	Y	45	2.09	0.30	0.80	3	0.14	0.02	0.05
15	254.6	32.3	Y	42	1.30	0.36	1.72	2	0.06	0.02	0.08

Appendix Table 15b. Biomass (g) of rainbow tout per pool in the MRAT1 section (rkm 6.0) of Rattlesnake Creek during summer 2002. Pools were sampled using one-pass electrofishing.

Unit number	Distance from start (m)	Pool length (m)	Sampled (Y/N)	Age-0 rainbow trout				Age-1 or older rainbow trout			
				Biomass (g)	g/m	g/m^2	g/m^3	Biomass (g)	g/m	g/m^2	g/m^3
1	0.0	10.9	Y	41.94	3.85	0.62	2.22	47.38	4.35	0.70	2.50
2.1	36.8	10.3	Y	5.37	0.52	0.12	0.30	0.00	0.00	0.00	0.00
5	72.2	53.3	Y	317.55	5.96	0.63	1.06	757.30	14.20	1.51	2.52
7	142.6	4.7	Y	15.92	3.39	0.57	1.91	17.30	3.68	0.62	2.08
9	149.4	30.5	Y	211.76	6.94	1.12	1.70	78.61	2.58	0.42	0.63
11	197.5	26.3	Y	91.42	3.48	0.76	2.44	61.79	2.35	0.51	1.65
13	224.8	21.5	Y	166.95	7.77	1.13	2.96	76.29	3.55	0.51	1.35
15	254.6	32.3	Y	158.42	4.90	1.36	6.49	138.08	4.27	1.19	5.65

Appendix Table 16a. Number of rainbow trout per pool in upper Rattlesnake Creek (URAT, rkm 11.2) during summer 2002. Pools were sampled using one-pass electrofishing.

Unit number	Distance from start (m)	length (m)	Pool Sampled (Y/N)	Age-0 rainbow trout				Age-1 or older rainbow trout			
				Total	no./m	no./m^2	no./m^3	Total	no./m	no./m^2	no./m^3
1	0.0	12.1	Y	3	0.25	0.06	0.20	1	0.08	0.02	0.07
3	16.7	7.9	Y	2	0.25	0.09	0.38	2	0.25	0.09	0.38
5	29.1	20.6	Y	10	0.49	0.12	0.58	1	0.05	0.01	0.06
9	137.1	7.5	Y	2	0.27	0.03	0.09	0	0.00	0.00	0.00
15	220.8	24.6	Y	27	1.10	0.21	0.53	7	0.28	0.05	0.14
21	336.7	21.6	Y	3	0.14	0.02	0.09	0	0.00	0.00	0.00
23	373.0	9.9	Y	6	0.61	0.09	0.55	0	0.00	0.00	0.00
27	419.1	5.3	Y	2	0.38	0.10	0.28	0	0.00	0.00	0.00
29	432.2	7.5	Y	1	0.13	0.03	0.11	0	0.00	0.00	0.00
31	446.3	34.0	Y	25	0.74	0.13	0.29	4	0.12	0.02	0.05
33	480.8	6.6	Y	1	0.15	0.04	0.18	0	0.00	0.00	0.00
35	489.0	10.6	Y	2	0.19	0.04	0.13	2	0.19	0.04	0.13

Appendix Table 16b. Biomass (g) of rainbow tout per pool in upper Rattlesnake Creek (URAT, rkm 11.2) during summer 2002. Pools were sampled using one-pass electrofishing.

Unit number	Distance from start (m)	Pool length (m)	Sampled (Y/N)	Age-0 rainbow trout				Age-1 or older rainbow trout			
				Biomass (g)	g/m	g/m^2	g/m^3	Biomass (g)	g/m	g/m^2	g/m^3
1	0.0	12.1	Y	12.33	1.02	0.26	0.82	13.57	1.12	0.29	0.90
3	16.7	7.9	Y	6.03	0.76	0.28	1.13	124.32	15.74	5.83	23.31
5	29.1	20.6	Y	39.08	1.90	0.45	2.26	37.26	1.81	0.43	2.15
9	137.1	7.5	Y	6.55	0.87	0.10	0.28	0.00	0.00	0.00	0.00
15	220.8	24.6	Y	118.32	4.81	0.93	2.31	244.86	9.95	1.91	4.79
21	336.7	21.6	Y	7.50	0.35	0.05	0.23	0.00	0.00	0.00	0.00
23	373.0	9.9	Y	20.52	2.07	0.32	1.88	0.00	0.00	0.00	0.00
27	419.1	5.3	Y	6.14	1.16	0.32	0.85	0.00	0.00	0.00	0.00
29	432.2	7.5	Y	3.72	0.50	0.10	0.41	0.00	0.00	0.00	0.00
31	446.3	34.0	Y	99.16	2.92	0.52	1.16	96.43	2.84	0.51	1.13
33	480.8	6.6	Y	3.12	0.47	0.12	0.58	0.00	0.00	0.00	0.00
35	489.0	10.6	Y	12.65	1.19	0.24	0.81	57.72	5.54	1.13	3.77

Appendix Table 17a. Number of cutthroat trout per pool in middle Indian Creek (MIND, rkm 2.40), a tributary to Rattlesnake Creek, during summer 2002. Pools were sampled using one-pass electrofishing.

Unit number	Distance from start (m)	Pool length (m)	Sampled (Y/N)	Age-0 rainbow trout				Age-1 or older rainbow trout			
				Total	no./m	no./m^2	no./m^3	Total	no./m	no./m^2	no./m^3
1	0.0	3.2	Y	0	0.00	0.00	0.00	1	0.31	0.11	0.74
3	8.2	3.2	Y	1	0.31	0.14	1.36	1	0.31	0.14	1.36
5	13.6	1.5	Y	0	0.00	0.00	0.00	1	0.67	0.30	3.79
7	18.7	5.5	Y	1	0.18	0.10	0.96	0	0.00	0.00	0.00
9	25.4	1.5	Y	0	0.00	0.00	0.00	0	0.00	0.00	0.00
11	29.4	2.9	Y	2	0.69	0.46	4.60	1	0.34	0.23	2.30
15	37.7	1.7	Y	2	1.18	0.49	4.08	0	0.00	0.00	0.00
17	41.3	3.3	Y	0	0.00	0.00	0.00	4	1.21	0.58	2.89
19	47.3	1.8	Y	0	0.00	0.00	0.00	1	0.56	0.40	3.97
21	56.1	1.8	Y	0	0.00	0.00	0.00	0	0.00	0.00	0.00
27	83.1	6.6	Y	3	0.45	0.22	1.55	3	0.45	0.22	1.55
29	93.9	6.1	N								
31	107.5	3.6	Y	0	0.00	0.00	0.00	0	0.00	0.00	0.00

Appendix Table 17b. Biomass (g) of cutthroat trout per meter in middle Indian Creek (MIND, rkm 2.40), a tributary to Rattlesnake Creek, during summer 2002. Pools were sampled using one-pass electrofishing.

Unit number	Distance from start (m)	Pool length (m)	Sampled (Y/N)	Age-0 rainbow trout				Age-1 or older rainbow trout			
				Biomass (g)	g/m	g/m^2	g/m^3	Biomass (g)	g/m	g/m^2	g/m^3
1	0.0	3.2	Y	0.00	0.00	0.00	0.00	5.60	1.75	0.62	4.17
3	8.2	3.2	Y	0.76	0.24	0.10	1.03	8.56	2.68	1.16	11.63
5	13.6	1.5	Y	0.00	0.00	0.00	0.00	12.13	8.09	3.68	45.95
7	18.7	5.5	Y	0.66	0.12	0.06	0.63	0.00	0.00	0.00	0.00
9	25.4	1.5	Y	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
11	29.4	2.9	Y	1.05	0.36	0.24	2.41	22.45	7.74	5.16	51.61
15	37.7	1.7	Y	2.18	1.28	0.53	4.45	0.00	0.00	0.00	0.00
17	41.3	3.3	Y	0.00	0.00	0.00	0.00	100.02	30.31	14.43	72.16
19	47.3	1.8	Y	0.00	0.00	0.00	0.00	20.56	11.42	8.16	81.59
21	56.1	1.8	Y	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
27	83.1	6.6	Y	1.39	0.21	0.10	0.72	20.86	3.16	1.51	10.75
29	93.9	6.1	N								
31	107.5	3.6	Y	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Appendix Table 18a. Number of rainbow trout per pool in lower Mill Creek (LMIL, rkm 0), a tributary to Rattlesnake Creek, during summer 2002. Pools were sampled using one-pass electrofishing.

Unit number	Distance from start (m)	Pool length (m)	Sampled (Y/N)	Age-0 rainbow trout				Age-1 or older rainbow trout			
				Total	no./m	no./m^2	no./m^3	Total	no./m	no./m^2	no./m^3
2	7.6	2.7	Y	1	0.37	0.15	0.74	0	0.00	0.00	0.00
4	23.2	3.5	Y	0	0.00	0.00	0.00	0	0.00	0.00	0.00
6	28.8	5.8	Y	1	0.17	0.05	0.27	1	0.17	0.05	0.27
10	59.6	3.1	Y	1	0.32	0.10	0.50	1	0.32	0.10	0.50
16	75.1	4.8	Y	2	0.42	0.18	0.91	0	0.00	0.00	0.00
18	92.2	6.0	Y	1	0.17	0.07	0.23	0	0.00	0.00	0.00
20	109.1	6.2	Y	1	0.16	0.05	0.26	0	0.00	0.00	0.00
26	143.6	5.5	Y	0	0.00	0.00	0.00	0	0.00	0.00	0.00
28	161.5	3.1	Y	1	0.32	0.09	0.31	0	0.00	0.00	0.00
30	177.4	4.0	Y	0	0.00	0.00	0.00	4	1.00	0.20	0.45
34	202.8	5.9	Y	0	0.00	0.00	0.00	0	0.00	0.00	0.00
43	282.1	3.6	Y	0	0.00	0.00	0.00	0	0.00	0.00	0.00
45	291.3	3.6	Y	0	0.00	0.00	0.00	1	0.28	0.13	0.88
49	335.5	2.3	Y	0	0.00	0.00	0.00	0	0.00	0.00	0.00
55	367.6	2.7	Y	0	0.00	0.00	0.00	0	0.00	0.00	0.00
59	383.2	1.2	Y	0	0.00	0.00	0.00	0	0.00	0.00	0.00
61	389.3	3.1	Y	0	0.00	0.00	0.00	0	0.00	0.00	0.00
63	412.1	1.9	Y	0	0.00	0.00	0.00	0	0.00	0.00	0.00
65	420.8	2.6	Y	0	0.00	0.00	0.00	0	0.00	0.00	0.00
67	433.7	4.8	Y	0	0.00	0.00	0.00	0	0.00	0.00	0.00

Appendix Table 18a Number of rainbow trout per pool in lower Mill Creek (LMIL, rkm 0), a tributary to Rattlesnake Creek, during summer 2002 continued.

Unit number	Distance from start (m)	Pool length (m)	Sampled (Y/N)	Age-0 rainbow trout				Age-1 or older rainbow trout			
				Total	no./m	no./m^2	no./m^3	Total	no./m	no./m^2	no./m^3
69	438.8	2.5	Y	0	0.00	0.00	0.00	3	1.20	1.09	3.64
71	456.1	4.9	Y	0	0.00	0.00	0.00	0	0.00	0.00	0.00
73	467.0	2.9	Y	0	0.00	0.00	0.00	0	0.00	0.00	0.00
75	472.6	3.0	Y	0	0.00	0.00	0.00	0	0.00	0.00	0.00
77	487.0	2.7	Y	0	0.00	0.00	0.00	1	0.37	0.14	0.62
79	489.9	3.6	Y	0	0.00	0.00	0.00	2	0.56	0.21	0.82
81	496.1	2.1	Y	0	0.00	0.00	0.00	0	0.00	0.00	0.00
83	509.9	2.9	Y	0	0.00	0.00	0.00	0	0.00	0.00	0.00

Appendix Table 18b. Biomass (g) of rainbow tout per pool in lower Mill Creek (LMIL, rkm 0), a tributary to Rattlesnake Creek, during summer 2002. Pools were sampled using one-pass electrofishing.

Unit number	Distance from start (m)	Pool length (m)	Sampled (Y/N)	Age-0 rainbow trout				Age-1 or older rainbow trout			
				Biomass (g)	g/m	g/m^2	g/m^3	Biomass (g)	g/m	g/m^2	g/m^3
2	7.6	2.7	Y	1.13	0.42	0.17	0.84	0.00	0.00	0.00	0.00
4	23.2	3.5	Y	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6	28.8	5.8	Y	1.78	0.31	0.10	0.48	32.00	5.52	1.72	8.62
10	59.6	3.1	Y	2.94	0.95	0.30	1.48	35.13	11.33	3.54	17.71
16	75.1	4.8	Y	4.52	0.94	0.41	2.05	0.00	0.00	0.00	0.00
18	92.2	6.0	Y	1.33	0.22	0.10	0.31	0.00	0.00	0.00	0.00
20	109.1	6.2	Y	0.65	0.10	0.04	0.17	0.00	0.00	0.00	0.00
26	143.6	5.5	Y	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
28	161.5	3.1	Y	2.51	0.81	0.22	0.78	0.00	0.00	0.00	0.00
30	177.4	4.0	Y	0.00	0.00	0.00	0.00	121.23	30.31	6.19	13.74
34	202.8	5.9	Y	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
43	282.1	3.6	Y	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
45	291.3	3.6	Y	0.00	0.00	0.00	0.00	24.60	6.83	3.25	21.69
49	335.5	2.3	Y	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
55	367.6	2.7	Y	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
59	383.2	1.2	Y	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
61	389.3	3.1	Y	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
63	412.1	1.9	Y	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
65	420.8	2.6	Y	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
67	433.7	4.8	Y	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Appendix Table 18b . Biomass (g) of rainbow tout per pool in lower Mill Creek (LMIL, rkm 0), a tributary to Rattlesnake Creek, during summer 2002 continued.

Unit number	Distance from start (m)	Pool length (m)	Sampled (Y/N)	Age-0 rainbow trout				Age-1 or older rainbow trout			
				Biomass (g)	g/m	g/m^2	g/m^3	Biomass (g)	g/m	g/m^2	g/m^3
69	438.8	2.5	Y	0.00	0.00	0.00	0.00	94.95	37.98	34.53	115.09
71	456.1	4.9	Y	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
73	467.0	2.9	Y	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
75	472.6	3.0	Y	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
77	487.0	2.7	Y	0.00	0.00	0.00	0.00	12.61	4.67	1.73	7.86
79	489.9	3.6	Y	0.00	0.00	0.00	0.00	73.64	20.46	7.58	30.30
81	496.1	2.1	Y	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
83	509.9	2.9	Y	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Appendix Table 19a. Number of rainbow trout per pool in upper Mill Creek (UMIL, rkm 2.6), a tributary to Rattlesnake Creek, during summer 2002. Pools were sampled using one-pass electrofishing.

Unit number	Distance from start (m)	Pool length (m)	Sampled (Y/N)	Age-0 rainbow trout				Age-1 or older rainbow trout			
				Total	no./m	no./m^2	no./m^3	Total	no./m	no./m^2	no./m^3
2	7.3	28.0	Y	0	0.00	0.00	0.00	7	0.25	0.08	0.22
8	56.8	3.8	Y	0	0.00	0.00	0.00	0	0.00	0.00	0.00
10	62.8	2.5	Y	0	0.00	0.00	0.00	1	0.40	0.13	0.50
12	68.6	4.8	Y	0	0.00	0.00	0.00	0	0.00	0.00	0.00
16	82.7	5.3	Y	0	0.00	0.00	0.00	0	0.00	0.00	0.00
18	107.0	5.4	N								
20	113.2	3.9	Y	0	0.00	0.00	0.00	0	0.00	0.00	0.00
22	119.8	13.3	Y	0	0.00	0.00	0.00	0	0.00	0.00	0.00
24	137.7	17.6	N								
26	168.4	11.0	N								

Appendix Table 19b. Biomass (g) of rainbow tout per pool in upper Mill Creek (UMIL, rkm 2.6), a tributary to Rattlesnake Creek, during summer 2002. Pools were sampled using one-pass electrofishing.

Unit number	Distance from start (m)	Pool length (m)	Sampled (Y/N)	Age-0 rainbow trout				Age-1 or older rainbow trout			
				Biomass (g)	g/m	g/m^2	g/m^3	Biomass (g)	g/m	g/m^2	g/m^3
2	7.3	28.0	Y	0.00	0.00	0.00	0.00	323.90	11.57	3.86	10.15
8	56.8	3.8	Y	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
10	62.8	2.5	Y	0.00	0.00	0.00	0.00	39.33	15.73	5.07	19.52
12	68.6	4.8	Y	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
16	82.7	5.3	Y	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
18	107.0	5.4	N								
20	113.2	3.9	Y	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
22	119.8	13.3	Y	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
24	137.7	17.6	N								
26	168.4	11.0	N								

Appendix Tables. Results from the U. S. Fish and Wildlife's Lower Columbia River Fish Health Center disease profiling for rainbow trout, cutthroat trout, longnose dace, and shorthead sculpin collected on Rattlesnake Creek during 2002.

U.S. Fish & Wildlife Service
LOWER COLUMBIA RIVER FISH HEALTH CENTER
61552 S.R. 14
Underwood, WA 98651
Phone: 509-493-3156
Fax: 509-493-2748

FISH HEALTH REPORT 2002

FISH SOURCE	FISH EXAMINED
Location: Lower Rattlesnake Creek **County**: Klickitat **Contact Person:** Pat Connolly **Affiliation:** USGS CRRL **Phone:** (509) 538-2299 ext. 269	**Species:** Rainbow trout **Age:** Juvenile/Adults **CHN:** 02-195 **Number of fish:** 20 **Date Sampled:** 06-25-02

DISEASE AGENT [1]	SAMPLE SIZE	RESULTS	COMMENTS
IPNV	20	negative	EPC and CHSE-214 cells
IHNV	20	negative	EPC and CHSE-214 cells
VHS	20	negative	EPC and CHSE-214 cells
AS	20	negative	BHIA medium
YR	20	negative	BHIA medium
RS	20	not detected	ELISA
BCD	20	negative	TYES medium
CD	20	negative	TYES medium
ESC	20	negative	BHIA medium
WD	20	negative	Pepsin/Trypsin Digest
CS	10	negative	microscopic examination

Comments	*Nanophyetus* found on the skin and in the kidney (high). *Trichodina* found on the skin and hind-gut (low).

[1] **IPNV** Infectious Pancreatic Necrosis Virus, **IHNV** Infectious Hematopoietic Necrosis Virus, **VHS** Viral Hemorrhagic Septicemia Virus, **AS** Furunculosis (*Aeromonas salmonicida)* , **YR** Enteric Redmouth (*Yersinia ruckeri),* **RS** BKD (*Renibacterium salmoninarum*), **BCD** Coldwater Disease (*Flexibacter psychrophilum)*, **CD** Columnaris (*Flexibacter columnaris)*, **ESC** Emphysematous Putrefactive Disease *(Edwardsiella ictaluri),* **WD** Whirling Disease (*Myxobolus cerebralis*), **CS** Salmonid Ceratomyxosis (*Ceratomyxa shasta).*

U.S. Fish & Wildlife Service
LOWER COLUMBIA RIVER FISH HEALTH CENTER
61552 S.R. 14
Underwood, WA 98651
Phone: 509-493-3156
Fax: 509-493-2748

FISH HEALTH REPORT 2002

FISH SOURCE	FISH EXAMINED
Location: Lower Rattlesnake Creek **County**: Klickitat **Contact Person:** Pat Connolly **Affiliation:** USGS CRRL **Phone:** (509) 538-2299 ext. 269	**Species:** Sculpin **Age:** Juvenile/Adults **CHN:** 02-196 **Number of fish:** 3 **Date Sampled:** 06-25-02

DISEASE AGENT [1]	SAMPLE SIZE	RESULTS	COMMENTS
IPNV	3	negative	EPC and CHSE-214 cells
IHNV	3	negative	EPC and CHSE-214 cells
VHS	3	negative	EPC and CHSE-214 cells
AS	3	negative	BHIA medium
YR	3	negative	BHIA medium
RS	3	not detected	ELISA
BCD	3	negative	TYES medium
CD	3	negative	TYES medium
ESC	3	negative	BHIA medium
WD	3	negative	Pepsin/Trypsin Digest
CS	-	not tested	microscopic examination

Comments	Fish appeared to be in good health.

[1] **IPNV** Infectious Pancreatic Necrosis Virus, **IHNV** Infectious Hematopoietic Necrosis Virus, **VHS** Viral Hemorrhagic Septicemia Virus, **AS** Furunculosis (*Aeromonas salmonicida)* , **YR** Enteric Redmouth (*Yersinia ruckeri),* **RS** BKD (*Renibacterium salmoninarum*), **BCD** Coldwater Disease (*Flexibacter psychrophilum)*, **CD** Columnaris (*Flexibacter columnaris)*, **ESC** Emphysematous Putrefactive Disease *(Edwardsiella ictaluri),* **WD** Whirling Disease (*Myxobolus cerebralis*), **CS** Salmonid Ceratomyxosis (*Ceratomyxa shasta).*

U.S. Fish & Wildlife Service
LOWER COLUMBIA RIVER FISH HEALTH CENTER
61552 S.R. 14
Underwood, WA 98651
Phone: 509-493-3156
Fax: 509-493-2748

FISH HEALTH REPORT 2002

FISH SOURCE	FISH EXAMINED
Location: Lower Rattlesnake Creek **County**: Klickitat **Contact Person:** Pat Connolly **Affiliation:** USGS CRRL **Phone:** (509) 538-2299 ext. 269	**Species:** Dace **Age:** Juvenile/Adults **CHN:** 02-197 **Number of fish:** 4 **Date Sampled:** 06-25-02

DISEASE AGENT [1]	SAMPLE SIZE	RESULTS	COMMENTS
IPNV	4	negative	EPC and CHSE-214 cells
IHNV	4	negative	EPC and CHSE-214 cells
VHS	4	negative	EPC and CHSE-214 cells
AS	4	negative	BHIA medium
YR	4	negative	BHIA medium
RS	-	not testd	ELISA
BCD	4	negative	TYES medium
CD	4	negative	TYES medium
ESC	4	negative	BHIA medium
WD	4	negative	Pepsin/Trypsin Digest
CS	-	not tested	microscopic examination

Comments	Fish appeared to be in good health.

[1] **IPNV** Infectious Pancreatic Necrosis Virus, **IHNV** Infectious Hematopoietic Necrosis Virus, **VHS** Viral Hemorrhagic Septicemia Virus, **AS** Furunculosis (*Aeromonas salmonicida)* , **YR** Enteric Redmouth (*Yersinia ruckeri),* **RS** BKD (*Renibacterium salmoninarum*), **BCD** Coldwater Disease (*Flexibacter psychrophilum)*, **CD** Columnaris (*Flexibacter columnaris)*, **ESC** Emphysematous Putrefactive Disease *(Edwardsiella ictaluri),* **WD** Whirling Disease (*Myxobolus cerebralis*), **CS** Salmonid Ceratomyxosis (*Ceratomyxa shasta).*

U.S. Fish & Wildlife Service
LOWER COLUMBIA RIVER FISH HEALTH CENTER
61552 S.R. 14
Underwood, WA 98651
Phone: 509-493-3156
Fax: 509-493-2748

FISH HEALTH REPORT 2002

FISH SOURCE	FISH EXAMINED
Location: Lower Rattlesnake Creek **County**: Klickitat **Contact Person:** Pat Connolly **Affiliation:** USGS CRRL **Phone:** (509) 538-2299 ext. 269	**Species:** Rainbow trout **Age:** Juvenile/Adults **CHN:** 02-198 **Number of fish:** 60 **Date Sampled:** 06-26-02

DISEASE AGENT [1]	SAMPLE SIZE	RESULTS	COMMENTS
IPNV	60	negative	EPC and CHSE-214 cells
IHNV	60	negative	EPC and CHSE-214 cells
VHS	60	negative	EPC and CHSE-214 cells
AS	33	negative	BHIA medium
YR	33	negative	BHIA medium
RS	9	**Suspect**	+2/5 pools detected by ELISA, not confirmed by PCR 0/2
BCD	33	negative	TYES medium
CD	33	negative	TYES medium
ESC	33	negative	BHIA medium
WD	60	negative	Pepsin/Trypsin Digest
CS	5	negative	microscopic examination

Comments	ELISA samples pooled. Fish appeared to be in good health.

[1] **IPNV** Infectious Pancreatic Necrosis Virus, **IHNV** Infectious Hematopoietic Necrosis Virus, **VHS** Viral Hemorrhagic Septicemia Virus, **AS** Furunculosis (*Aeromonas salmonicida)* , **YR** Enteric Redmouth (*Yersinia ruckeri),* **RS** BKD (*Renibacterium salmoninarum*), **BCD** Coldwater Disease (*Flexibacter psychrophilum)*, **CD** Columnaris (*Flexibacter columnaris)*, **ESC** Emphysematous Putrefactive Disease *(Edwardsiella ictaluri),* **WD** Whirling Disease (*Myxobolus cerebralis*), **CS** Salmonid Ceratomyxosis (*Ceratomyxa shasta).*

U.S. Fish & Wildlife Service
LOWER COLUMBIA RIVER FISH HEALTH CENTER
61552 S.R. 14
Underwood, WA 98651
Phone: 509-493-3156
Fax: 509-493-2748

FISH HEALTH REPORT 2002

FISH SOURCE	FISH EXAMINED
Location: Lower Rattlesnake Creek **County**: Klickitat **Contact Person:** Pat Connolly **Affiliation:** USGS CRRL **Phone:** (509) 538-2299 ext. 269	**Species:** Sculpin **Age:** Juvenile/Adults **CHN:** 02-199 **Number of fish:** 40 **Date Sampled:** 06-26-02

DISEASE AGENT [1]	SAMPLE SIZE	RESULTS	COMMENTS
IPNV	40	negative	EPC and CHSE-214 cells
IHNV	40	negative	EPC and CHSE-214 cells
VHS	40	negative	EPC and CHSE-214 cells
AS	20	negative	BHIA medium
YR	20	negative	BHIA medium
RS	40	**Suspect**	+2/4 pools detected by ELISA, not confirmed by PCR 0/2
BCD	20	negative	TYES medium
CD	20	negative	TYES medium
ESC	20	negative	BHIA medium
WD	40	negative	Pepsin/Trypsin Digest
CS	-	not tested	microscopic examination

Comments	Fish appeared to be in good health.

[1] **IPNV** Infectious Pancreatic Necrosis Virus, **IHNV** Infectious Hematopoietic Necrosis Virus, **VHS** Viral Hemorrhagic Septicemia Virus, **AS** Furunculosis (*Aeromonas salmonicida)* , **YR** Enteric Redmouth (*Yersinia ruckeri),* **RS** BKD (*Renibacterium salmoninarum*), **BCD** Coldwater Disease (*Flexibacter psychrophilum)*, **CD** Columnaris (*Flexibacter columnaris)*, **ESC** Emphysematous Putrefactive Disease *(Edwardsiella ictaluri),* **WD** Whirling Disease (*Myxobolus cerebralis*), **CS** Salmonid Ceratomyxosis (*Ceratomyxa shasta).*

U.S. Fish & Wildlife Service
LOWER COLUMBIA RIVER FISH HEALTH CENTER
61552 S.R. 14
Underwood, WA 98651
Phone: 509-493-3156
Fax: 509-493-2748

FISH HEALTH REPORT 2002

FISH SOURCE	FISH EXAMINED
Location: Lower Rattlesnake Creek **County**: Klickitat **Contact Person:** Pat Connolly **Affiliation:** USGS CRRL **Phone:** (509) 538-2299 ext. 269	**Species:** Dace **Age:** Juvenile/Adults **CHN:** 02-200 **Number of fish:** 20 **Date Sampled:** 06-26-02

DISEASE AGENT [1]	SAMPLE SIZE	RESULTS	COMMENTS
IPNV	20	negative	EPC and CHSE-214 cells
IHNV	20	negative	EPC and CHSE-214 cells
VHS	20	negative	EPC and CHSE-214 cells
AS	20	negative	BHIA medium
YR	20	negative	BHIA medium
RS	20	not detected	ELISA
BCD	16	negative	TYES medium
CD	16	negative	TYES medium
ESC	20	negative	BHIA medium
WD	20	negative	Pepsin/Trypsin Digest
CS	-	not tested	microscopic examination

Comments	Fish appeared to be in good health.

[1] **IPNV** Infectious Pancreatic Necrosis Virus, **IHNV** Infectious Hematopoietic Necrosis Virus, **VHS** Viral Hemorrhagic Septicemia Virus, **AS** Furunculosis (*Aeromonas salmonicida)* , **YR** Enteric Redmouth (*Yersinia ruckeri),* **RS** BKD (*Renibacterium salmoninarum*), **BCD** Coldwater Disease (*Flexibacter psychrophilum)*, **CD** Columnaris (*Flexibacter columnaris)*, **ESC** Emphysematous Putrefactive Disease *(Edwardsiella ictaluri),* **WD** Whirling Disease (*Myxobolus cerebralis*), **CS** Salmonid Ceratomyxosis (*Ceratomyxa shasta).*

U.S. Fish & Wildlife Service
LOWER COLUMBIA RIVER FISH HEALTH CENTER
61552 S.R. 14
Underwood, WA 98651
Phone: 509-493-3156
Fax: 509-493-2748

FISH HEALTH REPORT 2002

FISH SOURCE	FISH EXAMINED
Location: Lower Rattlesnake Creek **County**: Klickitat **Contact Person:** Pat Connolly **Affiliation:** USGS CRRL **Phone:** (509) 538-2299 ext. 269	**Species:** Rainbow trout **Age:** Juvenile/Adults **CHN:** 02-203 **Number of fish:** 20 **Date Sampled:** 07-01-02

DISEASE AGENT [1]	SAMPLE SIZE	RESULTS	COMMENTS
IPNV	20	negative	EPC and CHSE-214 cells
IHNV	20	negative	EPC and CHSE-214 cells
VHS	20	negative	EPC and CHSE-214 cells
AS	16	negative	BHIA medium
YR	16	negative	BHIA medium
RS	10	**Suspect**	+1/1 pools detected by ELISA, not confirmed by PCR 0/1
BCD	16	negative	TYES medium
CD	16	negative	TYES medium
ESC	16	negative	BHIA medium
WD	20	negative	Pepsin/Trypsin Digest
CS	-	not tested	microscopic examination

Comments	Fish appeared to be in good health.

[1] **IPNV** Infectious Pancreatic Necrosis Virus, **IHNV** Infectious Hematopoietic Necrosis Virus, **VHS** Viral Hemorrhagic Septicemia Virus, **AS** Furunculosis (*Aeromonas salmonicida)* , **YR** Enteric Redmouth (*Yersinia ruckeri),* **RS** BKD (*Renibacterium salmoninarum*), **BCD** Coldwater Disease (*Flexibacter psychrophilum)*, **CD** Columnaris (*Flexibacter columnaris)*, **ESC** Emphysematous Putrefactive Disease *(Edwardsiella ictaluri),* **WD** Whirling Disease (*Myxobolus cerebralis*), **CS** Salmonid Ceratomyxosis (*Ceratomyxa shasta).*

U.S. Fish & Wildlife Service
LOWER COLUMBIA RIVER FISH HEALTH CENTER
61552 S.R. 14
Underwood, WA 98651
Phone: 509-493-3156
Fax: 509-493-2748

FISH HEALTH REPORT 2002

FISH SOURCE	FISH EXAMINED
Location: Rattlesnake Creek (middle) **County**: Klickitat **Contact Person:** Pat Connolly **Affiliation:** USGS CRRL **Phone:** (509) 538-2299 ext. 269	**Species:** Rainbow trout **Age:** Juvenile/Adults **CHN:** 02-206 **Number of fish:** 20 **Date Sampled:** 07-16-02

DISEASE AGENT [1]	SAMPLE SIZE	RESULTS	COMMENTS
IPNV	20	negative	EPC and CHSE-214 cells
IHNV	20	negative	EPC and CHSE-214 cells
VHS	20	negative	EPC and CHSE-214 cells
AS	16	negative	BHIA medium
YR	16	negative	BHIA medium
RS	10	**Suspect**	+3/3 detected by ELISA, not confirmed by PCR 0/3
BCD	16	negative	TYES medium
CD	16	negative	TYES medium
ESC	16	negative	BHIA medium
WD	20	negative	Pepsin/Trypsin Digest
CS	-	not tested	microscopic examination

Comments	Black spot (*Neascus*) on skin (high). *Trichodina* and *Gyrodactylus* on skin (low). *Nanophyetus* on gills and in the hind-gut (low).

[1] **IPNV** Infectious Pancreatic Necrosis Virus, **IHNV** Infectious Hematopoietic Necrosis Virus, **VHS** Viral Hemorrhagic Septicemia Virus, **AS** Furunculosis (*Aeromonas salmonicida)* , **YR** Enteric Redmouth (*Yersinia ruckeri),* **RS** BKD (*Renibacterium salmoninarum*), **BCD** Coldwater Disease (*Flexibacter psychrophilum)*, **CD** Columnaris (*Flexibacter columnaris)*, **ESC** Emphysematous Putrefactive Disease *(Edwardsiella ictaluri),* **WD** Whirling Disease (*Myxobolus cerebralis*), **CS** Salmonid Ceratomyxosis (*Ceratomyxa shasta).*

U.S. Fish & Wildlife Service
LOWER COLUMBIA RIVER FISH HEALTH CENTER
61552 S.R. 14
Underwood, WA 98651
Phone: 509-493-3156
Fax: 509-493-2748

FISH HEALTH REPORT 2002

FISH SOURCE	FISH EXAMINED
Location: Rattlesnake Creek (middle) **County**: Klickitat **Contact Person:** Pat Connolly **Affiliation:** USGS CRRL **Phone:** (509) 538-2299 ext. 269	**Species:** Dace **Age:** Juvenile/Adults **CHN:** 02-207 **Number of fish:** 21 **Date Sampled:** 07-16-02

DISEASE AGENT [1]	SAMPLE SIZE	RESULTS	COMMENTS
IPNV	21	negative	EPC and CHSE-214 cells
IHNV	21	negative	EPC and CHSE-214 cells
VHS	21	negative	EPC and CHSE-214 cells
AS	10	negative	BHIA medium
YR	10	negative	BHIA medium
RS	18	**Suspect**	+2/2 detected by ELISA, not confirmed by PCR 0/2
BCD	-	not tested	TYES medium
CD	-	not tested	TYES medium
ESC	10	negative	BHIA medium
WD	21	negative	Pepsin/Trypsin Digest
CS	-	not tested	microscopic examination

Comments	A couple of fish with missing caudal fins.

[1] **IPNV** Infectious Pancreatic Necrosis Virus, **IHNV** Infectious Hematopoietic Necrosis Virus, **VHS** Viral Hemorrhagic Septicemia Virus, **AS** Furunculosis (*Aeromonas salmonicida)* , **YR** Enteric Redmouth (*Yersinia ruckeri),* **RS** BKD (*Renibacterium salmoninarum*), **BCD** Coldwater Disease (*Flexibacter psychrophilum)*, **CD** Columnaris (*Flexibacter columnaris)*, **ESC** Emphysematous Putrefactive Disease *(Edwardsiella ictaluri),* **WD** Whirling Disease (*Myxobolus cerebralis*), **CS** Salmonid Ceratomyxosis (*Ceratomyxa shasta).*

U.S. Fish & Wildlife Service
LOWER COLUMBIA RIVER FISH HEALTH CENTER
61552 S.R. 14
Underwood, WA 98651
Phone: 509-493-3156
Fax: 509-493-2748

FISH HEALTH REPORT 2002

FISH SOURCE	FISH EXAMINED
Location: Rattlesnake Creek (middle) **County**: Klickitat **Contact Person:** Pat Connolly **Affiliation:** USGS CRRL **Phone:** (509) 538-2299 ext. 269	**Species:** Rainbow trout **Age:** Juvenile/Adults **CHN:** 02-208 **Number of fish:** 3 **Date Sampled:** 07-17-02

DISEASE AGENT [1]	SAMPLE SIZE	RESULTS	COMMENTS
IPNV	3	negative	EPC and CHSE-214 cells
IHNV	3	negative	EPC and CHSE-214 cells
VHS	3	negative	EPC and CHSE-214 cells
AS	3	negative	BHIA medium
YR	3	negative	BHIA medium
RS	3	**Suspect**	+1/1 detected by ELISA, not confirmed by PCR 0/1
BCD	3	negative	TYES medium
CD	3	negative	TYES medium
ESC	3	negative	BHIA medium
WD	3	negative	Pepsin/Trypsin Digest
CS	3	negative	microscopic examination

Comments	*Nanophyetus* and *Sanguinicola* on the gills (moderate).

[1] **IPNV** Infectious Pancreatic Necrosis Virus, **IHNV** Infectious Hematopoietic Necrosis Virus, **VHS** Viral Hemorrhagic Septicemia Virus, **AS** Furunculosis (*Aeromonas salmonicida)* , **YR** Enteric Redmouth (*Yersinia ruckeri),* **RS** BKD (*Renibacterium salmoninarum*), **BCD** Coldwater Disease (*Flexibacter psychrophilum)*, **CD** Columnaris (*Flexibacter columnaris)*, **ESC** Emphysematous Putrefactive Disease *(Edwardsiella ictaluri),* **WD** Whirling Disease (*Myxobolus cerebralis*), **CS** Salmonid Ceratomyxosis (*Ceratomyxa shasta).*

U.S. Fish & Wildlife Service
LOWER COLUMBIA RIVER FISH HEALTH CENTER
61552 S.R. 14
Underwood, WA 98651
Phone: 509-493-3156
Fax: 509-493-2748

FISH HEALTH REPORT 2002

FISH SOURCE	FISH EXAMINED
Location: Rattlesnake Creek (middle) **County**: Klickitat **Contact Person:** Pat Connolly **Affiliation:** USGS CRRL **Phone:** (509) 538-2299 ext. 269	**Species:** Dace **Age:** Juvenile/Adults **CHN:** 02-209 **Number of fish:** 13 **Date Sampled:** 07-17-02

DISEASE AGENT [1]	SAMPLE SIZE	RESULTS	COMMENTS
IPNV	13	negative	EPC and CHSE-214 cells
IHNV	13	negative	EPC and CHSE-214 cells
VHS	13	negative	EPC and CHSE-214 cells
AS	10	negative	BHIA medium
YR	10	negative	BHIA medium
RS	13	**Positive**	+1/1 detected by ELISA, confirmed by PCR +1/1
BCD	-	not tested	TYES medium
CD	-	not tested	TYES medium
ESC	10	negative	BHIA medium
WD	13	negative	Pepsin/Trypsin Digest
CS	-	not tested	microscopic examination

Comments	*Aeromonas* bacteria growth on a couple of fish.

[1] **IPNV** Infectious Pancreatic Necrosis Virus, **IHNV** Infectious Hematopoietic Necrosis Virus, **VHS** Viral Hemorrhagic Septicemia Virus, **AS** Furunculosis (*Aeromonas salmonicida*) , **YR** Enteric Redmouth (*Yersinia ruckeri),* **RS** BKD (*Renibacterium salmoninarum*), **BCD** Coldwater Disease (*Flexibacter psychrophilum)*, **CD** Columnaris (*Flexibacter columnaris)*, **ESC** Emphysematous Putrefactive Disease *(Edwardsiella ictaluri),* **WD** Whirling Disease (*Myxobolus cerebralis*), **CS** Salmonid Ceratomyxosis (*Ceratomyxa shasta).*

U.S. Fish & Wildlife Service
LOWER COLUMBIA RIVER FISH HEALTH CENTER
61552 S.R. 14
Underwood, WA 98651
Phone: 509-493-3156
Fax: 509-493-2748

FISH HEALTH REPORT 2002

FISH SOURCE	FISH EXAMINED
Location: Rattlesnake Creek (middle) **County**: Klickitat **Contact Person:** Pat Connolly **Affiliation:** USGS CRRL **Phone:** (509) 538-2299 ext. 269	**Species:** Rainbow trout **Age:** Juvenile **CHN:** 02-210 **Number of fish:** 1 **Date Sampled:** 07-18-02

DISEASE AGENT [1]	SAMPLE SIZE	RESULTS	COMMENTS
IPNV	1	negative	EPC and CHSE-214 cells
IHNV	1	negative	EPC and CHSE-214 cells
VHS	1	negative	EPC and CHSE-214 cells
AS	1	negative	BHIA medium
YR	1	negative	BHIA medium
RS	1	not detected	ELISA
BCD	1	negative	TYES medium
CD	1	negative	TYES medium
ESC	1	negative	BHIA medium
WD	1	negative	Pepsin/Trypsin Digest
CS	1	negative	microscopic examination

Comments	*Nanophyetus* in the hind-gut (low).

[1] **IPNV** Infectious Pancreatic Necrosis Virus, **IHNV** Infectious Hematopoietic Necrosis Virus, **VHS** Viral Hemorrhagic Septicemia Virus, **AS** Furunculosis (*Aeromonas salmonicida*) , **YR** Enteric Redmouth (*Yersinia ruckeri),* **RS** BKD (*Renibacterium salmoninarum*), **BCD** Coldwater Disease (*Flexibacter psychrophilum)*, **CD** Columnaris (*Flexibacter columnaris)*, **ESC** Emphysematous Putrefactive Disease *(Edwardsiella ictaluri),* **WD** Whirling Disease (*Myxobolus cerebralis*), **CS** Salmonid Ceratomyxosis (*Ceratomyxa shasta).*

U.S. Fish & Wildlife Service
LOWER COLUMBIA RIVER FISH HEALTH CENTER
61552 S.R. 14
Underwood, WA 98651
Phone: 509-493-3156
Fax: 509-493-2748

FISH HEALTH REPORT 2002

FISH SOURCE	FISH EXAMINED
Location: Rattlesnake Creek (middle) **County**: Klickitat **Contact Person:** Pat Connolly **Affiliation:** USGS CRRL **Phone:** (509) 538-2299 ext. 269	**Species:** Sculpin **Age:** Juvenile **CHN:** 02-211 **Number of fish:** 1 **Date Sampled:** 07-18-02

DISEASE AGENT [1]	SAMPLE SIZE	RESULTS	COMMENTS
IPNV	1	negative	EPC and CHSE-214 cells
IHNV	1	negative	EPC and CHSE-214 cells
VHS	1	negative	EPC and CHSE-214 cells
AS	1	negative	BHIA medium
YR	1	negative	BHIA medium
RS	1	**Suspect**	+1/1 detected by ELISA, not confirmed by PCR 0/1
BCD	1	negative	TYES medium
CD	1	negative	TYES medium
ESC	1	negative	BHIA medium
WD	1	negative	Pepsin/Trypsin Digest
CS	-	not tested	microscopic examination

Comments	Caudal fin eroded away. Small hemorrhaged spots along body, underbelly.

[1] **IPNV** Infectious Pancreatic Necrosis Virus, **IHNV** Infectious Hematopoietic Necrosis Virus, **VHS** Viral Hemorrhagic Septicemia Virus, **AS** Furunculosis (*Aeromonas salmonicida)* , **YR** Enteric Redmouth (*Yersinia ruckeri),* **RS** BKD (*Renibacterium salmoninarum*), **BCD** Coldwater Disease (*Flexibacter psychrophilum)*, **CD** Columnaris (*Flexibacter columnaris)*, **ESC** Emphysematous Putrefactive Disease *(Edwardsiella ictaluri),* **WD** Whirling Disease (*Myxobolus cerebralis*), **CS** Salmonid Ceratomyxosis (*Ceratomyxa shasta).*

U.S. Fish & Wildlife Service
LOWER COLUMBIA RIVER FISH HEALTH CENTER
61552 S.R. 14
Underwood, WA 98651
Phone: 509-493-3156
Fax: 509-493-2748

FISH HEALTH REPORT 2002

FISH SOURCE	FISH EXAMINED
Location: Rattlesnake Creek (middle) **County**: Klickitat **Contact Person:** Pat Connolly **Affiliation:** USGS CRRL **Phone:** (509) 538-2299 ext. 269	**Species:** Dace **Age:** Juvenile **CHN:** 02-212 **Number of fish:** 16 **Date Sampled:** 07-18-02

DISEASE AGENT [1]	SAMPLE SIZE	RESULTS	COMMENTS
IPNV	16	negative	EPC and CHSE-214 cells
IHNV	16	negative	EPC and CHSE-214 cells
VHS	16	negative	EPC and CHSE-214 cells
AS	10	negative	BHIA medium
YR	10	negative	BHIA medium
RS	10	not detected	ELISA
BCD	-	not tested	TYES medium
CD	-	not tested	TYES medium
ESC	10	negative	BHIA medium
WD	16	negative	Pepsin/Trypsin Digest
CS	-	not tested	microscopic examination

Comments	*Aeromonas* bacterial growth on a few fish.

[1] **IPNV** Infectious Pancreatic Necrosis Virus, **IHNV** Infectious Hematopoietic Necrosis Virus, **VHS** Viral Hemorrhagic Septicemia Virus, **AS** Furunculosis (*Aeromonas salmonicida)* , **YR** Enteric Redmouth (*Yersinia ruckeri),* **RS** BKD (*Renibacterium salmoninarum*), **BCD** Coldwater Disease (*Flexibacter psychrophilum)*, **CD** Columnaris (*Flexibacter columnaris)*, **ESC** Emphysematous Putrefactive Disease *(Edwardsiella ictaluri),* **WD** Whirling Disease (*Myxobolus cerebralis*), **CS** Salmonid Ceratomyxosis (*Ceratomyxa shasta).*

U.S. Fish & Wildlife Service
LOWER COLUMBIA RIVER FISH HEALTH CENTER
61552 S.R. 14
Underwood, WA 98651
Phone: 509-493-3156
Fax: 509-493-2748

FISH HEALTH REPORT 2002

FISH SOURCE	FISH EXAMINED
Location: Indian Creek **County**: Klickitat **Contact Person:** Pat Connolly **Affiliation:** USGS CRRL **Phone:** (509) 538-2299 ext. 269	**Species:** Cutthroat trout **Age:** Juvenile **CHN:** 02-259 **Number of fish:** 4 **Date Sampled:** 08-19-02

DISEASE AGENT [1]	SAMPLE SIZE	RESULTS	COMMENTS
IPNV	4	negative	EPC and CHSE-214 cells
IHNV	4	negative	EPC and CHSE-214 cells
VHS	4	negative	EPC and CHSE-214 cells
AS	4	negative	BHIA medium
YR	4	negative	BHIA medium
RS	4	not detected	ELISA
BCD	4	negative	TYES medium
CD	4	negative	TYES medium
ESC	4	negative	BHIA medium
WD	4	negative	Pepsin/Trypsin Digest
CS	-	not tested	microscopic examination

Comments	Fish appeared to be in good health.

[1] **IPNV** Infectious Pancreatic Necrosis Virus, **IHNV** Infectious Hematopoietic Necrosis Virus, **VHS** Viral Hemorrhagic Septicemia Virus, **AS** Furunculosis (*Aeromonas salmonicida)* , **YR** Enteric Redmouth (*Yersinia ruckeri),* **RS** BKD (*Renibacterium salmoninarum*), **BCD** Coldwater Disease (*Flexibacter psychrophilum)*, **CD** Columnaris (*Flexibacter columnaris)*, **ESC** Emphysematous Putrefactive Disease *(Edwardsiella ictaluri),* **WD** Whirling Disease (*Myxobolus cerebralis*), **CS** Salmonid Ceratomyxosis (*Ceratomyxa shasta).*

U.S. Fish & Wildlife Service
LOWER COLUMBIA RIVER FISH HEALTH CENTER
61552 S.R. 14
Underwood, WA 98651
Phone: 509-493-3156
Fax: 509-493-2748

FISH HEALTH REPORT 2002

FISH SOURCE	FISH EXAMINED
Location: Indian Creek **County**: Klickitat **Contact Person:** Pat Connolly **Affiliation:** USGS CRRL **Phone:** (509) 538-2299 ext. 269	**Species:** Cutthroat trout **Age:** Juvenile **CHN:** 02-260 **Number of fish:** 6 **Date Sampled:** 08-20-02

DISEASE AGENT [1]	SAMPLE SIZE	RESULTS	COMMENTS
IPNV	6	negative	EPC and CHSE-214 cells
IHNV	6	negative	EPC and CHSE-214 cells
VHS	6	negative	EPC and CHSE-214 cells
AS	6	negative	BHIA medium
YR	6	negative	BHIA medium
RS	6	not detected	ELISA
BCD	6	negative	TYES medium
CD	6	negative	TYES medium
ESC	6	negative	BHIA medium
WD	6	negative	Pepsin/Trypsin Digest
CS	4	negative	microscopic examination

Comments	*Nanophytus* in the hind-gut, skin, and kidney (high). Skin also had *Epistylis* and *Gyrodactylus* (low).

[1] **IPNV** Infectious Pancreatic Necrosis Virus, **IHNV** Infectious Hematopoietic Necrosis Virus, **VHS** Viral Hemorrhagic Septicemia Virus, **AS** Furunculosis (*Aeromonas salmonicida)* , **YR** Enteric Redmouth (*Yersinia ruckeri),* **RS** BKD (*Renibacterium salmoninarum*), **BCD** Coldwater Disease (*Flexibacter psychrophilum)*, **CD** Columnaris (*Flexibacter columnaris)*, **ESC** Emphysematous Putrefactive Disease *(Edwardsiella ictaluri),* **WD** Whirling Disease (*Myxobolus cerebralis*), **CS** Salmonid Ceratomyxosis (*Ceratomyxa shasta).*

U.S. Fish & Wildlife Service
LOWER COLUMBIA RIVER FISH HEALTH CENTER
61552 S.R. 14
Underwood, WA 98651
Phone: 509-493-3156
Fax: 509-493-2748

FISH HEALTH REPORT 2002

FISH SOURCE	FISH EXAMINED
Location: Rattlesnake Creek **County**: Klickitat **Contact Person:** Pat Connolly **Affiliation:** USGS CRRL **Phone:** (509) 538-2299 ext. 269	**Species:** Rainbow trout **Age:** Juvenile **CHN:** 02-267 **Number of fish:** 12 **Date Sampled:** 08-27-02

DISEASE AGENT [1]	SAMPLE SIZE	RESULTS	COMMENTS
IPNV	12	negative	EPC and CHSE-214 cells
IHNV	12	negative	EPC and CHSE-214 cells
VHS	12	negative	EPC and CHSE-214 cells
AS	12	negative	BHIA medium
YR	12	negative	BHIA medium
RS	12	not detected	ELISA
BCD	12	negative	TYES medium
CD	12	negative	TYES medium
ESC	12	negative	BHIA medium
WD	12	negative	Pepsin/Trypsin Digest
CS	-	not tested	microscopic examination

Comments	ELISA and virus pooled.

[1] **IPNV** Infectious Pancreatic Necrosis Virus, **IHNV** Infectious Hematopoietic Necrosis Virus, **VHS** Viral Hemorrhagic Septicemia Virus, **AS** Furunculosis (*Aeromonas salmonicida)* , **YR** Enteric Redmouth (*Yersinia ruckeri),* **RS** BKD (*Renibacterium salmoninarum*), **BCD** Coldwater Disease (*Flexibacter psychrophilum)*, **CD** Columnaris (*Flexibacter columnaris)*, **ESC** Emphysematous Putrefactive Disease *(Edwardsiella ictaluri),* **WD** Whirling Disease (*Myxobolus cerebralis*), **CS** Salmonid Ceratomyxosis (*Ceratomyxa shasta).*

U.S. Fish & Wildlife Service
LOWER COLUMBIA RIVER FISH HEALTH CENTER
61552 S.R. 14
Underwood, WA 98651
Phone: 509-493-3156
Fax: 509-493-2748

FISH HEALTH REPORT 2002

FISH SOURCE	FISH EXAMINED
Location: Rattlesnake Creek **County**: Klickitat **Contact Person:** Pat Connolly **Affiliation:** USGS CRRL **Phone:** (509) 538-2299 ext. 269	**Species:** Rainbow trout **Age:** Adult **CHN:** 02-271 **Number of fish:** 1 **Date Sampled:** 08-29-02

DISEASE AGENT [1]	**SAMPLE SIZE**	**RESULTS**	**COMMENTS**
IPNV	1	negative	EPC and CHSE-214 cells
IHNV	1	negative	EPC and CHSE-214 cells
VHS	1	negative	EPC and CHSE-214 cells
AS	1	negative	BHIA medium
YR	1	negative	BHIA medium
RS	1	**Suspect**	+1/1 detected by ELISA, not confirmed by PCR
BCD	1	negative	TYES medium
CD	1	negative	TYES medium
ESC	1	negative	BHIA medium
WD	1	negative	Pepsin/Trypsin Digest
CS	-	not tested	microscopic examination

Comments	Nanophyetus in kidney (high). Spawned out female.

[1] **IPNV** Infectious Pancreatic Necrosis Virus, **IHNV** Infectious Hematopoietic Necrosis Virus, **VHS** Viral Hemorrhagic Septicemia Virus, **AS** Furunculosis (*Aeromonas salmonicida*) , **YR** Enteric Redmouth (*Yersinia ruckeri),* **RS** BKD (*Renibacterium salmoninarum*), **BCD** Coldwater Disease (*Flexibacter psychrophilum)*, **CD** Columnaris (*Flexibacter columnaris)*, **ESC** Emphysematous Putrefactive Disease *(Edwardsiella ictaluri),* **WD** Whirling Disease (*Myxobolus cerebralis*), **CS** Salmonid Ceratomyxosis (*Ceratomyxa shasta).*

U.S. Fish & Wildlife Service
LOWER COLUMBIA RIVER FISH HEALTH CENTER
61552 S.R. 14
Underwood, WA 98651
Phone: 509-493-3156
Fax: 509-493-2748

FISH HEALTH REPORT 2002

FISH SOURCE	FISH EXAMINED
Location: Rattlesnake Creek **County**: Klickitat **Contact Person:** Pat Connolly **Affiliation:** USGS CRRL **Phone:** (509) 538-2299 ext. 269	**Species:** Rainbow trout **Age:** Adult **CHN:** 02-278 **Number of fish:** 1 **Date Sampled:** 09-09-02

DISEASE AGENT [1]	SAMPLE SIZE	RESULTS	COMMENTS
IPNV	1	negative	EPC and CHSE-214 cells
IHNV	1	negative	EPC and CHSE-214 cells
VHS	1	negative	EPC and CHSE-214 cells
AS	1	negative	BHIA medium
YR	1	negative	BHIA medium
RS	1	not detected	ELISA
BCD	1	negative	TYES medium
CD	1	negative	TYES medium
ESC	1	negative	BHIA medium
WD	1	negative	Pepsin/Trypsin Digest
CS	1	not tested	microscopic examination

Comments	Mortality. Spawned out female. Pit tag. Looked like Pit tag was interfering with hind-gut. It was at the lower hind-gut close to the vent. Fish did not have any food in the gut and had no fat in the pyloric cecum. *Nanophyetus* (high) in kidney.

[1] **IPNV** Infectious Pancreatic Necrosis Virus, **IHNV** Infectious Hematopoietic Necrosis Virus, **VHS** Viral Hemorrhagic Septicemia Virus, **AS** Furunculosis (*Aeromonas salmonicida)* , **YR** Enteric Redmouth (*Yersinia ruckeri),* **RS** BKD (*Renibacterium salmoninarum*), **BCD** Coldwater Disease (*Flexibacter psychrophilum)*, **CD** Columnaris (*Flexibacter columnaris)*, **ESC** Emphysematous Putrefactive Disease *(Edwardsiella ictaluri),* **WD** Whirling Disease (*Myxobolus cerebralis*), **CS** Salmonid Ceratomyxosis (*Ceratomyxa shasta).*

U.S. Fish & Wildlife Service
LOWER COLUMBIA RIVER FISH HEALTH CENTER
61552 S.R. 14
Underwood, WA 98651
Phone: 509-493-3156
Fax: 509-493-2748

FISH HEALTH REPORT 2002

FISH SOURCE	FISH EXAMINED
Location: Rattlesnake Creek (upstream of falls) **County**: Klickitat **Contact Person:** Pat Connolly **Affiliation:** USGS CRRL **Phone:** (509) 538-2299 ext. 269	**Species:** Rainbow trout **Age:** Adult **CHN:** 02-287 **Number of fish:** 10 **Date Sampled:** 09-11-02

DISEASE AGENT [1]	SAMPLE SIZE	RESULTS	COMMENTS
IPNV	10	negative	EPC and CHSE-214 cells
IHNV	10	negative	EPC and CHSE-214 cells
VHS	10	negative	EPC and CHSE-214 cells
AS	10	negative	BHIA medium
YR	10	negative	BHIA medium
RS	10	**Suspect**	+2/2 detected by ELISA, not confirmed by PCR 0/2
BCD	10	negative	TYES medium
CD	10	negative	TYES medium
ESC	10	negative	BHIA medium
WD	10	negative	Pepsin/Trypsin Digest
CS	-	not tested	microscopic examination

Comments	ELISA and virus pooled. *Nanophyetus* in the hind-gut (moderate).

[1] **IPNV** Infectious Pancreatic Necrosis Virus, **IHNV** Infectious Hematopoietic Necrosis Virus, **VHS** Viral Hemorrhagic Septicemia Virus, **AS** Furunculosis (*Aeromonas salmonicida*) , **YR** Enteric Redmouth (*Yersinia ruckeri),* **RS** BKD (*Renibacterium salmoninarum*), **BCD** Coldwater Disease (*Flexibacter psychrophilum)*, **CD** Columnaris (*Flexibacter columnaris)*, **ESC** Emphysematous Putrefactive Disease *(Edwardsiella ictaluri),* **WD** Whirling Disease (*Myxobolus cerebralis*), **CS** Salmonid Ceratomyxosis (*Ceratomyxa shasta).*

U.S. Fish & Wildlife Service
LOWER COLUMBIA RIVER FISH HEALTH CENTER
61552 S.R. 14
Underwood, WA 98651
Phone: 509-493-3156
Fax: 509-493-2748

FISH HEALTH REPORT 2002

FISH SOURCE	FISH EXAMINED
Location: Rattlesnake Creek (upper Stevens land) **County**: Klickitat **Contact Person:** Pat Connolly **Affiliation:** USGS CRRL **Phone:** (509) 538-2299 ext. 269	**Species:** Rainbow trout **Age:** Adult **CHN:** 02-289 **Number of fish:** 3 **Date Sampled:** 09-12-02

DISEASE AGENT [1]	SAMPLE SIZE	RESULTS	COMMENTS
IPNV	3	negative	EPC and CHSE-214 cells
IHNV	3	negative	EPC and CHSE-214 cells
VHS	3	negative	EPC and CHSE-214 cells
AS	3	negative	BHIA medium
YR	3	negative	BHIA medium
RS	3	not detected	ELISA
BCD	3	negative	TYES medium
CD	3	negative	TYES medium
ESC	3	negative	BHIA medium
WD	3	negative	Pepsin/Trypsin Digest
CS	-	not tested	microscopic examination

Comments	ELISA and virus pooled. *Nanophyetus* in the gills (moderate).

[1] **IPNV** Infectious Pancreatic Necrosis Virus, **IHNV** Infectious Hematopoietic Necrosis Virus, **VHS** Viral Hemorrhagic Septicemia Virus, **AS** Furunculosis (*Aeromonas salmonicida)* , **YR** Enteric Redmouth (*Yersinia ruckeri),* **RS** BKD (*Renibacterium salmoninarum*), **BCD** Coldwater Disease (*Flexibacter psychrophilum)*, **CD** Columnaris (*Flexibacter columnaris)*, **ESC** Emphysematous Putrefactive Disease *(Edwardsiella ictaluri),* **WD** Whirling Disease (*Myxobolus cerebralis*), **CS** Salmonid Ceratomyxosis (*Ceratomyxa shasta).*

Report B: Instream PIT-Tag Detection System

Prepared by:

Ian Jezorek
Fishery Biologist

Patrick J. Connolly, Ph.D.
Research Fishery Biologist

U.S. Geological Survey
Western Fisheries Research Center
Columbia River Research Laboratory
5501-a Cook-Underwood Road
Cook, WA 98605

***In:* Connolly, P.J., editor. Assess Current and Potential Salmonid Production in Rattlesnake Creek Associated with Restoration Efforts**

2002 Annual Report
(Contract year: May 2002—April 2003)

December 2003

Prepared for:
Bonneville Power Administration
Division of Fish and Wildlife
COTR: John Baugher
P.O. Box 3621
Portland, OR 97208-3621

BPA Project Number: 2001-025-00
Account Number: 003882
Contract Number: 00005068

Introduction

In order to track movement and life-history attributes of resident rainbow trout and resident cutthroat trout in Rattlesnake Creek, a tributary of the White Salmon River, Washington, we began tagging fish in both streams with Passive Integrated Transponder (PIT) tags. The PIT tags provided a unique mark for each fish and allowed information on movement and growth of individuals to be collected. We began PIT tagging in 2001 and continued in 2002. To investigate the potential linkage between Rattlesnake Creek and the White Salmon River, we desired to have a facility to track movement of fish between the two streams. We cooperated with National Marine Fisheries Service's (NMFS) Manchester Research Station to develop an instream PIT-tag detection system in Rattlesnake Creek. Personnel from NMFS, under the direction of Earl Prentice, installed the system hardware and software. The PIT-tag-detection system was installed at the downstream end of our study area in Rattlesnake Creek (Rkm 0.3), near its confluence with the White Salmon River. Personnel from USGS-CRRL collected and PIT tagged fish, handled data collection and treatment, and monitored the detection site. A private landowner agreed to allow the system installed on his property.

The detection system was deployed to provide information on movement and habitat use of PIT-tagged salmonids at the reach and watershed scale. The objective of work by U.S. Geological Survey's Columbia River Research Laboratory (USGS-CRRL) was to characterize life-history attributes and habitat use of resident rainbow and cutthroat trout. This work corresponds to Task *2-b* of Objective 2 as stated in the Statement of Work submitted in May 2001. The Rattlesnake Creek work occurred in concert with a companion study, funded by the U.S. Forest Service, of rainbow trout on

the White Salmon River. The White Salmon River study was an investigation of rainbow trout seasonal habitat use and migration in the White Salmon River and Northwestern Lake.

PIT tags allow tracking of individuals within a population. PIT tags consist of a copper coil and a circuit chip encased in glass. Those used in fish are generally 10 – 32 mm in length and 2 – 4 mm in diameter. When energized by an electromagnetic signal, the tag returns a unique alphanumeric code of 10 digits with 34×10^9 possible combinations. Because PIT tags are passive (no battery power), they have an expected life of at least 10 years. PIT tags can be read at speeds over an antenna of up to 3.6 m/s (Prentice et al. 1990). The tags are generally placed in the body cavity of a fish by injection or surgically (Prentice et al. 1990; Gries and Letcher 2002). PIT tags have not adversely affected growth or survival of fish in laboratory or field tests (Prentice et al. 1990; Achord et al. 1996; Ombredane et al. 1998; Gries and Letcher 2002). Their long life and lack of adverse affect on fish make PIT tags good tools for monitoring of individuals. Because PIT tags are passive, the range at which they can be read is small, necessitating the need to physically capture the fish or have the fish pass very close to an antenna.

Use of Passive Integrated Transponder (PIT) tags in fish research has recently increased, particularly in the Columbia River basin of the Pacific Northwest. PIT tags have become a primary method for monitoring juvenile salmonid passage through dams and for computing survival past these dams (Prentice et al. 1986; Nunnallee et al. 1998; Skalski et al. 1998; Muir et al. 2001a). With their long life, PIT tags can also provide information on returning adult anadromous fish. Much has been done to outfit fish

ladders in the Columbia River Basin with detectors for adults (McCutcheon et al. 1994). Because of the interest in monitoring fate of individual fish for studies of habitat use, population structure, survival, and responses to environmental variables (Lucas 2000; Bell et al. 2001; Muir et al. 2001b) the use of PIT tags has increased substantially.

Researchers have investigated both fish life-history attributes and physical aspects (e.g., antenna design, read range, read efficiency) of instream PIT-tag-detection studies. Greenberg et al. (2001) used instream antennae to investigate diel use of pools and riffles with differing substrates by brown trout tagged with 11-mm PIT tags. Brannas and Lundquist (1994) used 12-mm PIT tags in arctic char in an artificial stream channel with two antennae to monitor directional movement. They used video cameras to tape fish as they swam over the antennae. When fish crossed an antenna singly, read efficiencies were 100%, but when two or more fish were near an antenna, only the stronger tag would be read. They reduced this problem by removing substrate from the antenna area to make it less attractive as habitat. In an experiment with Atlantic salmon tagged with 12-mm tags, Armstrong et al. (1996) found 99% of fish movements were recorded with use of a 4-antennae system. Additionally, Armstrong reported no adverse reaction of the fish to the electromagnetic field generated by the antennae. In a separate experiment with Atlantic salmon tagged with 12-mm tags, Armstrong et al. (2001) found efficiency to be 70.5% and read range to be 2.3-cm for parr swimming into and out of a redd surrounded by an antenna. There was a difference in efficiency for parr entering and leaving the redd implying that direction of movement can influence efficiency. Fish moving in differing directions, particularly in an area of moving water, may travel at different depths or orientation relative to an antenna.

Some researchers have made use of larger PIT tags that have greater read ranges. Morhardt et al. (2000) achieved read ranges up to 59-cm with a 32-mm tag in brown trout in an artificial stream channel. Zydlewski et al. (2001) used 23-mm tags in Atlantic salmon smolts and monitored downstream passage with two antennae anchored to a bridge covering the full 8-m width of Smith Brook, Vermont. Read range for the 23-mm tags was 45-cm from the plane of the antenna coil. She measured detection efficiencies of 93% by using captures at downstream smolt traps and drones. Additional studies are warranted to investigate both fish behavior and the emerging technology of instream detectors, particularly in streams where full coverage of the stream width or the water column is not possible.

Methods

During August 2001, NMFS personnel installed two PIT-tag antennas in Rattlesnake Creek. The antennas were anchored in the thalweg, one 15 m upstream of the other. Two antennas were used so that direction of fish movement and read efficiency could be determined. The antennas were housed in 10-cm diameter PVC pipe with overall dimensions of 203 cm by 81 cm. The antennas were deployed in three configurations: pass-by, pass-through, and hybrid. The downstream antenna was mounted flat against the stream bottom (pass-by design; Figures 1 and 2) and the upstream antenna was mounted upright (pass-through design; Figures 3 and 4). Under low-flow conditions (as shown in Figures 1, 3, and 5), the antennae were capable of scanning very close to 100% of the water passing them. At base flow, maximum water

depth at the antennae is 21-cm at the pass-by, and 23-cm at the pass-through. Because it was mounted flat on the stream bottom, the pass-by design was expected to sustain high flows and debris, but the fraction of the water column scanned was expected to decrease as flow and depth increased. The pass-through design was expected to scan a higher fraction of the water column as flow and depth increased, but because it was exposed to debris loading and strong current, it was likely to be more susceptible to loss during high flow or damage than the pass-by design.

During summer 2002, we replaced the original pass-through antenna with a pivoting antenna, hereafter referred to as "hybrid" (Figure 5). In the event of high flow or debris loading, the hybrid antenna was designed to pivot down and lay flat on the bottom, and at times of moderate flow, the antenna was designed to pivot up to cover more of the water column. The dimensions of the hybrid were the same as the pass-through antenna.

Each antenna was driven by a transceiver. The transceivers were model FS 1001-A 24-V units (Figure 6), manufactured by Digital Angel, South Saint Paul, Minnesota. Power for the transceivers was from an AC source on the property. Because we found that use of direct AC power caused high interference readings on the transceivers, the AC power was converted to DC at the transceiver housing. Data on tag detection and system diagnostics were sent to a computer housed on-site. The MULTIMON program (developed by NMFS and Pacific Northwest National Laboratory) combined data from the two transceivers into one file each day. Personnel from USGS-CRRL sent the files for incorporation into Pacific States Marine Fisheries Commission's (PSMFC) PTAGIS database.

At sites above the hydroelectric system on the Columbia River, researchers have largely been limited to using 12-mm tags due to the concern of larger tags "blocking" reads from other tagged fish at bypass routes at dams. All PIT tags that we used were 12 mm long, with a frequency of 134.2 kHz. For all PIT tagging, we followed the procedures and guidelines outlined by Columbia Basin Fish and Wildlife Authority (1999). During summer 2001, personnel from USGS-CRRL deployed 544 PIT tags in rainbow trout and cutthroat trout in Rattlesnake Creek, 30 PIT tags in cutthroat trout in Indian Creek, and 59 PIT tags in rainbow trout in the White Salmon River. During 2002, personnel form USGS-CRRL deployed 659 PIT tags in rainbow and cutthroat trout in Rattlesnake Creek, 72 PIT tags in cutthroat trout in Indian Creek, 20 PIT tags in rainbow trout in Mill Creek, and 126 PIT tags in rainbow trout in the White Salmon River. We PIT tagged rainbow trout or cutthroat trout that were 80 mm or greater in fork length. Fish were PIT tagged in four reaches of Rattlesnake Creek (Table 1): LRAT started at Rkm 0.2 and was about 1000 m, BRAT started at Rkm 2.5 and was about 1000 m, MRAT started at Rkm 7.1 and was about 500 m, and URAT started at Rkm 10.8 and was about 1000 m. Sections 2 and 3 were above a set of small falls (the largest drop of about 3.6 m) that may be an upstream barrier to resident rainbow trout and cutthroat trout. We electrofished to collect fish in Rattlesnake and Indian creeks and used hook and line sampling to collect fish in the mainstem White Salmon River. All PIT-tagging data were submitted to the PTAGIS database administered by PSMFC.

As part of a companion study funded by the U.S. Forest Service (USFS), we radio tagged adult rainbow trout during 2001 and 2002 in the White Salmon River. Some of the radio-tagged fish also received a PIT tag, and fish that were too small to radio tag

received a PIT tag only. We installed a radio receiver at the site of the instream PIT-tag antennas (Figure 7). We hoped to use this system of dual tagging to help us determine reader efficiencies.

We monitored flow and temperature through the study period. We had a flow site 15 m below the site of the pass-by antenna. Flow was taken with a Marsh-McBirney flow meter following the protocol of Gallagher and Stevenson (1999). We measured flow about ever two weeks from June – October, as well as during several high water events. Additionally, we measured stage height (Figure 8) at the Highway 141 bridge over Rattlesnake Creek, located about 180 m below the antenna site. A network of thermographs, deployed and maintained by Underwood Conservation District, was in place throughout Rattlesnake Creek during the study period.

Results

The instream PIT-tag detection system became operational on 23 August 2001. Both antennas immediately detected tagged fish. During the period 23 August 2001 to 31 December 2002, the detection system recorded 69 individual fish. Initially, the transceivers were set to record every instance of a tag read. Several fish were using the antennas as cover, and because the transceivers can record many reads per second, this setup was generating extremely large data files. To reduce the size of the files and to make data analysis easier, the transceivers were set to record individual tags one time per minute. If two tags are in the field simultaneously, only the tag with the strongest signal

will be detected (Brannas and Lundquist 1994). When fish use the antenna for cover, there is a much higher potential for missed detections if another fish passes through the field. We found that some tagged fish were using the antenna as habitat, and we subsequently removed several of these fish.

We classified PIT-tagged fish in Rattlesnake Creek into “local” or “non-local”. Non-local fish were those tagged and released more than 50 m upstream of the antennae. Of the 69 individual fish recorded by the detector during the period 23 August 2001 to 31 December 2002, 28 were non-locals from Rattlesnake Creek, 10 were from the White Salmon River, and 1 was from Indian Creek. Of the 28 non-local Rattlesnake Creek fish detected, 25 fish were from the LRAT reach, and 3 fish were from the BRAT reach. The BRAT reach is above a falls that is likely a barrier to upstream movement of resident trout. The 10 fish from the White Salmon River that were detected at the site were all from the section of the White Salmon River within 200 m upstream and 600 m downstream of the confluence with Rattlesnake Creek. We PIT tagged fish in the White Salmon River from Rkm 8.0 to Rkm 17.0. Although we PIT tagged 139 fish in the White Salmon River outside of the 800-m section at the confluence of Rattlesnake Creek, we did not detect any of these fish in Rattlesnake Creek.

The detections from 23 August 2001 to 31 December 2002 were primarily during the fall and spring periods (Figure 8). With the exception of one Rattlesnake fish recorded in August 2001, we saw no movement of Rattlesnake Creek fish in July, August, or September; Rattlesnake Creek downstream migrants were recorded in all other months except February. White Salmon migrants were recorded in February, March, and April 2001, and December 2002. During the period covered by this report, two fish from

the White Salmon River tagged with both PIT tags and radio tags entered Rattlesnake Creek. One of these fish was recorded on both gear types; the other had a dead radio-tag battery upon entry to Rattlesnake Creek.

During the study period, measured flows ranged from 0.3 cfs to 160.3 cfs; higher flows occurred, but we were physically unable to get a measurement. Water temperature at the site has ranged from 0.1 C to 23.5 C. Continuing monitoring will allow us to correlate fish movement with environmental variables such as flow and temperature.

On 14 December 2001, the pass-through antenna blew out during a high-flow event. High flow prevented us from resetting the antenna until 12 March 2002. On 12 May 2002, the power-cable to the pass-through antenna was pulled out by debris; it was reconnected on 28 May 2002. On 10 June 2002, we deployed the hybrid antenna in place of the pass-through design. The hybrid antenna remained in the stream through the remainder of the time period covered by this report. During this time, it was not exposed to severe high water events.

Discussion

Despite the blowouts of the pass-through antenna, instream PIT-tag detection operations in Rattlesnake Creek during the latter half of 2001 and 2002, demonstrated the feasibility and potential of such a system. We successfully detected fish from nearby habitat, and from upstream and downstream locations. Improvements in the system planned for 2003, such as multiplexing (one transceiver running multiple antennas),

additional antennas, and tags with greater read ranges (i.e., “supertags”), promise to make our instream PIT-tag detection system more efficient.

The hybrid antenna promises to be less subject to washout than the pass-through design, while still providing more coverage of the water column than the pass-by design. Future winters should provide high flows to test the hybrid antenna. Pass-through type antenna designs may be most suited to very small streams that carry light debris loads, streams that have controlled-flow conditions, or streams that have existing structures to which antennae can be anchored, as used by Zydlewski et al. (2001).

Although an instream PIT-tag detection system could be used for studies of unit scale habitat use (Armstrong et al. 1997; Greenberg et al. 2001), the propensity of fish to use the antennae as habitat is problematic. Our current system appears best suited to studies of fish movement at the reach and watershed scale. Researchers wishing to investigate unit-scale movement with instream PIT-tag readers should make the instream-antennae area undesirable to fish as habitat, yet insure that it is not an impediment to fish movement.

Our instream PIT-tag detection work in Rattlesnake Creek has helped demonstrate a linkage between the lower portion of Rattlesnake Creek and the White Salmon River. The White Salmon River and Rattlesnake Creek were isolated from anadromous fish with the construction of Condit Dam on the White Salmon River in 1913. The resident fish within the basin may exhibit different forms of potamodromy, or migration wholly within freshwater, as summarized by Gresswell et al. (1997). The trout present in Rattlesnake Creek, the White Salmon River, and Northwestern Lake may be fluvial, fluvial-adfluvial, lacustrine-adfluvial, or lacustrine (Northcote 1997). Data from the instream detection

system has shown a downstream migration of fish from Rattlesnake Creek to the White Salmon River. Our PIT-tag data demonstrates frequent use of Rattlesnake Creek by adult rainbow trout from the White Salmon River. Radio-telemetry and spawning survey data (see Report A) have provided insight into the upstream extent of use of Rattlesnake Creek by these fish. The combined data suggest a population of potadromous rainbow trout that exhibit an adfluvial migratory pattern. Further monitoring and tagging in these systems will enhance our understanding of the various life histories and populations within Rattlesnake Creek and the White Salmon River.

This first full year of operation has been an encouraging start for our studies of life-history strategies and habitat connectivity in Rattlesnake Creek and the White Salmon subbasin. Using detections by non-local migrants at the antennas, we hope to produce efficiency estimates for each antenna. With our current PIT-tagged fish in the White Salmon River, Rattlesnake Creek, and Indian Creek, and with additional tagging in 2003, we hope to more fully determine patterns of habitat use and population links between Rattlesnake Creek and the mainstem White Salmon River. Our success and lessons learned during the first year of operation suggest that continued use of this detection system will yield much valuable information.

Acknowledgements

A number of people helped with this work. Steve Stampfli allowed use of his property for the system. Sandra Downing, Bruce Jonasson, Ed Nunnallee, and Earl Prentice of NMFS were instrumental with the hardware and software installation and with troubleshooting. Brady Allen and Kyle Martens served as field crew leaders. Brian Beardsley, Jodi Charrier, Sarah Rose, Brien Rose, and Chris Schafer all helped with fish collection and tagging. An acknowledgement goes to John Baugher, our BPA Contracting Officer, and to Jim Petersen, our Project Leader at CRRL.

References

Achord, S., G. M. Matthews, O. W. Johnson, and D. M. Marsh. 1996. Use of passive integrated transponder (PIT) tags to monitor migrations timing of Snake River chinook salmon smolts. North American Journal of Fisheries Management 16:302-313.

Armstrong, J. D., V. A. Braithwaite, and P. Rycroft. 1996. A flat-bed passive integrated transponder antenna array for monitoring behavior of Atlantic salmon parr and other fish. Journal of Fish Biology 48:539-541.

Armstrong, J. D., S. Einum, I. A. Fleming, and P. Rycroft. 2001. A method for tracking the behavior of mature and immature salmon parr around nests during spawning. Journal of Fish Biology 59:1023-1032.

Bell, E., W. G. Duffy, and T. D. Roelofs. 2001. Fidelity and survival of juvenile coho in response to a flood. Transactions of the American Fisheries Society 130:450-458.

Brannas, E., H. Lundqvist, E. Prentice, M. Schmitz, K. Brannas, and B. Wiklund. 1994. Use of the passive integrated transponder (PIT) in a fish identification and monitoring system for fish behavioral studies. Transactions of the American Fisheries Society 123:395-401

Columbia Basin Fish and Wildlife Authority, PIT Tag Steering Committee. 1999. PIT Tag Marking Procedures Manual. Portland, Oregon.

Gallagher, A. S., and N. J. Stevenson. 1999. Streamflow. Pages 149-155 *in* M. B. Bain and N. J. Stevenson, editors. Aquatic habitat assessment: common methods. American Fisheries Society, Bethesda, Maryland.

Greenberg, L. A., T. Steinwall, and H. Persson. 2001. Effect of depth and substrate on use of stream pools by brown trout. Transactions of the American Fisheries Society 130:699-705

Gresswell, R. E. 1997. Introduction to ecology and management of potamodromous salmonids. North American Journal of Fisheries Management 17:1027-1028.

Gries, G., and B. H. Letcher. 2002. Tag retention and survival of age-0 Atlantic salmon following surgical implantation with passive integrated transponder tags. North American Journal of Fisheries Management 22:219-222.

Lucas, L. C. 2000. The influence of environmental factors on movements of lowland-river fish in the Yorkshire Ouse system. The Science of the Total Environment 251/252:223-232.

McCutcheon, C. S., E. F. Prentice, and D. L. Park. 1994. Passive monitoring of migrating adult steelhead with PIT tags. North American Journal of Fisheries Management 14:220-223.

Morhardt, J. E., D. Bishir, C. I. Handlin, and S. D. Mulder. 2000. A portable system for reading large passive integrated transponder tags from wild trout. North American Journal of Fisheries Management 20:276-283.

Muir, M. D., S. G. Smith, J. G. Williams, and B. P. Sandford. 2001a. Survival of juvenile salmonids passing through bypass systems, turbines and spillways with and without flow deflectors at Snake River dams. North American Journal of Fisheries Management 21:135-146.

Muir, M. D., S. G. Smith, J. G. Williams, and E. E. Hockersmith. 2001b. Survival estimates for migrant yearling spring chinook salmon and steelhead tagged with passive integrated transponders in the lower Snake and lower Columbia rivers, 1993-1998. North American Journal of Fisheries Management 21:269-282.

Northcote, T. G. 1997. Potamodromy in salmonidae – living and moving in the fast lane. North American Journal of Fisheries Management 22:1029-1045.

Nunnallee, E. P., E. F. Prentice, B. F. Jonasson, and W. Patten. 1998. Evaluation of a flat-plate PIT tag interrogation system at Bonneville Dam. Aquacultural Engineering 17:261-272.

Ombredane D., J. L. Baglinière, and F. Marchand. 1998. The effects of passive integrated transponder tags on survival and growth of juvenile brown trout (*Salmo trutta* L.) and their use for studying movement in a small river. Hydrobiologia 371/372:99-106.

Prentice, E. F., T. A. Flagg, and C. S. McCutcheon. 1990. Feasibility of using implantable passive integrated transponder (PIT) tags in salmonids. American Fisheries Society Symposium 7:317-322.

Skalski, J. R., S. G. Smith, R. N. Iwamoto, J. G. Williams, and A. Hoffman. 1998. Use of passive integrated transponder tags to estimate survival of migrant juvenile salmonids in the Snake and Columbia rivers. Canadian Journal of Fisheries and Aquatic Sciences 55:1484-1493.

Zydlewski, G. B., A. Haro, K. G. Whalen, and S. D. McCormick. 2001. Performance of stationary and portable passive transponder detections systems for monitoring of fish movements. Journal of Fish Biology 58:1471-1475.

Table 1. Number of rainbow trout (RBT) and cutthroat trout (CTT) PIT tagged in Rattlesnake Creek, Indian Creek, and White Salmon River during 2001 and those detected at instream readers, 23 August 2001 through 31 December 2002. Unit PT = pass-through; Unit PB = pass-by.

Location	Species	No. PIT tagged 2001	No. PIT tagged 2002	Total number detected	Number detected by antenna[a]	
					Unit PT[b,c]	Unit PB
Rattlesnake Cr.						
LRAT	RBT	185	167	25	21	15
	CTT	5	6	0	-	-
	BRK	0	1	0	-	-
BRAT	RBT	315	348	3	2	3
MRAT	RBT	36	86	0	-	-
URAT	RBT	0	51	0	-	-
	Total	**544**	**659**	**28**	**23**	**18**
Indian Cr.	CTT/RBT	30	72	1	1	1
Mill Cr.	RBT	0	20	0	-	-
White Salmon R.						
Upper	RBT	43[d]	34[e]	10	5	10
Lower	RBT	16[f]	92[g]			
	Grand Total	**633**	**877**	**39**	**29**	**29**

[a] = System was not functional on 17 October 2001, 21 November 2001, from 29 November 2001 to 6 December 2001, and from 12 April 2001 to 15 April 2001.
[b] = PT unit was not functional from 14 December 2001 to 11 March 2002, from 12 May 2002 to 29 May 2002, and from 1 July 2002 to 2 July 2002.
[c] = On 10 June 2002, the PT antenna was replace with the hybrid design.
[d] = Includes 10 fish with both a PIT tag and radio tag.
[e] = Includes 10 fish with both a PIT tag and radio tag.
[f] = Includes 7 fish with both a PIT tag and radio tag.
[g] = Includes 10 fish with both a PIT tag and radio tag.

Figure 1. Photos of the pass-by antenna at low flow in Rattlesnake Creek.

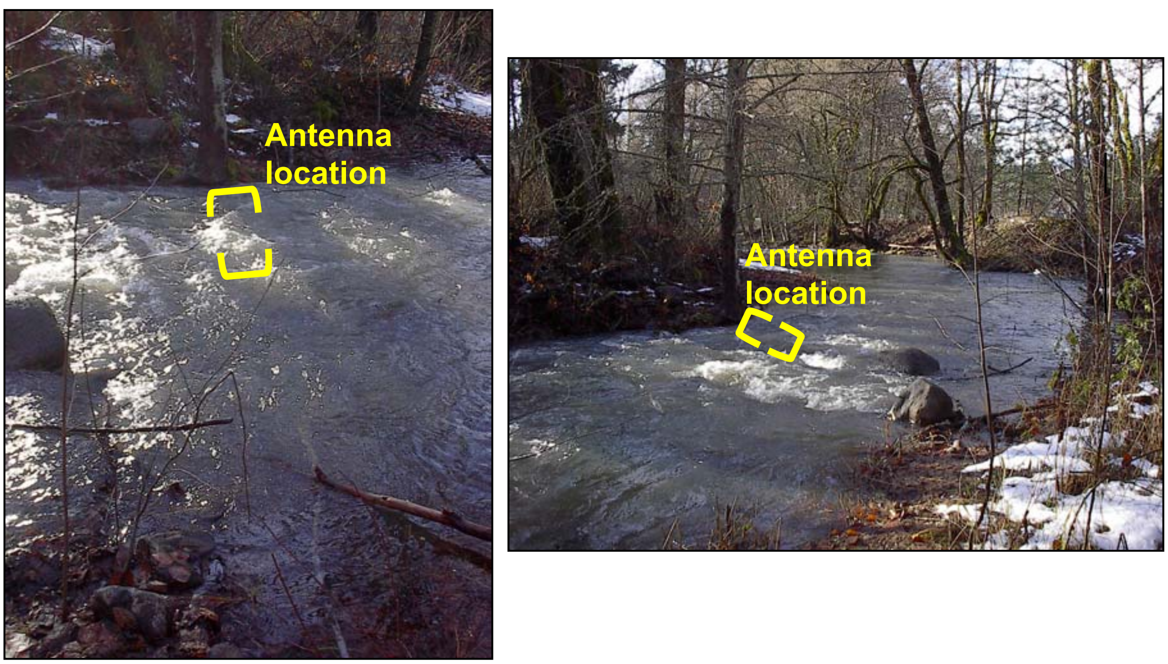


Figure 2. Photos of the pass-by antenna at high flow in Rattlesnake Creek.

Figure 3. The pass-through antenna at low flow in Rattlesnake Creek.

Figure 4. The pass-through antenna at high flow in Rattlesnake Creek.

Figure 5. The pivoting antenna ("hybrid") at low flow in Rattlesnake Creek. Flow is from left to right, the pivot points are on the upstream tube.

Figure 6. Transceivers and housing at Rattlesnake Creek.

Figure 7. Fixed-site radio receiver at Rattlesnake Creek.

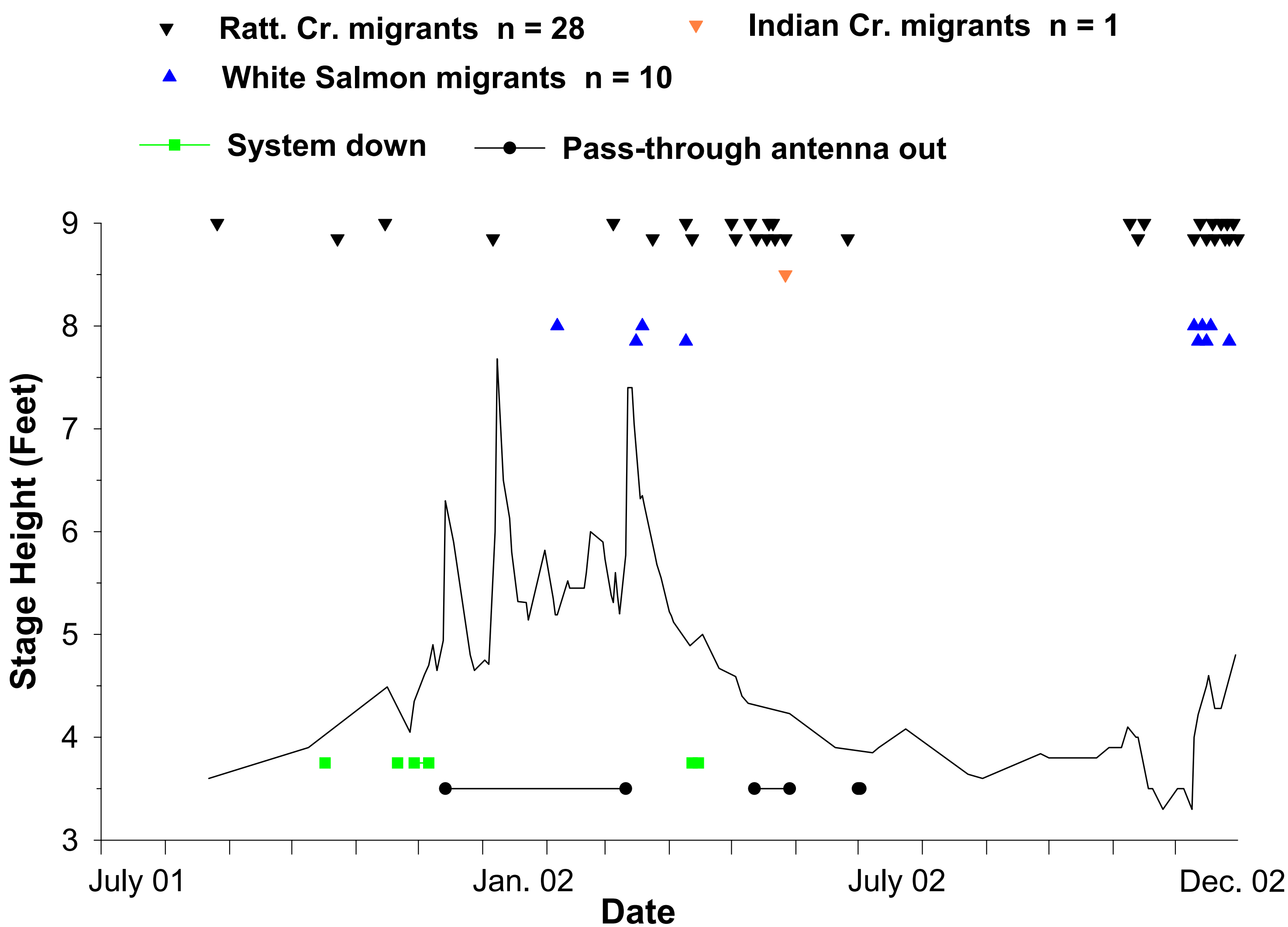


Figure 8. Timing of detections of PIT-tagged rainbow and cutthroat trout at a fixed PIT-tag detection system at Rkm 0.2 in Rattlesnake Creek and stage height of Rattlesnake Creek at the Highway 141 bridge for August 2001 through December 2002. Also shown are periods when the detection system was inoperable or the pass-through antenna was out. All fish reported are considered non-local to the antennas (tagged and released over 50 m from the detection site) and were assumed to be migrating.