YAKIMA/KLICKITAT FISHERIES PROJECT – KLICKITAT MONITORING AND EVALUATION

2009 Annual Report

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The Confederated Tribes and Bands of
The Yakama Nation

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Introduction

This report describes the results of monitoring and evaluation (M&E) activities for salmonid fish populations and habitat in the Klickitat River subbasin in south-central Washington. The M&E activities described here were conducted as a part of the Bonneville Power Administration (BPA)-funded Yakima/Klickitat Fisheries Project (YKFP) and were designed by consensus of the scientists with the Yakama Nation (YN) Fisheries Program. YKFP is a joint project between YN and Washington Department of Fish and Wildlife (WDFW). Overall YKFP goals are to increase natural production of and opportunity to harvest salmon and steelhead in the Yakima and Klickitat subbasins using hatchery supplementation, harvest augmentation and habitat improvements. Klickitat subbasin M&E activities have been subjected to scientific and technical review by members of the YKFP Science/Technical Advisory Committee (STAC) as part of the YKFP's overall M&E proposal. Yakama Nation YKFP biologists have transformed the conceptual design into the tasks described. YKFP biologists have also been involved in various Columbia basin regional efforts to standardize M&E data collection and reporting protocols, and are working towards keeping Klickitat M&E activities consistent with applicable standards.

This report describes progress and results for the following major categories of YN-managed tasks under this contract:

1. Adult salmonid monitoring – monitoring adult salmonid population sizes, demographics, and spatial distribution via spawner surveys, adult salmonid trapping at the Lyle Falls Fishway on the lower Klickitat River, and radio telemetry
2. Juvenile and resident salmonid monitoring – monitoring outmigration, survival, spatial distribution, and life history patterns of juvenile and resident salmonids via smolt trapping, stream population surveys, and PIT tagging
3. Genetic analysis – characterizing genetic traits of salmonid stocks, and developing YKFP supplementation broodstock collection protocols for the preservation of genetic variability, by refining methods of detecting within-stock and between-stock variation
4. Habitat monitoring – monitoring physical habitat parameters and ecosystem responses to habitat actions via habitat surveys, sediment, temperature, water quality, and streamflow monitoring

These tasks have elements of status and trend monitoring of fish populations and habitat, as well as incorporating designs aimed at monitoring effectiveness of hatchery and habitat actions in the Klickitat subbasin.

Additional and updated information for this project is also available at the YKFP website (www.ykfp.org/klickitat/).

Acknowledgements

YN Fisheries/YKFP technicians (Sandy Pinkham, Rodger Begay, Roger Stahi, Jeremy Takala, Bennie Martinez, and Scott Spino) collected most of the field data presented in this report. YN Fisheries/YKFP Klickitat subbasin coordinator Bill Sharp (under Klickitat Management, Data, & Habitat Project, BPA Project # 198812035) provided oversight and management, and habitat restoration specialist Will Conley (under the Klickitat Watershed Enhancement Project, BPA

Project # 199705600) assisted with data management and database report development for many habitat monitoring tasks. Jeanette Burkhardt, YN/YKFP watershed planner/outreach coordinator, provided website content development. Shawn Narum and Jon Hess with Columbia River Inter-Tribal Fish Commission (CRITFC) provided genetic analysis information. Lyle adult trap operation and population estimation began as a joint project between WDFW and YN/YKFP – methods have been adapted from that effort as begun by Steve Gray and Dan Rawding of WDFW. U.S. Geological Survey Columbia River Research Laboratory staff (Brady Allen, Ian Jezorek, Carrie Munz, Phil Haner, Jamie Sprando, Jessica Fischer, Gabriel Hansen, Cara Holem-Bell, Christy Barszewski, and Scott Evans) installed and maintained PIT and radio tag equipment, and collected field data. YN Water Resources Program staff (Scott Ladd and Rocco Clark) collected streamflow data.

Work Elements

Spawning ground surveys (redd counts)

Objective: Monitor spatial and temporal redd distribution of spring and fall Chinook, coho, and steelhead, and collect biological data from carcasses. Spawning ground surveys provide a means of monitoring annual adult spawner escapement as well as spawner distribution.

Methods: Regular foot and/or raft surveys were conducted within the known geographic range for each species. Surveys were generally conducted every two weeks in each river reach. Individual redds were counted and their locations recorded using handheld GPS units. Counts of live fish and carcasses were also recorded. Carcasses were examined for sex determination, egg/milt retention (percent spawned), and presence of CWT tags or external experimental marks. Observations of carcasses with floy tags (inserted into adult salmon and hatchery steelhead at the Lyle Falls adult trap at RM 2.4) aided in population estimation. Scale samples were also taken from carcasses using methods outlined in Crawford et al. (2007).

Spawning ground surveys were conducted as follows: spring Chinook – mid August through early October; fall Chinook – late October through mid December; coho – late October through late January; steelhead – late February through mid June. Attempts were made to cover the entire known spawning range of each species, although in some cases, access, flows, and visibility limited surveys. Stream reaches were surveyed multiple times during the spawning periods, with most reaches receiving at least 2-3 passes, and survey passes being conducted approximately two weeks apart in each reach. Subsequent survey passes generally continued in each reach until no live spawners were observed. Methods generally followed those of Gallagher et al. (2007).

Results: Spawner survey results are briefly discussed by species below. Figures 1 through 4 show the observed spawning distribution in 2009 for spring Chinook, fall Chinook, coho, and steelhead, respectively. A tabular summary of spawning ground survey results by species is presented in Appendix A.

Spring Chinook

Spring Chinook redd counts provide a more accurate indicator of annual spawner escapement than other species due to the fairly limited geographic area of spawning and relatively good survey conditions in most years (low flows and good visibility). Spring Chinook surveys were conducted from August 18 to October 3, 2009, covering over 60 river miles. Natural spring Chinook spawning typically occurs in the Klickitat mainstem upstream of the Little Klickitat River confluence (RM 20), with most of the spawning occurring upstream of the Big Muddy Creek confluence (RM 54) up to Castile Falls (RM 64). Additional spawning occurs above Castile Falls which historically had some natural passage and had also been seeded in recent years (2000 and 2002-4) by transporting and releasing surplus adult spring Chinook that returned to the Klickitat Hatchery. No adult fish have been transported above Castile Falls since 2004. Recently completed (summer 2005) improvements at the Castile Falls fish ladders have enhanced fish passage, correcting problems with the original 1960s ladders which had actually impaired natural passage and may have decreased fish numbers above the falls from historic levels. In 2009 above Castile Falls, four redds were observed, and 9 live spring Chinook adults were observed. While this was an increase over what was observed in 2008 (0 redds and only 1 live fish), it was a substantial decrease from 2007 (in which 36 redds were observed above Castile Falls) when there had appeared to be an increasing trend in redd counts above Castile following the recently-completed passage improvements (see Figure A2 in Appendix A). A total of 70 redds were observed in the Klickitat River from above Castile Falls down to about RM 27 below Stinson Flats. Most of these redds (47) were located in the 10.3 river miles between Big Muddy Creek and Castile Falls. The total redd count of 70 is among the lowest on record since 1989 (see Table A2 in Appendix A). This reflects what have appeared to be relatively low returns of wild spring Chinook in recent years in the Klickitat River (see also the Adult salmonid monitoring section), giving some cause for concern regarding the status and recent trend of this depressed population. A total of 11 spring Chinook carcasses were counted; of these adipose fin status could be determined on nine fish. One of these 9 carcasses was adipose-clipped; the rest were wild fish (Klickitat Hatchery spring Chinook are 100% adipose fin clipped). The hatchery fish carcass was found just above Big Muddy Creek. See Table A1 in Appendix A for detailed results of 2009 spring Chinook spawner surveys. See Table A2 and Figure A1 for a summary of spring Chinook redd counts (as well as estimated total run size in the Klickitat River) from 1989-2009.

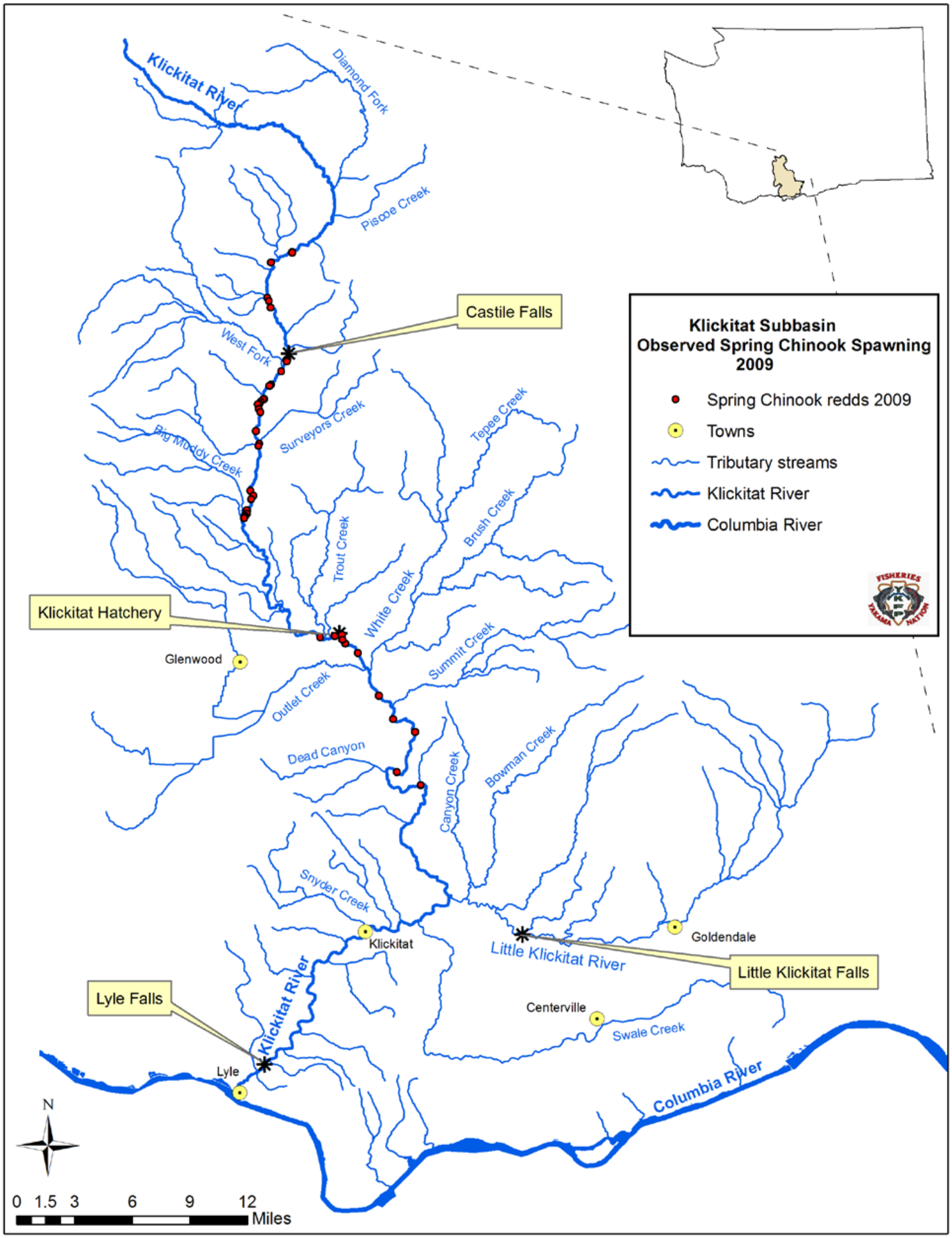

Figure 1. Observed spring Chinook spawning distribution in the Klickitat subbasin in 2009.

Fall Chinook

Fall Chinook are mainstem spawners and generally utilize the lower portion of the river, downstream of the Klickitat Hatchery. Surveys were conducted from October 28 to December 3, 2009. The total 2009 redd count was 754, which is higher than redd counts of the previous few years and is similar to an average redd count over the period of record for fall Chinook surveys. The 2009 counts were also probably biased somewhat low due to river ice, then snow, rain, and high turbidity in early and mid-December, which precluded surveys for much of the month. This would indicate that the 2009 Klickitat fall Chinook return was at least average to slightly above average. The highest redd densities were found in the 5.5 miles from Klickitat Hatchery downstream to Summit Creek. This segment contained 313 redds (42% of the total redd count) with a density of about 57 redds per mile. This segment also contained the largest number of observed live fall Chinook adults. Average redd densities observed in 2009 were about 19 redds per mile. A total of 151 fall Chinook carcasses were counted; none were floy-tagged. Of the carcasses for which adipose fin presence/absence could be determined, 9 out of 151 (6%) were adipose-clipped; the rest were either wild or unmarked hatchery fish. See Table A3 in Appendix A for detailed results of 2009 fall Chinook spawner surveys. See Table A4 for a summary of fall Chinook redd counts from 1995-2009.

Coho

Coho spawning generally occurs in the lower reaches of most lower river tributaries and the mainstem below Parrott's Crossing (RM 49.4). Coho spawner surveys began on November 17, 2009 and continued until February 25, 2010. River ice, followed by snow, rain, and high turbidity in early and mid-December, precluded surveys for much of the month. High flows and turbidity in mid January also limited surveys for about 1 week. These factors likely biased the redd counts somewhat low for 2009-10. The total redd count was 214. More redds were observed in the reach below the Klickitat Hatchery (73) than in any other reach. A large number of redds (65) were also observed in Canyon Creek below Lyle Falls. Redds were also observed in Bowman, Swale and Snyder creeks. Live fish were also observed in Summit and Logging Camp creeks. No floy-tagged fish were observed. Of the carcasses for which adipose fin presence/absence could be determined, 66 out of 155 were adipose-clipped; the rest were either wild or unmarked hatchery fish. See Table A4 in Appendix A for detailed results of 2009-10 coho spawner surveys.

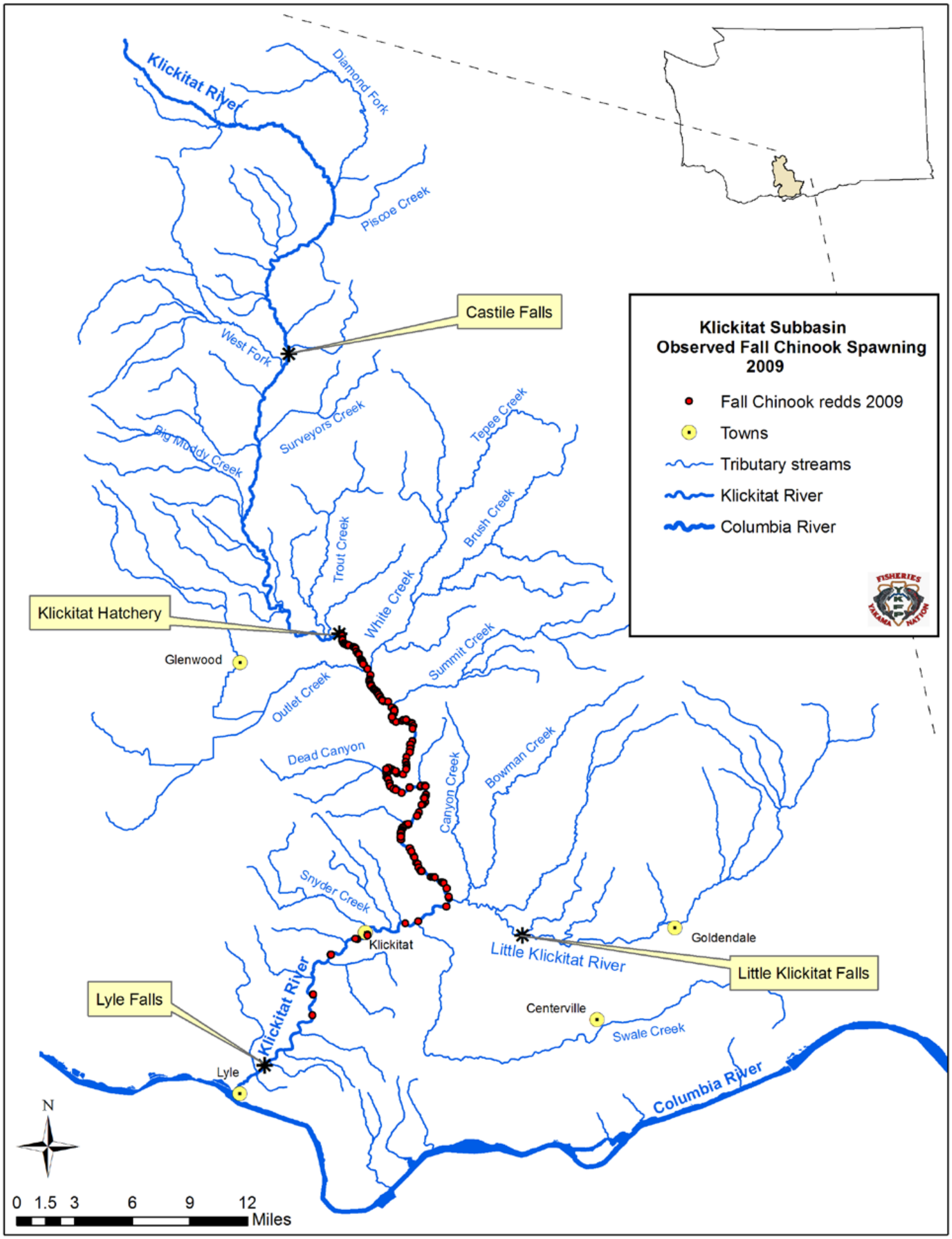

Figure 2. Observed fall Chinook spawning distribution in the Klickitat subbasin in 2009.

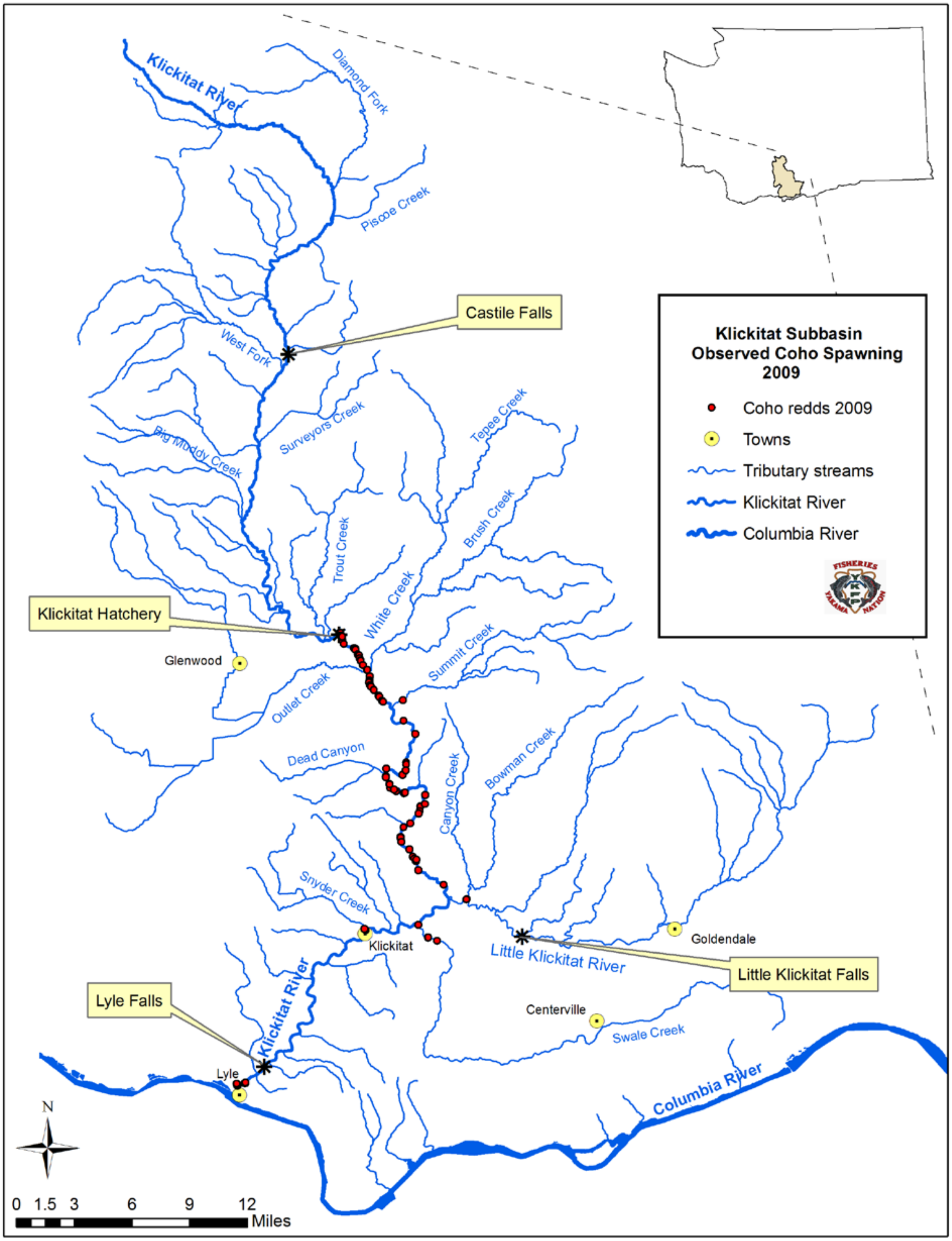

Figure 3. Observed coho spawning distribution in the Klickitat subbasin in 2009-10.

Steelhead

Steelhead spawner surveys typically span two annual reporting periods due to the spawn timing (February through May). In this report we present final steelhead spawning data from spring 2009 and a progress report for spring 2010. Surveys in 2009 began in early February and ended in mid June.

In most years, high spring flows and turbidity limit the effectiveness of the mainstem Klickitat steelhead redd surveys, leading to an unavoidable bias toward undercounting of redds. In 2009, snow and high flows and turbidity limited access and surveys in the White Creek watershed and the upper Klickitat River until late April, then rain and resulting high flows in early May further delayed surveys in these reaches. Continued high flows above Castile Falls into June prevented complete surveys in the upper Klickitat River. All of these factors probably biased the total redd count quite low.

The total redd count was 62, and included 10 in the mainstem Klickitat and 52 in tributaries. No redds were observed above Castile Falls (see the spring Chinook spawner survey results section for a description of passage at Castile Falls); however, only limited late-season surveys were conducted in the upper Klickitat. The White Creek watershed (including Tepee and Brush creeks) had 58% of the total observed redds. Summit Creek, Dead Canyon Creek, Little Klickitat River, Swale Creek, and Snyder Creek each had observed redds as well. See Table A6 in Appendix A for detailed results of 2009 steelhead spawner surveys.

Steelhead spawner surveys for 2010 also began during this reporting period. High flows and turbidity also limited surveys in some of the same areas as in 2009, but mainstem Klickitat survey conditions were better early in the season and overall redd counts are not biased as low as 2008 and 2009. Final results will be presented in the 2010 annual report.

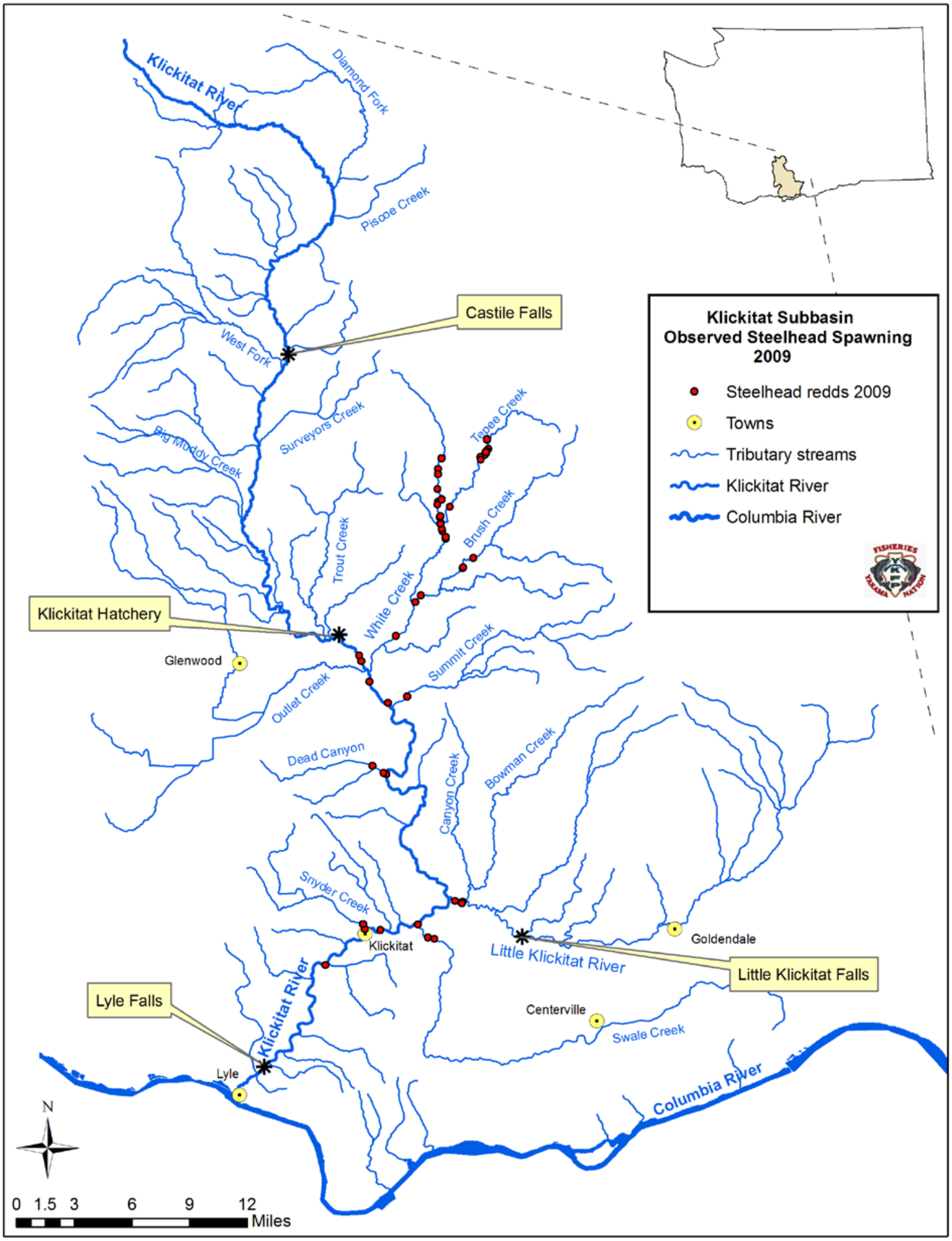

Figure 4. Observed steelhead spawning distribution in the Klickitat subbasin in 2009.

Adult salmonid monitoring at Lyle Falls fishway

Objective: Monitor adult salmonid passage, run size, and run timing, and collect biological data at the Lyle Falls fishway on the lower Klickitat River.

Methods: Adult salmonids were trapped, enumerated, and then released in the upstream end of the Lyle Falls fish ladder at RM 2.4 on the Klickitat River. Biological data were collected from individual fish including fork length, sex, scales, genetic samples, body and gill color, existing marks, and presence of CWT (coded wire tag) and PIT (passive integrated transponder) tags. The Lyle Falls fishway was constructed in the early 1950s to improve fish passage in the lower Klickitat River; however the natural falls are not a complete barrier and many adult salmonids do ascend the falls (counts of fish in the adult trap are not a census of fish returning to the Klickitat River). To monitor run size, marks (opercle punches and floy tags) were administered and subsequently used along with a second sampling event to develop mark-recapture population estimates. Spring Chinook population estimates were made following recapture of hatchery fish that voluntarily returned to the adult holding pond at the Klickitat Hatchery. Carcass recovery during spawner surveys also potentially provides recapture data on marked fish for salmon species, but to date too few marked carcasses have been observed to yield precise population estimates with that method. Steelhead recaptures occurred via anglers; a select group of anglers fishing at various locations on the middle and lower Klickitat River (but above Lyle Falls) recorded total numbers of steelhead caught and numbers of tagged steelhead caught during the sport steelhead fishing season (June 1 – November 30). Steelhead in the Klickitat River are listed as threatened under the Endangered Species Act (ESA), and only hatchery steelhead were tagged with floy tags at Lyle Falls. For population estimation, wild steelhead were assumed to use the fish ladder in the same proportion as hatchery fish, and the same capture-recapture ratio was used to generate wild steelhead estimates (using the total number of wild steelhead trapped at Lyle Falls as the "marked" fish). Steelhead were also divided into two runs for estimation purposes: summer run (those passing Lyle Falls from May 1 through November 30) and winter run (those passing Lyle Falls December 1 through April 30). The mark-recapture population estimates were generated for summer steelhead (hatchery and wild), but for winter steelhead due to the lack of a recapture effort (there is no sport steelhead angling season during the winter run), trap counts for the December-April period were used as a census count. This assumes all steelhead during the winter period use the fish ladder and do not ascend the natural falls; although this is what is believed to occur at falls on other nearby rivers such as the Wind and Kalama due to low water temperatures (Gray 2006), this assumption requires further evaluation on the Klickitat River. Hatchery steelhead passing Lyle Falls December 1 through April 30 were counted as summer steelhead because all hatchery juveniles released in the Klickitat River are summer-run Skamania Hatchery stock. The counts of these hatchery fish were simply added to the mark-recapture estimates for summer hatchery steelhead.

Population estimates were generated using the Peterson estimator with modification for small sample size (Chapman 1951, as described in Seber 1982):

$$N = \frac{(m-1)(c-1)}{(r-1)} - 1$$

where N = population estimate (in this case N represents the population/run size estimate at Lyle Falls), m = the number of fish marked or tagged and released back into the population, c = total number of fish captured at the second sampling event, and r = number of fish captured in the second sampling event that were marked or tagged (recaptures). Variance was estimated as:

$$S^2 = \frac{(m+1)(c+1)(m-r)(c-r)}{(r+1)^2(r+2)}$$

(Seber 1982). Normal confidence intervals can be calculated as:

$$95\%\ CI = 1.96 * S$$

However, a non-normal confidence interval calculation with improved coverage was generally used (Arnason et al. 1991, as described in Gray 2006):

$$T = N^{-1/3}$$
$$S(T) = T * \frac{S(N)}{3N}$$
$$(T_L, T_U) = T \pm 1.96 * S(T)$$
$$(N_L, N_U) = (1/T_L^3\,, 1/T_U^3)$$

In cases where winter steelhead trap counts were added to population estimates (as described above), these assumed census counts were also simply added to the upper and lower confidence limits that resulted from the above equations.

Results: A total of 3813 adult steelhead, spring Chinook, fall Chinook, and coho salmon were trapped and released at Lyle Falls during this reporting period. Fish counts by date, species, and marks are presented in Table B1 (Appendix B). Results of scale sampling are presented in the Scale Analysis section and in Appendix D and results of genetic sampling are presented in the Genetic Analysis section.

Results of spring Chinook mark-recapture population estimation are presented in Table B2 (Appendix B) and also in Figure A1 (Appendix A). The run size estimates for wild spring Chinook in for the last 3 years have not been very high (averaging about 500 fish) and do not seem consistent with historical reports of a "large run of spring chinook" (Bryant 1949). Although Klickitat spring Chinook, as part of the Middle Columbia River evolutionarily significant unit, are not listed under the ESA, they are rated as "depressed" by WDFW's Salmonid Stock Inventory (SaSI) due to chronically low returns (WDFW 2002). These estimates along with recent results from Klickitat spring Chinook redd counts (see Spawning Ground Survey section) warrant some level of concern regarding the status and trend of this native population.

Steelhead population estimates are presented in Table B3 (Appendix B). Winter steelhead counts are also presented. The 2009-10 estimate represents the first estimate after a two-year gap resulting from difficulties setting up angler recapture data collection. Also in 2009, a large run of hatchery steelhead destined for the upper Columbia and Snake rivers was observed in the lower mainstem Columbia River (FPC 2009). From floy tag return reports and preliminary radio tracking (see Radio telemetry monitoring section), it is believed that a substantial number of steelhead migrating up the Columbia River dip into the Klickitat River during the summer and fall months before continuing migration up the Columbia, and it is possible that presence of these fish in the Lyle adult trap may have biased the 2009 hatchery steelhead estimate high.

Current updated daily count data is also available at the YKFP website (http://www.ykfp.org/klickitat/Data_lyleadulttrap.htm).

Juvenile outmigration monitoring

Objective: To continue developing methods of using rotary screw traps for long term monitoring of juvenile production in the upper and lower Klickitat River. Screw traps provide a means of estimating outmigration timing and magnitude on a daily, seasonal or annual basis. Screw traps also provide a means of collecting biological data and samples, and tagging juvenile fish for survival and smolt-to-adult rate estimation.

Methods: Floating rotary screw traps were fished at two locations in 2009-2010. One trap located just above Lyle Falls (RM 2.8) was operated on a year-round basis. A second trap located above Castile Falls (RM 64.6) was fished seasonally as access and flows allowed.

At each daily trap check, environmental and trap data is recorded along with biological data on 10 to 30 of each salmonid species represented. The excess and non-salmonid fish are tallied by species. Biodata consists of fork lengths, weights and smoltification stage. During this reporting period, PIT tagging was also begun at the Lyle screw trap (see PIT tagging section). Environmental and trap data recorded includes weather conditions, water temperature and clarity, trap cone revolution speed, and debris load in the trap cone and live box.

Trap efficiency studies have been conducted at both traps in order to establish a fish-entrainment-to-river-discharge relationship. During each efficiency trial, a sample of fish (generally ranging from 50 to 500 fish) was marked with a fin clip and released a short distance (approximately 1 mile) upstream of the trap. The proportion of marked fish that were recaptured over the following week to ten days allowed for an estimate of the trap's catch rate. Efficiency trials have been conducted at various streamflows over the last several years, but no additional trials were conducted in 2009.

In an effort to supplement screw trapping and provide a more continuously-operating monitoring tool, a trial study was conducted using hydroacoustic equipment to monitor outmigrating juvenile salmonid abundance in the lower Klickitat River. This equipment has successfully been used to monitor smolt abundance at various sites including on the Columbia River. In June 2009, staff from Hydroacoustic Technology Incorporated (HTI) conducted, as a subcontract under the Klickitat M&E project, a feasibility assessment using a portable split-beam echo sounder at a potentially suitable site at RM 3 on the Klickitat River. The echo sounder was deployed for approximately a 1-day period, placed near the river bank and oriented to aim horizontally and perpendicular to river flow. Data collected were then evaluated for ability to accurately estimate smolt abundance. Detailed methods are provided in Appendix K and results of this trial are discussed below.

Results: The five-foot trap located above Castile Falls was fished from June 22, 2009 to October 8, 2009. High flows in the upper Klickitat River delayed the start time for this trap until late June. The eight-foot Lyle Falls trap was fished throughout much of the year, except during periods of very high flows and debris loads, and during large releases of hatchery fish. High flows in spring months limited fishing times, and several repairs needed on this trap precluded fishing for much of August, September, and October. The catch of each trap, along with days per month the trap fished, is summarized on a monthly basis and presented in Appendix C.

Developing flow/entrainment relationships and estimating trap efficiency (the percentage captured of the total number of fish moving past the trap site) is a continuing project goal. For the Castile Falls and Lyle Falls trap, results of efficiency testing to date are presented in Appendix C. For the Castile trap, efficiency estimates ranged from approximately 19% to 45%. For the Lyle trap, efficiency estimates ranged from 1.2% to 20.1%. For both traps, efficiency depends largely on streamflow, but other factors (such as trap position in current and species/size of fish) also play a role. These relationships will continue to be developed, with the overall goal of producing valid juvenile production estimates. Gaps in trap operation during high flows and multiple large hatchery releases during peak smolt outmigration periods (over 8 million hatchery smolts are released in the Klickitat River between March and June) continue to make precise smolt abundance estimates difficult to obtain.

Results of the hydroacoustic trial indicated that the lower Klickitat River generally had too much turbulence to be able to detect smolt-sized fish and accurately distinguish them from entrained air bubbles in the river. A more detailed description of this study trial can be found in the HTI report in Appendix K. Although at some flow levels certain sites on the lower Klickitat River appear suitable for hydroacoustic monitoring, spring flows during peak smolt outmigration times cause sufficient turbulence to create acoustic “noise” and interfere with hydroacoustic signals. Sites where hydroacoustic equipment has been successfully used generally have more laminar flow. It was determined that without significant amounts of research and development, smolt monitoring using this method on the Klickitat River was infeasible and was not pursued further.

The inability of the hydroacoustic equipment to accurately count smolts and the lack of precise smolt abundance estimates to date from screw trapping points to a need to revise methods and/or devote more resources to this task. The large multiple gaps in trap data from various hatchery releases and high flows have to date made precise estimates unobtainable. Rough monthly estimates for some species have been generated, but are undergoing further development. These estimates use monthly catch expanded for percent of the month fished, and expanded again based on mean monthly flow and trap efficiency at that flow. Past efforts with existing staff to fish traps during hatchery releases and high spring flows have resulted in some fish mortality and trap damage; additional staff and more frequent trap checks during certain periods may help reduce these gaps, and this will likely be attempted in the future. However, it seems likely that smolt abundance estimates on the Klickitat will not have high precision.

Juvenile and resident salmonid population surveys

Objective: Determine the spatial distribution and relative abundance of salmonids throughout the basin to guide design of enhancement program, and to evaluate effectiveness of habitat restoration/enhancement projects.

Methods: Electrofishing surveys were conducted to estimate juvenile steelhead/resident rainbow trout (*O. mykiss*) abundance in eight reaches of Tepee Creek and White Creek in 2009. The four reaches in Tepee Creek will be the location of a habitat improvement project planned for 2011 under the Klickitat Watershed Enhancement Project (BPA Project # 199705600), with the objectives of raising streambed elevation, increasing channel sinuosity, and restoring riparian meadow conditions. The four reaches in White Creek are control reaches with analogous conditions to the Tepee Creek treatment reaches. The 2009 surveys provided pre-project data for comparisons to post-project fish abundance data, as part of a before-after control-impact design (Roni et al. 2005). The fish abundance surveys are part of a larger, ongoing habitat effectiveness study that is also monitoring responses in invertebrate communities and riparian vegetation at these sites.

Two-pass mark-recapture methods were used to estimate fish abundance at these sites (following methods similar to those of Rosenberger and Dunham 2005). Block nets were set up at the upstream and downstream ends of the reach, fish captured via backpack electrofisher were marked with Passive Integrated Transponder (PIT) tags on the first pass, then were released back into the blocknetted reach. A second pass on the following day recorded newly captured fish and tagged fish within the same blocknetted reach. A Petersen population estimate and normal confidence intervals (equations described in Adult salmonid monitoring section) were generated for each reach. PIT-tagged fish were also part of the White Creek steelhead PIT tagging study described in the PIT tagging section.

Results: Resulting *O. mykiss* population estimates are presented in Table D1 (Appendix D). Numbers of fish tagged and recaptured in some reaches were lower than expected, yielding less precise estimates than anticipated. Future surveys at these sites will continue to evaluate and refine the two-pass mark-recapture method and compare it to standard multiple pass depletion electrofishing methods for population estimation. Additional pre-project surveys are planned, with post-project data collection planned for 2012.

Scale analysis

Objective: Determine age composition and length-at-age of adult salmonid stocks. Results are used by state and tribal fisheries managers for run reconstruction and forecasting.

Methods: Scale samples were collected from adult carcasses encountered during spawner surveys and from fish captured at the Lyle Falls adult trap (RM 2.4 on the Klickitat River). Scale collection follows methods outlined in Crawford et al. (2007). Scales were analyzed by YKFP/YN Fisheries Program staff; scales are pressed and read according to methods described in DeVries and Frie (1996). Coded wire tags (CWT), collected from carcasses on spawner surveys, were also used to validate and correct age determinations from scale reading when possible. Age data are presented in the "year-old" format as described in Groot and Margolis (1991), i.e., number of years old for an individual fish represents number of winters starting with the egg stage.

Results: Scale samples were obtained from a total of 186 adult spring Chinook, fall Chinook, and coho salmon carcasses during 2009-2010 spawner surveys. A total of 157 adult spring Chinook, fall Chinook, and coho salmon were sampled for scales in the Lyle adult trap in 2009-2010. A total of 329 steelhead were sampled for scales at the adult trap in during this reporting period (steelhead carcasses are rarely encountered on spawner surveys). A brief description of the results by species is below. Appendix E presents the age breakdown by sex with accompanying fork and postorbital-hypural length averages and ranges for each species sampled. Due to a lack of 100% marking of fall Chinook and coho stocks, origin (hatchery or wild) of these fish sampled could not always be reliably determined. Klickitat Hatchery spring Chinook salmon are 100% adipose-clip marked, as are Skamania Hatchery steelhead released in the Klickitat River, and results for these stocks are presented in Appendix E separately for adipose-clipped fish and adipose-present fish.

Scale samples were obtained from a total of 6 spring Chinook carcasses during 2009 spawner surveys; 1 of these was adipose-clipped. Of scale-sampled spring Chinook at Lyle adult trap, 125 out of 146 were adipose-clipped. Five-year-old fish comprised a majority (67%) of the spawner survey fish and 4-year-old fish comprised a majority (60%) of the adult trap fish.

During 2009 spawner surveys 125 fall Chinook carcasses were sampled for scales. Seven fall Chinook were also sampled at the Lyle adult trap in 2009. For spawner survey samples, 61.6% were 4-year-olds and 31.2% were 5-year-olds. At the adult trap, 4- and 5-year-olds made up 57.1% and 28.6% of the total, respectively.

For coho, 55 fish were sampled on spawner surveys and 4 fish were sampled at Lyle adult trap (large numbers of coho were counted at the adult trap in 2009-10, but most were not scale sampled). Nearly all were 3-year-olds (96.4% of spawner survey fish and 100% of adult trap fish).

A total of 329 steelhead were sampled at the adult trap from 5/1/2009 to 4/30/2010 (94 hatchery fish and 235 wild fish). Most of these fish were 4-year-olds (56.4% of hatchery fish and 50.6% of wild fish).

Sediment monitoring

Objective: Monitor stream sediment loads associated with anthropogenic factors (e.g., logging, agriculture and road building), affecting streams basin wide. Excessive sediment loads can significantly decrease egg-to-fry survival, and can depress survival and alter habitat for many other life stages of salmonids.

Methods: Twelve sites throughout the basin (8 in the mainstem Klickitat, 3 in Diamond Fork Creek, and 1 in White Creek) were sampled in 2009. See Figure F1 in Appendix F for a map showing locations of sampling sites. Twelve samples were collected from representative spawning gravels at each site (from 3 different riffles at each site, 4 samples from each riffle) using McNeil core gravel samplers. Samples from each site were analyzed to estimate the percentage of fine particles present and determine the particle size distribution. Samples were collected and analyzed using TFW Salmonid Spawning Gravel Composition Survey methodology (Schuett-Hames et al. 1999a). Information gathered was incorporated into the EDT model and used to characterize sediment levels throughout the basin.

Results: Detailed results from sediment monitoring at these 11 sites sampled in 2008, including particle size distributions and percentages of fine sediments (presented as particles < 1.7 mm and particles < 6.73 mm), are presented in Appendix F. Some general trends that are indicated by the data are described below. Monitoring at most of these sites began in 1998, 1999, or 2000, and continued through 2009. Changes in channel morphology at 2 sites (Klickitat R. near Stinson Flats and Klickitat R. at Ice House Park) led to sampling of different riffles than what had been sampled in previous years; recent data are presented for these sites but is not lumped with past data for trend analysis.

Percentage of fines at many sites appears to be fluctuating over periods of several years, with no long-term directional trend readily apparent. Fines percentages at some of the sites appear to be fluctuating within the range of approximately 10% to 20% (particles < 1.7 mm). These sites tend to be the higher elevation sites, and include: Klickitat R. at McCormick Meadows, Klickitat near Cow Camp, and the Diamond Fork sites. Fines percentages at most other sites range higher, up to 25-30%. One site that does appear to show an increasing trend in fine sediments is Klickitat R. near Leidl Bridge, with particles < 1.7 mm generally increasing from 21 to 29%, and particles < 6.73 mm increasing from 26 to 39% over the period of 1998 to 2009.

Data is also available at the YKFP website (http://www.ykfp.org/klickitat/Data_SedRpts.htm).

Temperature and water quality monitoring

Objective: Monitor stream temperatures and record water quality measurements on selected tributaries and within selected habitat survey reaches on a seasonal basis.

Methods: Stream temperatures were monitored via continuously-recording Onset thermographs (set to record at 30-min. intervals) at 35 locations on 23 streams within the Klickitat subbasin. Air temperatures were also monitored at five locations in lower-, mid-, and upper-elevation areas within the subbasin. Portable field meters were used to measure and record the following parameters on a seasonal basis at these same sites: temperature, dissolved oxygen, conductivity, pH, and turbidity. See Appendix G for a map and tabular description of thermograph locations. Temperature and water quality data are being stored in relational databases.

Results: Summaries of temperature data for each location are presented in Appendix G. These summaries include (for each month during the reporting period): the number of days during which temperature was recorded; the number of times the daily minimum temperature was less than 0.5°C and 4.4°C; the number of times the daily average temperature was less than 0.5°C and 4.4°C; the number of times the daily maximum temperature was greater than 23°C and 24°C; the number of times the 7-day average daily maximum temperature was greater than 12°C, 16°C, 17.5°C, 18°C, and 22°C (the 7-day average daily maximum was calculated by averaging the daily maximum temperatures across the time period that started 3 days prior to and ended 3 days after a given day); the monthly 1-day maximum temperature (the highest instantaneous temperature recorded in a given month); the monthly 1-day maximum range (the largest daily range in temperature recorded during a given month); and the monthly average daily range (the average daily range in temperature recorded during a given month).

Water temperatures are generally higher in the lower basin, from White Creek downstream. High temperatures and associated reductions in dissolved oxygen, along with dewatering, present significant habitat limitations for juvenile salmonids, especially for Mid-Columbia steelhead. Stranding has been observed in a number of tributaries. Considerable mortality likely occurs annually in White, Tepee, Brush, Dead Canyon, Swale, and Dillacort creeks as a result of dewatering and/or warming of refugia pools.

Other basic water quality parameters that have been recorded have been entered into a relational database. Development and quality control of this database is ongoing; these data will be used to monitor trends and differences between selected sites.

Additional data (including temperature data from the full period of record for each monitored site) is also available at the YKFP website (http://www.ykfp.org/klickitat/Data_thermo.htm).

Streamflow monitoring

Objective: In order to develop and maintain stage-discharge rating curves and tables, for developing annual hydrographs, and flood peak analyses, streamflow is monitored at various sites within the Klickitat subbasin. These data are collected in conjunction with YKFP Klickitat Watershed Enhancement Project (#199705600) and YN Water Resources Program, and assist with status and trend monitoring and prioritization and design of restoration projects.

Methods: Instantaneous measurement of stream discharge was collected at established locations on the upper mainstem Klickitat River and within the subwatersheds of Swale, Summit, White, Tepee, Surveyors, Piscoe, and Diamond Fork. Staff gauges were maintained at each site to develop stage-discharge rating curves. Crest stage data was also collected from each of the sites one time to record the annual maximum. These data are stored in an internal relational database.

Results: Twelve sites were monitored with about 60 discharge measurements taking place during this reporting period. Rating curves have been developed for nearly all sites. Data is stored in a database maintained by YN Water Resources Program.

Habitat surveys

Objective: The Klickitat M&E project initiated a new basin wide rapid assessment stream inventory data collection procedure in 2009. Prior to 2009, habitat inventories were conducted using the TFW monitoring methodology. The TFW methodology focused on intensive monitoring of discrete sections (1,500 feet) of stream over time. M&E and KWEP personnel designed the new rapid assessment protocol to increase the spatial extent of stream inventories throughout the Klickitat River sub-basin. The advantage of the rapid stream inventory assessment protocol compared to the intensive TFW methodology include: 1) ability to conduct effectiveness monitoring, 2) expands spatial extent of inventories, 3) provides baseline information to guide design of future management objectives, 4) and strengthens funding proposals for future restoration efforts.

Methods: A significant component of the rapid stream inventory assessment protocol incorporates methodology described in the TFW stream inventory protocol (Pleus et al. 1999; Schuett-Hames et al. 1999b). Surveys started at a designated point and proceeded upstream by delineating and sequentially numbering each habitat unit. The following variables were collected for each delineated habitat unit: habitat type (pool, riffle, or glide), wetted width, maximum and residual pool depth, percent undercut banks, and bankfull width. Each delineated habitat type was geo-referenced with a GPS point and documented by a photo with a digital camera. Large woody debris (LWD) and jam surveys were conducted in conjunction with the habitat surveys using methods described in Schuett-Hames et al. (1999b). Each LWD piece and jam was geo-referenced to a delineated habitat unit. In addition, spawning patches and bedrock outcroppings were counted and geo-referenced to a delineated habitat unit(s). Fish surveys will be conducted in stream sections following completion of habitat inventories. Fish surveys (by electrofishing or snorkeling) are designed to spatially characterize fish distribution by estimating relative abundance estimates at the habitat unit level. A relational database was developed to house data collected from the rapid assessment stream inventory and fish surveys.

Results: Stream inventory survey data collected in 2009 served as a pilot study to a more comprehensive effort that will begin in 2010. Stream habitat inventory surveys were completed on 9.4 miles of stream in 2009. This data represents baseline data for effectiveness monitoring of three stream restoration projects. Tables H1 and H2 in Appendix H summarize habitat, spawning, bedrock outcrop, LWD, and jams data collected in 2009. Fish distribution surveys are scheduled to begin in 2011.

Pathogen sampling

Objective: In order to determine if supplementation increases the incidence of pathogens, a baseline data set will be established describing existing levels of pathogens in wild populations of steelhead/rainbow trout (*Oncorhynchus mykiss*), Chinook salmon (*O. tshawytscha*) and coho salmon (*O. kisutch*).

Methods: Juvenile or resident fish are collected via electrofishing or capture in rotary screw traps from sites throughout the Klickitat subbasin. Laboratory testing is performed by the USFWS Lower Columbia River Fish Health Center. Fish are examined using the protocols from the Laboratory Procedures Manual for the National Wild Fish Health Survey.

Results: Due to time required for other fieldwork priorities (such as Juvenile and resident salmonid population surveys, White Creek steelhead PIT tagging study, and Hatchery spring Chinook and steelhead PIT tagging), and an existing baseline of pathogen samples having been collected in recent years, very few pathogen samples were collected during this reporting period. Samples that were collected (primarily via rotary screw traps) were delivered to the Lower

Columbia River Fish Health Center for analysis. Previously collected samples have been compiled into existing datasets covering 2002-2005. Additional pathogen samples will likely be collected in future reporting periods concurrent with changes in hatchery practices at the Klickitat Hatchery.

Genetic Analysis

Objective: Gain a thorough understanding of the genetic make-up of target stocks in order to maintain long term genetic variability and minimize the impacts of domestication on supplemented stocks (spring Chinook and summer steelhead). As identified in the draft Klickitat Subbasin Anadromous Fishery Master Plan both spring Chinook and summer steelhead may be collected for broodstock at Lyle Falls. A thorough knowledge of baseline genetic conditions and dip-in rates by out-of-basin adults is important in order to adhere to the YKFP genetic guidelines.

Methods: Genetic samples were collected from adult steelhead and Chinook salmon at the Lyle adult trap on the lower Klickitat River (RM 2.4). As fish were enumerated, netted and removed from the live trap, small fin clips or opercle punches of Chinook and steelhead were collected. These samples will be analyzed by CRITFC geneticists and information added to existing databases and incorporated into future reports and management actions.

In addition, genetic samples were collected from adult spring Chinook spawned for broodstock at the Klickitat Hatchery in August-September 2009. These samples were also sent to CRITFC for analysis.

Results: During this reporting period, further analysis focused on spring Chinook samples, and the previously identified mixed genotype that is apparent in Klickitat spring Chinook populations (showing both stream-type [spring] Chinook and ocean-type [summer or fall] Chinook alleles). This appears to be an unusual genotype as compared to other Columbia basin spring Chinook populations, and it appears to be present in both hatchery and wild Klickitat fish. Several possible explanations exist for this finding: broodstock mixing of stream- and ocean-type stocks during hatchery spawning operations, mixing of hatchery and wild fish or spring and summer Chinook on natural spawning grounds, or perhaps this is a natural genotype found in the Klickitat subbasin. Previous releases of summer Chinook stocks in the Klickitat River as well as past operational evidence from Klickitat Hatchery staff point to the possibility of broodstock mixing (late-arriving, late-ripening fish that were incorporated into spring Chinook broodstock spawning). Alternatively, this genotype could be naturally present in the Klickitat River, an intermediate river basin in between coastal and inland watersheds, with an intermediate genotype between stream- and ocean-type stocks. It is unknown if presence of this genotype has any effects on fitness or survival. During this reporting period, analysis and preliminary conclusions pointed to hatchery broodstock mixing as a likely source of this genotype. YKFP staff were also able to procure Klickitat spring Chinook scale samples collected in the early 1980s, and these have been incorporated into the analysis as well, for comparison to present-day samples to further evaluate the likelihood of the different explanations. A draft manuscript discussing the findings is also being prepared for submission to peer-reviewed journals; a more final version will be presented in future annual reports. Ongoing analysis will focus any possible affects on fitness, and appropriate management options.

PIT tagging

Hatchery spring Chinook and steelhead PIT tagging

Objective: Use Passive Integrated Transponder (PIT) tagging as a means of monitoring spring Chinook salmon and steelhead travel and/or holdover time between the Klickitat River and Bonneville Dam detection sites, estimating smolt survival rates, and estimating smolt-to-adult return rates.

Methods: Spring Chinook salmon juveniles from the Klickitat Hatchery were injected with PIT tags in June 2009 and released from the hatchery into the Klickitat River in March 2010. More than 35,000 fish were tagged; an estimated 34,688 fish were released. The most reliable estimate of number of fish released came from monitoring the hatchery pond for tagged-fish mortalities and subtracting these fish from the total number of fish tagged. Tag data was entered into the regional PIT Tag Information System (PTAGIS) database for monitoring at mainstem Columbia River detection sites. Returning adult fish are detected at Bonneville Dam adult fish ladders to provide smolt-to-adult return rate (SAR) information.

Approximately 10,000 hatchery steelhead juveniles were PIT-tagged at Skamania Hatchery in early October 2009; these fish were transported via truck and released as smolts into the Klickitat River in April 2010. Future adult returns of these fish will provide SAR information, and will be presented in future reports.

Results: To date, returning adult information is available up through return year 2010 (which includes returns up to age-4 fish for brood year 2006, and age-5 fish for brood year 2005). A summary of tagging and returning fish detections is given below in Table 1. A preliminary average SAR estimate (using projected returns of 5- and 6-year-old fish based on average age compositions) for brood years 2005 and 2006 fish is fairly low, at approximately 0.5%. Additional returns in subsequent years will yield more complete SAR estimates for Klickitat Hatchery spring Chinook.

Table 1. Klickitat Hatchery spring Chinook PIT tagging numbers and returns to date.

Brood Year	Tagging Year	Release Year	Total Jack/Adult Returns[3] (Age 3-6)	Total Adult Returns[3] (Age 4-6)	Number of Fish Tagged	Number of Tagged Fish Released[2]	SAR[3] (incl. jacks)
2004	2005	2005	0	0	9943	9830	0%[4]
2005	2006	2007	*17*	*14*	5000	4917	*0.35%*
2006	2007	2008	*29*	*24*	4917	4644	*0.62%*
2007	2008	2009			6931	6848	
2008	2009	2010			35560	34688	
						Average	*0.49%*

[1]Based on detections at Bonneville adult ladders

[2]Based on known tagged fish minus known pre-release mortalities at Klickitat Hatchery

[3]Italicized numbers are projections based on partial brood year returns and average age composition

[4]2005 release was thinning group with lower survival expected, not included in average

Wild salmonid PIT tagging

Objective: In order to monitor smolt-to-adult return rates and travel times through the Columbia River system of wild Klickitat anadromous stocks, outmigrating juvenile salmonids were trapped in the lower the Klickitat River, sampled for biological data, and implanted with a 12mm passive integrated transponder (PIT) tag. Detections will occur at the Bonneville Dam juvenile and adult passage facilities.

Methods: Juvenile fish were trapped in the Lyle Falls eight-foot rotary screw trap at RM 2.8 on the Klickitat River, placed in a five gallon bucket of fresh water, and transported to a work-up station on the adjacent bank. Fish were anesthetized using MS-222 and were weighed, measured, and identified for species. A single 12mm PIT tag was injected into the abdominal cavity of study fish using a disinfected, stainless steel hypodermic needle and syringe. Study fish were immediately transferred to a bucket of fresh water to recover from anesthesia. Tagged fish were released approximately 100 meters downstream of the screw trap to avoid re-capture.

Results: Activities during this reporting period consisted of setup and training of staff for PIT tagging at smolt traps using a small sample of hatchery smolts. Eleven fall Chinook salmon were PIT tagged during the winter of 2009-2010. Tagged fish varied in length between 107mm and 83mm. All recovered from anesthesia and were released. No juvenile fish PIT tagged during this period has yet to be detected in the Columbia River (Bonneville Dam PIT tag detectors). Additional tagging (with primarily wild spring Chinook and steelhead smolts) is planned for future reporting periods.

White Creek steelhead PIT tagging study

Objective: Determine temporal and spatial movement patterns of downstream migrant juvenile and resident *O. mykiss* in the White Creek watershed. Redd counts and other past studies (Narum et al. 2007) have indicated that the White Creek watershed is an important producer of steelhead in the Klickitat River basin. Increasing knowledge of life history strategies employed by *O. mykiss* in the White Creek watershed will provide baseline information to guide design of future management objectives. Passive Integrated Transponder (PIT) tagging and detection technology was used to monitor fish for this study. The four specific objectives of this study include: 1) determine the proportion of *O. mykiss* that leave the White Creek watershed as downstream migrants, 2) determine run timing of downstream migrants, 3) identify the proportion of tagged individuals that out-migrate as juvenile steelhead based on results from Bonneville Dam detection sites, 4) and determine how these life history types are displayed spatially throughout the watershed.

Methods: A total of 21 tagging sites were selected to capture a representative sample of fish distribution throughout the watershed (Fig. 5 Site Map; Appendix I Table I1). Single-pass electrofishing was used to capture fish. Captured fish were held in 5-gallon buckets with aeration supplied by battery powered aerators. Fish were anesthetized with MS-222. Anesthetized fish were injected with a PIT tag delivered by a hollow tip syringe, length and weight recorded and held in a recovery bucket. Recovered fish were placed in flow-through buckets in the stream and released at the completion of sampling. Injected PIT tag codes and fish metrics were entered directly into the PTAGIS 3 program in the field.

To detect tagged outmigrating fish, a Destron Fearing Multiplexing transceiver (Model FS1001M) and antennae array was installed in July 2009 at lower White Creek approximately 200 feet upstream of the confluence with the Klickitat River. Each antenna is comprised of 10-gauge wire encased in water tight PVC tubing, connected to the transceiver via coaxial cable. A total of six antennae were installed on the streambed at the site. To maximize detection capability, antennae were paired to cover the width of the stream. Paired antennae arrays were longitudinally spaced approximately 50 feet apart for coverage over three stream cross-sections. A record (indicating detection date and time and antenna detection source) was logged on the transceiver for each PIT tagged fish detected by an antenna array. USGS Columbia River Research Laboratory staff constructed and installed the antenna system under subcontract to this project.

Results: A total of 1,727 *O. mykiss* were PIT tagged during the 2009 field season (Appendix I Table I2). The number of fish sampled at the tagging sites ranged from 11-272 individuals. Overall, the mean fish length and weight were 104.4 (SE ±0.7) millimeters and 20.4 (SE ±0.6) grams, respectively. Fish in the 60-99 millimeters size range dominated the 2009 sampling pool accounting for 987 (57%) of the 1,727 individuals tagged (Fig. 6). Fish measured in the 100-139 millimeters range comprised the second largest group accounting for 540 (31%) of PIT tagged fish. Fish ≥ 140 millimeters accounted for the fewest number of PIT tagged fish (200 fish).

A total of 386 (22.4%) fish were detected at the White Creek PIT tag array between September 19, 2009 and September 30, 2010 (Appendix I Table I3). The mean length and weight (measured at the time of tagging) of fish detected at the array were 93.6 (SE ±0.9) millimeters and 12.7(SE ±0.4) grams, respectively. Lengths of detected fish closely tracked the length frequency of the smaller size classes observed in the pool of tagged fish (Fig. 6). Interestingly, there were no detections of fish ≥160 millimeters suggesting larger fish likely display a resident life history form.

Detections were observed from fish originating from 19 of 21 tagging sites (Appendix I Table I3). Of the 386 fish detected at the White Creek PIT tag array, 260, 116, and 10 tagged fish originated from tagging sites in White Creek, Tepee Creek, and Brush Creek, respectively. PIT tagged fish exhibited substantial variation in distance traveled ranging from 0.2-29.1 kilometers within the White Creek watershed (Appendix I Table I1). Approximately 42% of the detected fish originated from the two downstream most tagging sites (90 and 99) located in the lower 5 kilometers of the White Creek watershed (Fig. 5 Site Map; Appendix I Table I1). The lower section of White Creek below the confluence of Brush Creek maintains a perennial flow as opposed to intermittent flow patterns above the confluence. Preliminary results suggest that the section of White Creek below the Brush Creek confluence may serve as both a refuge and staging area for downstream migrants during the low flow period. Also, 29% of the detected fish originated from sites 92 (11%), 85 (10%), and 81 (8%) all of which travelled more than 14 kilometers (Appendix I Table I3). The remaining one-third of detected fish originated from the other 14 tagging sites.

Downstream migrants exited the White Creek watershed over an 11 month period. Fish detections ranged from an initial observation on September 19, 2009 through the final observation on August 06, 2010. Preliminary results of fish detections at the array indicate that downstream migrants exhibited a bi-modal out migration pattern (Fig. 7). The initial pulse of fish moving through the array was observed December 20, 2009 through January 27, 2010. Approximately 74% of the detected fish exited the watershed between April 19 and June 10, 2010 peaking May 12 through May 17. The initial spike in fish movement out of White Creek appeared to coincide with the first large discharge. The peak annual discharge appeared to mark the start of the main out-migration period followed by the bulk of the fish exiting during the receding limb of the hydrograph.

A total of 23 fish were detected at either Bonneville Dam (20 fish) or by a matrix trawl in the Columbia River estuary (3 fish) (Appendix I Table I3). Six of the fish detected in the Columbia River were not detected by the White Creek PIT array. Two potential explanations why a proportion of the fish were not detected at the White Creek array may have been due to high flow events and power outages. Further analysis of detection efficiencies will be completed to address this issue. A total of 17 (4.5%) of 386 fish detected at the White Creek PIT array were detected in the Columbia River. A total of the 11 fish detected in the Columbia River were tagged at the lowest site (90) while the remaining 6 fish originated from 5 other tagging sites. The mean fish length (125 millimeters) was substantially greater for fish detected in the Columbia River compared to fish at the White Creek array (93.6 millimeters). Preliminary results suggest that smaller fish (<100 millimeters) exiting White Creek may spend an additional year rearing in the Klickitat River prior to out-migrating to the Columbia River. Results collected from the 2010-2011 out-migration cohort will help provide more insight into this rearing question.

Additional tagging at all tag sites and monitoring of the White Creek PIT array will continue through 2010-2011. A mobile PIT tagging component will be implemented in fall 2011. Mobile PIT tag detection surveys using portable antennae will be conducted along the entire fish bearing length of stream. The objective will be to spatially identify rearing and refuge areas utilized by fish during annual low flow levels.

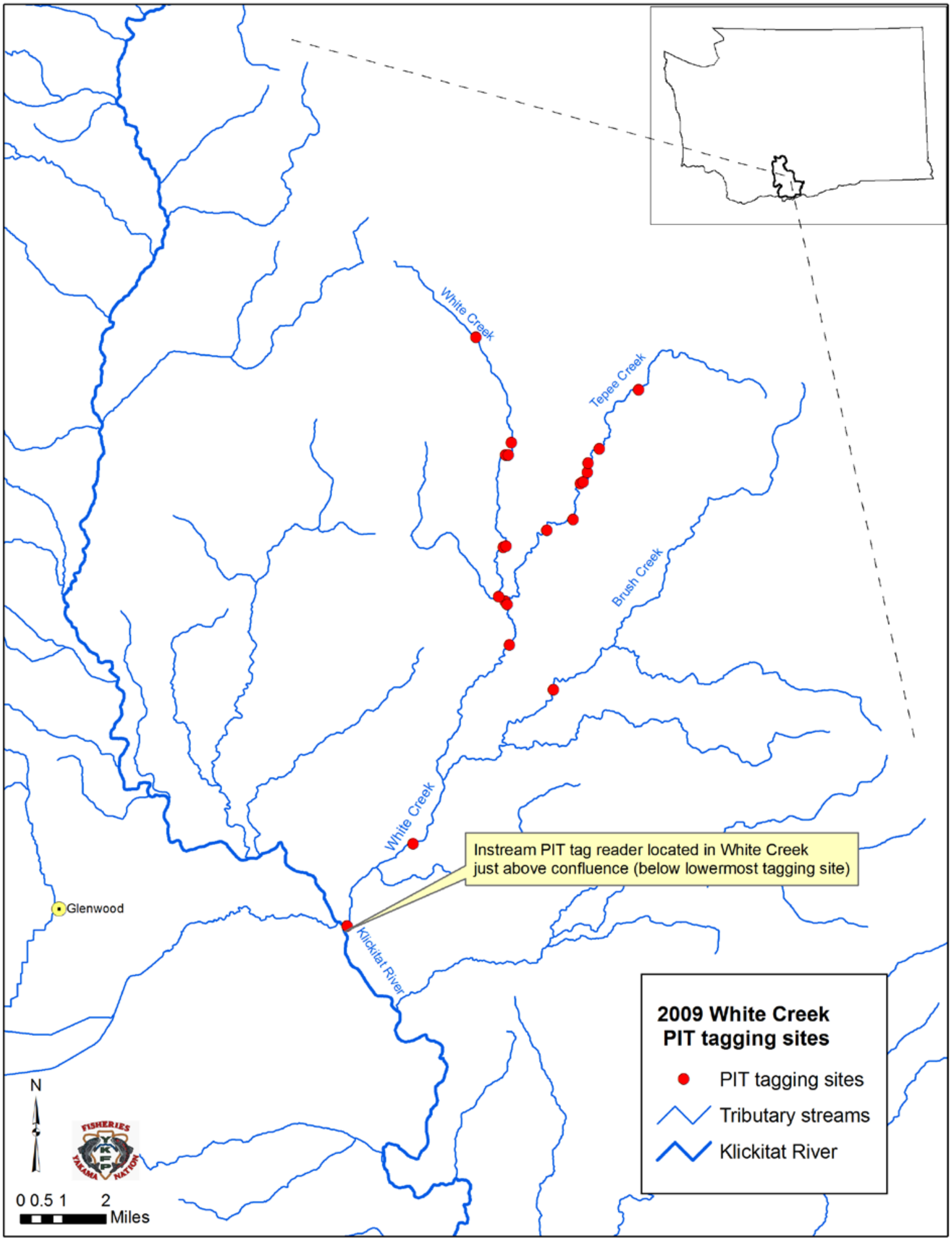

Figure 5. Map of PIT tagging sites in the White Creek watershed.

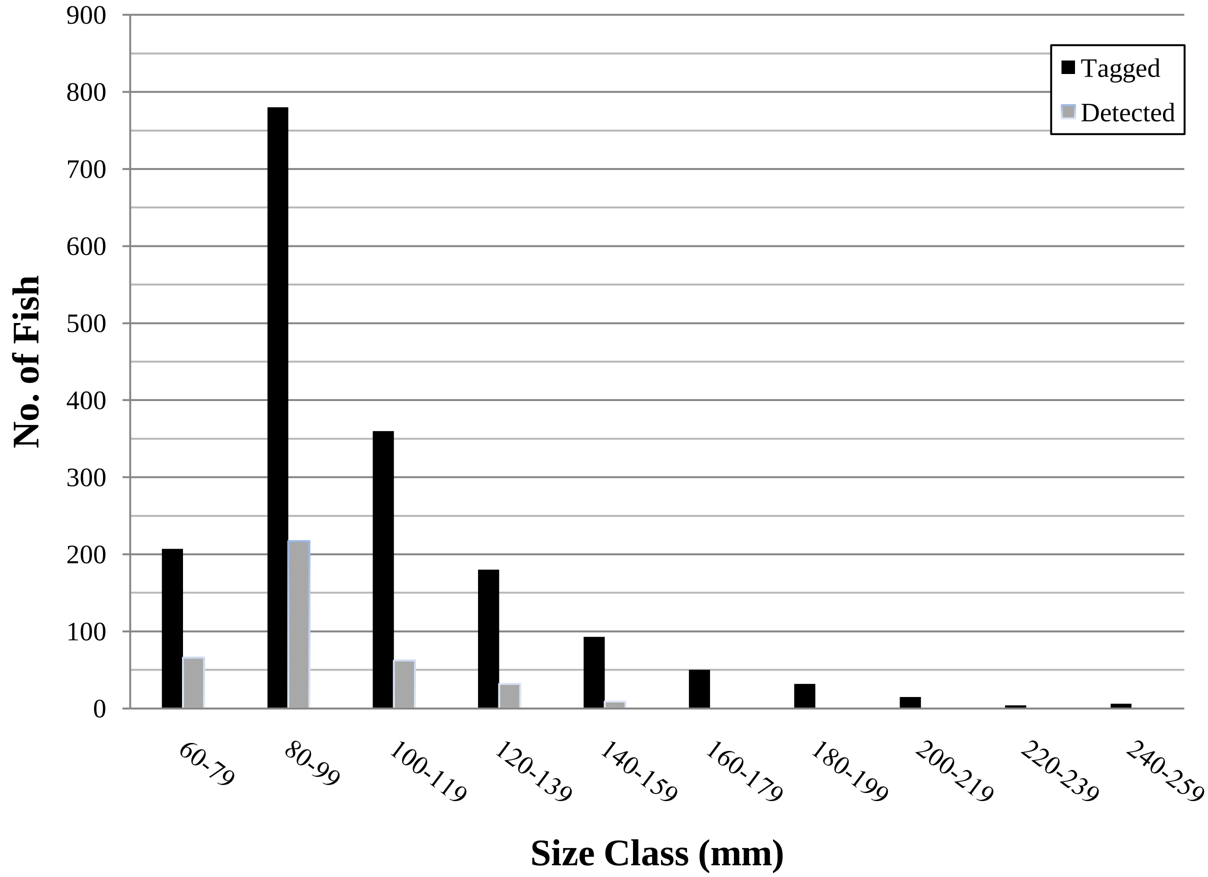

Figure 6. Length frequency histogram comparing overall pool of tagged (black bar) *O. mykiss* to fish detected (grey bar) at the White Creek PIT tag array.

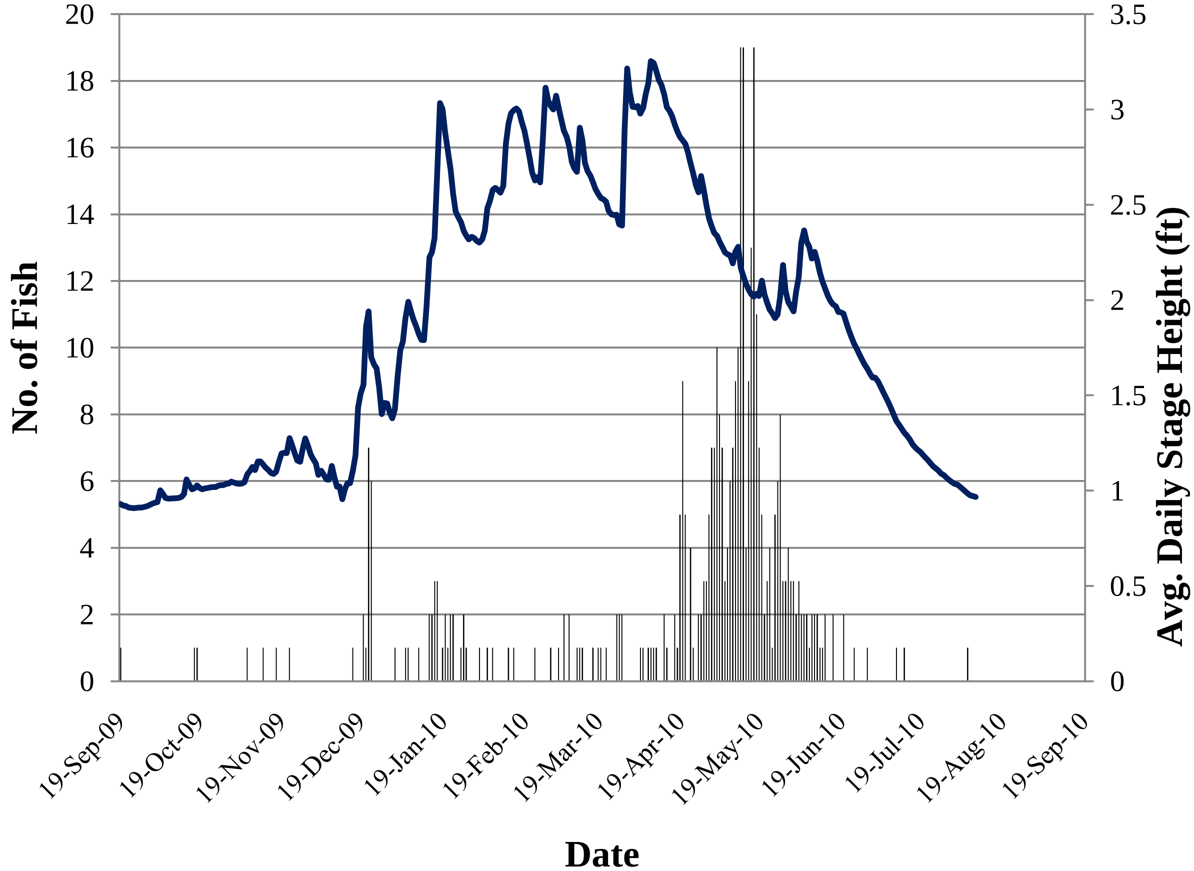

Figure 7. A graph illustrating the relationship between *O. mykiss* detections at the White Creek PIT array to stream discharge (as measured by stage height) during 2009-2010.

Radio telemetry monitoring

Objective: Radio telemetry (fish tagging and tracking via fixed sites and mobile surveys) will be used to provide answers to several important questions relating to Klickitat anadromous stocks including evaluation of passage at several critical sites, geographic distribution of winter and summer steelhead spawning habitat, and geographic distribution of hatchery vs. wild spawners for steelhead and spring Chinook. The duration of this study will be approximately 3-5 years depending on project success and results.

Methods: In the fall of 2009, fixed-location radio telemetry receivers were installed at nine locations in the Klickitat River drainage with the downstream-most site at the confluence of the Klickitat and the Columbia rivers and the upstream-most site at the upper Castile Falls fish ladder, river mile 64.5. Fixed-receiver sites were chosen for their relative locations in the Klickitat drainage as well as proximity to potential spawning tributaries (see Figure J1 in Appendix J for map of fixed sites). Following the installation of fixed-receiver sites, steelhead, and later spring Chinook salmon, were trapped, sampled for bio-data, and tagged with a radio transmitter. Study fish receiving a radio tag were also implanted with a PIT tag. These fish were later released into the Klickitat River and subsequently tracked throughout their spawning migration. Staff from USGS Columbia River Research Laboratory, under subcontract to this project, provided telemetry equipment, installed fixed telemetry sites, and assisted with fish tagging and tracking.

Fish were caught in the Lyle Falls Adult Trap (LAT) at river mile 2.4 of the mainstem Klickitat River. Fish were netted in the LAT and sampled for length, species, sex, and origin. A scale sample was taken from each study fish as well as a tissue sample. At the onset of the study in September 2009, and until mid-February 2010, carbon dioxide was used to anesthetize study fish. Once sampled for biological data, fish were placed, one at a time, in a 94-quart "marine" cooler containing river water saturated with carbon dioxide.

Prior to placing the study fish in the cooler, carbon dioxide was bubbled through the water at a rate of three liters/minute for approximately 1.5 minutes, saturating the water and causing fish to become lethargic and thus easier to handle and tag. Once a fish was sufficiently anesthetized, it was held belly-up in the water and against the inside wall of the cooler with just its mouth above the water surface while a single radio tag was inserted through the fish's mouth and into its stomach leaving approximately eight inches of the antenna exposed. The antenna was crimped at the corner of the fish's mouth to prevent it from protruding out and in front of the fish. A single, 12mm passive integrated transponder (PIT) tag was injected into the dorsal sinus of each radio-tagged fish. Immediately after being tagged, study fish were placed in a cooler of equal size containing river water for recovery and transport to release site. Recovery coolers were oxygenated continuously and monitored for dissolved oxygen content and water temperature. No more than two fish were placed in a single cooler. Water temperature in the recovery coolers was maintained at the temperature of the river at the time of tagging. Ice cubes were used to cool the recovery water when necessary and were placed in quart-size, sealed baggies before being added to the recovery coolers. Dissolved oxygen content was monitored using a YSI meter and was maintained between 120% and 140% saturation. Study fish were transported upstream roughly 0.5 miles in recovery coolers to a large pool where they were released directly into the river provided they made a full recovery after tagging. This release site was selected for its distance upstream of the Lyle Falls complex and for its deep water and slow current theoretically decreasing the likelihood of fish being washed downstream immediately upon release.

Beginning in mid-February the use of carbon dioxide as an anesthetic was abandoned and an electro-anesthesia system was adopted and used since. A regulated DC power supply (Protek brand, model 3006B) was used to produce an electrical current in a holding tank. The Protek was powered with a 110V gasoline generator. A heavy-duty plastic trough, approximately 15 cubic foot capacity, was filled with river water. A thin aluminum plate (approximately 12" x 14") was fastened to the inside of each end of the trough. The positive lead was connected to one plate while the negative was connected to the other causing a current to pass through the water which, under proper settings, caused immediate incapacitation of the fish. The electrical output was set at approximately 30 Volts and 0.03 Amps for anesthetizing Steelhead while approximately 55 Volts and 0.06 Amps were required to produce the desired results with Chinook. Electrical current was run through the water continually while fish were being tagged. Tagged-fish recovery and transport protocol did not change with the introduction of the electro-anesthesia system.

Lotek brand (model SRX 400) radio receivers were installed at all but one of the fixed-receiver sites. An Orion radio receiver (Grant Systems Engineering Inc) was installed at the lower Castile Falls site due to the inaccessibility of that site during winter months and the capability of the Orion receiver to shut down and restart itself as solar electricity production allows. Solar panel (Sharp brand, 80 Watt) arrays were used to power six of the sites. Two sites were plugged directly into 110 Volt hard power. The upper Castile site was powered by a Thermo-electric generator and propane due to its inaccessibility during winter months. Six-element, aerial antennas were installed at all sites in locations providing directionality of tagged fish movement. Two antennas were installed at the Klickitat/Columbia river confluence; a minimum of three aerial antennas were installed at all other sites with three sites also utilizing lower-sensitivity "whip antennas" constructed of stripped coaxial cable which were placed in fishways/ladders at the Lyle Falls, Klickitat Hatchery, lower Castile, and upper Castile sites. See Table J1 in Appendix J for fixed-site descriptions.

Mobile tracking of fish was done on a weekly basis using a Lotek SRX 400 radio receiver and an omni-directional, car-top antenna. The majority of the lower 40 miles of the Klickitat River was tracked via river-adjacent roads/highway. A six-element, hand-held Yagi antenna was also used to find more precise locations when necessary. Locations of tagged fish were recorded and stored as waypoint data with a Garmin (model GPSmap 76CSx) GPS unit.

Results: As this study is ongoing, results for this reporting period are preliminary and will be added to in future reports. A total of 72 Steelhead and four spring Chinook were radio-tagged between project inception in September 2009 and April 30, 2010. Of the 72 Steelhead tagged, nine were adipose fin-clipped (hatchery origin) and 63 were adipose fin-present (wild origin). All four spring Chinook tagged were adipose fin-clipped (hatchery origin). See Table J2 in Appendix J for detailed description of tagged-fish by species, origin, and stock.

Preliminary data suggest a substantial straying or dip-in rate among Klickitat River Steelhead and spring Chinook captured at Lyle Falls. Twenty five percent of all radio-tagged Steelhead exited the Klickitat River soon after being released, returned to the Columbia River, and were never detected again in the Klickitat drainage (N=72; 18/72=0.25 x 100=25%). Though the sample size is quite small, likewise, a substantial proportion of radio-tagged spring Chinook exited the Klickitat River, returned to the Columbia River, and were never detected in the Klickitat drainage again (N=4; 2/4=0.50 x 100=50%).

Fixed-site detections showed radio-tagged Steelhead ascending three different tributary streams including Swale Creek, Little Klickitat River, and White Creek. Seven percent (N=57; 4/57=0.07 x 100=7%) of radio-tagged wild, winter Steelhead ascended White Creek (Klickitat River mile 40); two of which never descended back to the mainstem Klickitat River. One tag was recovered on the bank at river mile 0.6 of White Creek; no fish carcass was present. Particularly interesting is the migration of one of the White Creek fish, a wild, winter Steelhead carrying tag #36027; this fish was detected by all fixed sites between the release location and White Creek as it ascended the Klickitat River. Fish #36027 was radio-tagged on February 11, 2010 and entered White Creek 37 days later on March 20, 2010. The fish wasn't detected again until it exited

White Creek and returned to the Klickitat River on May 4, 2010 spending 45 days in White Creek during which time it presumably spawned. It was detected again by all fixed sites below White Creek as it returned to the Columbia River on May 10, 2010 taking only six days to exit the Klickitat River. This fish was detected by PIT tag readers going downstream through Bonneville Dam the next day. See Table J3 in Appendix J for a table of fixed-site detections of #36027; see Figure J2 in Appendix J for a spawning migration graph of #36027. This type of data will continue to be collected as a part of this study to address questions described above in the Objectives section.

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Appendices

Appendix A. Spawning ground surveys (redd counts)

Table A1. Results of 2009 Spring Chinook spawning surveys in the Klickitat subbasin.

STREAM	REACH	MILES	# PASSES	REACH REDD TOTALS	REDDS /MILE	LIVE OBS. Floy Tag	LIVE OBS. No Floy	LIVE OBS. Unk	MORTS OBS. Ad-clipped Floy Tag	MORTS OBS. Ad-clipped No Floy	MORTS OBS. Unclipped Floy Tag	MORTS OBS. Unclipped No Floy	MORTS OBS. Unk
Klickitat R.													
MAINSTEM	Huckleberry Cr. confl - road washout	3.4	3	0	0.00	0	1	0	0	0	0	0	0
	Road washout - Caldwell Prairie outhouse	3.2	3	0	0.00	0	1	0	0	0	0	0	0
	Caldwell Prairie outhouse - Cow Camp	2.0	3	0	0.00	0	1	0	0	0	0	0	0
	Cow Camp - 255 Road bridge	2.2	3	0	0.00	0	0	0	0	0	0	0	0
	255 Road bridge - turnout/turnaround	2.3	3	0	0.00	0	0	0	0	0	0	0	0
	Turnout/turnaround - McCreedy confluence	2.0	3	1	0.49	0	0	0	0	0	0	1	0
	McCreedy confl. - Chaparral confluence	2.7	3	1	0.37	0	1	0	0	0	0	1	0
	Chaparral confluence - old upper trap site	1.7	3	2	1.17	0	2	0	0	0	0	0	0
	Old upper trap site - top of Castile falls complex	1.3	3	0	0.00	0	3	0	0	0	0	0	0
	Extent of Castile Falls complex	0.7	3	0	0.00	0	0	0	0	0	0	0	0
	Bottom of Castile complex - West Fork conflu.	0.8	3	8	10.67	1	0	9	0	0	0	0	0
	West Fork - Signal Peak bridge	2.3	3	13	5.55	0	0	1	0	0	0	2	1
	Signal Peak bridge - Surveyors Cr. confluence	2.4	3	7	2.91	0	3	0	0	0	0	0	0
	Surveyors Cr. confluence - Portage	2.0	3	2	1.00	0	4	0	0	0	0	0	0
	Portage - Big Muddy confluence	2.8	3	17	6.07	0	17	0	0	1	0	3	1
	Big Muddy confluence - old USGS gage site	3.6	3	0	0.00	0	0	0	0	0	0	0	0
	Old USGS gage - Deer Springs	4.1	3	0	0.00	0	1	0	0	0	0	1	0
	Deer Springs - Hatchery	4.2	3	3	0.71	1	0	2	0	0	0	0	0
	Hatchery - White Cr. confluence	2.9	2	8	2.76	0	5	0	0	0	0	0	0
	White Cr. - Summit Cr. confluence	2.5	2	1	0.40	0	2	0	0	0	0	0	0
	Summit Cr. - Gage cable above Leidl	2.5	2	2	0.80	1	1	0	0	0	0	0	0
	Gage cable - Leidl bridge	2.6	2	0	0.00	0	0	0	0	0	0	0	0
	Leidl bridge - Stinson boat landing	2.9	2	2	0.69	0	1	0	0	0	0	0	0
	Stinson landing - Matt's pond	2.0	2	3	1.52	0	0	0	0	0	0	0	0
	Matt's pond - Beeks Cr. confluence	2.0	2	0	0.00	0	0	0	0	0	0	0	0
	Beeks Cr. confluence - Cattle Gate	2.0	0	0	0.00	0	0	0	0	0	0	0	0
	Cattle Gate - Little Klickitat confluence	3.4	0	0	0.00	0	0	0	0	0	0	0	0
	Mainstem Totals (surveyed reaches)	**61.2**		**70**	**1.1**	**3**	**43**	**12**	**0**	**1**	**0**	**8**	**2**
TRIBUTARIES													
DIAMOND FORK	Butte Meadows Cr. to Cuitin Cr.	2.8	0	0	0.00	0	0	0	0	0	0	0	0
	Cuitin Cr. to Rd. Xing/ford	3.3	0	0	0.00	0	0	0	0	0	0	0	0
	Rd. Xing ford to confluence	5.0	0	0	0.00	0	0	0	0	0	0	0	0
	Tributary Totals (surveyed reaches)	**0.0**		**0**	**-**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
	KLICKITAT WATERSHED TOTALS	**61.2**		**70**		**3**	**43**	**12**	**0**	**1**	**0**	**8**	**2**
	Above Castile Falls contribution			**6%**		**0%**	**21%**	**0%**	**-**	**0%**	**-**	**25%**	**0%**
	Below Castile Falls contribution			**94%**		**100%**	**79%**	**100%**	**-**	**100%**	**-**	**75%**	**100%**

Unk = Unknown

Total Floy-tagged Morts Observed	0
Total Morts Observed (excluding unk.)	9
Percentage Floy-tagged	0.0%

Table A2. Spring Chinook spawning surveys (redd counts) in the Klickitat subbasin, 1989-2009.

		Redd Counts																				
REACH	MILES	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Diamond Fork	8.5	ns	0	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	0	0	0	0	0	ns
McCormick Mdws - Castile Falls	18.0	0	0	0	0	0	1	0	0	0	0	0	64	2	243	165	122	4	6	36	0	4
Castile Falls #10 - Falls #1	0.8	ns	ns	ns	ns	ns	ns	ns	ns	3	3	2	0	7	0	4	0	0	0	3	0	0
Castile Falls - Signal Peak Br.	3.3	20	17	28	34	33	18	17	24	87	56	40	39	33	50	41	18	11	14	18	15	21
Signal Peak Br. - Big Muddy Cr.	6.9	33	42	61	63	84	20	25	51	118	53	38	29	78	75	71	38	9	39	34	34	26
Big Muddy Cr. - Old USGS gage	3.3	ns	ns	0	5	15	0	0	0	0	0	0	2	0	5	0	0	0	0	0	2	0
Old USGS gage - Klickitat Hatchery	8.2	ns	ns	ns	ns	ns	ns	ns	14	2	0	0	27	1	16	34	10	15	4	8	5	3
Klickitat Hatchery - Summit Cr.	5.5	ns	ns	2	ns	ns	ns	ns	8	14	1	2	4	1	0	17	3	7	15	5	9	9
Summit Creek - Leidl	5.6	ns	ns	2	ns	ns	ns	ns	8	3	0	1	2	1	0	0	1	3	3	0	11	2
Leidl - Stinson Flats	3.2	ns	ns	ns	ns	ns	ns	ns	5	4	ns	ns	ns	ns	ns	ns	0	1	0	0	0	2
Stinson Flats - Soda Springs	7.5	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	3	0	1	0	0	3
Soda Springs - Twin Bridges	6.4	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
Twin Bridges - Pitt Bridge	8	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
Pitt - Turkey Farm	5	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
Turkey Farm - Lyle Falls	2	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
Totals	**92.2**	**53**	**59**	**93**	**102**	**132**	**39**	**42**	**110**	**231**	**113**	**83**	**167**	**123**	**389**	**332**	**195**	**50**	**82**	**104**	**76**	**70**
Totals (minus releases above Castile)		**53**	**59**	**93**	**102**	**132**	**39**	**42**	**110**	**231**	**113**	**83**	**103**	**123**	**146**	**167**	**73**	**50**	**82**	**104**	**76**	**70**
Totals above Castile (minus releases)		**0**	**0**	**0**	**0**	**0**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**2**	**0**	**0**	**0**	**4**	**6**	**36**	**0**	**4**
Totals in Wild index reach		53	59	89	97	117	38	42	75	205	109	78	68	111	125	112	56	20	53	52	49	47
Percent of Total in Wild index reach		100%	100%	96%	95%	89%	97%	100%	68%	89%	96%	94%	66%	90%	86%	67%	77%	40%	65%	50%	64%	67%

ns = not surveyed

Note: In 2000, 2002, 2003, and 2004 surplus spring Chinook adults from Klickitat Hatchery were transported and released above Castile Falls. High redd counts above Castile Falls in those years are almost exclusively a result of those releases. For this reason the "Totals (minus releases above Castile)" row provides for a more consistent across-year comparison of natural spawner escapement in the Klickitat subbasin. The "Totals above Castile (minus releases)" row provides an across-year comparison of natural spawner escapement and passage above Castile Falls, assuming virtually no natural passage in 2000, 2002, 2003, and 2004. The "Wild Index Reach" is Castile Falls to Big Muddy Cr.

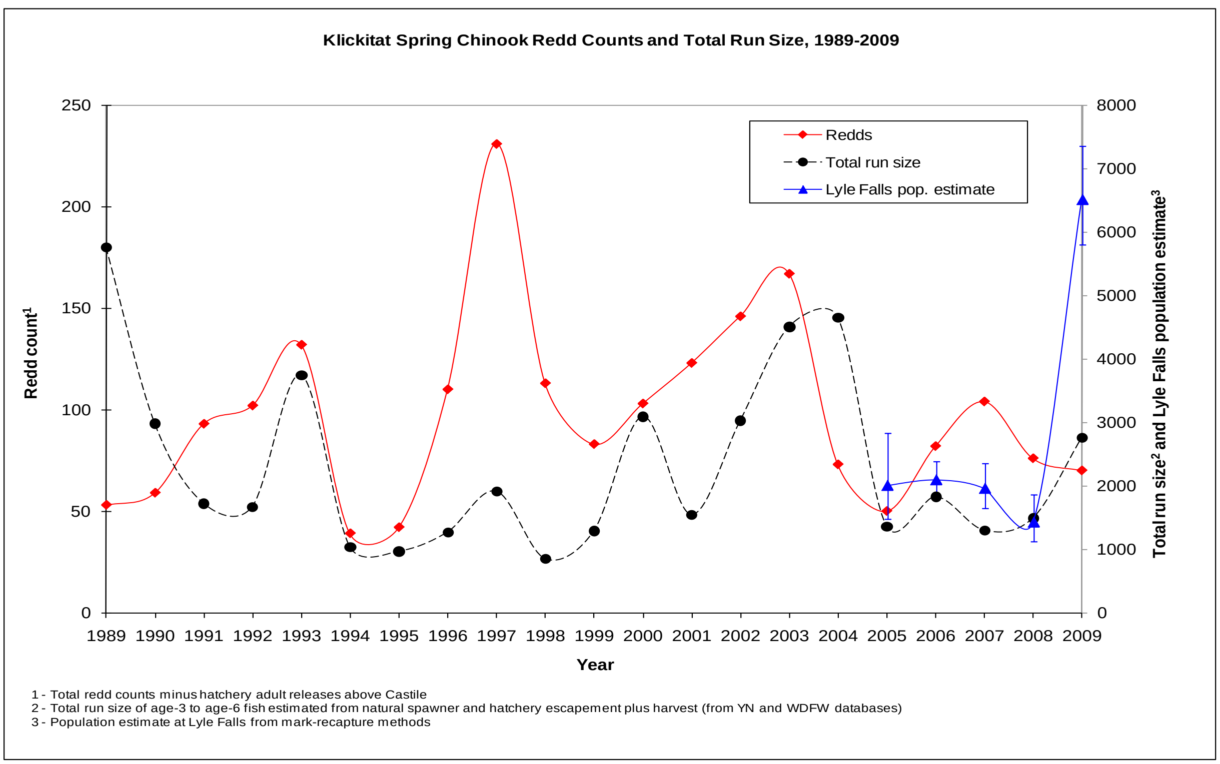


Figure A1. Spring Chinook redd counts, estimated total run size, and mark-recapture population estimates in the Klickitat subbasin, 1989-2009. Error bars on Lyle Falls mark-recapture population estimates represent 95% confidence intervals.

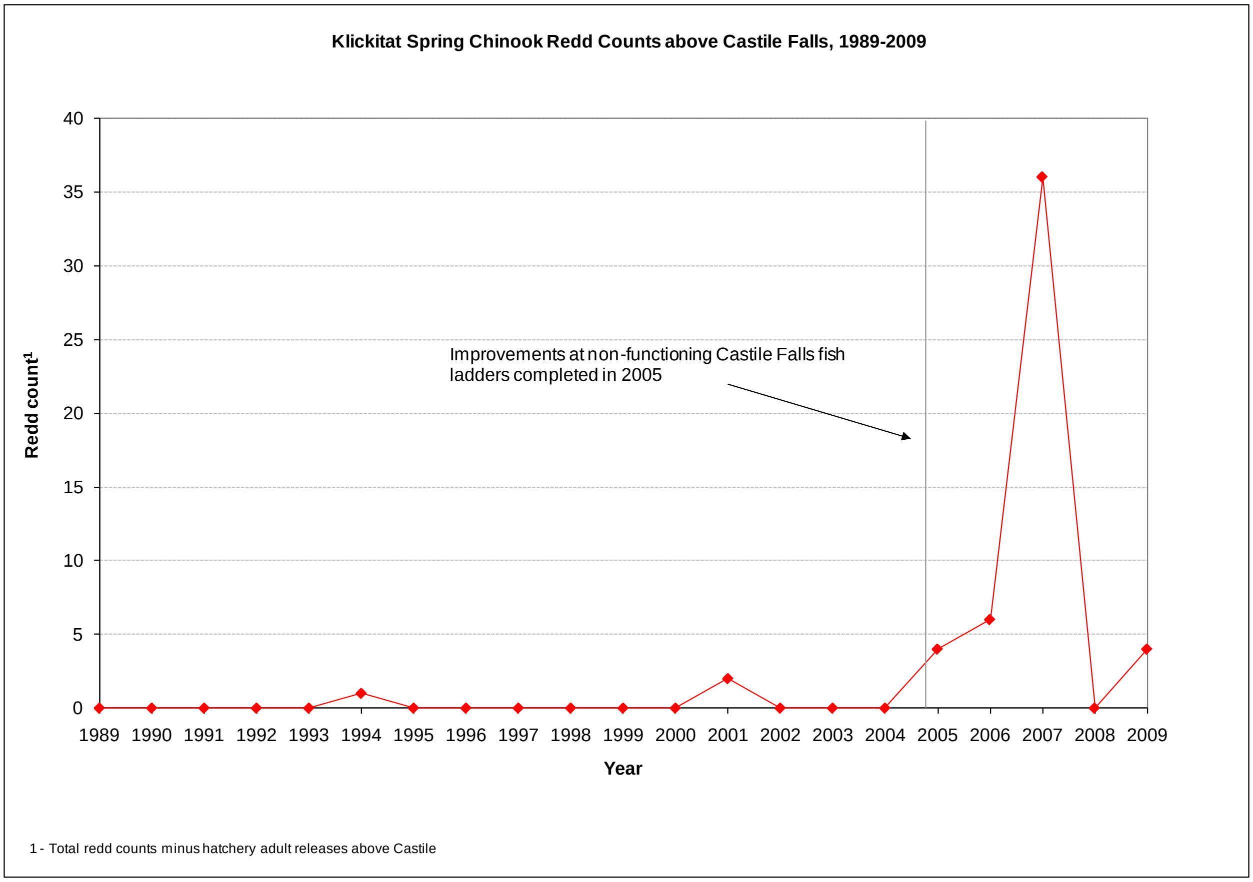


Figure A2. Spring Chinook redd counts above Castile Falls on the upper Klickitat River, 1989-2009.

Table A3. Results of 2009 Fall Chinook spawning surveys in the Klickitat subbasin.

STREAM	REACH	MILES	# PASSES	REACH REDD TOTALS	REDDS /MILE	LIVE OBS. Floy Tag	LIVE OBS. No Floy	LIVE OBS. Unk	MORTS OBS. Ad-clipped Floy Tag	MORTS OBS. Ad-clipped No Floy	MORTS OBS. Unclipped Floy Tag	MORTS OBS. Unclipped No Floy	MORTS OBS. Unk
Klickitat													
MAIN STEM													
	Castile Falls #11 - Castile Falls #1	0.6	0	0	0.00	0	0	0	0	0	0	0	0
	Castile Falls #1 - Signal Peak Br.	3.3	0	0	0.00	0	0	0	0	0	0	0	0
	Signal Peak Br. - old USGS gage	10.5	0	0	0.00	0	0	0	0	0	0	0	0
	Old USGS gage - Hatchery	8.2	0	0	0.00	0	0	0	0	0	0	0	0
	Hatchery - Summit Cr.	5.5	2	313	56.91	0	604	17	0	2	0	29	62
	Summit Cr. - Leidl Br.	5.6	2	108	19.29	0	272	0	0	0	0	7	39
	Leidl Br. - Stinson Flats	2.5	2	101	40.40	0	144	1	0	0	0	11	11
	Stinson Flats - Beeks Canyon	4.5	2	60	13.33	0	126	4	0	0	0	17	13
	Beeks Canyon - Little Klick	4.8	2	150	31.25	0	79	0	0	3	0	37	20
	Little Klick - Twin Bridges	1.5	1	2	1.33	0	0	29	0	0	0	3	3
	Twin Bridges - Klick Field Office	1.2	1	1	0.83	0	0	12	0	2	0	5	4
	Klick Field Office - Klickitat Town	3.6	1	3	0.83	0	0	14	0	0	0	13	12
	Klickitat Town - Pitt Bridge	3.4	1	8	2.35	0	9	0	0	1	0	14	16
	Pitt Bridge - Turkey Farm CG	5.4	1	8	1.48	0	4	0	0	1	0	5	8
	Turkey Farm CG - Lyle Falls trap	2.5	1	0	0.00	0	1	0	0	0	0	1	4
	Below Lyle Falls	0.1	0	0	0.00	0	0	0	0	0	0	0	0
	Mainstem Totals (surveyed reaches)	**40.5**		**754**	**18.6**	**0**	**1239**	**77**	**0**	**9**	**0**	**142**	**192**
	KLICKITAT WATERSHED TOTALS			**754**	**18.6**	**0**	**1239**	**77**	**0**	**9**	**0**	**142**	**192**

n/s = not surveyed
Unk = Unknown

Total Floy-tagged Morts Observed	0
Total Morts Observed (excluding unk.)	151
Percentage Floy-tagged	0.0%

Note: River ice, then snow, rain, and high turbidity in early-mid Dec. precluded surveys for much of the month.

Table A4. Fall Chinook spawning surveys (redd counts) in the Klickitat subbasin, 1995-2009.

REACH	MILES	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
		Redd Counts													
Old USGS gage - Klickitat Hatchery	8.2	ns	1	12	6	0	0	0	3	ns	4	1	ns	5	0
Klickitat Hatchery - Summit Cr.	5.5	194	300	248	475	263	468	35	75	18	65	88	72	112	92
Summit Creek - Leidl	5.6		303	310	434	239	492	49	258	159	94	199	1	23	16
Leidl - Stinson Flats	3.2	120	104	144	183	160	207	138	97	190	52	55	2	39	21
Stinson Flats - Soda Springs	7.5		159	68	180	66	86	53	160	26	84	68	23	24	2
Soda Springs - Twin Bridges	6.4	140	146	90	413	82	227	112	420	43	368	77	21	32	12
Twin Bridges - Pitt Bridge	8	27	100	46	1	19	138	1	163	34	68	13	0	15	0
Pitt - Turkey Farm	5	15	18	11	8	6	31	7	38	0	18	4	0	0	0
Turkey Farm - Lyle Falls	2	ns	2	ns	ns	ns	ns	ns	11	4	10	0	0	2	ns
Below Lyle Falls	0.3	ns	ns	ns	ns	ns	ns	13	ns	ns	14	0	ns	1	4
Totals	**51.7**	**496**	**1133**	**929**	**1700**	**835**	**1649**	**408**	**1225**	**474**	**777**	**505**	**119**	**253**	**147**

ns = not surveyed

Note: High flows and/or turbidity in some years (especially 2003, 2006, 2008, and 2009) limit survey coverage and visibility and may bias redd counts low. High flows and suspended sediment in October 2003 and November 2006 also caused significant pre-spawn mortality of fall Chinook. Some survey reaches were combined in 1995 data.

Table A5. Results of 2009-10 Coho spawning surveys in the Klickitat subbasin.

STREAM	REACH	MILES	# PASSES	REACH REDD TOTALS	REDDS /MILE	LIVE OBS. Floy Tag	LIVE OBS. No Floy	LIVE OBS. Unk	MORTS OBS. Ad-clipped Floy Tag	MORTS OBS. Ad-clipped No Floy	MORTS OBS. Unclipped Floy Tag	MORTS OBS. Unclipped No Floy	MORTS OBS. Unk
Klickitat													
MAIN STEM	Castile Falls #10 - Castile Falls #1	0.6	0	0	0.00	0	0	0	0	0	0	0	0
	Castile Falls - Signal Peak Br.	3.3	0	0	0.00	0	0	0	0	0	0	0	0
	Signal Peak Br. - Big Muddy Cr.	6.9	0	0	0.00	0	0	0	0	0	0	0	0
	Big Muddy Cr. - old USGS gage	3.3	0	0	0.00	0	0	0	0	0	0	0	0
	Old USGS gage - Klickitat Hatchery	8.2	1	0	0.00	0	0	0	0	0	0	0	0
	Hatchery - Summit Cr.	5.4	3	73	13.52	0	84	18	0	0	0	0	15
	Summit Cr. - Leidl Br.	5.2	1	9	1.73	0	8	0	0	0	0	0	0
	Leidl Br. - Stinson Flat	2.9	1	11	3.79	0	0	6	0	0	0	1	0
	Stinson Flat - Beeks Canyon	4.5	1	9	2.00	0	0	5	0	0	0	0	0
	Beeks Canyon - Little Klickitat	4.8	2	16	3.33	0	0	0	0	0	0	1	2
	Little Klickitat - Twin br.	1.5	1	0	0.00	0	0	0	0	0	0	0	0
	Twin Br. - Field Office	1.3	1	0	0.00	0	0	0	0	0	0	0	0
	Field office - Ice house landing	1.5	1	0	0.00	0	0	0	0	0	0	0	0
	Ice house landing - Klickitat Town	2.1	0	0	0.00	0	0	0	0	0	0	0	0
	Klickitat Town - Pitt Bridge	3.4	0	0	0.00	0	0	0	0	0	0	0	0
	Pitt - bus turn around	2.0	1	0	0.00	0	0	0	0	0	0	0	0
	Bus turn around - Turkey Farm	3.3	1	0	0.00	0	0	0	0	2	0	0	0
	Turkey Farm - Lyle Falls screw trap	2.5	1	0	0.00	0	0	0	0	0	0	0	0
	Below Lyle Falls (County Park riffle)	0.1	1	17	170.00	0	125	0	0	3	0	7	52
	Mainstem Totals (surveyed reaches)	**43.2**		**135**	**3.1**	**0**	**217**	**29**	**0**	**5**	**0**	**9**	**69**
TRIBUTARIES													
Trib of trib													
OUTLET CREEK		0.3	0	0	0.00	0	0	0	0	0	0	0	0
WHITE CREEK	Bottom 1.5 miles	1.5	0	0	0.00	0	0	0	0	0	0	0	0
SUMMIT CREEK	Falls - mouth	1.3	2	0	0.00	0	6	0	0	0	0	2	1
DEAD CANYON CR	Willis Canyon to Haul Rd. Xing	0.8	1	0	0.00	0	0	0	0	0	0	0	0
	Haul Rd. Xing to mouth	0.2	1	0	0.00	0	0	0	0	0	0	0	0
BEEKS CANYON		0.5	1	0	0.00	0	0	0	0	0	0	0	0
LITTLE KLICKITAT	Bowman Cr. - mouth	1.2	1	0	0.00	0	0	0	0	0	0	0	0
Bowman Cr.	Falls - mouth	1.0	1	5	5.00	0	0	0	0	0	0	0	0
Canyon Cr.	Right bank trib #3 - left bank trib #1	1.0	0	0	0.00	0	0	0	0	0	0	0	0
	Left bank trib #1 - Weeping Wall	1.0	0	0	0.00	0	0	0	0	0	0	0	0
	Weeping wall - mouth	1.0	0	0	0.00	0	0	0	0	0	0	0	0
SWALE CREEK	2nd RR trestle to school bus/houses	1.2	3	0	0.00	0	0	0	0	0	0	0	0
	school bus/houses to 1st RR tresle (on LB trib)	1.2	3	3	2.50	0	29	5	0	0	0	0	7
	1st RR trestle (on LB trib) to mouth	1.2	3	1	0.83	0	2	3	0	0	0	0	11
SNYDER CREEK	Upper bridge to mouth	0.9	3	5	5.56	0	5	0	0	0	0	0	0
LOGGING CAMP CR	Bedrock slide to mouth	1.0	3	0	0.00	0	11	0	0	0	0	0	1
WHEELER CREEK	2nd Falls (abv Johnson Cr) to 1st Falls/Cascade	0.6	0	0	0.00	0	0	0	0	0	0	0	0
	1st Falls/Cascade to mouth	0.5	1	0	0.00	0	0	0	0	0	0	0	0
DILLACORTE CR	Falls - mouth	1.5	1	0	0.00	0	0	0	0	0	0	0	0
SILVA CREEK	Bottom	0.1	0	0	0.00	0	0	0	0	0	0	0	0
CANYON CREEK	Bottom 1/4 mile	0.3	3	65	216.67	0	795	0	0	61	0	78	5
	Tributary Totals (surveyed reaches)	**12.8**		**79**	**6.2**	**0**	**848**	**8**	**0**	**61**	**0**	**80**	**25**
	KLICKITAT WATERSHED TOTALS	56.0		**214**		**0**	**1065**	**37**	**0**	**66**	**0**	**89**	**94**
	Tributary Contribution			**37%**		**-**	**80%**	**22%**	**-**	**92%**	**-**	**90%**	**27%**
	Mainstem Contribution			**63%**		**-**	**20%**	**78%**	**-**	**8%**	**-**	**10%**	**73%**

unk = unknown

Total Floy-tagged Morts Observed	0
Total Morts Observed (excluding unk.)	155
Percentage Floy-tagged	0.0%

Note - River ice, then snow, rain, and high turbidity in early-mid Dec. precluded surveys for much of the month. High flows/turbidity in mid January also limited surveys for ~1 week.

Table A6. Results of 2009 Steelhead spawning surveys in the Klickitat subbasin.

STREAM	REACH	MILES	# PASSES	REACH REDD TOTALS	REDDS /MILE	LIVE OBS. Floy Tag	LIVE OBS. No Floy	LIVE OBS. Unk	MORTS OBS. Ad-clipped Floy Tag	MORTS OBS. Ad-clipped No Floy	MORTS OBS. Unclipped Floy Tag	MORTS OBS. Unclipped No Floy	MORTS OBS. Unk
Klickitat R.													
MAIN STEM	Huckleberry Cr. confl - road washout	3.4	0	0	0.00	0	0	0	0	0	0	0	0
	Road washout - outhouse	3.2	0	0	0.00	0	0	0	0	0	0	0	0
	Outhouse - Cow Camp	2.0	2	0	0.00	0	0	0	0	0	0	0	0
	Cow Camp - main road bridge	2.2	1	0	0.00	0	0	0	0	0	0	0	0
	Main road bridge - turnout/turnaround	2.3	1	0	0.00	0	0	0	0	0	0	0	0
	Turnout/turnaround - McCreedy confluence	2.0	1	0	0.00	0	0	0	0	0	0	0	0
	McCreedy confl. - Chaparral confluence	2.7	0	0	0.00	0	0	0	0	0	0	0	0
	Chaparral confluence - old upper trap site	1.7	0	0	0.00	0	0	0	0	0	0	0	0
	Old upper trap site - top of Castile falls complex	1.3	0	0	0.00	0	0	0	0	0	0	0	0
	Extent of Castile Falls complex	0.7	0	0	0.00	0	0	0	0	0	0	0	0
	Bottom of Castile complex - West Fork conflu.	0.8	0	0	0.00	0	0	0	0	0	0	0	0
	West Fork - Signal Peak bridge	2.3	0	0	0.00	0	0	0	0	0	0	0	0
	Signal Peak bridge - Surveyors Cr. confluence	2.4	0	0	0.00	0	0	0	0	0	0	0	0
	Surveyors Cr. confluence - Portage	2.0	0	0	0.00	0	0	0	0	0	0	0	0
	Portage - Big Muddy confluence	2.8	0	0	0.00	0	0	0	0	0	0	0	0
	Big Muddy confluence - old USGS gage site	3.6	0	0	0.00	0	0	0	0	0	0	0	0
	Old USGS gage - Deer Springs	4.1	0	0	0.00	0	0	0	0	0	0	0	0
	Deer Springs - Hatchery	4.2	0	0	0.00	0	0	0	0	0	0	0	0
	Hatchery - White Cr. confluence	2.9	1	2	0.69	0	0	0	0	0	0	0	0
	White Cr. - Summit Cr. confluence	2.5	1	2	0.80	0	0	0	0	0	0	0	0
	Summit Cr. - Gage cable above Leidl	2.5	1	0	0.00	0	0	0	0	0	0	0	0
	Gage cable - Leidl bridge	2.6	1	0	0.00	0	0	0	0	0	0	0	0
	Leidl bridge - Stinson boat landing	2.9	2	0	0.00	0	0	5	0	0	0	0	0
	Stinson landing - Matt's pond	2.0	2	1	0.51	0	0	6	0	0	0	0	0
	Matt's pond - Beeks Cr. confluence	2.0	2	0	0.00	0	0	0	0	0	0	0	0
	Beeks Cr. confluence - Cattle Gate	2.0	2	0	0.00	0	0	3	0	0	0	0	0
	Cattle Gate - Little Klickitat confluence	3.4	2	0	0.00	0	0	7	0	0	0	0	0
	Little Klick - Klickitat Field Office	2.7	2	0	0.00	0	3	0	0	0	0	0	0
	Klickitat Field Office - Ice house boat landing	1.3	2	0	0.00	0	1	0	0	0	0	0	0
	Ice house landing - Klickitat town boat landing	2.1	2	1	0.47	0	0	0	0	0	0	0	0
	Klickitat town boat landing - Pitt Bridge boat landing	3.4	2	4	1.18	0	4	0	0	0	0	0	0
	Pitt bridge - Logging Camp Cr. confluence	1.2	2	0	0.00	0	1	0	0	0	0	0	0
	Logging Camp Cr. - Bus Turnaround (RM 8)	0.9	2	0	0.00	0	0	0	0	0	0	0	0
	Bus Turnaround - Dillacort Cr. confluence	3.1	1	0	0.00	0	0	0	0	0	0	0	0
	Dillacort Cr. - Lyle falls screw trap	2.6	0	0	0.00	0	0	0	0	0	0	0	0
	County Park area below Lyle Falls	0.2	0	0	0.00	0	0	0	0	0	0	0	0
	Mainstem Totals (surveyed reaches)	**46.2**		**10**	**0.2**	**0**	**9**	**21**	**0**	**0**	**0**	**0**	**0**
TRIBUTARIES													
Trib of trib													
DIAMOND FORK			0	0	-	0	0	0	0	0	0	0	0
McCREEDY CR.	1 mile upstream to confluence	1.0	0	0	0.00	0	0	0	0	0	0	0	0
CHAPARRAL CR.	Klick road to confluence	0.8	1	0	0.00	0	0	0	0	0	0	0	0
PISCOE CR.	Bottom 1 mile	1.0	1	0	0.00	0	0	0	0	0	0	0	0
SURVEYORS CR.	2nd xing to 1st xing	2.2	1	0	0.00	0	0	0	0	0	0	0	0
	1st xing to mouth	1.7	1	0	0.00	0	0	0	0	0	0	0	0
BIG MUDDY	End of Rd. to falls	1.4	0	0	0.00	0	0	0	0	0	0	0	0
TROUT CREEK	River Route Rd. xing to cascades	2.3	0	0	0.00	0	0	0	0	0	0	0	0
	cascades to confluence	1.0	2	0	0.00	0	0	0	0	0	0	0	0
Bear Cr.		1.0	0	0	0.00	0	0	0	0	0	0	0	0
OUTLET CREEK		0.3	0	0	0.00	0	0	0	0	0	0	0	0
WHITE CREEK	Upper Rd. Xing - IXL Rd.	2.8	2	0	0.00	0	0	0	0	0	0	0	0
	IXL Rd. - 191 Rd. Xing	3.1	2	5	1.61	0	6	0	0	0	0	0	0
	191 Rd. Xing - Cedar Valley Rd.	2.4	2	11	4.58	0	0	0	0	0	0	0	0
	Cedar Valley Rd. - Brush Cr.	4.6	1	0	0.00	0	0	0	0	0	0	0	0
	Brush Cr. - Washed out xing	1.8	2	2	1.11	0	0	0	0	0	0	0	1
	Washed out Xing. - mouth	3.1	1	1	0.32	0	0	0	0	1	0	0	0
West Fork White Cr.	Lower LB trib. - mouth	1.9	0	0	0.00	0	0	0	0	0	0	0	0
Tepee Cr.	RB Trib - IXL Rd.	2.2	2	4	1.82	0	0	0	0	0	0	0	0
	IXL Rd.- Tepee Cr. Rd.	2.5	3	6	2.40	0	0	0	0	0	0	0	0
	Tepee Cr. Rd. - mouth	3.4	2	2	0.59	0	0	0	0	0	0	0	0
East Fork Tepee Cr.			0	0	-	0	0	0	0	0	0	0	0
Brush Creek	Xing 3.8 mi above Coyote Springs Rd.	3.8	1	0	0.00	0	0	0	0	0	0	0	0
	Coyote Springs Rd. - Cedar Valley Rd.	2.0	1	1	0.50	0	0	0	0	0	0	0	0
	Cedar Valley Rd. - Blue Creek	2.6	1	2	0.77	0	0	0	0	0	0	0	0
	Blue Creek - mouth	2.2	1	3	1.36	0	0	0	0	0	0	0	0
SUMMIT CREEK	Falls - Confluence	1.3	3	1	0.77	0	7	0	0	0	0	0	0
DEAD CANYON CR	Big falls/Masondale Spr. trib to 1st falls	0.8	0	0	0.00	0	0	0	0	0	0	0	0
	1st falls to LB trib	1.0	0	0	0.00	0	0	0	0	0	0	0	0
	LB trib to Willis Canyon	1.5	2	1	0.67	0	0	0	0	0	0	0	0
	Willis Canyon to Haul Rd. Xing	0.8	3	1	1.25	0	0	0	0	0	0	0	0
	Haul Rd. Xing to mouth	0.2	3	0	0.00	0	0	0	0	0	0	0	0
BEEKS CANYON	Falls to mouth	0.5	2	0	0.00	0	0	0	0	0	0	0	0
LITTLE KLICKITAT	3 Creeks Lodge to Woodland Rd.	4.6	2	0	0.00	0	0	0	0	0	0	0	0
	Woodland Rd. to Hwy. 97	3.9	2	0	0.00	0	0	0	0	0	0	0	0
	Hwy. 97 to City Park	2.1	2	0	0.00	0	0	0	0	0	0	0	0
	City Park to Hwy. 142	1.5	0	0	0.00	0	0	0	0	0	0	0	0
	Falls to Mill Cr.	2.6	1	0	0.00	0	0	0	0	0	0	0	0
	Mill Cr. to Bowman Cr.	2.5	1	0	0.00	0	0	0	0	0	0	0	0
	Bowman Cr. - Hwy. 142 Bridge	0.9	1	5	5.56	0	1	0	0	0	0	0	1
	Hwy. 142 Bridge to mouth	0.3	1	0	0.00	0	0	0	0	0	0	0	0
Bowman Cr.	Falls - Hwy. 142	0.6	1	0	0.00	0	0	0	0	0	0	0	0
	Hwy. 142 to mouth	0.5	1	0	0.00	0	0	0	0	0	0	0	0
Canyon Cr.	Big falls to mostly impass. cascade (Falls 3)	1.5	0	0	0.00	0	0	0	0	0	0	0	0
	Cascade/Falls 3 to mouth	1.9	0	0	0.00	0	0	0	0	0	0	0	0
Mill Cr.			0	0	-	0	0	0	0	0	0	0	0
East Prong		1.0	0	0	0.00	0	0	0	0	0	0	0	0
West Prong		1.0	0	0	0.00	0	0	0	0	0	0	0	0
SWALE CREEK	2nd RR trestle to school bus/houses	1.2	3	0	0.00	0	0	0	0	0	0	0	0
	school bus/houses to 1st RR tresle (on LB trib)	1.2	3	2	1.67	0	0	0	0	0	0	0	0
	1st RR trestle (on LB trib) to mouth	1.2	3	1	0.83	0	0	0	0	0	0	0	0
SNYDER CREEK	Upper falls - Lower falls	0.5	0	0	0.00	0	0	0	0	0	0	0	0
	Lower falls - upper bridge	1.9	0	0	0.00	0	0	0	0	0	0	0	0
	Upper bridge - mouth	0.9	3	4	4.44	0	0	3	0	0	0	0	0
LOGGING CAMP CR	Bedrock slide to mouth	1.0	3	0	0.00	0	2	0	0	0	0	0	0
WHEELER CREEK	2nd Falls (abv Johnson Cr) to 1st Falls/Cascade	0.6	0	0	0.00	0	0	0	0	0	0	0	0
	1st Falls/Cascade to mouth	0.5	2	0	0.00	0	0	0	0	0	0	0	0
DILLACORT CR	Falls - mouth	1.5	2	0	0.00	0	0	0	0	0	0	0	0
SILVA CREEK	Bottom	0.1	0	0	0.00	0	0	0	0	0	0	0	0
CANYON CREEK	Bottom 1/4 mile	0.3	0	0	0.00	0	0	0	0	0	0	0	0
	Tributary Totals (surveyed reaches)	**73.0**		**52**	**0.7**	**0**	**16**	**3**	**0**	**1**	**0**	**0**	**2**
	KLICKITAT WATERSHED TOTALS	**119.2**		**62**		**0**	**25**	**24**	**0**	**1**	**0**	**0**	**2**
	Tributary Contribution			**84%**		**-**	**64%**	**13%**	**-**	**100%**	**-**	**-**	**100%**
	Mainstem Contribution			**16%**		**-**	**36%**	**88%**	**-**	**0%**	**-**	**-**	**0%**

Unk = Unknown

Note - Snow and high flows/turbidity limited access and surveys in White Cr. watershed and upper Klickitat R. until late April, then rain and resulting high flows in early May further delayed surveys in these reaches. Continued high flows above Castile Falls into June prevented complete surveys in the upper Klickitat R.

Appendix B. Adult salmonid monitoring at Lyle Falls fishway

Table B1. Daily fish counts at the Lyle adult trap by species and mark for May 1, 2009 - April 30, 2010.

Date	Ad Present Chinook	Ad Present Chinook Jack	Ad Clipped Chinook	Ad Clipped Chinook Jack	Ad Present Coho	Ad Present Coho Jack	Ad Clipped Coho	Ad Clipped Coho Jack	Wild Steelhead	Hatchery Steelhead
01-May-09	0	0	0	0	0	0	0	0	0	2
04-May-09	1	0	0	0	0	0	0	0	0	0
05-May-09	0	0	0	0	0	0	0	0	1	0
06-May-09	0	0	2	0	0	0	0	0	0	2
07-May-09	0	0	1	2	0	0	0	0	1	4
12-May-09	3	0	26	1	0	0	0	0	1	17
13-May-09	1	0	16	5	0	0	0	0	0	8
14-May-09	0	0	7	1	0	0	0	0	0	2
15-May-09	1	0	42	3	0	0	0	0	3	7
20-May-09	0	0	5	2	0	0	0	0	0	1
21-May-09	0	0	8	4	0	0	0	0	1	1
22-May-09	0	0	23	2	0	0	0	0	0	10
27-May-09	0	0	6	0	0	0	0	0	0	0
28-May-09	7	2	61	11	0	0	0	0	9	16
29-May-09	4	0	23	4	0	0	0	0	2	17
02-Jun-09	5	0	25	16	0	0	0	0	3	4
03-Jun-09	8	0	26	11	0	0	0	0	3	13
04-Jun-09	0	0	4	2	0	0	0	0	1	7
11-Jun-09	3	0	14	6	0	0	0	0	4	30
12-Jun-09	0	0	12	6	0	0	0	0	4	18
16-Jun-09	1	0	10	6	0	0	0	0	5	29
17-Jun-09	1	0	0	0	0	0	0	0	2	0
18-Jun-09	0	0	18	3	0	0	0	0	4	31
19-Jun-09	0	0	5	6	0	0	0	0	1	18
23-Jun-09	0	0	12	3	0	0	0	0	6	25
24-Jun-09	0	0	1	0	0	0	0	0	1	2
25-Jun-09	0	0	0	3	0	0	0	0	3	11
30-Jun-09	0	0	4	4	0	0	0	0	14	25
01-Jul-09	0	0	2	0	0	0	0	0	1	15
02-Jul-09	0	1	2	0	0	0	0	0	1	13
07-Jul-09	0	0	0	1	0	0	0	0	3	10
08-Jul-09	0	0	2	2	0	0	0	0	10	27
09-Jul-09	0	0	0	0	0	0	0	0	7	20
10-Jul-09	0	0	0	2	0	0	0	0	5	23
14-Jul-09	2	0	3	5	0	0	0	0	10	19
15-Jul-09	0	0	1	0	0	0	0	0	1	7
16-Jul-09	0	0	1	0	0	0	0	0	4	7
17-Jul-09	0	1	2	0	0	0	0	0	7	31
21-Jul-09	0	0	2	0	0	0	0	0	7	11
22-Jul-09	0	1	0	1	0	0	0	0	5	30
23-Jul-09	0	0	2	4	0	0	0	0	8	30
24-Jul-09	0	1	1	0	0	0	0	0	4	17
28-Jul-09	1	0	0	1	0	0	0	0	4	20
29-Jul-09	0	0	1	0	0	0	0	0	2	5
30-Jul-09	0	0	0	1	0	0	0	0	6	4
05-Aug-09	2	0	0	0	0	0	0	0	5	12
06-Aug-09	1	0	0	0	0	0	0	0	2	5
07-Aug-09	0	0	0	0	0	0	0	0	0	0
11-Aug-09	0	0	0	0	0	0	0	0	2	1
12-Aug-09	0	0	0	0	0	0	0	0	0	0
13-Aug-09	0	0	0	0	0	0	0	0	0	0
14-Aug-09	0	0	0	0	0	0	0	0	0	0
18-Aug-09	0	0	0	0	0	0	0	0	4	2
19-Aug-09	0	0	0	0	0	0	0	0	0	4
20-Aug-09	0	0	0	0	0	0	0	0	0	0
21-Aug-09	0	0	0	0	0	0	0	0	3	2
01-Sep-09	0	0	0	0	0	0	0	0	3	3
02-Sep-09	0	0	0	0	0	0	0	0	5	6
03-Sep-09	1	0	0	0	0	0	0	0	3	13
04-Sep-09	1	0	0	0	0	0	0	0	7	9
09-Sep-09	0	0	0	0	0	0	0	0	3	3
10-Sep-09	2	0	0	0	0	0	0	0	0	2
15-Sep-09	1	0	0	0	0	0	0	0	1	4
16-Sep-09	0	0	0	0	0	0	0	0	1	5

Date	Ad Present Chinook	Ad Present Chinook Jack	Ad Clipped Chinook	Ad Clipped Chinook Jack	Ad Present Coho	Ad Present Coho Jack	Ad Clipped Coho	Ad Clipped Coho Jack	Wild Steelhead	Hatchery Steelhead
17-Sep-09	0	0	0	0	0	0	0	0	3	3
22-Sep-09	0	0	0	0	0	0	0	0	5	5
23-Sep-09	0	0	1	0	0	0	0	0	0	1
25-Sep-09	0	0	0	0	0	0	0	0	0	0
30-Sep-09	2	0	0	2	0	0	1	0	1	3
01-Oct-09	0	0	0	0	0	0	0	0	0	1
02-Oct-09	0	0	0	0	0	0	0	0	0	0
08-Oct-09	0	2	0	0	2	0	1	0	0	0
13-Oct-09	0	0	0	0	0	0	0	0	0	0
16-Oct-09	0	0	0	0	0	0	0	0	4	3
18-Oct-09	0	2	0	0	2	0	1	0	0	0
20-Oct-09	0	0	0	0	912	0	0	0	0	0
21-Oct-09	0	0	0	0	250	0	244	0	2	1
22-Oct-09	0	0	0	0	325	0	174	0	0	0
29-Oct-09	0	0	0	0	35	0	21	0	0	0
30-Oct-09	0	0	0	0	30	0	10	0	0	0
04-Nov-09	0	0	0	0	0	0	0	0	0	0
10-Nov-09	0	0	0	0	3	0	2	0	0	0
18-Nov-09	0	0	0	0	0	0	0	0	0	0
19-Nov-09	0	0	0	0	2	0	4	0	0	0
01-Dec-09	0	0	0	0	0	0	0	0	0	0
02-Dec-09	0	0	0	0	1	0	0	0	0	0
15-Dec-09	0	0	0	0	0	0	0	0	0	0
29-Dec-09	0	0	0	0	4	0	2	0	0	0
04-Jan-10	0	0	0	0	2	0	0	0	0	0
05-Jan-10	0	0	0	0	1	0	0	0	3	0
06-Jan-10	0	0	0	0	11	0	4	0	1	0
07-Jan-10	0	0	0	0	8	0	4	0	0	0
08-Jan-10	0	0	0	0	11	0	4	0	0	0
11-Jan-10	0	0	0	0	30	0	12	0	0	0
13-Jan-10	0	0	0	0	0	0	0	0	0	0
19-Jan-10	0	0	0	0	0	0	0	0	0	0
20-Jan-10	0	0	0	0	0	0	0	0	0	0
21-Jan-10	0	0	0	0	0	0	0	0	0	0
22-Jan-10	0	0	0	0	0	0	0	0	0	0
26-Jan-10	0	0	0	0	1	0	0	0	0	0
27-Jan-10	0	0	0	0	0	0	0	0	6	0
28-Jan-10	0	0	0	0	0	0	0	0	0	0
29-Jan-10	0	0	0	0	0	0	0	0	0	0
03-Feb-10	0	0	0	0	0	0	0	0	10	0
04-Feb-10	0	0	0	0	0	0	0	0	2	1
05-Feb-10	0	0	0	0	0	0	0	0	3	1
09-Feb-10	0	0	0	0	0	0	0	0	1	2
11-Feb-10	0	0	0	0	0	0	0	0	4	2
17-Feb-10	0	0	0	0	0	0	0	0	0	0
23-Feb-10	0	0	0	0	0	0	0	0	3	0
24-Feb-10	0	0	0	0	0	0	0	0	1	0
25-Feb-10	0	0	0	0	0	0	0	0	1	0
26-Feb-10	0	0	0	0	0	0	0	0	2	1
01-Mar-10	0	0	0	0	0	0	0	0	4	2
02-Mar-10	0	0	0	0	0	0	0	0	3	0
04-Mar-10	0	0	0	0	0	0	0	0	12	4
05-Mar-10	0	0	0	0	0	0	0	0	8	0
10-Mar-10	0	0	0	0	0	0	0	0	3	1
11-Mar-10	0	0	0	0	0	0	0	0	0	0
15-Mar-10	0	0	0	0	0	0	0	0	9	2
17-Mar-10	0	0	0	0	0	0	0	0	14	5
18-Mar-10	0	0	0	0	0	0	0	0	1	1
19-Mar-10	0	0	0	0	0	0	0	0	3	0
24-Mar-10	0	0	0	0	0	0	0	0	8	1
31-Mar-10	0	0	0	0	0	0	0	0	7	10
07-Apr-10	0	0	0	0	0	0	0	0	8	2
13-Apr-10	0	0	0	0	0	0	0	0	7	4
14-Apr-10	0	0	0	0	0	0	0	0	1	4
15-Apr-10	0	0	0	0	0	0	0	0	1	2
16-Apr-10	0	0	0	0	0	0	0	0	1	5
19-Apr-10	0	0	0	0	0	0	0	0	2	10
20-Apr-10	0	0	2	0	0	0	0	0	6	11
21-Apr-10	0	0	7	0	0	0	0	0	2	4
27-Apr-10	0	0	0	0	0	0	0	0	2	11
28-Apr-10	0	0	6	0	0	0	0	0	1	5
29-Apr-10	0	0	3	0	0	0	0	0	1	3
30-Apr-10	0	0	6	0	0	0	0	0	2	4
Totals	**48**	**10**	**395**	**120**	**1630**	**0**	**484**	**0**	**351**	**775**

Table B2. Spring Chinook population estimates by return year at Lyle Falls from mark-recapture methods (see Adult Salmonid Monitoring section for methods description). Estimates include adults and jacks. Hatchery and wild numbers estimated from proportions observed at Lyle Falls adult trap.

Year	Pop. Estimate (total)	L 95% CL	U 95% CL	Hatchery	Wild
2005 [1]	2011	1475	2842		
2006 [1]	2100	1884	2391		
2007 [2]	1965	1653	2362	1553	413
2008	1432	1125	1861	1016	416
2009	6522	5803	7364	5846	675
Avg.	2806			2805	501

[1]Estimates from Gray 2007

[2]2007 is first year all returning adult age classes were 100% ad marked

Table B3. Steelhead population estimates by return year at Lyle Falls from mark-recapture methods (see Adult Salmonid Monitoring section for methods description).

	Total			Hatchery			Wild (Summer and Winter)			Wild (Summer)			
Year	Pop. Estimate	L 95% CL	U 95% CL	Pop. Estimate	L 95% CL	U 95% CL	Pop. Estimate	L 95% CL	U 95% CL	Pop. Estimate	L 95% CL	U 95% CL	Wild (Winter)[1]
2005-06 [2]	3,410	2,967	3,961	1,833	1,572	2,160	1,577	1,395	1,801	1,252	1,070	1,476	325
2006-07 [2,3]	3,523	2,718	5,918	1,854	1,394	3,231	1,669	1,324	2,687	1,325	980	2,343	
2007-08 [4]													90
2008-09 [4]													82
2009-10 [5]	4,972	4,084	6,157	3,700	3,010	4,626	1,272	1,074	1,531	1,127	929	1,386	145
Avg:	3,968			2,462			1,506			1,235			161

[1]Count of fish captured in Lyle adult trap Dec 1 - Apr 30 (assumes no winter steelhead ascend falls)

[2]From Gray 2007

[3]No winter steelhead count due to trap damage; total wild estimate based on 2005-6 winter steelhead proportion of total

[4]No estimate

[5]2009 estimate of hatchery fish may be biased high by a high dip-in rate by out-of-basin fish

Appendix C. Juvenile outmigration monitoring (screw traps)

Table C1. Catch summary of target species for the Lyle Falls screw trap for May 1, 2009 – April 30, 2010.

Month	Days Fished	Chinook	Coho	Hatchery *O.mykiss*	Wild *O.mykiss*	***Totals***
May	1	1	123		5	129
June	5	1014				1014
July	12	12566				12566
August	0					0
September	0					0
October	0					0
November	6	68	6		10	84
December	7	160	46	1	17	224
January	15	92	83		11	186
February	11	14	12	1	5	32
March	14	3574	13	1	5	3593
April	8	4	6794	1	5	6804
Totals	79	17493	7077	4	58	24632

Table C2. Results of efficiency testing at the Lyle Falls screw trap 2003-2006.

Date	Species	Flow*	No. of fish marked	No. of fish recaptured	Efficiency (%)	
4/10/2003	Hcoho	2065	283	16	5.7%	
4/11/2003	Hcoho	2100	566	26	4.6%	
4/16/2003	Hcoho	2095	377	29	7.7%	
4/17/2003	Hcoho	2031	300	5	1.7%	
4/28/2003	Hcoho	1970	293	23	7.8%	
4/29/2003	Hcoho	2055	94	3	3.2%	
5/5/2003	Homy	2040	300	14	4.7%	
5/6/2003	Homy	1945	300	6	2.0%	
9/4/2003	chk	721	244	49	20.1%	
3/9/2004	Hschk	1525	300	43	14.3%	
3/10/2004	Hschk	1570	92	12	13.0%	
3/12/2004	Hschk	1535	300	28	9.3%	
4/20/2004	Hcoho	1600	311	38	12.2%	
4/21/2004	Hcoho	1550	299	29	9.7%	
5/12/2004	Homy	1620	289	17	5.9%	
5/13/2004	Homy	1570	300	13	4.3%	
8/10/2004	Hfchk	634	329	39	11.9%	
2/14/2005	Wschk, Wchk, Wcoho	814	238	25	10.5%	**
2/28/2005	Wschk, Wcoho	751	62	12	19.4%	
7/25/2005	Hfchk	576	419	5	1.2%	
8/1/2005	Hfchk	565	196	26	13.3%	
4/25/2006	Hcoho	2530	150	7	4.7%	
4/25/2006	Homy	2530	50	1	2.0%	
6/27/2006	Hfchk	1655	301	8	2.7%	

* Flow values are 2-day averages of mean daily flows starting on test date (USGS gage 14113000 Klickitat River near Pitt).
** This test may slightly underestimate efficiency (by approximately 1-2%) due to a gap in trap operation during test.

Table C3. Catch summary of target species for the Castile Falls screw trap for May 1, 2009 – April 30, 2010.

Month	Days Fished	Wild *O.mykiss*	Wild Chinook	Hatchery Chinook	Brook Trout	***Totals***
May	0					0
June	4					0
July	29	6				6
August	22	3	7			10
September	15	1	11		1	13
October	5	4	21			25
Totals	75	14	39	0	1	54

Table C4. Results of efficiency testing at Castile Falls screw trap 2003-2005.

Date	Species	Flow*	No. of fish marked	No. of fish recaptured	Efficiency (%)
8/12/2003	Hatchery spring Chinook	107	55	17	30.9%
8/13/2003	Hatchery spring Chinook	107	110	35	31.8%
9/5/2003	Hatchery spring Chinook	87	68	16	23.5%
7/19/2004	Hatchery spring Chinook	176	52	15	28.8%
7/20/2004	Hatchery spring Chinook	166	40	18	45.0%
5/20/2005	Hatchery spring Chinook	324	500	95	19.0%
5/24/2005	Hatchery spring Chinook	264	286	63	22.0%
7/26/2005	Wild spring Chinook	91	195	51	26.2%
8/1/2005	Wild spring Chinook	83	190	71	37.4%

* Flow values are 2-day averages of mean daily flows starting on test date (USGS gage 14107000 above West Fork near Glenwood [above Castile Falls])

Appendix D. Juvenile and resident salmonid population surveys

Table D1. Results of population surveys in Tepee and White creeks prior to habitat improvement work. Two-pass mark-recapture methods were used (see Juvenile and resident population survey section in narrative for descriptions); number s of *O. mykiss* captured in each pass along with resulting population estimates (N) and 95% confidence intervals are presented.

Stream	Date	Reach	Start Latitude	Start Longitude	Pass 1	Pass 2 New	Pass 2 Recaps	N		95% CI
Tepee Creek	7/7-8/2009	1	46.1652728	-121.0370214	9	7	3	27	±	15
	7/7-8/2009	2	46.16578954	-121.0356601	25	14	8	65	±	26
	7/7-8/2009	3	46.16910257	-121.0337302	30	10	6	74	±	35
	7/8-9/2009	4	46.17226423	-121.0332373	25	31	4	186	±	125
Tepee Creek totals					*89*	*62*	*21*	*343*	±	*105*
White Creek	7/22-23/2009	1	45.86207296	-120.9994997	36	31	14	112	±	35
	7/22-23/2009	2	46.14389459	-121.0733265	15	10	2	68	±	54
	7/22-23/2009	3	46.17478852	-121.0737624	22	9	12	38	±	9
	7/22-23/2009	4	46.1748508	-121.0723411	10	1	2	14	±	6
White Creek totals					*83*	*51*	*30*	*221*	±	*48*

Appendix E. Scale age and length data

Table E1. Average, minimum, and maximum fork length and postorbital-hypural length by age and sex for naturally-spawning spring Chinook in the Klickitat R. in 2009.

2009 Spring Chinook Natural Spawner Scale Age Data - Adipose Clipped Fish

			Fork Length (mm)			Postorbital-Hypural Length (mm)				
Age	Sex	Count	Mean	Min	Max	Mean	Min	Max	% of sex	% of total
3	Male	1	475	475	475	385	385	385	100.0%	100.0%
Total Females		0								
Total Males		1								
Grand Total		1								

2009 Spring Chinook Natural Spawner Scale Age Data - Adipose Present Fish

			Fork Length (mm)			Postorbital-Hypural Length (mm)				
Age	Sex	Count	Mean	Min	Max	Mean	Min	Max	% of sex	% of total
4	Female	1	664	664	664	564	564	564	100.0%	20.0%
5	Male	3	889	817	964	741	686	778	100.0%	60.0%
5	unknown	1	934	934	934	777	777	777		20.0%
Total Females		1								
Total Males		3								
Grand Total (incl. unk.)		5								

Table E2. Average, minimum, and maximum fork length by age and sex for spring Chinook captured in the Lyle Falls adult fish trap in 2009.

2009 Spring Chinook Adult Fish Trap Scale Age Data - Adipose Clipped Fish

			Fork Length (mm)				
Age	Sex	Count	Mean	Min	Max	% of sex	% of total
3	unknown	1	650	650	650		0.8%
3	Female	3	537	485	610	8.8%	2.4%
3	Male	23	548	469	650	29.1%	18.4%
4	unknown	9	744	685	790		7.2%
4	Female	28	742	640	865	82.4%	22.4%
4	Male	42	745	560	940	53.2%	33.6%
5	unknown	2	835	820	850		1.6%
5	Female	3	793	770	840	8.8%	2.4%
5	Male	14	810	724	915	17.7%	11.2%
Total Females		34					
Total Males		79					
Grand Total (incl. unk.)		125					

2009 Spring Chinook Adult Fish Trap Scale Age Data - Adipose Present Fish

			Fork Length (mm)				
Age	Sex	Count	Mean	Min	Max	% of sex	% of total
3	Male	3	470	460	480	23.1%	14.3%
4	unknown	1					4.8%
4	Female	2	657	657	657	33.3%	9.5%
4	Male	6	733	590	865	46.2%	28.6%
5	unknown	1					4.8%
5	Female	4	811	800	820	66.7%	19.0%
5	Male	4	874	810	930	30.8%	19.0%
Total Females		6					
Total Males		13					
Grand Total (incl. unk.)		21					

Table E3. Average, minimum, and maximum fork length and postorbital-hypural length by age and sex for naturally-spawning fall Chinook in the Klickitat R. in 2009.

2009 Fall Chinook Natural Spawner Scale Age Data

			Fork Length (mm)			Postorbital-Hypural Length (mm)				
Age	Sex	Count	Mean	Min	Max	Mean	Min	Max	% of sex	% of total
3	unknown	1	667	667	667	531	531	531		0.8%
3	Male	8	586	470	672	483	405	540	12.1%	6.4%
4	Female	36	834	647	966	696	519	785	62.1%	28.8%
4	Male	41	813	618	978	663	510	825	62.1%	32.8%
5	Female	22	853	777	954	713	643	807	37.9%	17.6%
5	Male	17	918	795	1069	746	650	866	25.8%	13.6%
Total Females		58								
Total Males		66								
Grand Total (incl. unk.)		125								

Table E4. Average, minimum, and maximum fork length by age and sex for fall Chinook captured in the Lyle Falls adult fish trap in 2009.

2009 Fall Chinook Adult Fish Trap Scale Age Data

			Fork Length (mm)				
Age	Sex	Count	Mean	Min	Max	% of sex	% of total
3	Male	1	465	465`	465	25.0%	14.3%
4	Female	2	797	768	827	66.7%	28.6%
4	Male	2	608	433	784	50.0%	28.6%
5	Female	1	920	920	920	33.3%	14.3%
5	Male	1	862	862	862	25.0%	14.3%
Total Females		3					
Total Males		4					
Grand Total		7					

Table E5. Average, minimum, and maximum fork length and postorbital-hypural length by age and sex for naturally-spawning coho in the Klickitat subbasin in 2009-10.

2009-10 Coho Natural Spawner Scale Age Data

			Fork Length (mm)			Postorbital-Hypural Length (mm)				
Age	Sex	Count	Mean	Min	Max	Mean	Min	Max	% of sex	% of total
2	Male	2	475	465	484	382	380	383	6.1%	3.6%
3	Female	22	708	593	842	579	490	711	100.0%	40.0%
3	Male	31	630	463	770	508	374	615	93.9%	56.4%
Total Females		22								
Total Males		33								
Grand Total		55								

Table E6. Average, minimum, and maximum fork length by age and sex for coho captured in the Lyle Falls adult fish trap in 2009-10.

2009-10 Coho Adult Fish Trap Scale Age Data

			Fork Length (mm)				
Age	Sex	Count	Mean	Min	Max	% of sex	% of total
3	Female	3	537	521	560	100.0%	75.0%
3	Male	1				100.0%	25.0%
Total Females		3					
Total Males		1					
Grand Total		4					

Table E7. Average, minimum, and maximum fork length by age and sex for steelhead captured in the Lyle Falls adult fish trap from 5/1/2009 to 4/30/2010.

2009-10 Steelhead Adult Fish Trap Scale Age Data - Adipose Clipped Fish

			Fork Length (mm)				
Age	Sex	Count	Mean	Min	Max	% of sex	% of total
3	Female	11	642	570	701	25.0%	11.7%
3	Male	5	653	614	724	11.1%	5.3%
4	unknown	3	672	660	696		3.2%
4	Female	25	694	560	745	56.8%	26.6%
4	Male	25	718	649	841	55.6%	26.6%
5	unknown	2	700	670	730		2.1%
5	Female	8	736	685	790	18.2%	8.5%
5	Male	15	739	660	810	33.3%	16.0%
Total Females		44					
Total Males		45					
Grand Total (incl. unk.)		94					

2009-10 Steelhead Adult Fish Trap Scale Age Data - Adipose Present Fish

			Fork Length (mm)				
Age	Sex	Count	Mean	Min	Max	% of sex	% of total
3	unknown	3	737	737	737		1.3%
3	Female	74	630	535	762	49.7%	31.5%
3	Male	27	638	531	713	37.5%	11.5%
4	unknown	8					3.4%
4	Female	69	681	540	841	46.3%	29.4%
4	Male	42	725	610	860	58.3%	17.9%
5	unknown	3	718	695	740		1.3%
5	Female	6	720	661	770	4.0%	2.6%
5	Male	3	775	710	840	4.2%	1.3%
Total Females		149					
Total Males		72					
Grand Total (incl. unk.)		235					

Appendix F. Sediment data

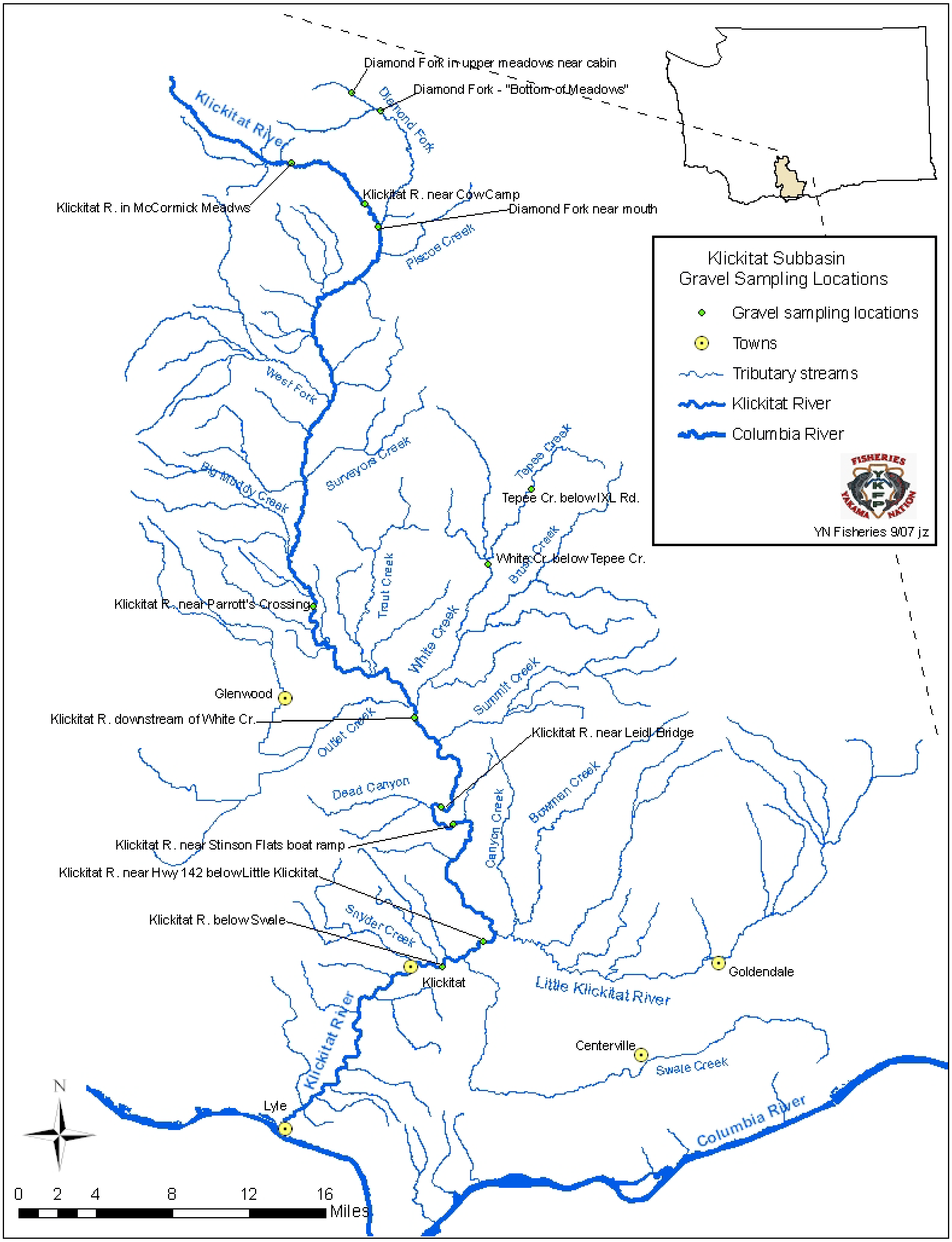


Figure F1. Locations of Klickitat subbasin sediment sampling sites.

Site Name: Diamond Fork in upper meadows near cabin

Year:	%<75.0mm	%<26.5mm	%<13.5mm	%<9.5mm	%<6.73mm	%<3.35mm	%<1.7mm	%<1.0mm	%<0.85mm	%<0.425mm	%<0.212mm
2000	100.0	78.7	60.1	52.9	45.6	35.1	27.2	22.2	20.6	13.8	8.4
2001	98.2	73.1	55.4	48.9	42.5	32.4	24.5	19.9	18.6	13.4	8.7
2002	95.0	52.4	35.6	30.1	25.1	17.7	11.5	8.6	7.8	5.8	4.6
2003	100.0	72.0	46.4	38.3	31.1	21.7	15.2	11.7	10.9	6.5	3.7
2004	100.0	66.4	43.7	37.5	31.4	22.3	15.5	11.3	10.3	6.4	3.9
2005	100.0	72.8	53.8	47.0	40.1	28.8	20.7	15.7	14.5	8.8	5.1
2006	98.6	77.0	56.4	48.6	41.2	30.3	21.6	16.0	14.4	9.4	5.8
2007	98.7	66.8	45.1	37.9	30.7	20.9	14.6	11.3	10.2	7.0	4.1
2008	98.8	69.6	51.7	44.6	36.9	26.3	18.5	13.8	12.2	7.9	4.6
2009	98.5	65.6	47.7	41.6	35.1	25.3	18.3	13.7	12.5	8.3	4.9

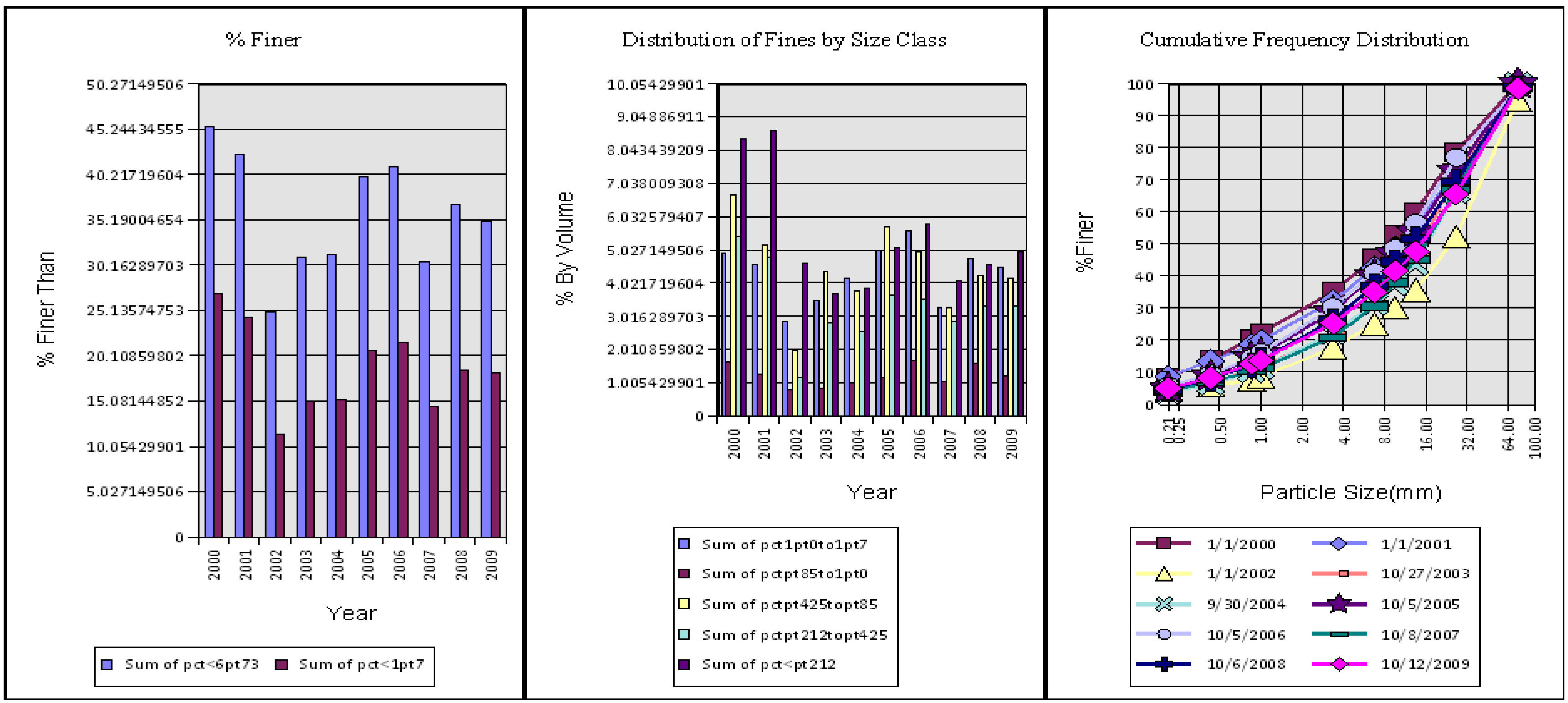


Figure F2. Sediment sampling data from Diamond Fork in upper meadows 2000-2009.

Site Name: Diamond Fork - "Bottom of Meadows"

Year:	%<75.0mm	%<26.5mm	%<13.5mm	%<9.5mm	%<6.73mm	%<3.35mm	%<1.7mm	%<1.0mm	%<0.85mm	%<0.425mm	%<0.212mm
2001	90.4	57.4	41.5	35.8	30.5	21.9	14.5	10.2	9.2	6.7	4.9
2002	100.0	76.6	56.3	48.7	41.3	29.6	20.3	14.3	12.9	8.3	5.0
2003	96.0	61.7	47.2	42.0	37.1	30.1	24.8	20.8	19.3	11.6	6.9
2004	99.0	66.3	47.9	41.6	35.6	26.6	19.1	14.1	12.4	7.7	4.7
2005	98.6	72.1	52.0	45.1	38.3	27.7	19.4	14.7	13.2	8.6	5.5
2006	100.0	65.8	48.2	41.6	35.5	26.6	20.6	15.3	13.5	7.7	4.4
2007	96.9	63.4	44.0	37.3	30.9	22.8	17.1	12.9	11.4	6.9	3.7
2008	96.8	60.9	41.4	35.0	29.1	21.2	14.9	10.4	9.0	5.2	2.8
2009	98.3	66.3	49.2	41.7	34.8	24.8	17.6	13.1	11.7	7.3	4.7

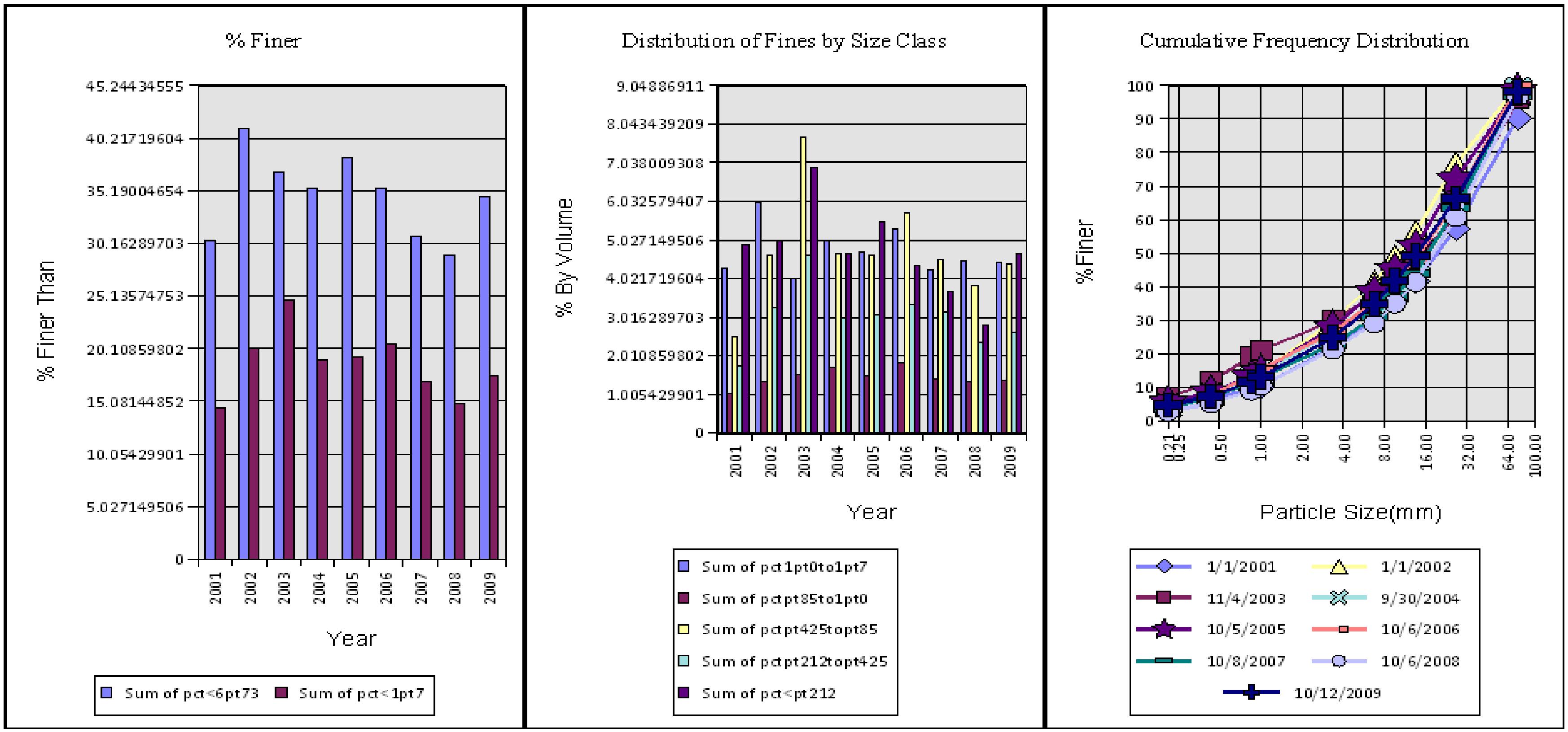


Figure F3. Sediment sampling data from Diamond Fork Bottom of Meadows 2001-2009.

Site Name: Diamond Fork near mouth

Year:	%<75.0mm	%<26.5mm	%<13.5mm	%<9.5mm	%<6.73mm	%<3.35mm	%<1.7mm	%<1.0mm	%<0.85mm	%<0.425mm	%<0.212mm
1999	97.3	64.9	47.0	40.1	35.0	26.7	19.0	14.3	13.1	9.8	7.8
2000	86.1	44.9	32.8	28.6	25.3	19.7	13.9	8.7	7.3	4.2	3.0
2003	93.8	62.2	43.5	36.3	29.7	19.7	12.5	8.9	8.0	5.8	4.2
2004	93.4	67.2	49.5	42.9	36.5	26.5	18.1	12.9	11.5	7.8	5.4
2005	89.6	62.4	44.9	38.8	33.0	24.0	17.7	13.3	12.0	8.3	5.8
2006	93.8	63.3	46.1	39.2	31.9	22.3	15.0	11.0	9.9	7.3	5.0
2007	97.0	60.0	43.6	37.6	31.4	21.9	15.6	12.1	11.0	7.6	5.4
2008	91.8	59.4	43.8	37.8	31.9	22.6	15.3	11.0	10.0	6.8	4.6
2009	91.9	58.6	42.5	36.9	31.3	23.1	16.3	11.3	10.0	6.9	5.0

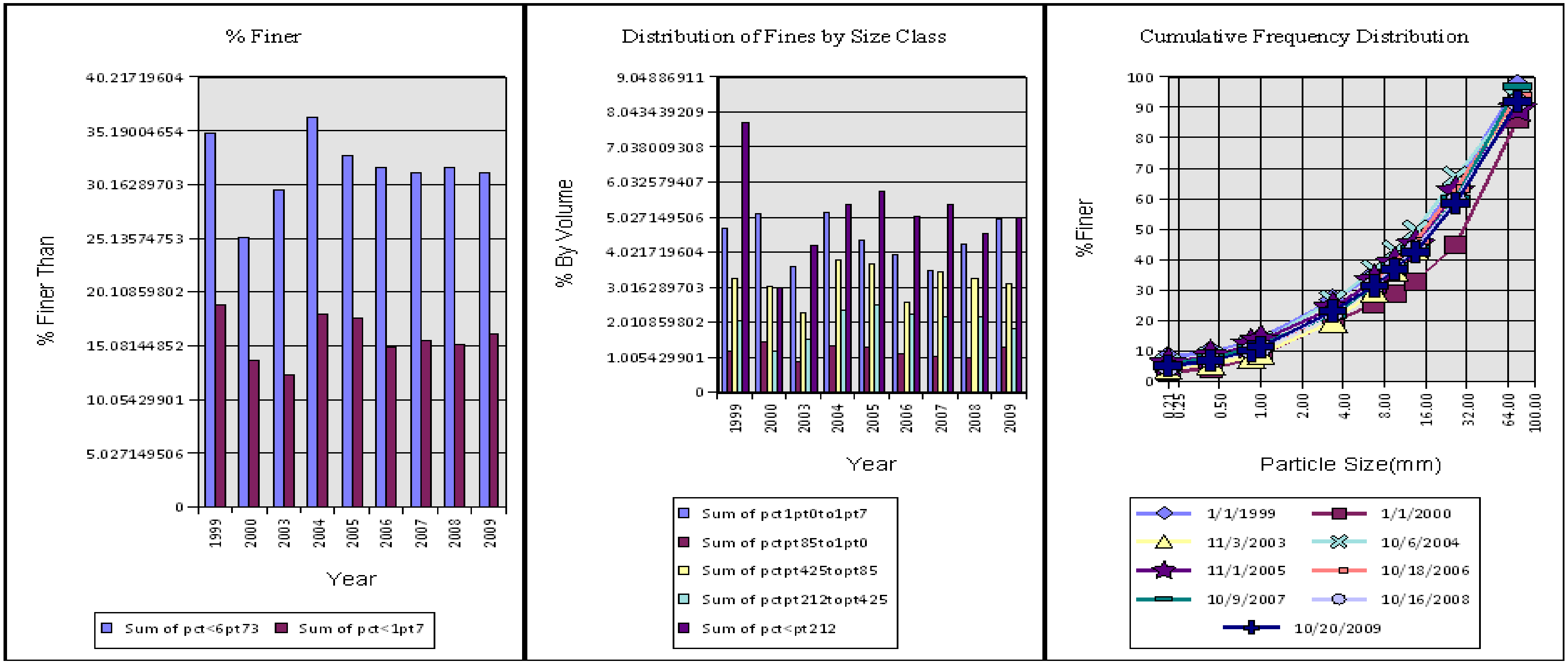


Figure F4. Sediment sampling data from Diamond Fork near mouth 1999-2009.

Site Name: White Creek meadow below Tepee Creek confluence

Year:	%<75.0mm	%<26.5mm	%<13.5mm	%<9.5mm	%<6.73mm	%<3.35mm	%<1.7mm	%<1.0mm	%<0.85mm	%<0.425mm	%<0.212mm
2005	100.0	78.2	55.8	47.7	40.8	31.9	26.4	23.9	22.7	16.6	12.5
2006	97.9	77.6	51.0	43.0	36.2	27.6	22.2	18.1	16.8	9.8	6.1
2008	99.6	78.2	53.2	45.6	39.3	30.4	23.6	19.8	18.9	15.3	12.2
2009	98.6	77.2	53.3	46.0	39.4	30.8	25.2	21.2	19.7	14.0	10.6

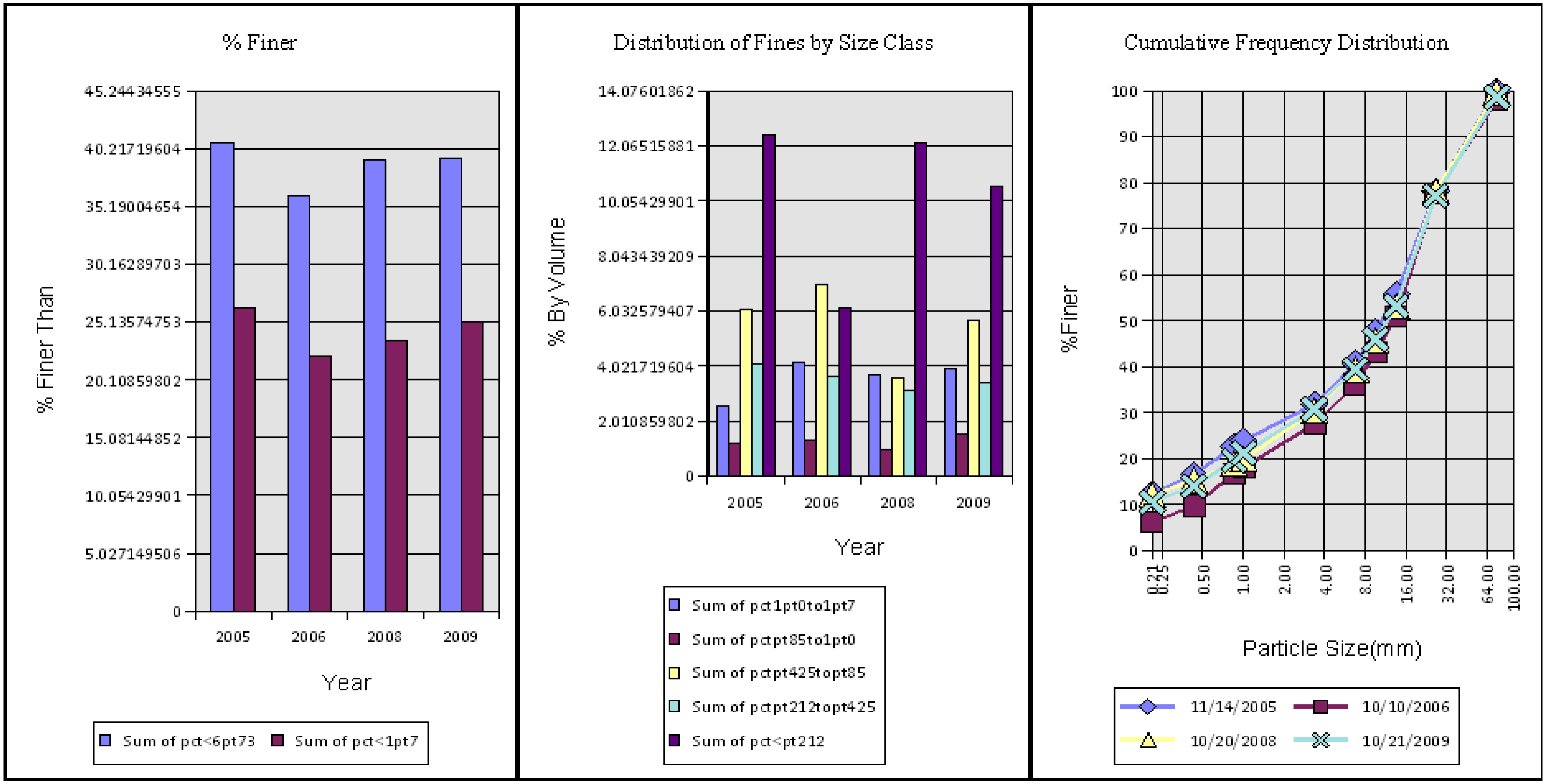


Figure F5. Sediment sampling data from White Creek meadow below Tepee Creek confluence 2005-2009.

Site Name: Klickitat R. near Cow Camp

Year:	%<75.0mm	%<26.5mm	%<13.5mm	%<9.5mm	%<6.73mm	%<3.35mm	%<1.7mm	%<1.0mm	%<0.85mm	%<0.425mm	%<0.212mm
1998	97.8	47.4	23.6	16.3	11.8	8.8	6.4	5.5	5.2	4.6	4.0
1999	98.1	57.7	38.8	32.3	27.0	20.5	16.3	13.9	13.1	10.9	8.7
2000	93.1	67.0	49.8	43.7	38.8	30.9	24.8	21.1	20.0	17.1	15.2
2001	97.1	62.6	42.3	35.5	30.0	22.4	16.8	13.9	13.1	10.7	8.7
2002	91.7	55.2	34.6	27.8	22.3	15.2	10.7	8.5	7.8	6.3	5.2
2003	90.4	45.0	26.4	20.6	16.2	10.8	7.6	5.9	5.4	4.0	3.1
2004	88.4	56.2	39.3	32.8	27.3	19.3	13.3	9.7	8.6	5.6	4.1
2005	87.0	58.3	41.7	35.3	29.4	20.8	14.2	10.3	9.4	6.2	4.3
2006	95.3	66.4	47.8	40.8	33.8	24.0	16.7	12.1	10.9	6.3	4.2
2007	96.2	59.5	43.8	37.8	31.3	22.4	15.2	11.3	9.9	6.2	4.3
2008	94.3	59.2	41.2	35.3	29.4	20.9	15.3	11.4	10.0	6.0	4.1
2009	95.5	67.2	48.7	40.6	33.7	23.6	16.6	11.6	10.1	6.0	4.0

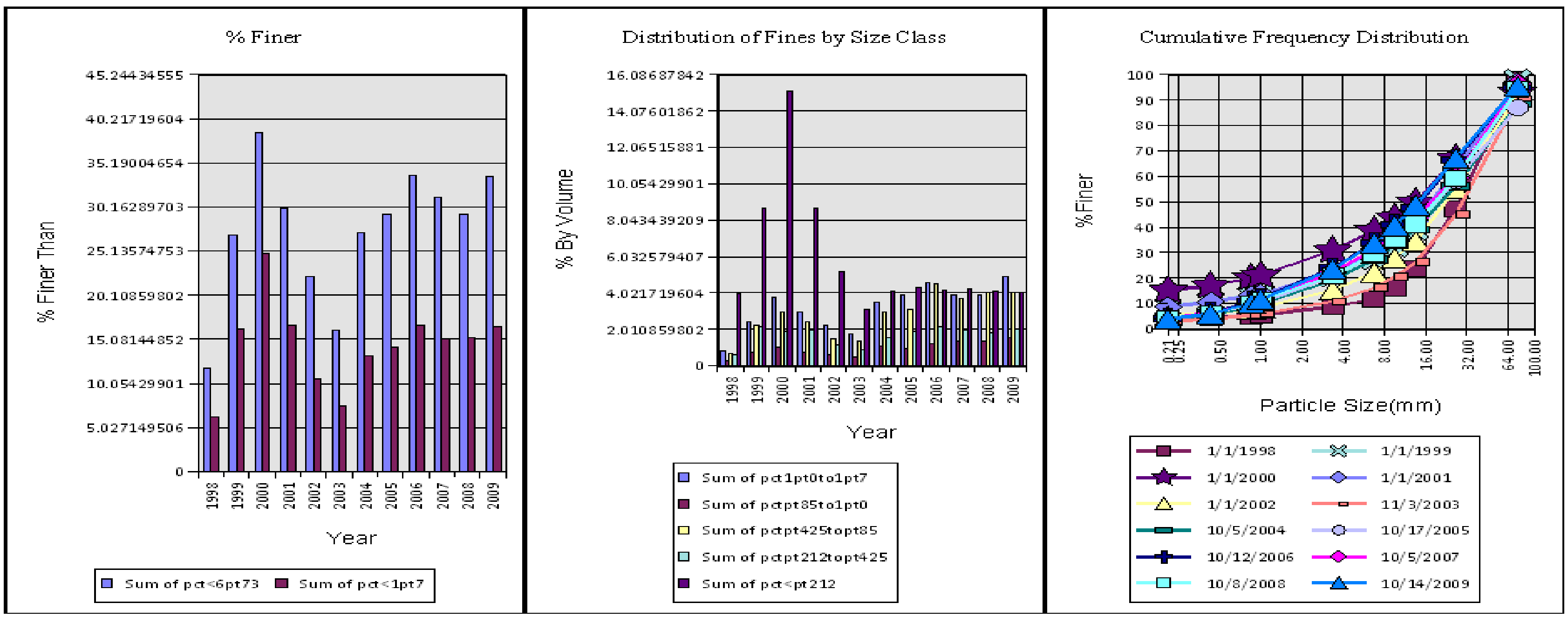


Figure F6. Sediment sampling data from Klickitat R. near Cow Camp 1998-2009.

Site Name: Klickitat R. in McCormick Meadows

Year:	%<75.0mm	%<26.5mm	%<13.5mm	%<9.5mm	%<6.73mm	%<3.35mm	%<1.7mm	%<1.0mm	%<0.85mm	%<0.425mm	%<0.212mm
2003	95.6	49.0	31.2	25.2	20.2	13.6	9.2	6.8	6.1	4.1	2.8
2004	99.2	60.3	39.9	33.2	27.0	18.8	13.0	9.4	8.2	5.1	3.5
2005	99.0	63.9	42.0	34.4	28.0	19.4	13.5	9.9	8.8	5.8	4.0
2006	99.1	63.3	44.9	38.4	31.9	22.6	15.4	10.8	9.5	5.3	3.7
2007	100.0	54.4	33.2	27.4	22.5	15.7	11.3	8.8	8.2	5.4	3.8
2008	96.2	57.0	39.8	33.5	27.1	17.9	11.5	8.6	7.9	5.1	3.1
2009	94.2	63.1	45.0	38.0	30.7	20.3	13.0	9.3	8.1	5.7	3.7

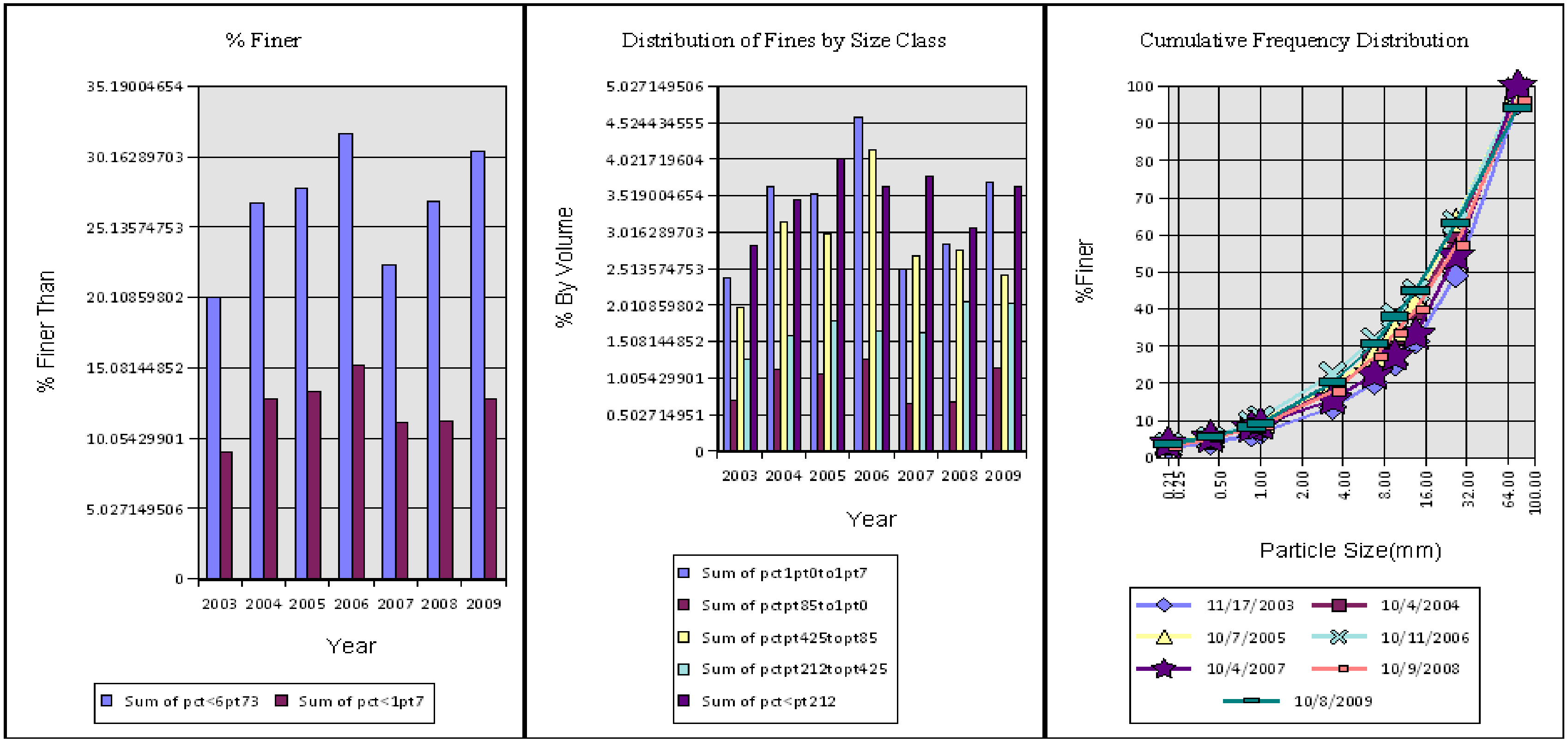


Figure F7. Sediment sampling data from Klickitat R. in McCormick Meadows 1998-2009.

Site Name: Klickitat R. near Parrott's Crossing

Year:	%<75.0mm	%<26.5mm	%<13.5mm	%<9.5mm	%<6.73mm	%<3.35mm	%<1.7mm	%<1.0mm	%<0.85mm	%<0.425mm	%<0.212mm
1999	91.4	62.4	50.7	46.5	42.4	35.3	28.7	23.3	21.5	14.2	8.4
2000	79.8	43.8	32.2	28.0	24.8	19.2	13.4	8.6	7.2	4.2	3.0
2002	92.6	45.7	30.3	25.6	22.3	18.2	14.8	10.7	9.2	5.1	3.0
2003	81.8	44.2	33.2	29.0	25.6	20.4	16.0	12.3	11.1	6.8	4.4
2004	96.6	56.3	42.0	36.3	30.8	22.5	15.5	11.0	9.7	5.8	4.1
2005	93.1	63.2	48.3	43.0	38.4	31.4	26.1	22.0	20.6	14.2	9.2
2006	87.6	61.5	48.0	43.2	38.6	31.2	24.1	17.7	15.5	8.4	5.6
2007	81.3	54.2	42.1	37.4	33.0	26.6	21.4	17.8	16.3	10.3	6.0
2008	91.1	57.6	44.4	39.3	34.6	27.4	21.4	17.3	15.8	11.1	7.1
2009	86.0	55.2	42.8	37.7	33.6	27.8	23.9	21.2	19.8	12.1	7.5

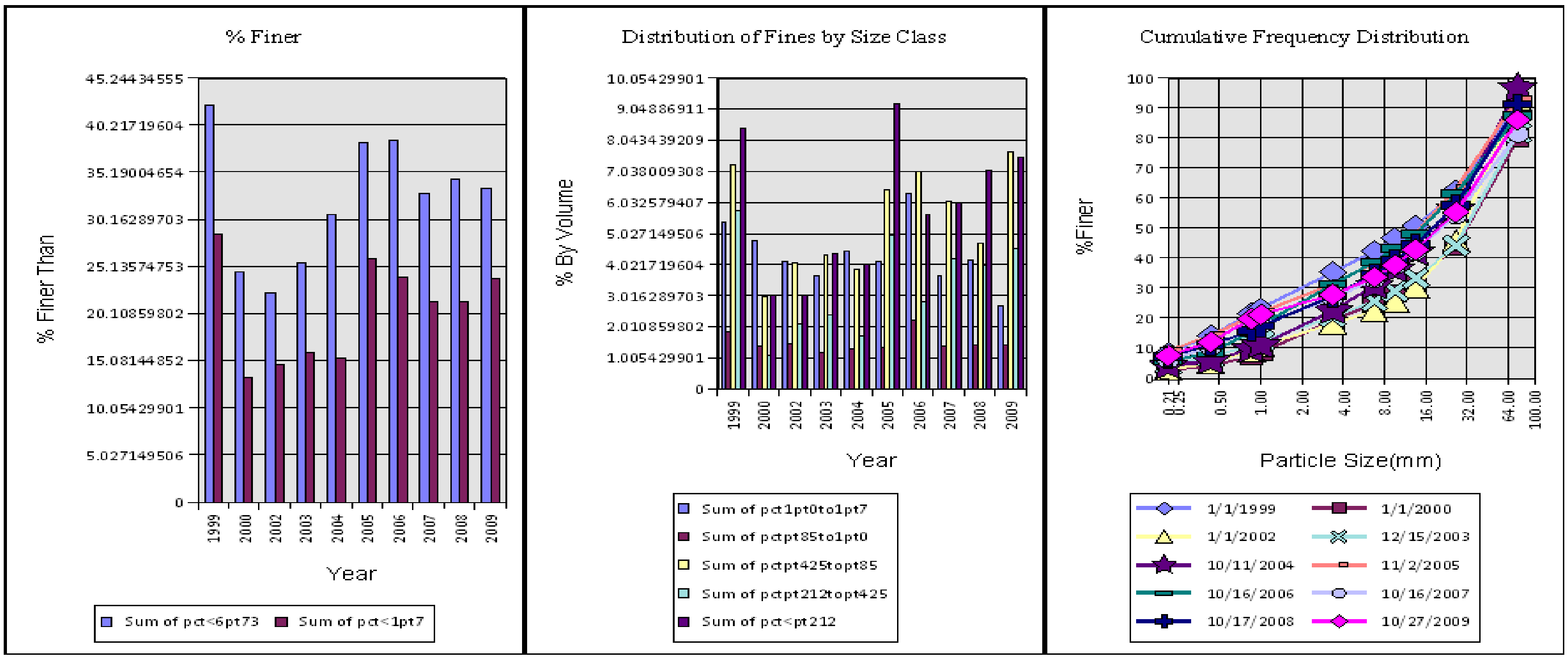


Figure F8. Sediment sampling data from Klickitat R. near Parrott's Crossing 1999-2009.

Site Name: Klickitat R. downstream of White Cr.

Year:	%<75.0mm	%<26.5mm	%<13.5mm	%<9.5mm	%<6.73mm	%<3.35mm	%<1.7mm	%<1.0mm	%<0.85mm	%<0.425mm	%<0.212mm
1999	94.2	53.6	37.9	33.2	29.5	23.8	18.2	13.1	11.5	7.0	4.9
2000	83.8	42.4	29.3	24.4	20.4	15.4	12.3	9.9	9.0	5.5	3.7
2001	92.0	49.1	34.0	29.8	26.2	21.6	16.7	11.2	9.5	5.2	3.2
2002	92.4	49.5	36.9	32.6	29.5	25.9	21.8	15.6	13.6	7.2	5.2
2003	94.9	61.5	43.8	38.2	33.6	27.2	21.1	14.9	12.8	7.6	5.4
2004	91.2	60.5	45.1	40.1	35.8	29.6	23.4	16.3	13.7	7.7	4.7
2005	85.2	55.2	39.9	34.4	29.9	23.4	18.1	13.3	11.7	7.6	4.3
2006	93.4	63.6	47.5	41.8	37.1	30.7	23.3	14.9	12.6	6.6	4.3
2007	93.8	65.4	50.2	45.0	40.0	32.5	25.1	17.8	15.2	7.4	3.8
2008	99.5	60.1	43.5	38.5	33.8	27.7	21.7	14.6	11.7	6.5	3.5
2009	90.1	57.0	36.2	30.6	26.1	20.6	16.6	11.9	10.2	6.4	4.1

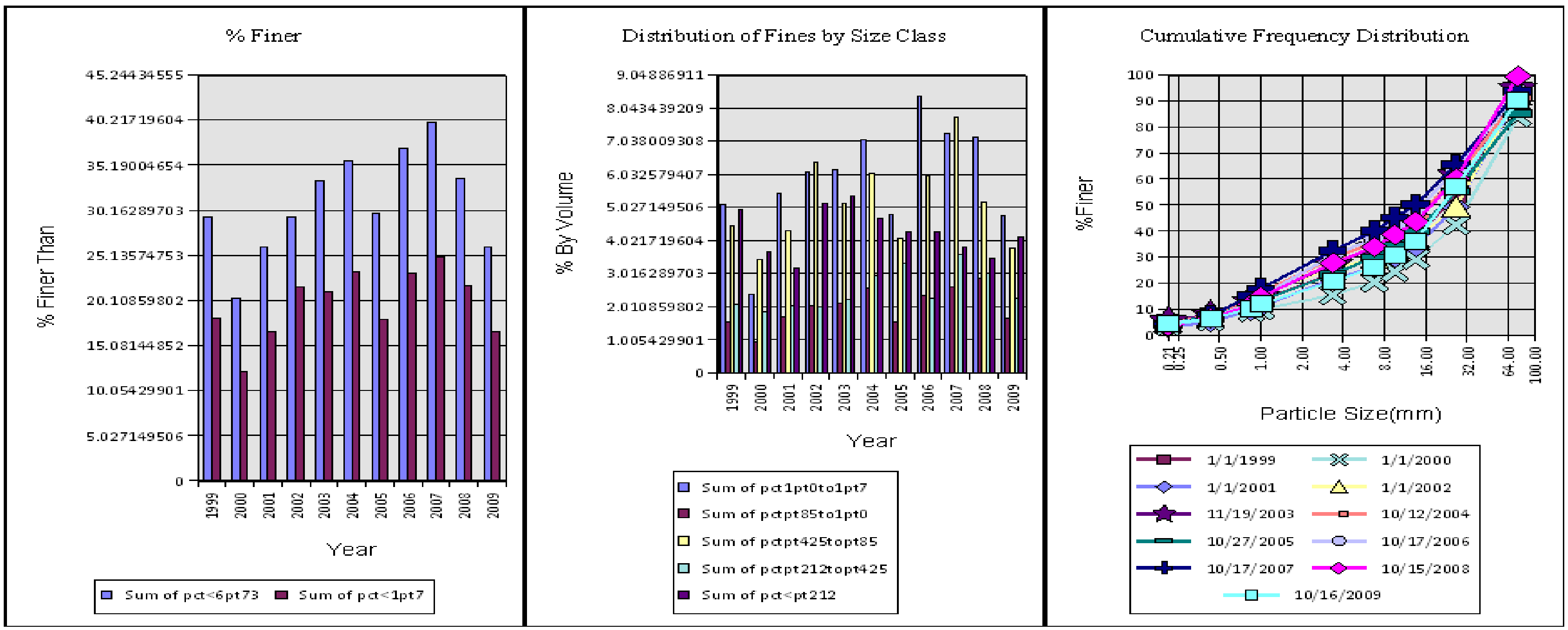


Figure F9. Sediment sampling data from Klickitat R. downstream of White Cr. 1999-2009.

Site Name: Klickitat R. near Leidl Bridge

Year:	%<75.0mm	%<26.5mm	%<13.5mm	%<9.5mm	%<6.73mm	%<3.35mm	%<1.7mm	%<1.0mm	%<0.85mm	%<0.425mm	%<0.212mm
1998	97.6	44.8	30.8	27.6	25.6	22.9	20.6	17.6	15.8	8.3	5.4
2000	92.2	34.8	23.7	21.2	19.1	16.9	14.2	10.7	9.3	5.0	3.1
2003	95.0	38.3	23.1	22.5	21.9	18.8	14.2	8.0	6.4	3.4	2.3
2004	93.3	51.4	37.8	34.3	31.1	25.7	20.7	14.8	11.5	5.9	3.6
2005	87.6	41.8	29.3	27.0	24.9	21.5	17.8	12.8	10.9	5.7	3.9
2006	99.3	44.1	29.2	26.3	23.9	21.0	17.3	12.3	10.9	6.4	4.1
2007	94.0	54.3	42.5	39.2	36.2	32.0	26.4	16.7	12.9	5.0	2.6
2008	89.1	53.2	41.5	37.6	34.0	28.9	22.9	16.5	13.5	5.7	3.4
2009	90.0	56.0	45.4	42.0	39.1	34.4	28.8	19.0	15.6	7.8	5.2

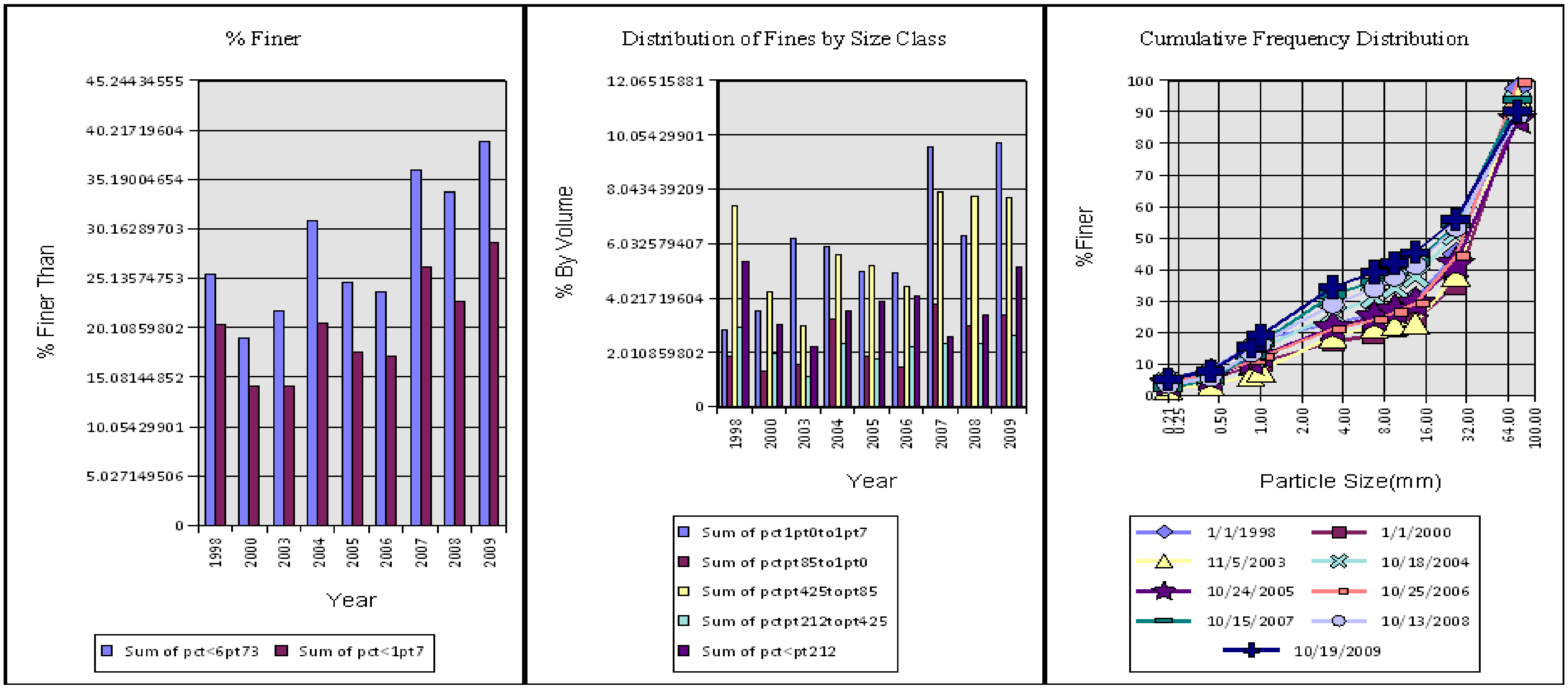


Figure F10. Sediment sampling data from Klickitat R. near Leidl Bridge 1998-2009.

Site Name: Klickitat R. near Stinson Flats boat ramp (RIGHT)

Year:	%<75.0mm	%<26.5mm	%<13.5mm	%<9.5mm	%<6.73mm	%<3.35mm	%<1.7mm	%<1.0mm	%<0.85mm	%<0.425mm	%<0.212mm
2008	89.8	46.9	33.7	30.8	28.1	22.6	17.5	15.2	14.7	9.2	3.9
2009	82.7	39.8	29.1	26.5	23.9	19.8	15.5	13.2	12.5	8.9	5.2

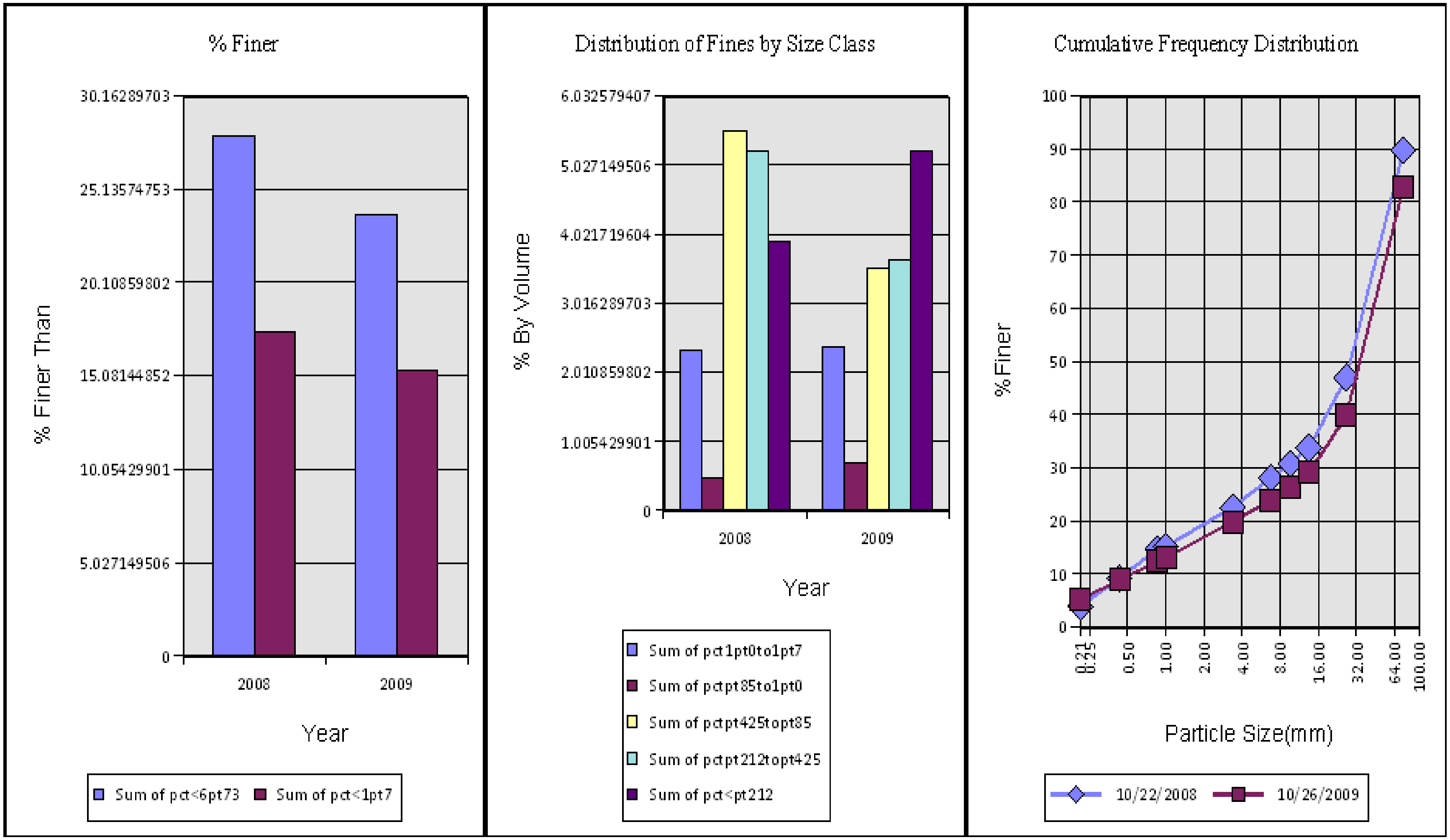


Figure F11. Sediment sampling data from Klickitat R. near Stinson Flats in 2008-2009.

Site Name: Klickitat R. near Hwy 142 below Little Klickitat

Year:	%<75.0mm	%<26.5mm	%<13.5mm	%<9.5mm	%<6.73mm	%<3.35mm	%<1.7mm	%<1.0mm	%<0.85mm	%<0.425mm	%<0.212mm
1999	88.1	60.1	47.6	42.6	38.3	32.8	28.2	24.3	22.7	15.8	11.6
2000	91.9	42.7	28.4	24.0	21.2	17.6	14.1	10.6	9.6	6.2	4.2
2001	88.7	56.4	40.2	34.5	29.7	23.9	20.0	17.0	15.6	11.5	8.5
2002	87.5	49.4	34.7	30.3	26.9	22.7	18.7	11.9	9.8	5.2	3.5
2003	82.9	49.3	32.8	28.0	24.2	19.3	15.9	13.6	12.4	8.8	5.8
2004	83.7	46.5	33.9	29.6	25.5	20.0	16.1	12.1	10.5	5.7	3.4
2005	86.5	54.6	39.8	34.6	29.5	23.4	19.0	15.5	14.1	8.1	4.9
2006	98.3	55.7	40.5	35.4	30.6	25.0	21.3	17.4	15.4	8.9	4.9
2007	92.2	59.4	44.2	38.7	33.8	27.5	23.1	18.5	17.0	9.8	5.5
2008	92.4	56.2	41.2	35.7	30.7	24.9	20.8	17.0	15.5	9.9	6.0
2009	92.0	57.3	41.3	35.8	30.4	23.7	19.4	15.8	14.3	9.0	5.2

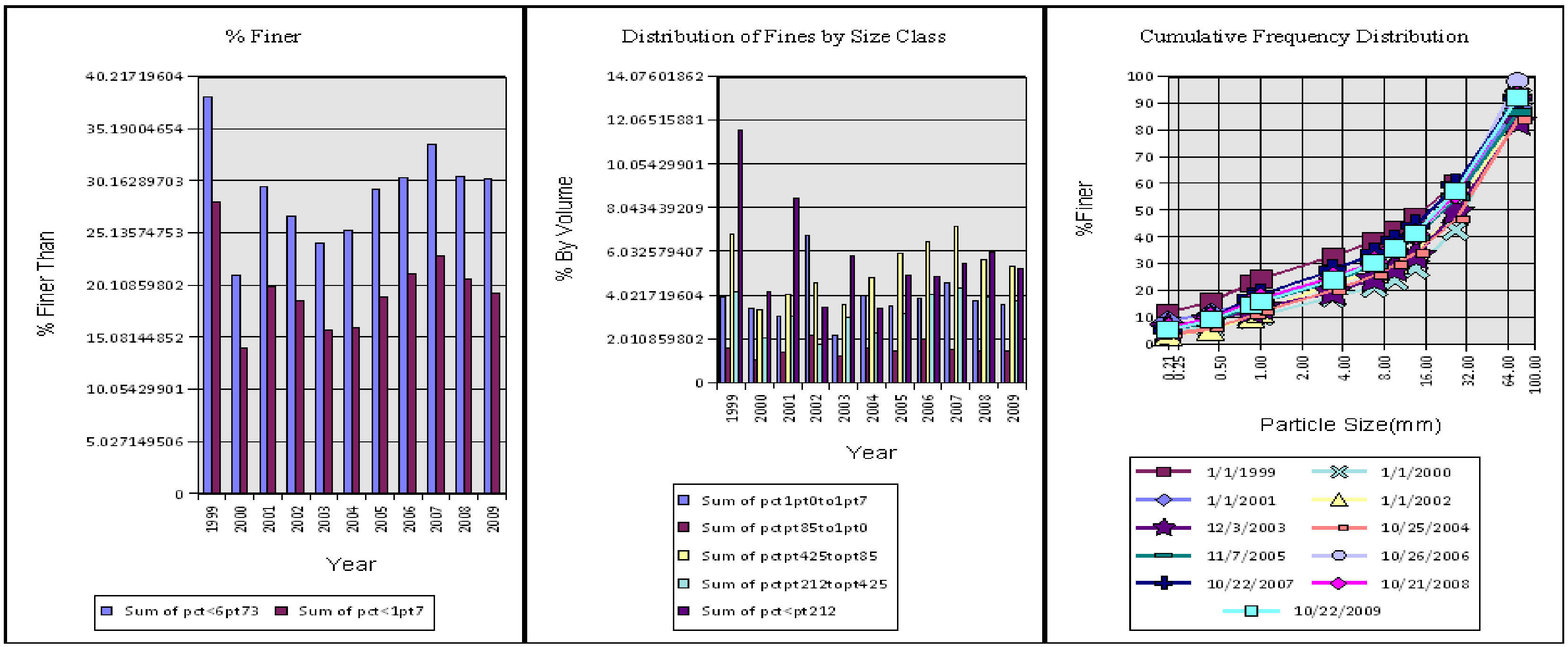


Figure F12. Sediment data from Klickitat R. below Little Klickitat R. 1999-2009.

Site Name: Klickitat River at Ice House Park

Year:	%<75.0mm	%<26.5mm	%<13.5mm	%<9.5mm	%<6.73mm	%<3.35mm	%<1.7mm	%<1.0mm	%<0.85mm	%<0.425mm	%<0.212mm
2007	97.6	76.3	62.0	58.3	55.3	51.0	38.7	16.4	13.0	5.6	2.8
2008	99.1	69.6	53.4	48.6	45.0	40.4	32.1	15.0	11.2	4.9	2.9
2009	97.5	70.3	54.0	49.3	45.9	41.6	32.6	15.0	11.7	5.5	3.1

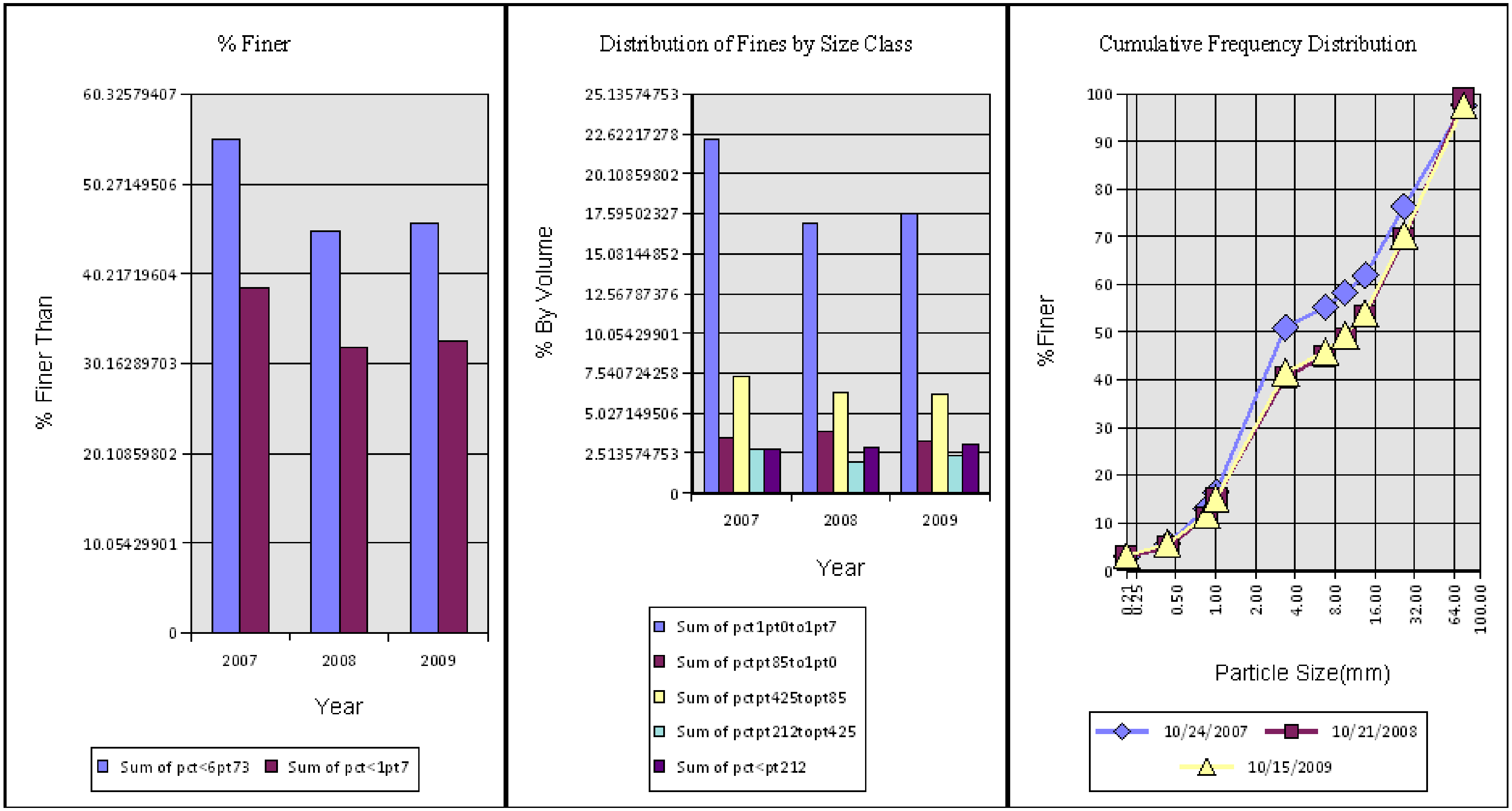


Figure F13. Sediment sampling data from Klickitat R. at Ice House Park 2007-2009.

Appendix G. Temperature monitoring data

Table G1. Site name and stream of Klickitat subbasin temperature and water quality monitoring locations.

Site Name	Stream
BEARMOUTHX	Bear
BOWMNMOUTH	Bowman
BUTTEMEDWS	Butte Meadows
CLEARWATER	Clearwater
DIALOWMEDW	Diamond Fork
DIAMOUTHRX	Diamond Fork
DIAUPPMEDW	Diamond Fork
DILLACORTX	Dillacort
EFTEPEE175RDX	East Fork Tepee
FISHLAKRDX	Fish Lake
KLCASTLEBR	Klickitat
KLCKYKFPHQ	Klickitat
KLCOWCAMPX	Klickitat
KLHATCHTRP	Klickitat
KLnewLYLETRP	Klickitat
LKLIKLODGE	Little Klickitat
LKLIKMOUTH	Little Klickitat
LKLIKOLSEN	Little Klickitat
LOGGCAMPCR	Logging Camp
MCCREEDRDX	McCreedy
OUTLETRDXG	Outlet
PISCOMOUTH	Piscoe
SNYDERMILL	Snyder
SNYDRMOUTH	Snyder
SUMITMOUTH	Summit
SURVEYORSX	Surveyors
SWALEHARMS	Swale
SWALEMOUTH	Swale
TEPEEIXLRDX	Tepee
TRAPPERRDX	Trappers
TROUTRVRTRDX	Trout
WESTFORKRX	West Fork
WHITEIXLRDX	White
WHITEMOUTH	White
WHITEUPPER	White

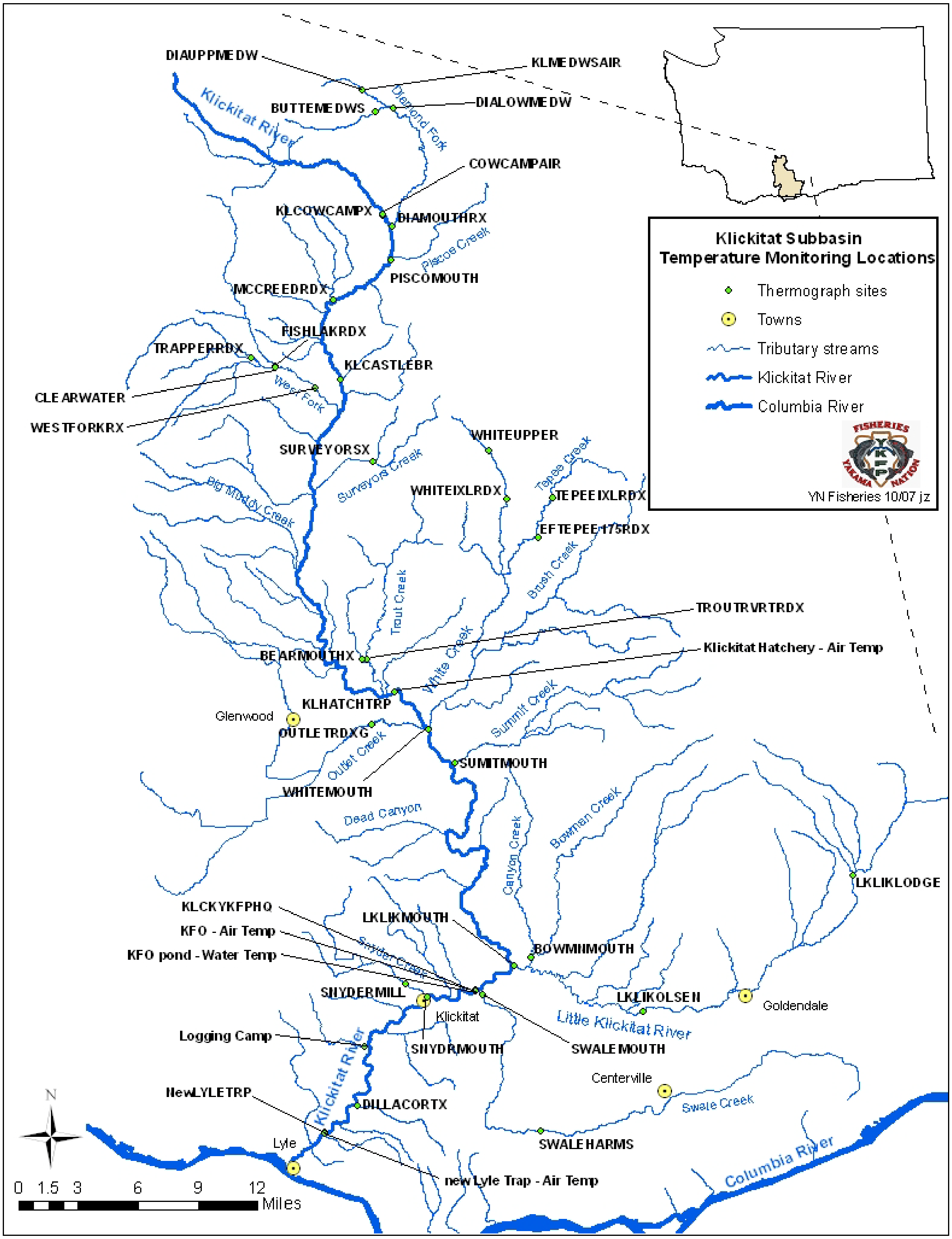


Figure G1. Locations of Klickitat subbasin temperature and water quality monitoring sites.

Table G2. Monthly temperature summaries from 40 sites (35 stream sites, 5 air sites) in the Klickitat subbasin for the reporting period 5/1/2009 – 4/30/2010. Site names correspond to those in Table G1. All temperatures and ranges in degrees Celsius. "--" indicates no data. See description under Temperature monitoring section in the narrative for an explanation of metrics used. Data not collected at several sites shown on above map due to lost thermographs.

BEARMOUTHX

2009	# Days	# 1Day Min		# 1Day Avg		# 1Day Max		#7Day Avg Daily Max					Monthly 1	Monthly 1 Day	Monthly Avg
	Recorded	< 0.5	< 4.4	<0.5	<4.4	>23	>24	>12	>16	>17.5	>18	>22	Day Max	Max Range	Daily Range
May	0	--	--	--	--	--	--	--	--	--	--	--	--	--	--
June	0	--	--	--	--	--	--	--	--	--	--	--	--	--	--
July	0	--	--	--	--	--	--	--	--	--	--	--	--	--	--
August	0	--	--	--	--	--	--	--	--	--	--	--	--	--	--
September	0	--	--	--	--	--	--	--	--	--	--	--	--	--	--
October	0	--	--	--	--	--	--	--	--	--	--	--	--	--	--
November	0	--	--	--	--	--	--	--	--	--	--	--	--	--	--
December	21	8	21	4	21	0	0	0	0	0	0	0	3.2	3.4	1.2

BEARMOUTHX

2010	# Days	# 1Day Min		# 1Day Avg		# 1Day Max		#7Day Avg Daily Max					Monthly 1	Monthly 1 Day	Monthly Avg
	Recorded	< 0.5	< 4.4	<0.5	<4.4	>23	>24	>12	>16	>17.5	>18	>22	Day Max	Max Range	Daily Range
January	31	0	31	0	31	0	0	0	0	0	0	0	4.4	1.7	0.8
February	28	0	26	0	18	0	0	0	0	0	0	0	6.1	2.8	1.5
March	31	0	23	0	7	0	0	0	0	0	0	0	7.7	4.4	2.5
April	30	0	11	0	3	0	0	0	0	0	0	0	10.5	5.1	3.4

BOWMNMOUTH

2009	# Days	# 1Day Min		# 1Day Avg		# 1Day Max		#7Day Avg Daily Max					Monthly 1	Monthly 1 Day	Monthly Avg
	Recorded	< 0.5	< 4.4	<0.5	<4.4	>23	>24	>12	>16	>17.5	>18	>22	Day Max	Max Range	Daily Range
May	31	0	0	0	0	0	0	17	0	0	0	0	16.1	5.5	4.1
June	30	0	0	0	0	0	0	30	1	0	0	0	16.2	4.8	3.4
July	31	0	0	0	0	0	0	31	26	13	8	0	19.2	4.9	3.9
August	31	0	0	0	0	0	0	31	24	4	3	0	19.1	5.2	3.6
September	30	0	0	0	0	0	0	29	2	0	0	0	17.7	5.9	3.3
October	31	0	0	0	0	0	0	0	0	0	0	0	11.8	3.7	2.1
November	15	0	6	0	1	0	0	0	0	0	0	0	9.0	2.7	1.7
December	24	6	24	4	24	0	0	0	0	0	0	0	4.0	2.9	0.9

BOWMNMOUTH

2010	# Days Recorded	# 1Day Min < 0.5	< 4.4	# 1Day Avg <0.5	<4.4	# 1Day Max >23	>24	#7Day Avg Daily Max >12	>16	>17.5	>18	>22	Monthly 1 Day Max	Monthly 1 Day Max Range	Monthly Avg Daily Range
January	31	0	19	0	14	0	0	0	0	0	0	0	6.5	1.7	1.0
February	28	0	8	0	4	0	0	0	0	0	0	0	8.0	2.7	1.6
March	31	0	6	0	0	0	0	0	0	0	0	0	9.5	3.8	2.6
April	30	0	4	0	0	0	0	0	0	0	0	0	12.0	4.7	3.0

BUTTEMEDWS

2009	# Days Recorded	# 1Day Min < 0.5	< 4.4	# 1Day Avg <0.5	<4.4	# 1Day Max >23	>24	#7Day Avg Daily Max >12	>16	>17.5	>18	>22	Monthly 1 Day Max	Monthly 1 Day Max Range	Monthly Avg Daily Range
May	31	2	31	0	31	0	0	0	0	0	0	0	8.2	6.3	3.2
June	30	0	20	0	1	0	0	2	0	0	0	0	12.3	7.9	5.3
July	31	0	0	0	0	0	0	24	0	0	0	0	16.3	8.2	6.4
August	31	0	0	0	0	0	0	22	0	0	0	0	16.3	7.1	5.7
September	30	0	11	0	3	0	0	0	0	0	0	0	12.3	6.1	4.2
October	31	9	31	6	31	0	0	0	0	0	0	0	5.7	4.0	2.0
November	30	30	30	27	30	0	0	0	0	0	0	0	2.3	2.0	0.4
December	31	31	31	31	31	0	0	0	0	0	0	0	–0.1	0.0	0.0

BUTTEMEDWS

2010	# Days Recorded	# 1Day Min < 0.5	< 4.4	# 1Day Avg <0.5	<4.4	# 1Day Max >23	>24	#7Day Avg Daily Max >12	>16	>17.5	>18	>22	Monthly 1 Day Max	Monthly 1 Day Max Range	Monthly Avg Daily Range
January	31	26	31	14	31	0	0	0	0	0	0	0	1.5	1.2	0.5
February	28	24	28	19	28	0	0	0	0	0	0	0	1.6	1.3	0.6
March	31	25	31	19	31	0	0	0	0	0	0	0	2.1	2.2	1.0
April	30	17	30	11	30	0	0	0	0	0	0	0	3.2	2.4	1.2

CLEARWATER

2009	# Days Recorded	# 1Day Min < 0.5	< 4.4	# 1Day Avg <0.5	<4.4	# 1Day Max >23	>24	#7Day Avg Daily Max >12	>16	>17.5	>18	>22	Monthly 1 Day Max	Monthly 1 Day Max Range	Monthly Avg Daily Range
May	0	--	--	--	--	--	--	--	--	--	--	--	--	--	--
June	0	--	--	--	--	--	--	--	--	--	--	--	--	--	--
July	0	--	--	--	--	--	--	--	--	--	--	--	--	--	--
August	0	--	--	--	--	--	--	--	--	--	--	--	--	--	--
September	0	--	--	--	--	--	--	--	--	--	--	--	--	--	--
October	0	--	--	--	--	--	--	--	--	--	--	--	--	--	--
November	12	0	12	0	12	0	0	0	0	0	0	0	4.1	2.2	0.8
December	31	4	31	4	31	0	0	0	0	0	0	0	4.0	1.6	0.6

CLEARWATER

2010	# Days Recorded	# 1Day Min < 0.5	< 4.4	# 1Day Avg <0.5	<4.4	# 1Day Max >23	>24	#7Day Avg Daily Max >12	>16	>17.5	>18	>22	Monthly 1 Day Max	Monthly 1 Day Max Range	Monthly Avg Daily Range
January	31	0	31	0	31	0	0	0	0	0	0	0	4.0	1.4	0.6
February	28	0	28	0	28	0	0	0	0	0	0	0	4.3	1.6	0.8
March	31	0	31	0	31	0	0	0	0	0	0	0	5.1	1.9	1.2
April	30	0	30	0	22	0	0	0	0	0	0	0	5.8	2.5	1.7

COWCAMPAIR

2009	# Days Recorded	# 1Day Min < 0.5	< 4.4	# 1Day Avg <0.5	<4.4	# 1Day Max >23	>24	#7Day Avg Daily Max >12	>16	>17.5	>18	>22	Monthly 1 Day Max	Monthly 1 Day Max Range	Monthly Avg Daily Range
May	31	19	30	0	6	9	6	22	17	16	15	7	30.4	26.7	17.8
June	30	4	17	0	0	11	9	30	30	30	29	10	28.5	28.1	17.5
July	31	2	11	0	0	25	25	31	31	31	31	30	35.3	28.2	22.7
August	31	4	12	0	0	23	22	31	31	31	31	28	36.8	32.3	22.4
September	30	9	23	0	2	21	19	30	30	29	29	22	33.0	32.7	22.5
October	31	20	29	5	18	0	0	13	3	0	0	0	22.3	26.3	11.9
November	30	30	30	21	30	0	0	0	0	0	0	0	11.3	14.3	7.0
December	31	31	31	28	31	0	0	0	0	0	0	0	4.1	17.3	9.0

COWCAMPAIR

2010	# Days Recorded	# 1Day Min < 0.5	# 1Day Min < 4.4	# 1Day Avg <0.5	# 1Day Avg <4.4	# 1Day Max >23	# 1Day Max >24	#7Day Avg Daily Max >12	#7Day Avg Daily Max >16	#7Day Avg Daily Max >17.5	#7Day Avg Daily Max >18	#7Day Avg Daily Max >22	Monthly 1 Day Max	Monthly 1 Day Max Range	Monthly Avg Daily Range
January	31	31	31	18	31	0	0	0	0	0	0	0	6.8	9.8	4.4
February	28	28	28	12	28	0	0	0	0	0	0	0	9.7	19.9	8.6
March	31	31	31	10	31	0	0	4	0	0	0	0	14.2	21.0	12.6
April	30	28	30	8	19	0	0	10	0	0	0	0	18.4	20.2	12.2

DIALOWMEDW

2009	# Days Recorded	# 1Day Min < 0.5	# 1Day Min < 4.4	# 1Day Avg <0.5	# 1Day Avg <4.4	# 1Day Max >23	# 1Day Max >24	#7Day Avg Daily Max >12	#7Day Avg Daily Max >16	#7Day Avg Daily Max >17.5	#7Day Avg Daily Max >18	#7Day Avg Daily Max >22	Monthly 1 Day Max	Monthly 1 Day Max Range	Monthly Avg Daily Range
May	31	6	31	0	26	0	0	0	0	0	0	0	10.0	7.5	5.7
June	30	0	12	0	0	0	0	9	0	0	0	0	15.1	9.8	6.4
July	31	0	0	0	0	0	0	31	20	18	12	0	20.9	11.0	8.8
August	31	0	0	0	0	0	0	31	22	12	9	0	20.9	10.7	8.7
September	30	0	9	0	1	0	0	25	0	0	0	0	16.7	9.6	7.6
October	31	10	31	2	28	0	0	0	0	0	0	0	8.1	7.7	3.7
November	30	30	30	27	30	0	0	0	0	0	0	0	3.2	2.9	0.8
December	31	31	31	31	31	0	0	0	0	0	0	0	0.0	0.0	0.0

DIALOWMEDW

2010	# Days Recorded	# 1Day Min < 0.5	# 1Day Min < 4.4	# 1Day Avg <0.5	# 1Day Avg <4.4	# 1Day Max >23	# 1Day Max >24	#7Day Avg Daily Max >12	#7Day Avg Daily Max >16	#7Day Avg Daily Max >17.5	#7Day Avg Daily Max >18	#7Day Avg Daily Max >22	Monthly 1 Day Max	Monthly 1 Day Max Range	Monthly Avg Daily Range
January	31	31	31	25	31	0	0	0	0	0	0	0	2.0	2.1	0.4
February	28	26	28	19	28	0	0	0	0	0	0	0	2.5	2.3	0.7
March	31	30	31	16	31	0	0	0	0	0	0	0	3.9	4.0	1.8
April	30	20	30	9	30	0	0	0	0	0	0	0	6.3	5.6	2.6

DIAMOUTHRX

2009	# Days Recorded	# 1Day Min < 0.5	# 1Day Min < 4.4	# 1Day Avg <0.5	# 1Day Avg <4.4	# 1Day Max >23	# 1Day Max >24	#7Day Avg Daily Max >12	#7Day Avg Daily Max >16	#7Day Avg Daily Max >17.5	#7Day Avg Daily Max >18	#7Day Avg Daily Max >22	Monthly 1 Day Max	Monthly 1 Day Max Range	Monthly Avg Daily Range
May	31	0	31	0	14	0	0	0	0	0	0	0	10.1	5.8	4.3
June	30	0	0	0	0	0	0	6	0	0	0	0	13.4	6.7	4.4
July	31	0	0	0	0	12	9	31	19	17	17	13	26.7	13.9	9.4
August	31	0	0	0	0	6	4	31	31	30	23	3	25.7	13.3	9.9
September	30	0	7	0	1	0	0	24	2	0	0	0	18.1	8.8	6.4
October	31	9	26	3	18	0	0	0	0	0	0	0	11.6	9.5	4.7
November	30	23	30	9	30	0	0	0	0	0	0	0	9.8	9.7	2.7
December	31	31	31	31	31	0	0	0	0	0	0	0	1.0	0.9	0.1

DIAMOUTHRX

2010	# Days Recorded	# 1Day Min < 0.5	# 1Day Min < 4.4	# 1Day Avg <0.5	# 1Day Avg <4.4	# 1Day Max >23	# 1Day Max >24	#7Day Avg Daily Max >12	#7Day Avg Daily Max >16	#7Day Avg Daily Max >17.5	#7Day Avg Daily Max >18	#7Day Avg Daily Max >22	Monthly 1 Day Max	Monthly 1 Day Max Range	Monthly Avg Daily Range
January	31	5	31	2	31	0	0	0	0	0	0	0	2.5	1.3	0.7
February	28	6	28	4	28	0	0	0	0	0	0	0	3.3	2.0	1.1
March	31	7	31	1	31	0	0	0	0	0	0	0	4.4	3.2	2.1
April	30	6	30	0	30	0	0	0	0	0	0	0	6.5	4.4	3.0

DIAUPPMEDW

2009	# Days Recorded	# 1Day Min < 0.5	# 1Day Min < 4.4	# 1Day Avg <0.5	# 1Day Avg <4.4	# 1Day Max >23	# 1Day Max >24	#7Day Avg Daily Max >12	#7Day Avg Daily Max >16	#7Day Avg Daily Max >17.5	#7Day Avg Daily Max >18	#7Day Avg Daily Max >22	Monthly 1 Day Max	Monthly 1 Day Max Range	Monthly Avg Daily Range
May	31	1	31	0	30	0	0	0	0	0	0	0	7.9	5.6	3.9
June	30	0	13	0	1	0	0	4	0	0	0	0	12.8	7.8	4.8
July	31	0	0	0	0	0	0	31	10	3	2	0	18.7	8.9	7.2
August	31	0	0	0	0	0	0	31	9	3	2	0	18.9	8.9	7.3
September	30	0	7	0	1	0	0	13	0	0	0	0	15.3	8.1	6.2
October	31	10	31	3	30	0	0	0	0	0	0	0	7.4	5.9	2.9
November	30	27	30	19	30	0	0	0	0	0	0	0	4.2	4.2	1.0
December	31	31	31	30	31	0	0	0	0	0	0	0	0.8	0.6	0.2

DIAUPPMEDW

2010	# Days Recorded	# 1Day Min < 0.5	< 4.4	# 1Day Avg <0.5	<4.4	# 1Day Max >23	>24	#7Day Avg Daily Max >12	>16	>17.5	>18	>22	Monthly 1 Day Max	Monthly 1 Day Max Range	Monthly Avg Daily Range
January	31	13	31	6	31	0	0	0	0	0	0	0	2.0	1.8	0.8
February	28	20	28	10	28	0	0	0	0	0	0	0	2.1	1.7	0.9
March	31	23	31	6	31	0	0	0	0	0	0	0	2.7	2.4	1.5
April	30	11	30	5	30	0	0	0	0	0	0	0	3.8	2.8	1.6

DILLACORTX

2009	# Days Recorded	# 1Day Min < 0.5	< 4.4	# 1Day Avg <0.5	<4.4	# 1Day Max >23	>24	#7Day Avg Daily Max >12	>16	>17.5	>18	>22	Monthly 1 Day Max	Monthly 1 Day Max Range	Monthly Avg Daily Range
May	19	0	0	0	0	1	1	19	8	4	4	1	25.2	17.7	7.4
June	0	--	--	--	--	--	--	--	--	--	--	--	--	--	--
July	0	--	--	--	--	--	--	--	--	--	--	--	--	--	--
August	0	--	--	--	--	--	--	--	--	--	--	--	--	--	--
September	0	--	--	--	--	--	--	--	--	--	--	--	--	--	--
October	0	--	--	--	--	--	--	--	--	--	--	--	--	--	--
November	0	--	--	--	--	--	--	--	--	--	--	--	--	--	--
December	23	0	16	0	14	0	0	0	0	0	0	0	6.6	5.3	0.9

DILLACORTX

2010	# Days Recorded	# 1Day Min < 0.5	< 4.4	# 1Day Avg <0.5	<4.4	# 1Day Max >23	>24	#7Day Avg Daily Max >12	>16	>17.5	>18	>22	Monthly 1 Day Max	Monthly 1 Day Max Range	Monthly Avg Daily Range
January	31	0	16	0	12	0	0	0	0	0	0	0	6.1	1.1	0.7
February	28	0	6	0	4	0	0	0	0	0	0	0	7.6	2.2	1.3
March	31	0	3	0	0	0	0	0	0	0	0	0	9.9	3.6	2.5
April	30	0	0	0	0	0	0	9	0	0	0	0	13.1	4.8	3.3

EFTEPEE175RDX

2009	# Days Recorded	# 1Day Min < 0.5	# 1Day Min < 4.4	# 1Day Avg <0.5	# 1Day Avg <4.4	# 1Day Max >23	# 1Day Max >24	#7Day Avg Daily Max >12	#7Day Avg Daily Max >16	#7Day Avg Daily Max >17.5	#7Day Avg Daily Max >18	#7Day Avg Daily Max >22	Monthly 1 Day Max	Monthly 1 Day Max Range	Monthly Avg Daily Range
May	31	0	3	0	0	0	0	15	0	0	0	0	15.6	6.5	4.7
June	30	0	0	0	0	0	0	30	0	0	0	0	15.5	4.9	3.5
July	31	0	0	0	0	0	0	31	8	3	2	0	18.6	5.0	4.1
August	31	0	0	0	0	0	0	31	5	2	1	0	18.5	4.4	3.5
September	30	0	1	0	0	0	0	7	0	0	0	0	14.8	3.4	2.5
October	31	0	19	0	14	0	0	0	0	0	0	0	8.0	3.2	1.6
November	30	4	30	0	30	0	0	0	0	0	0	0	5.4	2.3	1.0
December	31	30	31	29	31	0	0	0	0	0	0	0	1.9	1.1	0.2

EFTEPEE175RDX

2010	# Days Recorded	# 1Day Min < 0.5	# 1Day Min < 4.4	# 1Day Avg <0.5	# 1Day Avg <4.4	# 1Day Max >23	# 1Day Max >24	#7Day Avg Daily Max >12	#7Day Avg Daily Max >16	#7Day Avg Daily Max >17.5	#7Day Avg Daily Max >18	#7Day Avg Daily Max >22	Monthly 1 Day Max	Monthly 1 Day Max Range	Monthly Avg Daily Range
January	31	5	31	3	31	0	0	0	0	0	0	0	3.3	1.3	0.7
February	28	0	28	0	28	0	0	0	0	0	0	0	4.7	2.8	1.5
March	31	0	31	0	22	0	0	0	0	0	0	0	6.6	3.9	2.5
April	30	0	16	0	10	0	0	0	0	0	0	0	10.2	5.5	3.5

FISHLAKRDX

2009	# Days Recorded	# 1Day Min < 0.5	# 1Day Min < 4.4	# 1Day Avg <0.5	# 1Day Avg <4.4	# 1Day Max >23	# 1Day Max >24	#7Day Avg Daily Max >12	#7Day Avg Daily Max >16	#7Day Avg Daily Max >17.5	#7Day Avg Daily Max >18	#7Day Avg Daily Max >22	Monthly 1 Day Max	Monthly 1 Day Max Range	Monthly Avg Daily Range
May	31	0	28	0	22	0	0	0	0	0	0	0	8.1	3.4	2.5
June	30	0	0	0	0	0	0	0	0	0	0	0	12.1	3.8	2.3
July	31	0	0	0	0	0	0	0	0	0	0	0	12.3	3.7	3.0
August	17	0	0	0	0	0	0	0	0	0	0	0	11.5	3.1	2.5
September	27	0	3	0	0	0	0	0	0	0	0	0	9.1	2.8	2.1
October	31	0	24	0	16	0	0	0	0	0	0	0	6.3	2.2	1.3
November	30	1	30	0	30	0	0	0	0	0	0	0	4.8	2.2	0.9
December	31	16	31	11	31	0	0	0	0	0	0	0	2.9	1.4	0.7

FISHLAKRDX

2010	# Days Recorded	# 1Day Min < 0.5	# 1Day Min < 4.4	# 1Day Avg <0.5	# 1Day Avg <4.4	# 1Day Max >23	# 1Day Max >24	#7Day Avg Daily Max >12	#7Day Avg Daily Max >16	#7Day Avg Daily Max >17.5	#7Day Avg Daily Max >18	#7Day Avg Daily Max >22	Monthly 1 Day Max	Monthly 1 Day Max Range	Monthly Avg Daily Range
January	31	0	31	0	31	0	0	0	0	0	0	0	3.1	1.1	0.6
February	28	1	28	0	28	0	0	0	0	0	0	0	3.5	1.8	0.9
March	31	0	31	0	31	0	0	0	0	0	0	0	4.6	2.0	1.4
April	30	0	30	0	30	0	0	0	0	0	0	0	5.4	2.7	1.9

HATCAIRTEM

2009	# Days Recorded	# 1Day Min < 0.5	# 1Day Min < 4.4	# 1Day Avg <0.5	# 1Day Avg <4.4	# 1Day Max >23	# 1Day Max >24	#7Day Avg Daily Max >12	#7Day Avg Daily Max >16	#7Day Avg Daily Max >17.5	#7Day Avg Daily Max >18	#7Day Avg Daily Max >22	Monthly 1 Day Max	Monthly 1 Day Max Range	Monthly Avg Daily Range
May	31	8	19	0	0	17	13	31	31	26	26	17	35.1	27.8	20.4
June	30	0	3	0	0	26	25	30	30	30	30	30	32.5	28.5	19.7
July	31	0	0	0	0	30	29	31	31	31	31	31	37.7	29.1	23.6
August	31	0	4	0	0	30	27	31	31	31	31	31	38.3	26.9	20.7
September	30	3	12	0	0	19	17	30	30	29	29	22	30.9	22.8	18.1
October	31	14	24	0	8	0	0	15	3	0	0	0	17.8	17.7	11.2
November	30	22	30	7	28	0	0	0	0	0	0	0	8.1	10.8	5.6
December	31	28	31	26	31	0	0	0	0	0	0	0	4.6	9.8	5.4

HATCAIRTEM

2010	# Days Recorded	# 1Day Min < 0.5	# 1Day Min < 4.4	# 1Day Avg <0.5	# 1Day Avg <4.4	# 1Day Max >23	# 1Day Max >24	#7Day Avg Daily Max >12	#7Day Avg Daily Max >16	#7Day Avg Daily Max >17.5	#7Day Avg Daily Max >18	#7Day Avg Daily Max >22	Monthly 1 Day Max	Monthly 1 Day Max Range	Monthly Avg Daily Range
January	31	23	31	5	31	0	0	0	0	0	0	0	7.1	6.8	4.2
February	28	14	28	6	23	0	0	0	0	0	0	0	13.6	15.3	8.0
March	31	24	30	1	18	0	0	21	6	0	0	0	19.6	22.0	14.6
April	30	18	28	0	7	2	0	23	20	13	11	0	23.6	23.9	15.7

KLCASTLEBR

2009	# Days	# 1Day Min		# 1Day Avg		# 1Day Max		#7Day Avg Daily Max					Monthly 1	Monthly 1 Day	Monthly Avg
	Recorded	< 0.5	< 4.4	<0.5	<4.4	>23	>24	>12	>16	>17.5	>18	>22	Day Max	Max Range	Daily Range
May	31	0	19	0	2	0	0	0	0	0	0	0	10.4	5.4	4.0
June	30	0	0	0	0	0	0	6	0	0	0	0	13.7	5.4	3.9
July	31	0	0	0	0	0	0	31	14	6	4	0	19.3	5.5	4.7
August	31	0	0	0	0	0	0	31	11	3	2	0	18.8	5.2	4.3
September	30	0	0	0	0	0	0	20	0	0	0	0	15.8	4.3	3.3
October	31	0	10	0	7	0	0	0	0	0	0	0	9.2	3.3	1.9
November	30	2	30	0	29	0	0	0	0	0	0	0	5.6	2.7	1.3
December	31	29	31	27	31	0	0	0	0	0	0	0	2.6	1.3	0.3

KLCASTLEBR

2010	# Days	# 1Day Min		# 1Day Avg		# 1Day Max		#7Day Avg Daily Max					Monthly 1	Monthly 1 Day	Monthly Avg
	Recorded	< 0.5	< 4.4	<0.5	<4.4	>23	>24	>12	>16	>17.5	>18	>22	Day Max	Max Range	Daily Range
January	31	1	31	0	31	0	0	0	0	0	0	0	3.8	1.7	0.9
February	28	3	28	0	28	0	0	0	0	0	0	0	4.4	2.5	1.6
March	31	0	31	0	30	0	0	0	0	0	0	0	5.8	3.4	2.4
April	30	1	30	0	10	0	0	0	0	0	0	0	7.7	4.7	3.2

KLCKYKFPHQ

2009	# Days	# 1Day Min		# 1Day Avg		# 1Day Max		#7Day Avg Daily Max					Monthly 1	Monthly 1 Day	Monthly Avg
	Recorded	< 0.5	< 4.4	<0.5	<4.4	>23	>24	>12	>16	>17.5	>18	>22	Day Max	Max Range	Daily Range
May	31	0	0	0	0	0	0	4	0	0	0	0	13.1	4.4	2.0
June	30	0	0	0	0	0	0	30	0	0	0	0	15.8	2.6	1.6
July	10	0	0	0	0	0	0	10	10	4	0	0	18.4	6.2	3.9
August	0	--	--	--	--	--	--	--	--	--	--	--	--	--	--
September	0	--	--	--	--	--	--	--	--	--	--	--	--	--	--
October	0	--	--	--	--	--	--	--	--	--	--	--	--	--	--
November	0	--	--	--	--	--	--	--	--	--	--	--	--	--	--
December	23	3	21	0	19	0	0	0	0	0	0	0	6.0	2.1	1.1

KLCKYKFPHQ

2010	# Days Recorded	# 1Day Min < 0.5	< 4.4	# 1Day Avg <0.5	<4.4	# 1Day Max >23	>24	#7Day Avg Daily Max >12	>16	>17.5	>18	>22	Monthly 1 Day Max	Monthly 1 Day Max Range	Monthly Avg Daily Range
January	31	0	18	0	13	0	0	0	0	0	0	0	6.6	1.8	0.8
February	28	0	5	0	2	0	0	0	0	0	0	0	8.2	2.6	1.3
March	31	0	2	0	0	0	0	0	0	0	0	0	9.9	3.7	2.5
April	30	0	0	0	0	0	0	0	0	0	0	0	12.2	3.8	2.5

KLCOWCAMPX

2009	# Days Recorded	# 1Day Min < 0.5	< 4.4	# 1Day Avg <0.5	<4.4	# 1Day Max >23	>24	#7Day Avg Daily Max >12	>16	>17.5	>18	>22	Monthly 1 Day Max	Monthly 1 Day Max Range	Monthly Avg Daily Range
May	31	0	24	0	9	0	0	0	0	0	0	0	8.5	5.0	2.8
June	30	0	0	0	0	0	0	0	0	0	0	0	11.8	5.1	3.1
July	31	0	0	0	0	0	0	24	0	0	0	0	15.1	5.0	3.0
August	31	0	0	0	0	0	0	24	0	0	0	0	14.9	2.9	2.1
September	30	0	0	0	0	0	0	2	0	0	0	0	12.8	2.8	1.9
October	31	0	17	0	10	0	0	0	0	0	0	0	7.3	2.1	1.0
November	30	1	30	0	30	0	0	0	0	0	0	0	5.1	2.6	1.0
December	31	30	31	26	31	0	0	0	0	0	0	0	2.9	1.5	0.4

KLCOWCAMPX

2010	# Days Recorded	# 1Day Min < 0.5	< 4.4	# 1Day Avg <0.5	<4.4	# 1Day Max >23	>24	#7Day Avg Daily Max >12	>16	>17.5	>18	>22	Monthly 1 Day Max	Monthly 1 Day Max Range	Monthly Avg Daily Range
January	31	3	31	0	31	0	0	0	0	0	0	0	3.7	2.1	1.0
February	28	5	28	1	28	0	0	0	0	0	0	0	4.4	3.0	1.8
March	31	2	31	0	31	0	0	0	0	0	0	0	6.4	4.6	3.2
April	30	3	30	0	19	0	0	0	0	0	0	0	7.7	5.6	3.7

KLHATCHTRP

2009	# Days Recorded	# 1Day Min < 0.5	# 1Day Min < 4.4	# 1Day Avg <0.5	# 1Day Avg <4.4	# 1Day Max >23	# 1Day Max >24	#7Day Avg Daily Max >12	>16	>17.5	>18	>22	Monthly 1 Day Max	Monthly 1 Day Max Range	Monthly Avg Daily Range
May	31	0	0	0	0	0	0	0	0	0	0	0	11.0	3.3	2.7
June	30	0	0	0	0	0	0	19	0	0	0	0	14.6	4.0	2.9
July	31	0	0	0	0	0	0	31	13	3	0	0	17.9	4.7	3.9
August	31	0	0	0	0	0	0	31	5	0	0	0	17.4	4.6	3.7
September	30	0	0	0	0	0	0	16	0	0	0	0	15.6	3.5	2.8
October	31	0	7	0	3	0	0	0	0	0	0	0	9.0	2.7	1.6
November	10	0	8	0	3	0	0	0	0	0	0	0	6.9	1.8	1.1
December	23	10	23	8	23	0	0	0	0	0	0	0	3.4	1.4	0.6

KLHATCHTRP

2010	# Days Recorded	# 1Day Min < 0.5	# 1Day Min < 4.4	# 1Day Avg <0.5	# 1Day Avg <4.4	# 1Day Max >23	# 1Day Max >24	#7Day Avg Daily Max >12	>16	>17.5	>18	>22	Monthly 1 Day Max	Monthly 1 Day Max Range	Monthly Avg Daily Range
January	31	0	31	0	31	0	0	0	0	0	0	0	4.9	1.8	0.7
February	28	0	25	0	16	0	0	0	0	0	0	0	5.7	1.9	1.0
March	31	0	20	0	6	0	0	0	0	0	0	0	6.9	2.5	1.7
April	30	0	11	0	4	0	0	0	0	0	0	0	8.3	3.1	2.3

KLMEDWSAIR

2009	# Days Recorded	# 1Day Min < 0.5	# 1Day Min < 4.4	# 1Day Avg <0.5	# 1Day Avg <4.4	# 1Day Max >23	# 1Day Max >24	#7Day Avg Daily Max >12	>16	>17.5	>18	>22	Monthly 1 Day Max	Monthly 1 Day Max Range	Monthly Avg Daily Range
May	31	22	31	3	15	0	0	15	7	6	5	0	22.8	19.5	12.5
June	30	2	19	0	0	0	0	30	16	8	7	0	22.2	21.3	12.3
July	31	2	12	0	0	16	12	31	31	28	27	20	28.6	21.0	16.6
August	31	4	13	0	0	11	9	31	31	26	26	13	29.0	24.1	16.4
September	30	9	25	0	2	6	6	28	22	19	19	2	27.3	25.7	16.4
October	31	25	31	7	23	0	0	0	0	0	0	0	16.2	20.6	10.0
November	30	30	30	26	30	0	0	0	0	0	0	0	14.8	21.7	10.5
December	31	31	31	29	31	0	0	0	0	0	0	0	7.9	29.0	13.1

KLMEDWSAIR

2010	# Days Recorded	# 1Day Min < 0.5	# 1Day Min < 4.4	# 1Day Avg <0.5	# 1Day Avg <4.4	# 1Day Max >23	# 1Day Max >24	#7Day Avg Daily Max >12	#7Day Avg Daily Max >16	#7Day Avg Daily Max >17.5	#7Day Avg Daily Max >18	#7Day Avg Daily Max >22	Monthly 1 Day Max	Monthly 1 Day Max Range	Monthly Avg Daily Range
January	31	31	31	28	31	0	0	0	0	0	0	0	13.2	22.3	6.3
February	28	28	28	27	28	0	0	0	0	0	0	0	10.0	23.1	10.3
March	31	31	31	25	31	0	0	0	0	0	0	0	10.8	21.5	11.1
April	30	28	30	12	28	0	0	0	0	0	0	0	12.6	17.6	9.2

KLnewLYLETRP

2009	# Days Recorded	# 1Day Min < 0.5	# 1Day Min < 4.4	# 1Day Avg <0.5	# 1Day Avg <4.4	# 1Day Max >23	# 1Day Max >24	#7Day Avg Daily Max >12	#7Day Avg Daily Max >16	#7Day Avg Daily Max >17.5	#7Day Avg Daily Max >18	#7Day Avg Daily Max >22	Monthly 1 Day Max	Monthly 1 Day Max Range	Monthly Avg Daily Range
May	31	0	0	0	0	0	0	16	0	0	0	0	14.9	4.0	3.0
June	30	0	0	0	0	0	0	30	12	0	0	0	17.2	4.3	3.0
July	31	0	0	0	0	0	0	31	31	26	18	0	20.8	3.1	2.2
August	31	0	0	0	0	0	0	31	31	18	10	0	20.6	1.8	1.4
September	30	0	0	0	0	0	0	30	4	0	0	0	17.7	1.6	1.1
October	31	0	0	0	0	0	0	0	0	0	0	0	11.6	1.4	0.9
November	10	0	0	0	0	0	0	0	0	0	0	0	9.4	1.3	0.7
December	23	0	0	0	0	23	23	23	23	23	23	23	40.4	2.6	0.9

KLnewLYLETRP

2010	# Days Recorded	# 1Day Min < 0.5	# 1Day Min < 4.4	# 1Day Avg <0.5	# 1Day Avg <4.4	# 1Day Max >23	# 1Day Max >24	#7Day Avg Daily Max >12	#7Day Avg Daily Max >16	#7Day Avg Daily Max >17.5	#7Day Avg Daily Max >18	#7Day Avg Daily Max >22	Monthly 1 Day Max	Monthly 1 Day Max Range	Monthly Avg Daily Range
January	31	0	0	0	0	31	31	31	31	31	31	31	43.2	2.7	1.2
February	28	0	0	0	0	28	28	28	28	28	28	28	46.1	3.1	1.9
March	31	0	0	0	0	31	31	31	31	31	31	31	48.9	4.9	3.3
April	30	0	0	0	0	30	30	30	30	30	30	30	53.1	5.6	4.1

KYKFPHQAIR

2009	# Days Recorded	# 1Day Min < 0.5	< 4.4	# 1Day Avg <0.5	<4.4	# 1Day Max >23	>24	#7Day Avg Daily Max >12	>16	>17.5	>18	>22	Monthly 1 Day Max	Monthly 1 Day Max Range	Monthly Avg Daily Range
May	31	3	11	0	0	15	13	31	31	28	25	17	32.6	25.2	17.0
June	30	0	1	0	0	24	23	30	30	30	30	30	30.7	24.2	15.4
July	31	0	0	0	0	28	28	31	31	31	31	31	38.4	25.8	19.6
August	31	0	0	0	0	29	28	31	31	31	31	31	37.7	27.1	18.1
September	30	0	7	0	0	24	23	30	30	30	30	29	33.6	27.3	19.7
October	31	9	22	0	3	1	1	31	19	16	14	0	25.1	24.2	15.1
November	30	18	30	0	17	0	0	8	0	0	0	0	17.7	19.2	11.2
December	31	28	31	24	31	0	0	0	0	0	0	0	10.9	16.2	8.3

KYKFPHQAIR

2010	# Days Recorded	# 1Day Min < 0.5	< 4.4	# 1Day Avg <0.5	<4.4	# 1Day Max >23	>24	#7Day Avg Daily Max >12	>16	>17.5	>18	>22	Monthly 1 Day Max	Monthly 1 Day Max Range	Monthly Avg Daily Range
January	31	16	30	3	23	0	0	0	0	0	0	0	13.8	14.2	6.0
February	28	10	26	0	9	0	0	14	0	0	0	0	16.2	19.9	10.6
March	31	17	29	0	1	0	0	31	13	8	5	0	20.8	22.1	15.7
April	30	10	23	0	1	3	3	30	20	12	11	2	25.1	23.2	14.8

LKLIKLODGE

2009	# Days Recorded	# 1Day Min < 0.5	< 4.4	# 1Day Avg <0.5	<4.4	# 1Day Max >23	>24	#7Day Avg Daily Max >12	>16	>17.5	>18	>22	Monthly 1 Day Max	Monthly 1 Day Max Range	Monthly Avg Daily Range
May	31	0	7	0	0	0	0	12	0	0	0	0	14.1	7.3	5.6
June	30	0	0	0	0	0	0	30	6	2	1	0	17.7	8.2	5.9
July	31	0	0	0	0	4	0	31	31	31	31	5	23.7	9.2	8.0
August	31	0	0	0	0	3	1	31	31	31	31	3	24.0	9.9	7.7
September	30	0	0	0	0	0	0	29	15	8	4	0	20.6	8.0	6.7
October	31	0	9	0	4	0	0	0	0	0	0	0	11.5	5.4	3.1
November	10	0	9	0	7	0	0	0	0	0	0	0	6.7	2.9	2.1
December	24	20	24	16	24	0	0	0	0	0	0	0	3.2	2.2	0.6

LKLIKLODGE

2010	# Days Recorded	# 1Day Min < 0.5	< 4.4	# 1Day Avg <0.5	<4.4	# 1Day Max >23	>24	#7Day Avg Daily Max >12	>16	>17.5	>18	>22	Monthly 1 Day Max	Monthly 1 Day Max Range	Monthly Avg Daily Range
January	31	0	31	0	31	0	0	0	0	0	0	0	4.8	1.9	1.1
February	28	1	28	0	24	0	0	0	0	0	0	0	6.2	3.3	1.9
March	31	0	30	0	16	0	0	0	0	0	0	0	7.9	5.3	3.4
April	30	0	20	0	8	0	0	0	0	0	0	0	10.4	7.1	4.1

LKLIKMOUTH

2009	# Days Recorded	# 1Day Min < 0.5	< 4.4	# 1Day Avg <0.5	<4.4	# 1Day Max >23	>24	#7Day Avg Daily Max >12	>16	>17.5	>18	>22	Monthly 1 Day Max	Monthly 1 Day Max Range	Monthly Avg Daily Range
May	31	0	0	0	0	0	0	19	6	1	0	0	18.3	4.5	3.5
June	14	0	0	0	0	0	0	14	14	7	4	0	19.5	5.7	3.6
July	0	--	--	--	--	--	--	--	--	--	--	--	--	--	--
August	0	--	--	--	--	--	--	--	--	--	--	--	--	--	--
September	0	--	--	--	--	--	--	--	--	--	--	--	--	--	--
October	0	--	--	--	--	--	--	--	--	--	--	--	--	--	--
November	0	--	--	--	--	--	--	--	--	--	--	--	--	--	--
December	25	15	25	14	25	0	0	0	0	0	0	0	3.0	2.2	0.4

LKLIKMOUTH

2010	# Days Recorded	# 1Day Min < 0.5	< 4.4	# 1Day Avg <0.5	<4.4	# 1Day Max >23	>24	#7Day Avg Daily Max >12	>16	>17.5	>18	>22	Monthly 1 Day Max	Monthly 1 Day Max Range	Monthly Avg Daily Range
January	31	1	21	0	18	0	0	0	0	0	0	0	6.1	2.0	0.8
February	28	0	7	0	4	0	0	0	0	0	0	0	8.0	2.1	1.2
March	31	0	3	0	0	0	0	0	0	0	0	0	9.9	3.0	2.0
April	30	0	1	0	0	0	0	0	0	0	0	0	12.4	3.5	2.5

LKLIKOLSEN

2009	# Days Recorded	# 1Day Min < 0.5	# 1Day Min < 4.4	# 1Day Avg <0.5	# 1Day Avg <4.4	# 1Day Max >23	# 1Day Max >24	#7Day Avg Daily Max >12	#7Day Avg Daily Max >16	#7Day Avg Daily Max >17.5	#7Day Avg Daily Max >18	#7Day Avg Daily Max >22	Monthly 1 Day Max	Monthly 1 Day Max Range	Monthly Avg Daily Range
May	31	0	0	0	0	0	0	18	5	0	0	0	17.5	5.5	4.1
June	30	0	0	0	0	1	0	30	30	21	20	4	23.1	8.0	4.9
July	31	0	0	0	0	26	22	31	31	31	31	31	28.2	8.9	7.6
August	31	0	0	0	0	12	8	31	31	31	31	21	27.9	8.3	6.6
September	30	0	0	0	0	1	0	30	25	19	18	0	23.4	6.5	5.1
October	31	0	1	0	0	0	0	3	0	0	0	0	13.1	4.8	2.7
November	10	0	3	0	0	0	0	0	0	0	0	0	9.5	3.1	2.1
December	25	20	25	13	25	0	0	0	0	0	0	0	2.5	2.4	0.6

LKLIKOLSEN

2010	# Days Recorded	# 1Day Min < 0.5	# 1Day Min < 4.4	# 1Day Avg <0.5	# 1Day Avg <4.4	# 1Day Max >23	# 1Day Max >24	#7Day Avg Daily Max >12	#7Day Avg Daily Max >16	#7Day Avg Daily Max >17.5	#7Day Avg Daily Max >18	#7Day Avg Daily Max >22	Monthly 1 Day Max	Monthly 1 Day Max Range	Monthly Avg Daily Range
January	31	1	29	0	23	0	0	0	0	0	0	0	5.9	2.0	1.0
February	28	0	14	0	7	0	0	0	0	0	0	0	7.9	2.9	1.8
March	31	0	13	0	1	0	0	0	0	0	0	0	9.8	4.4	2.8
April	30	0	7	0	0	0	0	0	0	0	0	0	12.0	4.5	3.3

LOGGCAMPCR

2009	# Days Recorded	# 1Day Min < 0.5	# 1Day Min < 4.4	# 1Day Avg <0.5	# 1Day Avg <4.4	# 1Day Max >23	# 1Day Max >24	#7Day Avg Daily Max >12	#7Day Avg Daily Max >16	#7Day Avg Daily Max >17.5	#7Day Avg Daily Max >18	#7Day Avg Daily Max >22	Monthly 1 Day Max	Monthly 1 Day Max Range	Monthly Avg Daily Range
May	31	0	0	0	0	0	0	9	0	0	0	0	15.2	2.9	2.1
June	30	0	0	0	0	2	0	30	21	12	7	0	23.8	11.5	4.4
July	31	0	0	0	0	11	7	31	31	31	31	14	26.4	12.3	6.2
August	31	0	0	0	0	0	0	31	31	25	12	0	20.7	1.0	0.5
September	30	0	0	0	0	0	0	30	8	0	0	0	17.8	0.7	0.5
October	31	0	0	0	0	0	0	4	0	0	0	0	12.9	0.8	0.4
November	10	0	0	0	0	0	0	0	0	0	0	0	9.9	0.9	0.4
December	23	8	18	6	16	0	0	0	0	0	0	0	6.2	2.0	0.6

LOGGCAMPCR

2010	# Days	# 1Day Min		# 1Day Avg		# 1Day Max		#7Day Avg Daily Max					Monthly 1	Monthly 1 Day	Monthly Avg
	Recorded	< 0.5	< 4.4	<0.5	<4.4	>23	>24	>12	>16	>17.5	>18	>22	Day Max	Max Range	Daily Range
January	31	0	13	0	7	0	0	0	0	0	0	0	5.9	1.1	0.6
February	28	0	6	0	3	0	0	0	0	0	0	0	7.0	1.4	0.8
March	31	0	3	0	0	0	0	0	0	0	0	0	8.1	2.4	1.5
April	30	0	0	0	0	0	0	0	0	0	0	0	10.5	2.6	1.7

MCCREEDRDX

2009	# Days	# 1Day Min		# 1Day Avg		# 1Day Max		#7Day Avg Daily Max					Monthly 1	Monthly 1 Day	Monthly Avg
	Recorded	< 0.5	< 4.4	<0.5	<4.4	>23	>24	>12	>16	>17.5	>18	>22	Day Max	Max Range	Daily Range
May	31	0	28	0	16	0	0	0	0	0	0	0	8.1	4.0	2.6
June	30	0	1	0	0	0	0	0	0	0	0	0	9.9	4.0	2.8
July	31	0	0	0	0	0	0	0	0	0	0	0	11.5	3.2	2.5
August	31	0	0	0	0	0	0	0	0	0	0	0	11.2	2.7	2.1
September	30	0	0	0	0	0	0	0	0	0	0	0	9.7	2.2	1.6
October	31	0	17	0	7	0	0	0	0	0	0	0	6.7	1.9	1.1
November	30	0	30	0	29	0	0	0	0	0	0	0	5.2	2.1	0.8
December	31	3	31	2	31	0	0	0	0	0	0	0	4.0	1.4	0.8

MCCREEDRDX

2010	# Days	# 1Day Min		# 1Day Avg		# 1Day Max		#7Day Avg Daily Max					Monthly 1	Monthly 1 Day	Monthly Avg
	Recorded	< 0.5	< 4.4	<0.5	<4.4	>23	>24	>12	>16	>17.5	>18	>22	Day Max	Max Range	Daily Range
January	31	0	31	0	31	0	0	0	0	0	0	0	4.1	1.1	0.5
February	28	0	28	0	28	0	0	0	0	0	0	0	4.5	1.4	0.8
March	31	0	31	0	31	0	0	0	0	0	0	0	4.9	1.8	1.1
April	30	0	30	0	30	0	0	0	0	0	0	0	5.5	2.3	1.4

nLyleTrpAIR

2009	# Days Recorded	# 1Day Min < 0.5	# 1Day Min < 4.4	# 1Day Avg <0.5	# 1Day Avg <4.4	# 1Day Max >23	# 1Day Max >24	#7Day Avg Daily Max >12	#7Day Avg Daily Max >16	#7Day Avg Daily Max >17.5	#7Day Avg Daily Max >18	#7Day Avg Daily Max >22	Monthly 1 Day Max	Monthly 1 Day Max Range	Monthly Avg Daily Range
May	31	0	2	0	0	12	10	31	30	23	21	14	30.7	19.1	12.4
June	30	0	0	0	0	22	17	30	30	30	30	30	28.9	17.8	10.5
July	31	0	0	0	0	27	27	31	31	31	31	31	39.0	20.3	14.2
August	31	0	0	0	0	25	23	31	31	31	31	31	37.8	20.2	11.9
September	30	0	0	0	0	23	21	30	30	30	30	26	33.8	19.7	12.9
October	31	0	9	0	1	0	0	28	13	5	4	0	21.2	17.3	8.6
November	30	2	29	0	12	0	0	2	0	0	0	0	13.7	10.2	6.4
December	31	26	31	22	31	0	0	0	0	0	0	0	8.1	10.7	4.8

nLyleTrpAIR

2010	# Days Recorded	# 1Day Min < 0.5	# 1Day Min < 4.4	# 1Day Avg <0.5	# 1Day Avg <4.4	# 1Day Max >23	# 1Day Max >24	#7Day Avg Daily Max >12	#7Day Avg Daily Max >16	#7Day Avg Daily Max >17.5	#7Day Avg Daily Max >18	#7Day Avg Daily Max >22	Monthly 1 Day Max	Monthly 1 Day Max Range	Monthly Avg Daily Range
January	31	6	28	0	17	0	0	0	0	0	0	0	10.7	8.9	3.8
February	28	7	19	0	7	0	0	2	0	0	0	0	13.8	12.4	6.8
March	31	5	22	0	1	0	0	24	0	0	0	0	18.9	16.7	10.4
April	30	3	13	0	0	1	1	24	14	9	7	0	24.4	18.3	10.1

OUTLETRDXG

2009	# Days Recorded	# 1Day Min < 0.5	# 1Day Min < 4.4	# 1Day Avg <0.5	# 1Day Avg <4.4	# 1Day Max >23	# 1Day Max >24	#7Day Avg Daily Max >12	#7Day Avg Daily Max >16	#7Day Avg Daily Max >17.5	#7Day Avg Daily Max >18	#7Day Avg Daily Max >22	Monthly 1 Day Max	Monthly 1 Day Max Range	Monthly Avg Daily Range
May	31	0	0	0	0	0	0	31	16	14	13	0	22.9	5.7	4.4
June	30	0	0	0	0	2	0	30	30	30	30	2	23.2	5.5	3.1
July	31	0	0	0	0	19	13	31	31	31	31	24	27.0	5.6	3.7
August	31	0	0	0	0	6	5	31	31	31	31	9	26.5	5.4	3.0
September	30	0	0	0	0	0	0	30	24	12	8	0	21.5	3.7	2.0
October	31	0	1	0	0	0	0	1	0	0	0	0	12.5	3.2	2.0
November	10	0	9	0	3	0	0	0	0	0	0	0	7.2	2.5	1.7
December	31	30	31	29	31	0	0	0	0	0	0	0	2.9	1.5	0.1

OUTLETRDXG

2010	# Days Recorded	# 1Day Min < 0.5	< 4.4	# 1Day Avg <0.5	<4.4	# 1Day Max >23	>24	#7Day Avg Daily Max >12	>16	>17.5	>18	>22	Monthly 1 Day Max	Monthly 1 Day Max Range	Monthly Avg Daily Range
January	31	18	31	15	31	0	0	0	0	0	0	0	4.5	1.8	0.6
February	28	0	15	0	8	0	0	0	0	0	0	0	8.4	3.5	1.8
March	31	0	6	0	0	0	0	0	0	0	0	0	11.5	4.5	3.0
April	30	0	3	0	0	0	0	18	0	0	0	0	16.4	5.2	3.6

PISCOMOUTH

2009	# Days Recorded	# 1Day Min < 0.5	< 4.4	# 1Day Avg <0.5	<4.4	# 1Day Max >23	>24	#7Day Avg Daily Max >12	>16	>17.5	>18	>22	Monthly 1 Day Max	Monthly 1 Day Max Range	Monthly Avg Daily Range
May	31	0	18	0	9	0	0	0	0	0	0	0	12.2	5.4	3.9
June	30	0	0	0	0	0	0	4	0	0	0	0	12.8	4.5	3.0
July	31	0	0	0	0	0	0	31	2	0	0	0	16.4	4.5	3.6
August	31	0	0	0	0	0	0	31	2	0	0	0	16.4	4.3	3.3
September	30	0	0	0	0	0	0	2	0	0	0	0	13.6	3.2	2.3
October	31	0	22	0	11	0	0	0	0	0	0	0	7.5	2.3	1.5
November	30	2	30	1	30	0	0	0	0	0	0	0	5.5	2.3	1.0
December	31	23	31	18	31	0	0	0	0	0	0	0	2.0	1.4	0.3

PISCOMOUTH

2010	# Days Recorded	# 1Day Min < 0.5	< 4.4	# 1Day Avg <0.5	<4.4	# 1Day Max >23	>24	#7Day Avg Daily Max >12	>16	>17.5	>18	>22	Monthly 1 Day Max	Monthly 1 Day Max Range	Monthly Avg Daily Range
January	31	0	31	0	31	0	0	0	0	0	0	0	2.8	1.2	0.6
February	28	3	28	1	28	0	0	0	0	0	0	0	3.4	1.6	0.8
March	31	1	31	0	31	0	0	0	0	0	0	0	4.0	1.9	1.3
April	30	1	30	0	30	0	0	0	0	0	0	0	6.3	3.7	2.2

SNYDERMILL

2009	# Days Recorded	# 1Day Min < 0.5	# 1Day Min < 4.4	# 1Day Avg <0.5	# 1Day Avg <4.4	# 1Day Max >23	# 1Day Max >24	#7Day Avg Daily Max >12	#7Day Avg Daily Max >16	#7Day Avg Daily Max >17.5	#7Day Avg Daily Max >18	#7Day Avg Daily Max >22	Monthly 1 Day Max	Monthly 1 Day Max Range	Monthly Avg Daily Range
May	31	0	0	0	0	0	0	10	0	0	0	0	15.7	1.8	1.1
June	30	0	0	0	0	0	0	30	8	0	0	0	16.9	2.7	1.7
July	31	0	0	0	0	7	5	31	31	31	24	11	26.3	6.6	4.5
August	31	0	0	0	0	5	5	31	31	31	31	7	26.2	6.2	4.7
September	30	0	0	0	0	0	0	30	18	6	3	0	20.3	4.2	2.5
October	31	0	0	0	0	0	0	7	0	0	0	0	13.5	2.1	1.0
November	30	0	0	0	0	0	0	0	0	0	0	0	10.4	1.0	0.4
December	31	11	26	9	25	0	0	0	0	0	0	0	6.9	2.6	0.5

SNYDERMILL

2010	# Days Recorded	# 1Day Min < 0.5	# 1Day Min < 4.4	# 1Day Avg <0.5	# 1Day Avg <4.4	# 1Day Max >23	# 1Day Max >24	#7Day Avg Daily Max >12	#7Day Avg Daily Max >16	#7Day Avg Daily Max >17.5	#7Day Avg Daily Max >18	#7Day Avg Daily Max >22	Monthly 1 Day Max	Monthly 1 Day Max Range	Monthly Avg Daily Range
January	31	1	31	0	31	0	0	0	0	0	0	0	4.8	2.2	0.7
February	28	0	13	0	8	0	0	0	0	0	0	0	6.6	2.0	1.1
March	31	0	11	0	3	0	0	0	0	0	0	0	8.0	2.7	1.7
April	30	0	5	0	1	0	0	0	0	0	0	0	10.7	3.6	2.4

SNYDRMOUTH

2009	# Days Recorded	# 1Day Min < 0.5	# 1Day Min < 4.4	# 1Day Avg <0.5	# 1Day Avg <4.4	# 1Day Max >23	# 1Day Max >24	#7Day Avg Daily Max >12	#7Day Avg Daily Max >16	#7Day Avg Daily Max >17.5	#7Day Avg Daily Max >18	#7Day Avg Daily Max >22	Monthly 1 Day Max	Monthly 1 Day Max Range	Monthly Avg Daily Range
May	31	0	0	0	0	0	0	17	6	3	1	0	18.9	4.8	3.2
June	30	0	0	0	0	0	0	30	30	30	26	1	21.6	6.4	4.8
July	31	0	0	0	0	25	23	31	31	31	31	31	35.0	14.3	9.9
August	31	0	0	0	0	31	28	31	31	31	31	31	34.6	12.7	9.9
September	30	0	0	0	0	9	4	30	30	28	28	11	26.0	9.7	7.8
October	31	0	3	0	0	0	0	15	1	0	0	0	17.0	8.6	4.7
November	10	0	2	0	0	0	0	0	0	0	0	0	9.5	2.8	2.0
December	23	10	23	8	23	0	0	0	0	0	0	0	3.9	2.7	0.7

SNYDRMOUTH

2010	# Days Recorded	# 1Day Min < 0.5	# 1Day Min < 4.4	# 1Day Avg <0.5	# 1Day Avg <4.4	# 1Day Max >23	# 1Day Max >24	#7Day Avg Daily Max >12	#7Day Avg Daily Max >16	#7Day Avg Daily Max >17.5	#7Day Avg Daily Max >18	#7Day Avg Daily Max >22	Monthly 1 Day Max	Monthly 1 Day Max Range	Monthly Avg Daily Range
January	31	0	30	0	24	0	0	0	0	0	0	0	5.3	1.6	0.7
February	28	0	11	0	6	0	0	0	0	0	0	0	6.8	1.8	1.0
March	31	0	9	0	1	0	0	0	0	0	0	0	8.7	3.5	2.0
April	30	0	3	0	0	0	0	0	0	0	0	0	11.4	4.0	2.4

SUMITMOUTH

2009	# Days Recorded	# 1Day Min < 0.5	# 1Day Min < 4.4	# 1Day Avg <0.5	# 1Day Avg <4.4	# 1Day Max >23	# 1Day Max >24	#7Day Avg Daily Max >12	#7Day Avg Daily Max >16	#7Day Avg Daily Max >17.5	#7Day Avg Daily Max >18	#7Day Avg Daily Max >22	Monthly 1 Day Max	Monthly 1 Day Max Range	Monthly Avg Daily Range
May	31	0	1	0	0	0	0	7	0	0	0	0	13.9	5.2	3.8
June	30	0	0	0	0	0	0	30	0	0	0	0	15.0	5.5	3.8
July	31	0	0	0	0	0	0	31	19	12	9	0	20.5	5.4	4.5
August	31	0	0	0	0	0	0	31	16	5	4	0	20.1	4.8	3.9
September	30	0	0	0	0	0	0	19	0	0	0	0	17.0	3.8	3.0
October	31	0	11	0	5	0	0	0	0	0	0	0	10.0	3.3	2.1
November	30	0	27	0	22	0	0	0	0	0	0	0	7.3	3.2	1.4
December	31	25	31	23	31	0	0	0	0	0	0	0	2.7	1.7	0.4

SUMITMOUTH

2010	# Days Recorded	# 1Day Min < 0.5	# 1Day Min < 4.4	# 1Day Avg <0.5	# 1Day Avg <4.4	# 1Day Max >23	# 1Day Max >24	#7Day Avg Daily Max >12	#7Day Avg Daily Max >16	#7Day Avg Daily Max >17.5	#7Day Avg Daily Max >18	#7Day Avg Daily Max >22	Monthly 1 Day Max	Monthly 1 Day Max Range	Monthly Avg Daily Range
January	31	1	31	0	31	0	0	0	0	0	0	0	4.7	2.1	0.8
February	28	0	22	0	15	0	0	0	0	0	0	0	6.2	2.2	1.3
March	31	0	23	0	11	0	0	0	0	0	0	0	7.1	3.5	2.1
April	30	0	12	0	4	0	0	0	0	0	0	0	9.7	4.2	2.6

SURVEYORSX

2009	# Days Recorded	# 1Day Min < 0.5	< 4.4	# 1Day Avg <0.5	<4.4	# 1Day Max >23	>24	#7Day Avg Daily Max >12	>16	>17.5	>18	>22	Monthly 1 Day Max	Monthly 1 Day Max Range	Monthly Avg Daily Range
May	31	0	8	0	0	0	0	0	0	0	0	0	12.0	3.8	2.8
June	30	0	0	0	0	0	0	2	0	0	0	0	12.5	4.2	2.8
July	31	0	0	0	0	0	0	31	0	0	0	0	16.1	4.4	3.5
August	31	0	0	0	0	0	0	28	0	0	0	0	16.0	3.5	2.8
September	30	0	0	0	0	0	0	2	0	0	0	0	13.2	2.9	2.2
October	31	0	10	0	7	0	0	0	0	0	0	0	8.0	2.3	1.4
November	13	0	12	0	11	0	0	0	0	0	0	0	6.0	2.3	1.0
December	0	--	--	--	--	--	--	--	--	--	--	--	--	--	--

SURVEYORSX

2010	# Days Recorded	# 1Day Min < 0.5	< 4.4	# 1Day Avg <0.5	<4.4	# 1Day Max >23	>24	#7Day Avg Daily Max >12	>16	>17.5	>18	>22	Monthly 1 Day Max	Monthly 1 Day Max Range	Monthly Avg Daily Range
January	0	--	--	--	--	--	--	--	--	--	--	--	--	--	--
February	0	--	--	--	--	--	--	--	--	--	--	--	--	--	--
March	0	--	--	--	--	--	--	--	--	--	--	--	--	--	--
April	0	--	--	--	--	--	--	--	--	--	--	--	--	--	--

SWALEHARMS

2009	# Days Recorded	# 1Day Min < 0.5	< 4.4	# 1Day Avg <0.5	<4.4	# 1Day Max >23	>24	#7Day Avg Daily Max >12	>16	>17.5	>18	>22	Monthly 1 Day Max	Monthly 1 Day Max Range	Monthly Avg Daily Range
May	0	--	--	--	--	--	--	--	--	--	--	--	--	--	--
June	0	--	--	--	--	--	--	--	--	--	--	--	--	--	--
July	0	--	--	--	--	--	--	--	--	--	--	--	--	--	--
August	0	--	--	--	--	--	--	--	--	--	--	--	--	--	--
September	0	--	--	--	--	--	--	--	--	--	--	--	--	--	--
October	0	--	--	--	--	--	--	--	--	--	--	--	--	--	--
November	0	--	--	--	--	--	--	--	--	--	--	--	--	--	--
December	0	--	--	--	--	--	--	--	--	--	--	--	--	--	--

SWALEHARMS

2010	# Days	# 1Day Min		# 1Day Avg		# 1Day Max		#7Day Avg Daily Max					Monthly 1	Monthly 1 Day	Monthly Avg
	Recorded	< 0.5	< 4.4	<0.5	<4.4	>23	>24	>12	>16	>17.5	>18	>22	Day Max	Max Range	Daily Range
January	0	--	--	--	--	--	--	--	--	--	--	--	--	--	--
February	0	--	--	--	--	--	--	--	--	--	--	--	--	--	--
March	0	--	--	--	--	--	--	--	--	--	--	--	--	--	--
April	0	--	--	--	--	--	--	--	--	--	--	--	--	--	--

SWALEMOUTH

2009	# Days	# 1Day Min		# 1Day Avg		# 1Day Max		#7Day Avg Daily Max					Monthly 1	Monthly 1 Day	Monthly Avg
	Recorded	< 0.5	< 4.4	<0.5	<4.4	>23	>24	>12	>16	>17.5	>18	>22	Day Max	Max Range	Daily Range
May	31	0	0	0	0	0	0	31	12	5	4	0	19.0	5.4	3.9
June	30	0	0	0	0	0	0	30	30	28	14	0	18.9	3.7	2.5
July	31	0	0	0	0	0	0	31	31	31	31	0	21.1	2.7	2.2
August	31	0	0	0	0	0	0	31	31	31	31	0	22.5	4.3	2.8
September	30	0	0	0	0	0	0	30	25	13	9	0	19.8	1.8	1.2
October	31	0	0	0	0	0	0	8	0	0	0	0	14.9	1.2	0.6
November	15	0	0	0	0	0	0	0	0	0	0	0	9.8	1.1	0.7
December	24	2	24	0	24	0	0	0	0	0	0	0	4.4	2.1	0.6

SWALEMOUTH

2010	# Days	# 1Day Min		# 1Day Avg		# 1Day Max		#7Day Avg Daily Max					Monthly 1	Monthly 1 Day	Monthly Avg
	Recorded	< 0.5	< 4.4	<0.5	<4.4	>23	>24	>12	>16	>17.5	>18	>22	Day Max	Max Range	Daily Range
January	31	0	20	0	17	0	0	0	0	0	0	0	6.2	1.8	0.8
February	28	0	6	0	2	0	0	0	0	0	0	0	8.1	2.6	1.3
March	31	0	2	0	0	0	0	0	0	0	0	0	10.2	3.7	2.4
April	30	0	0	0	0	0	0	15	0	0	0	0	13.1	4.0	2.9

TEPEEIXLRDX

2009	# Days Recorded	# 1Day Min < 0.5	# 1Day Min < 4.4	# 1Day Avg <0.5	# 1Day Avg <4.4	# 1Day Max >23	# 1Day Max >24	#7Day Avg Daily Max >12	#7Day Avg Daily Max >16	#7Day Avg Daily Max >17.5	#7Day Avg Daily Max >18	#7Day Avg Daily Max >22	Monthly 1 Day Max	Monthly 1 Day Max Range	Monthly Avg Daily Range
May	31	0	8	0	0	0	0	9	0	0	0	0	15.4	6.6	4.9
June	30	0	0	0	0	0	0	30	0	0	0	0	15.5	6.9	4.9
July	31	0	0	0	0	0	0	31	18	6	4	0	18.9	7.0	5.4
August	31	0	0	0	0	0	0	18	5	2	1	0	18.7	4.6	2.2
September	30	0	0	0	0	0	0	0	0	0	0	0	10.6	2.2	0.7
October	31	0	6	0	4	0	0	0	0	0	0	0	8.0	2.1	0.9
November	30	6	29	3	29	0	0	0	0	0	0	0	6.0	1.5	0.7
December	31	31	31	29	31	0	0	0	0	0	0	0	1.3	1.1	0.2

TEPEEIXLRDX

2010	# Days Recorded	# 1Day Min < 0.5	# 1Day Min < 4.4	# 1Day Avg <0.5	# 1Day Avg <4.4	# 1Day Max >23	# 1Day Max >24	#7Day Avg Daily Max >12	#7Day Avg Daily Max >16	#7Day Avg Daily Max >17.5	#7Day Avg Daily Max >18	#7Day Avg Daily Max >22	Monthly 1 Day Max	Monthly 1 Day Max Range	Monthly Avg Daily Range
January	31	2	31	1	31	0	0	0	0	0	0	0	3.5	1.6	0.8
February	28	0	28	0	28	0	0	0	0	0	0	0	4.3	1.9	1.2
March	31	0	31	0	29	0	0	0	0	0	0	0	5.8	3.5	1.7
April	30	0	19	0	10	0	0	0	0	0	0	0	8.5	4.6	2.3

TRAPPERRDX

2009	# Days Recorded	# 1Day Min < 0.5	# 1Day Min < 4.4	# 1Day Avg <0.5	# 1Day Avg <4.4	# 1Day Max >23	# 1Day Max >24	#7Day Avg Daily Max >12	#7Day Avg Daily Max >16	#7Day Avg Daily Max >17.5	#7Day Avg Daily Max >18	#7Day Avg Daily Max >22	Monthly 1 Day Max	Monthly 1 Day Max Range	Monthly Avg Daily Range
May	31	0	24	0	7	0	0	0	0	0	0	0	8.0	3.4	2.4
June	30	0	1	0	0	0	0	0	0	0	0	0	8.0	2.8	1.7
July	31	0	0	0	0	0	0	0	0	0	0	0	9.3	2.7	2.0
August	31	0	0	0	0	0	0	0	0	0	0	0	9.2	2.3	1.7
September	30	0	1	0	0	0	0	0	0	0	0	0	7.9	1.9	1.4
October	31	0	24	0	11	0	0	0	0	0	0	0	5.9	1.7	1.1
November	30	0	30	0	30	0	0	0	0	0	0	0	5.0	2.1	0.8
December	31	0	31	0	31	0	0	0	0	0	0	0	4.0	2.2	0.8

TRAPPERRDX

2010	# Days Recorded	# 1Day Min < 0.5	< 4.4	# 1Day Avg <0.5	<4.4	# 1Day Max >23	>24	#7Day Avg Daily Max >12	>16	>17.5	>18	>22	Monthly 1 Day Max	Monthly 1 Day Max Range	Monthly Avg Daily Range
January	31	0	31	0	31	0	0	0	0	0	0	0	4.1	1.5	0.6
February	28	0	28	0	28	0	0	0	0	0	0	0	4.4	1.8	0.9
March	31	0	31	0	31	0	0	0	0	0	0	0	5.2	2.1	1.4
April	30	0	30	0	21	0	0	0	0	0	0	0	6.1	2.8	1.8

TROUTRVRTRDX

2009	# Days Recorded	# 1Day Min < 0.5	< 4.4	# 1Day Avg <0.5	<4.4	# 1Day Max >23	>24	#7Day Avg Daily Max >12	>16	>17.5	>18	>22	Monthly 1 Day Max	Monthly 1 Day Max Range	Monthly Avg Daily Range
May	0	--	--	--	--	--	--	--	--	--	--	--	--	--	--
June	0	--	--	--	--	--	--	--	--	--	--	--	--	--	--
July	0	--	--	--	--	--	--	--	--	--	--	--	--	--	--
August	0	--	--	--	--	--	--	--	--	--	--	--	--	--	--
September	0	--	--	--	--	--	--	--	--	--	--	--	--	--	--
October	0	--	--	--	--	--	--	--	--	--	--	--	--	--	--
November	6	1	6	1	6	0	0	0	0	0	0	0	3.9	2.3	1.0
December	31	31	31	31	31	0	0	0	0	0	0	0	0.9	0.8	0.1

TROUTRVRTRDX

2010	# Days Recorded	# 1Day Min < 0.5	< 4.4	# 1Day Avg <0.5	<4.4	# 1Day Max >23	>24	#7Day Avg Daily Max >12	>16	>17.5	>18	>22	Monthly 1 Day Max	Monthly 1 Day Max Range	Monthly Avg Daily Range
January	31	6	25	5	21	0	0	0	0	0	0	0	5.4	2.4	0.5
February	28	0	0	0	0	0	0	0	0	0	0	0	6.2	0.9	0.3
March	31	0	0	0	0	0	0	0	0	0	0	0	6.4	0.8	0.3
April	30	0	0	0	0	0	0	0	0	0	0	0	7.5	1.3	0.5

WESTFORKRX

2009	# Days Recorded	# 1Day Min < 0.5	# 1Day Min < 4.4	# 1Day Avg <0.5	# 1Day Avg <4.4	# 1Day Max >23	# 1Day Max >24	#7Day Avg Daily Max >12	#7Day Avg Daily Max >16	#7Day Avg Daily Max >17.5	#7Day Avg Daily Max >18	#7Day Avg Daily Max >22	Monthly 1 Day Max	Monthly 1 Day Max Range	Monthly Avg Daily Range
May	31	0	25	0	17	0	0	0	0	0	0	0	8.4	3.5	2.6
June	30	0	0	0	0	0	0	0	0	0	0	0	11.0	3.9	2.4
July	31	0	0	0	0	0	0	0	0	0	0	0	11.9	4.0	3.3
August	31	0	0	0	0	0	0	0	0	0	0	0	11.5	3.6	2.9
September	30	0	2	0	0	0	0	0	0	0	0	0	9.5	3.0	2.1
October	31	0	23	0	12	0	0	0	0	0	0	0	6.4	2.3	1.3
November	30	1	30	0	29	0	0	0	0	0	0	0	5.0	2.6	0.9
December	31	12	31	7	31	0	0	0	0	0	0	0	3.5	2.0	0.8

WESTFORKRX

2010	# Days Recorded	# 1Day Min < 0.5	# 1Day Min < 4.4	# 1Day Avg <0.5	# 1Day Avg <4.4	# 1Day Max >23	# 1Day Max >24	#7Day Avg Daily Max >12	#7Day Avg Daily Max >16	#7Day Avg Daily Max >17.5	#7Day Avg Daily Max >18	#7Day Avg Daily Max >22	Monthly 1 Day Max	Monthly 1 Day Max Range	Monthly Avg Daily Range
January	31	0	31	0	31	0	0	0	0	0	0	0	3.6	1.5	0.7
February	28	0	28	0	28	0	0	0	0	0	0	0	4.1	1.8	1.0
March	31	0	31	0	31	0	0	0	0	0	0	0	5.2	2.2	1.5
April	30	0	30	0	27	0	0	0	0	0	0	0	5.9	2.9	2.0

WHITEIXLRDX

2009	# Days Recorded	# 1Day Min < 0.5	# 1Day Min < 4.4	# 1Day Avg <0.5	# 1Day Avg <4.4	# 1Day Max >23	# 1Day Max >24	#7Day Avg Daily Max >12	#7Day Avg Daily Max >16	#7Day Avg Daily Max >17.5	#7Day Avg Daily Max >18	#7Day Avg Daily Max >22	Monthly 1 Day Max	Monthly 1 Day Max Range	Monthly Avg Daily Range
May	31	0	9	0	0	0	0	5	0	0	0	0	13.9	5.3	3.7
June	30	0	0	0	0	0	0	30	0	0	0	0	15.5	7.5	5.0
July	31	0	0	0	0	4	1	31	25	17	15	5	25.7	10.8	7.8
August	31	0	0	0	0	7	6	31	31	31	30	9	26.3	13.5	10.7
September	30	0	4	0	0	0	0	26	3	1	0	0	20.5	9.8	6.5
October	31	6	26	0	15	0	0	0	0	0	0	0	9.9	5.8	3.7
November	30	18	30	12	30	0	0	0	0	0	0	0	4.8	3.9	1.7
December	31	31	31	31	31	0	0	0	0	0	0	0	0.1	3.5	0.9

WHITEIXLRDX

2010	# Days	# 1Day Min		# 1Day Avg		# 1Day Max		#7Day Avg Daily Max					Monthly 1	Monthly 1 Day	Monthly Avg
	Recorded	< 0.5	< 4.4	<0.5	<4.4	>23	>24	>12	>16	>17.5	>18	>22	Day Max	Max Range	Daily Range
January	31	31	31	31	31	0	0	0	0	0	0	0	0.0	0.5	0.1
February	28	25	28	22	28	0	0	0	0	0	0	0	4.6	6.1	1.6
March	31	5	31	0	31	0	0	0	0	0	0	0	6.5	6.3	3.1
April	30	0	27	0	14	0	0	0	0	0	0	0	7.2	5.3	2.4

WHITEMOUTH

2009	# Days	# 1Day Min		# 1Day Avg		# 1Day Max		#7Day Avg Daily Max					Monthly 1	Monthly 1 Day	Monthly Avg
	Recorded	< 0.5	< 4.4	<0.5	<4.4	>23	>24	>12	>16	>17.5	>18	>22	Day Max	Max Range	Daily Range
May	31	0	0	0	0	0	0	15	1	0	0	0	16.8	4.8	3.6
June	30	0	0	0	0	0	0	30	26	7	4	0	18.8	5.7	3.8
July	31	0	0	0	0	4	0	31	31	31	31	7	23.7	6.9	5.9
August	31	0	0	0	0	2	0	31	31	31	31	3	23.5	6.9	6.0
September	30	0	0	0	0	0	0	30	19	7	2	0	20.3	5.9	4.6
October	31	0	0	0	0	0	0	1	0	0	0	0	13.1	4.0	2.3
November	13	0	1	0	0	0	0	0	0	0	0	0	8.5	2.4	1.4
December	31	24	31	17	31	0	0	0	0	0	0	0	3.5	1.2	0.6

WHITEMOUTH

2010	# Days	# 1Day Min		# 1Day Avg		# 1Day Max		#7Day Avg Daily Max					Monthly 1	Monthly 1 Day	Monthly Avg
	Recorded	< 0.5	< 4.4	<0.5	<4.4	>23	>24	>12	>16	>17.5	>18	>22	Day Max	Max Range	Daily Range
January	31	1	31	0	31	0	0	0	0	0	0	0	4.0	1.1	0.6
February	28	0	27	0	24	0	0	0	0	0	0	0	5.7	1.7	1.0
March	31	0	23	0	13	0	0	0	0	0	0	0	7.0	3.0	1.8
April	30	0	10	0	5	0	0	0	0	0	0	0	10.1	3.9	2.4

WHITEUPPER

2009	# Days Recorded	# 1Day Min < 0.5	< 4.4	# 1Day Avg <0.5	<4.4	# 1Day Max >23	>24	#7Day Avg Daily Max >12	>16	>17.5	>18	>22	Monthly 1 Day Max	Monthly 1 Day Max Range	Monthly Avg Daily Range
May	31	0	15	0	3	0	0	1	0	0	0	0	12.9	4.6	3.4
June	30	0	0	0	0	0	0	1	0	0	0	0	12.2	3.7	2.6
July	31	0	0	0	0	0	0	21	0	0	0	0	15.6	3.7	2.8
August	31	0	0	0	0	0	0	21	0	0	0	0	15.8	2.7	2.0
September	30	0	0	0	0	0	0	1	0	0	0	0	13.1	2.1	1.5
October	31	0	18	0	13	0	0	0	0	0	0	0	6.6	2.0	1.0
November	30	5	30	2	30	0	0	0	0	0	0	0	4.7	1.5	0.6
December	31	31	31	30	31	0	0	0	0	0	0	0	1.3	1.3	0.1

WHITEUPPER

2010	# Days Recorded	# 1Day Min < 0.5	< 4.4	# 1Day Avg <0.5	<4.4	# 1Day Max >23	>24	#7Day Avg Daily Max >12	>16	>17.5	>18	>22	Monthly 1 Day Max	Monthly 1 Day Max Range	Monthly Avg Daily Range
January	31	6	31	4	31	0	0	0	0	0	0	0	2.8	1.1	0.5
February	28	0	28	0	28	0	0	0	0	0	0	0	3.2	1.7	0.6
March	31	0	31	0	31	0	0	0	0	0	0	0	4.1	2.1	1.3
April	30	1	30	0	27	0	0	0	0	0	0	0	6.6	3.4	2.0

Appendix H. Habitat survey data

Table H1. Summary of stream habitat inventory data collected in 2009. NC denotes no data collected.

Project	Stream	Total Length (ft)	Total Miles	Side Channel Length (ft)	Avg. Wetted Width (ft)	Avg. Habitat Unit Area (ft^2)	Avg. Max Pool Depth (ft)	Avg. Residual Pool Depth (ft)	Avg. Bankfull (ft)	Total Spawning Area (ft^2)	Total Bedrock Outcrops	Bedrock Outcrops/ Mile
Lower White Creek Habitat Restoration	Brush Creek	10488.2	2.0	1202.4	11.4	483.8	1.5	1.2	29.2	0.0	5	2.5
	White Creek	10272.2	2.0	787.6	16.3	855.2	1.8	1.4	34.2	433.4	7	3.6
Paired Food Web Study	Tepee Creek	7851.0	1.5	0.0	9.1	814.1	1.8	1.4	19.8	NC	0	0.0
	White Creek	1140.9	0.2	53.7	6.7	183.5	1.7	1.5	21.4	4247.0	0	0.0
Upper Klickitat - Phase 2	Klickitat River	19314.5	3.7	3271.5	42.3	11398.4	3.2	1.9	91.8	4745.0	5	1.4

Table H2. Summary of Large Woody Debris (LWD) and Jams inventory data collected in 2009. NC denotes no data collected.

Project	Stream	Total Length	Total Miles	Total LWD Pieces	LWD Pieces/Mile	Total Jams	Jams/Mile
Lower White Creek Habitat Restoration	Brush Creek	10488.2	2.0	181	91.9	13	6.6
	White Creek	10272.2	2.0	100	51.3	2	1.0
Paired Food Web Study	Tepee Creek	7851.0	1.5	NC	NC	0	0.0
	White Creek	1140.9	0.2	39	177.3	0	0.0
Upper Klickitat - Phase 2	Klickitat River	19314.5	3.7	304	83.1	21	5.7

Appendix I. White Creek PIT tagging data

Table I1. Location description of sampling sites in the White Creek Pit Tag Study.

Stream	Site ID	Site Length (ft)	Start Elevation (ft)	Distance (KM) from White Creek Array	Start Latitude	Start Longitude	End Latitude	End Longitude
Brush Creek	70	1394	2680.4	14.98	46.09512951	-121.0494935	46.09846677	121.0471888
E. F. Tepee Creek	89	917	2854.3	0.00	46.15305626	-121.0404996	46.15309448	121.0371962
Tepee Creek	80	912	2611.5	16.63	46.12508669	-121.073339	46.12624188	121.0701092
Tepee Creek	81	1190	2805.1	20.81	46.14935976	-121.0533557	46.15174281	121.0524055
Tepee Creek	82	260	2900.3	23.74	46.1652728	-121.0370214	46.1655437	121.0362061
Tepee Creek	83	201	2906.8	23.86	46.16578954	-121.0356601	46.16596062	121.0351878
Tepee Creek	84	333	2936.4	24.33	46.16910257	-121.0337302	46.16961236	121.0343105
Tepee Creek	85	1090	2939.6	25.63	46.17711509	-121.0278339	46.17855342	121.0262696
Tepee Creek	86	2560	3113.5	29.07	46.19728052	-121.0088727	46.20153467	121.0045026
Tepee Creek	87	284	2939.6	24.77	46.17226423	-121.0332373	46.17278927	121.0327371
W.F. White Creek	79	1376	2549.2	17.21	46.12660934	-121.0765954	46.1264039	-121.081012
White Creek	90	920	1168.0	0.20	46.01431573	-121.1494956	46.01615313	-21.1485477
White Creek	91	500	3326.8	28.72	46.21475084	-121.0887354	46.21547738	121.0904542
White Creek	92	2070	2519.7	14.74	46.11028735	-121.0711925	46.11449523	121.0684843
White Creek	93	1005	2965.9	24.05	46.17906438	-121.0710163	46.18167182	121.0707209
White Creek	94	1900	2578.7	16.94	46.12399276	-121.0724933	46.12775724	121.0768579
White Creek	95	315	2614.8	19.21	46.14345311	-121.0746263	46.14361698	121.0736853
White Creek	96	351	2618.1	19.32	46.14389459	-121.0733265	46.14452683	121.0733616
White Creek	97	213	2913.4	23.33	46.17473421	-121.0737744	46.17493981	121.0730121
White Creek	98	261	2910.1	23.44	46.1748508	-121.0723411	46.17493328	121.0714149
White Creek	99	925	1706.0	4.86	46.04246677	-121.1175217	46.04331133	121.1142319

Table I2. Summary statistics of fish sampled during the White Creek Pit Tag Study in 2009. Parentheses denote ±1 standard error of the mean.

Sample Date	Stream	Site ID	No. Fish Sampled	Mean Length (mm)	Median Length (mm)	Length Range (mm)	Mean Weight (g)	Median Weight (g)	Weight Range (g)
6/17/2009	Brush Creek	70	108	119.5 (3.1)	108	81-240	31.3 (3.1)	17.2	7.1-204.3
6/29/2009	E.F. Tepee Creek	89	29	100 (5.4)	98	70-175	16.3 (3.2)	11.6	4.0-75.1
6/23/2009	Tepee Creek	80	67	106.2 (4.4)	93	70-205	23.9 (3.8)	10.8	5.5-135.4
6/24/2009	Tepee Creek	81	101	95 (2.8)	85	70-198	14.9 (1.9)	7.9	4.3-115.6
7/7/2009	Tepee Creek	82	16	97.9 (4.5)	92	81-153	15.4 (3.0)	11.3	7.9-57.3
7/7/2009	Tepee Creek	83	39	110 (5.4)	100	81-228	23.1 (4.9)	12.2	6.5-151.6
7/7/2009	Tepee Creek	84	40	107.6 (3.4)	108	80-183	19.1 (2.6)	13.2	7.4-94.6
6/25/2009	Tepee Creek	85	154	100.3 (1.9)	93	72-200	16.6 (1.2)	11.4	4.8-116.5
6/26/2009	Tepee Creek	86	77	105.6 (3.7)	96	70-251	19.2 (2.3)	11	2.7-137.1
7/8/2009	Tepee Creek	87	56	98.6 (2.6)	94	72-174	15.5 (1.5)	12	5.2-76.2
6/30/2009	W.F. White Creek	79	14	97.4 (6.9)	86	70-157	16.1 (4.2)	8.4	4.6-62.9
8/4/2009	White Creek	90	272	100.2 (1.4)	95	67-215	16.9 (1.1)	11.8	3.6-163.8
7/9/2009	White Creek	91	31	106.1 (3.9)	97	75-160	19.3 (2.4)	13.4	6.4-58.6
7/10/2009	White Creek	92	230	108 (2.1)	97	70-257	23.5 (1.9)	13.2	5.4-249.1
6/22/2009	White Creek	93	28	102.5 (4.6)	95	71-165	16 (2.2)	11.2	4.5-55.2
7/14/2009	White Creek	94	119	110 (3.0)	100	74-225	22.4 (2.2)	13.1	6.2-132.2
7/22/2009	White Creek	95	67	90 (2.4)	85	65-165	12.4 (1.2)	8.7	4.2-65.3
7/22/2009	White Creek	96	25	88.9 (4.4)	82	60-138	12 (1.9)	8.5	3.2-36.5
7/22/2009	White Creek	97	31	124.4 (5.7)	118	83-200	34.4 (4.9)	27	8.7-110.2
7/22/2009	White Creek	98	11	107.2 (9.4)	96	65-164	23.5 (6.2)	13.4	5.3-69.4
7/27/2009	White Creek	99	212	106 (2.2)	94	70-243	23.5 (2.5)	11.7	4.2-256.2

Table I3. Summary of fish detections at the White Creek PIT tag array and Columbia River during in 2009-2010.

Stream	Site ID	No. Fish Sampled	No. Fish Detected at WC Array	% Fish Detected at WC Array	No. Fish Detected at Bonneville Dam	No. Fish Detected By Matrix Trawl
Brush Creek	70	108	10	9.3	0	0
E.F. Tepee Creek	89	29	7	24.1	0	0
Tepee Creek	80	67	15	22.4	1	1
Tepee Creek	81	101	30	29.7	0	0
Tepee Creek	82	16	4	25.0	0	0
Tepee Creek	83	39	8	20.5	0	0
Tepee Creek	84	40	5	12.5	1	0
Tepee Creek	85	154	37	24.0	2	1
Tepee Creek	86	77	3	3.9	0	0
Tepee Creek	87	56	9	16.1	0	0
W.F. White Creek	79	14	5	35.7	0	0
White Creek	90	272	109	40.1	11	1
White Creek	91	31	0	0.0	0	0
White Creek	92	230	44	19.1	1	0
White Creek	93	28	5	17.9	1	0
White Creek	94	119	18	15.1	0	0
White Creek	95	67	17	25.4	0	0
White Creek	96	25	6	24.0	0	0
White Creek	97	31	2	6.5	0	0
White Creek	98	11	0	0.0	0	0
White Creek	99	212	52	24.5	3	0

Appendix J. Radio Telemetry data

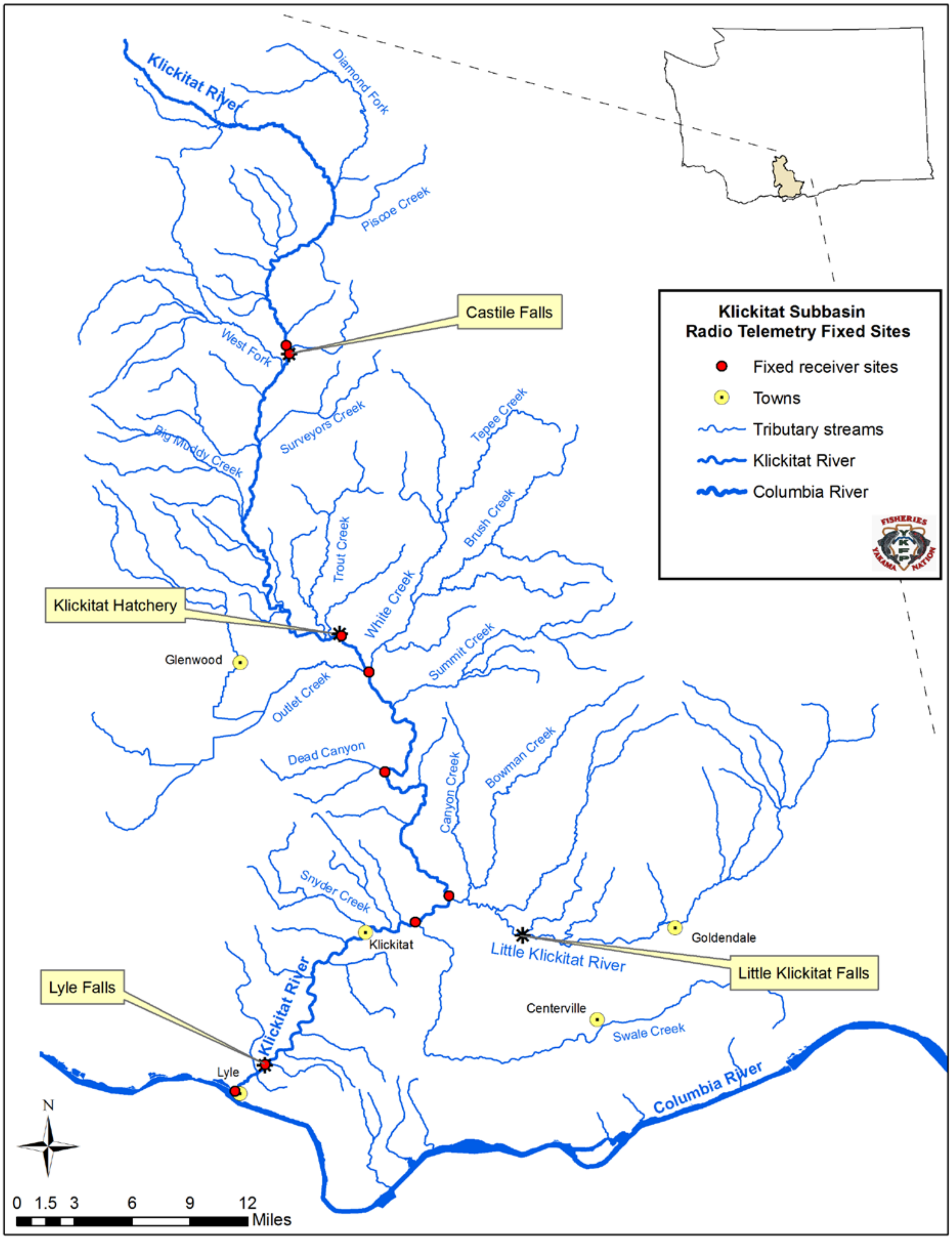


Figure J1. Map of fixed radio telemetry stations in the Klickitat subbasin.

Table J1. Description of fixed radio telemetry stations in the Klickitat subbasin.

Site Name	River mile	Physical location	Receiver type	Power source	# of antennas
Lyle	0.1	45.697N, 121.291W	Lotek	Hard power (110V)	2
Lyle Falls	2.5	45.717N, 121.259W	Lotek	solar panels	5
Wahkiacus	16	45.825N, 121.099W	Lotek	solar panels	3
Little Klickitat	19	45.845N, 121.063W	Lotek	solar panels	3
Dead Creek	31	45.938N, 121.133W	Lotek	solar panels	3
White Creek	40	46.013N, 121.151W	Lotek	solar panels	3
Klickitat Hatchery	43	46.040N, 121.181W	Lotek	Hard power (110V)	4
Lower Castile	64	46.252N, 121.240W	Orion	solar panels	3
Upper Castile	64.5	46.258N, 121.244W	Lotek	Thermo-electric generator	4

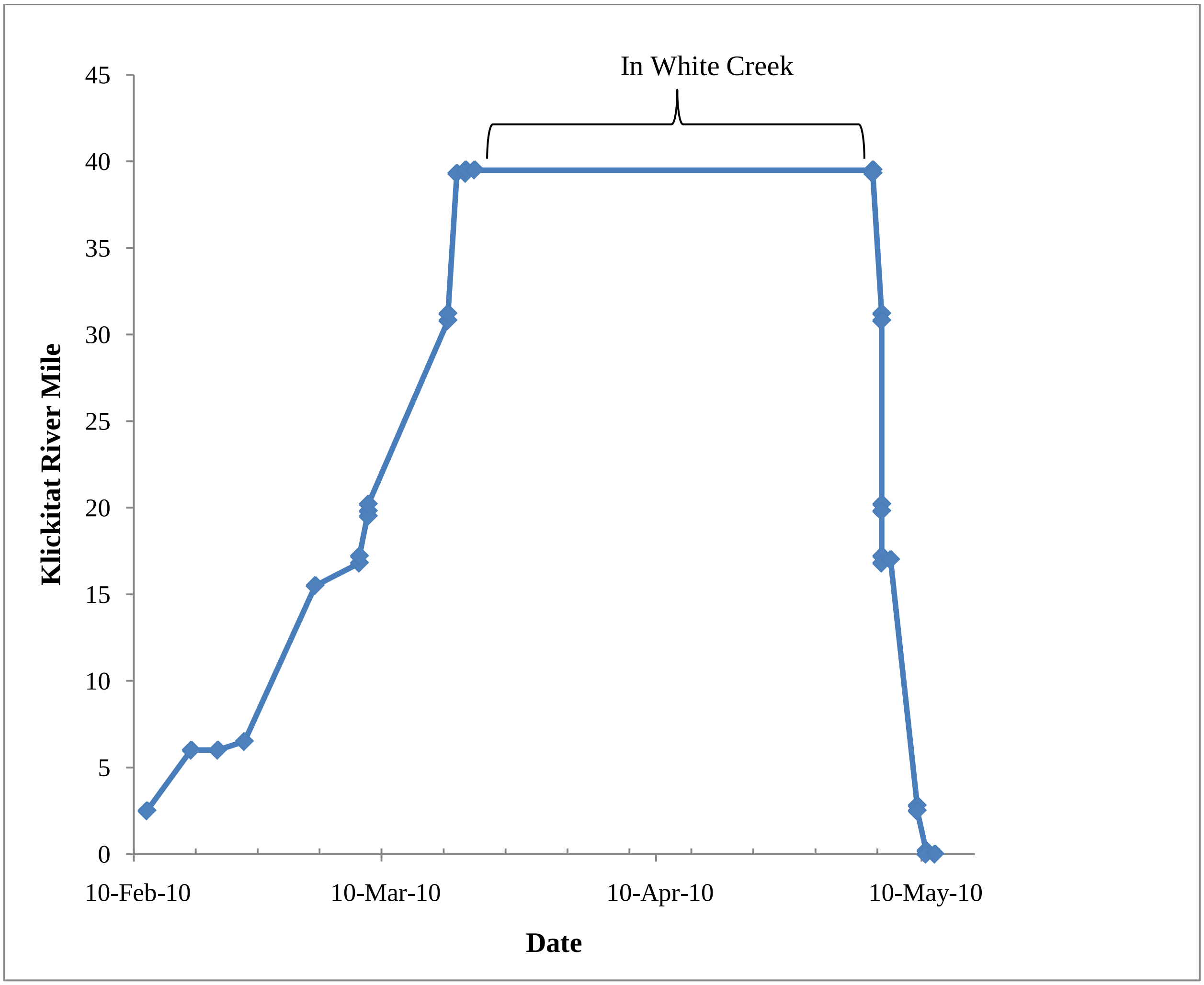
Table J2. Radio tagged fish by species, origin, and stock in the Klickitat River from September 2009 through April 30, 2010.

Steelhead		Spring Chinook	
Winter, Hatchery	Winter, Wild	Hatchery	Wild
2	57	4	0
Summer, Hatchery	Summer, Wild		
7	6		

Table J3. Fixed site receiver detections for radio tag #36027 (wild winter steelhead).

Watershed	River Mile	Date:Time	Receiver_Antenna	Location	Date
Klickitat River	2.5	11FEB2010:10:00:00			2/11/2010
Klickitat River	6	16FEB2010:08:15:30			2/16/2010
Klickitat River	6	19FEB2010:09:43:45			2/19/2010
Klickitat River	6.5	22FEB2010:08:51:00			2/22/2010
Klickitat River	15.5	02MAR2010:15:31:26			3/2/2010
Klickitat River	16.8	07MAR2010:19:29:41	U03_1	WAHKIACUS: DN	3/7/2010
Klickitat River	17.2	07MAR2010:20:21:18	U03_3	WAHKIACUS: UP	3/7/2010
Klickitat River	19.8	08MAR2010:06:28:02	U04_1	LITTLE KLICK: DN	3/8/2010
Klickitat River	19.5	08MAR2010:12:34:15			3/8/2010
Klickitat River	20.2	08MAR2010:14:57:26	U04_3	LITTLE KLICK: UP	3/8/2010
Klickitat River	30.8	17MAR2010:00:34:43	U05_1	DEAD CANYON: DN	3/17/2010
Klickitat River	31.2	17MAR2010:00:49:27	U05_3	DEAD CANYON: UP	3/17/2010
Klickitat River	39.3	18MAR2010:23:22:17	U06_1	WHITE CREEK: DN	3/18/2010
Klickitat River	39.3	19MAR2010:20:51:43	U06_1	WHITE CREEK: DN	3/19/2010
White Creek	39.5	19MAR2010:20:51:51	U06_2	IN WHITE CR	3/19/2010
White Creek	39.5	20MAR2010:16:51:35	U06_2	IN WHITE CR	3/20/2010
White Creek	39.5	04MAY2010:21:13:55	U06_2	IN WHITE CR	5/4/2010
White Creek	39.5	04MAY2010:21:25:06	U06_2	IN WHITE CR	5/4/2010
Klickitat River	39.3	04MAY2010:21:36:07	U06_1	WHITE CREEK: DN	5/4/2010
Klickitat River	39.3	04MAY2010:23:00:00			5/4/2010
Klickitat River	31.2	05MAY2010:00:20:20	U05_3	DEAD CANYON: UP	5/5/2010
Klickitat River	30.8	05MAY2010:00:23:46	U05_1	DEAD CANYON: DN	5/5/2010
Klickitat River	20.2	05MAY2010:20:13:20	U04_3	LITTLE KLICK: UP	5/5/2010
Klickitat River	19.8	05MAY2010:20:36:03	U04_1	LITTLE KLICK: DN	5/5/2010
Klickitat River	17.2	05MAY2010:23:33:41	U03_3	WAHKIACUS: UP	5/5/2010
Klickitat River	16.8	05MAY2010:23:36:38	U03_1	WAHKIACUS: DN	5/5/2010
Klickitat River	17	06MAY2010:01:18:01	U03_0	WAHKIACUS	5/6/2010
Klickitat River	2.8	09MAY2010:23:05:29	U02_5	LYLE FALLS: UP	5/9/2010
Klickitat River	2.5	09MAY2010:23:09:16	U02_0	LYLE FALLS	5/9/2010
Klickitat River	0.2	10MAY2010:02:20:25	U01_2	LYLE: UP	5/10/2010
Klickitat River	0	10MAY2010:02:22:03	U01_1	LYLE: DN	5/10/2010
Columbia River	0	11MAY2010:03:36:00			5/11/2010

Figure J2. Detected locations of wild winter steelhead with radio tag #36027.



Appendix K. Hydroacoustic Technology Inc. (HTI) report on Klickitat River smolt monitoring feasibility study

ASSESSMENT OF HYDROACOUSTIC SAMPLING TECHNIQUES TO ESTIMATE OUTMIGRANT SALMON SMOLT POPULATIONS ON THE KLICKITAT RIVER IN 2009

HTI Project P2786

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June 30, 2009

1.0 INTRODUCTION

A site visit to the Klickitat River was conducted on April 6, 2009 to assess the general suitability of potential sampling sites for a longer-term acoustic monitoring assessment. Based on the information gathered during the April site visit, Hydroacoustic Technology, Inc. (HTI) was contracted by the Yakama Nation Fisheries Program (YKFP) to conduct a feasibility study to evaluate the suitability of using hydroacoustic sampling methods to enumerate smolt outmigration on the Klickitat River. The primary objective of the study was to test the efficacy of using a single horizontally-oriented transducer to count downstream migrating juvenile salmonids as they passed a fixed monitoring location on the Klickitat River.

Two potential sampling sites that appeared conducive to hydroacoustic monitoring were identified during the April site visit (Appendix 1). Based on river bottom bathymetry and other site characteristics, the sampling site located at approximately RM 3.0 was selected for the subsequent feasibility study assessment (Figures 1 and 2).

2.0 METHODS

An HTI *Model 241 Portable Split-Beam Echo Sounder System* operating at a frequency of 200 kHz was used for the study, and deployment of the hydroacoustic equipment commenced on June 4, 2009. Since river access was difficult along this stretch of the Klickitat River, the hydroacoustic equipment was loaded into a rubber river raft and floated downstream to the study site.

The transducer mount was assembled on-site, and fitted with a 3°x10° elliptical beam width transducer and dual-axis rotator (Figure 3). The dual-axis rotator allows for the precise aiming of the transducer relative to the river bottom/surface, and placement of the sampling volume in the area where smolt are migrating downstream. The transducer mount assembly was then deployed approximately 1.5 m offshore on east bank of the river.

Prior to the 2009 feasibility assessment on the Klickitat River, the HTI *Model 241 Portable Split-Beam Echo Sounder System* used for data collection was laboratory-calibrated at HTI's calibration facility in Seattle, relative to a US Navy standard transducer of known sensitivity. An *in situ* standard target calibration using a 38.1 mm tungsten carbide sphere with known acoustic properties was also conducted on the transducer to verify system performance and conformity with the laboratory values (Figure 4). The field calibration process allowed the *Model 241System* to accurately measure background noise levels and establish accurate minimum detection thresholds.

The transducer mount assembly was then oriented in the river for smolt monitoring. The transducer mount was leveled and stabilized on the river substrate, and oriented such that the transducer was approximately in the mid-water column of the river and aimed perpendicular to the river flow (Figure 5). The acoustic system electronics (i.e., echo sounder and notebook computer) were housed in a commercial steel storage box, and power was supplied by four 12 VDC batteries.

An acoustic sampling (ping) rate of 5.0 pps was used during the standard target test, and during the preliminary transducer aiming process. Higher ping rates would be required for smolt monitoring. An initial on-axis echo detection threshold of -45 dB, and a 0.2 msec pulse width was also used.

3.0 RESULTS

Preliminary data collection during the transducer aiming process indicated that relatively high background acoustic noise levels at the site precluded using the relatively low -45 dB threshold for sampling Hydroacoustic sampling at the site was not limited by surface or bottom boundary interference. The site bathymetry was generally favorable for achieving adequate sampling volumes and range. The observed high background noise levels appeared to be due to entrained air present at the site, which negatively impacted the ability to resolve smaller fish targets. Through an iterative process, the threshold was subsequently 'stepped' up in 4 to 5 dB increments, to determine the functional minimum threshold and minimum fish detection length resolution at the sampling site (Figure 6). Figure 7 is a screen capture of an echogram from the acoustic system during the aiming process, using an on-axis data collection threshold of -36 dB. Significant acoustic interference was still evident at this higher data collection threshold. Background acoustic noise levels at the evaluated site varied with range and were estimated to be between -32 to -36 dB.

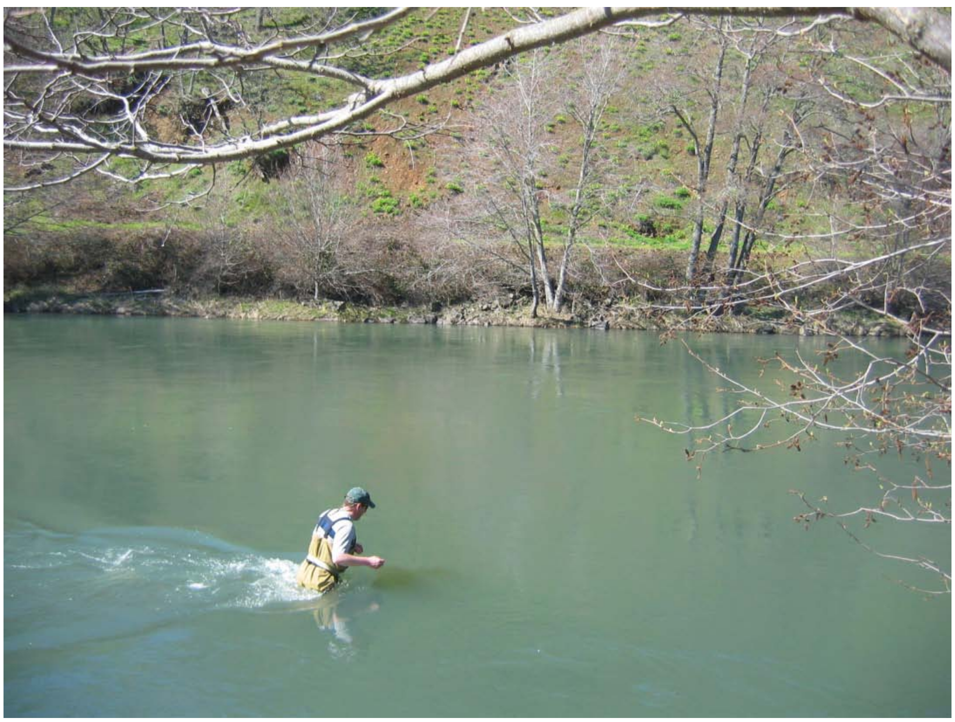

Figure 1. The smolt monitoring site at RM 3.0 under lower flow conditions during the site visit conducted on April 6, 2009. Note the four trees on the far bank, as a reference mark for comparison with Figure 2.

Figure 2. Transducer mount (lower right) deployed in the Klickitat River (RM 3.0), June 4-5, 2009. River discharge is approximately 2700 cfs, and some surface turbulence is evident at this level of discharge.

Figure 3. Transducer and dual-axis rotator attached to the transducer mount prior to deployment, June 4-5, 2009.

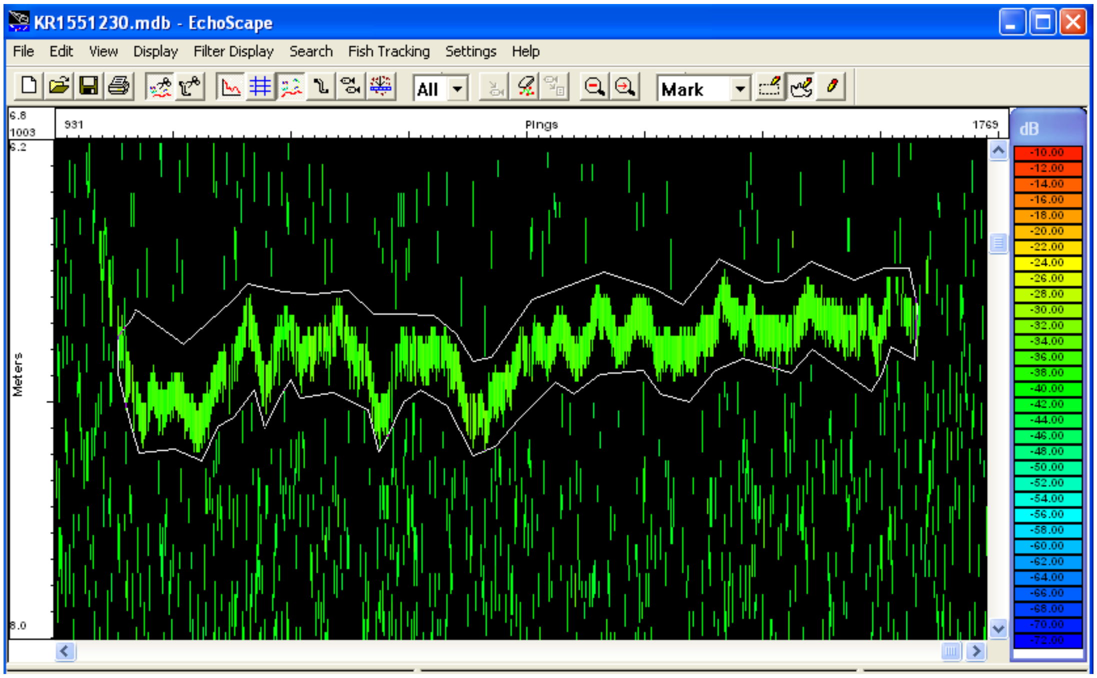

Figure 4. Echogram (zoomed view) of the standard target used for *in situ* field calibration of the system used to verify system sensitivity and performance. A -45 dB threshold was during the test, and the standard target suspended at a range of 6-7 m.

Figure 5. Transducer mount deployed for smolt monitoring at the Klickitat River sampling site on June 4-5, 2009.

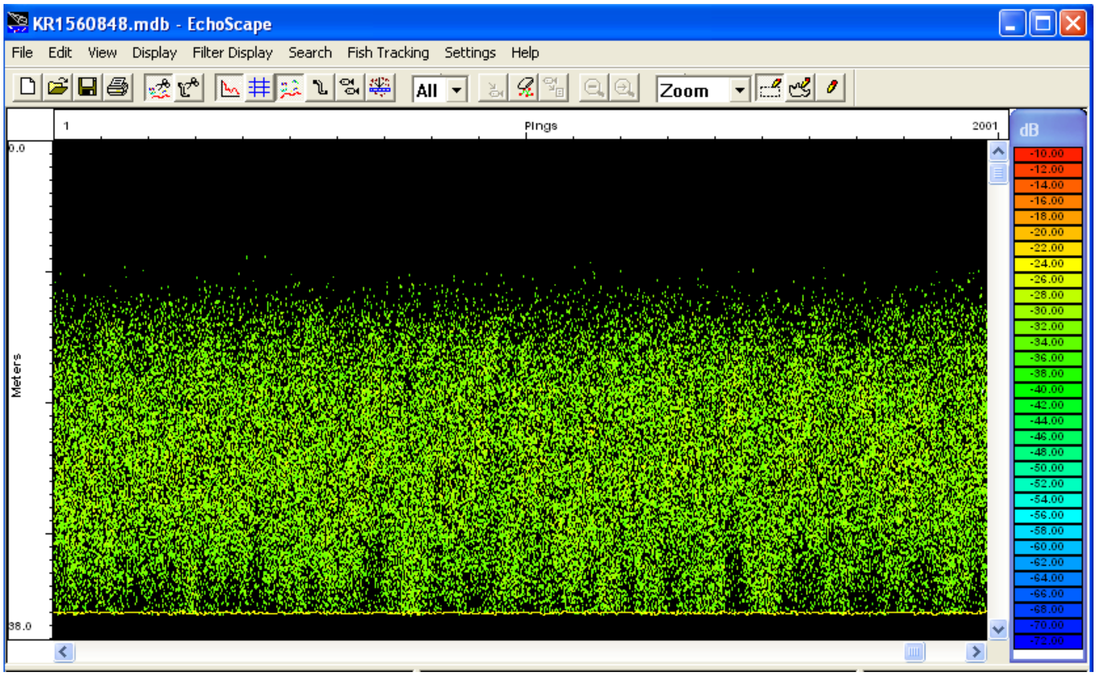

Figure 6. Echogram from the Klickitat River smolt monitoring deployment, June 5, 2009, with a threshold of -40 dB, and a maximum sampling range of 36 m.

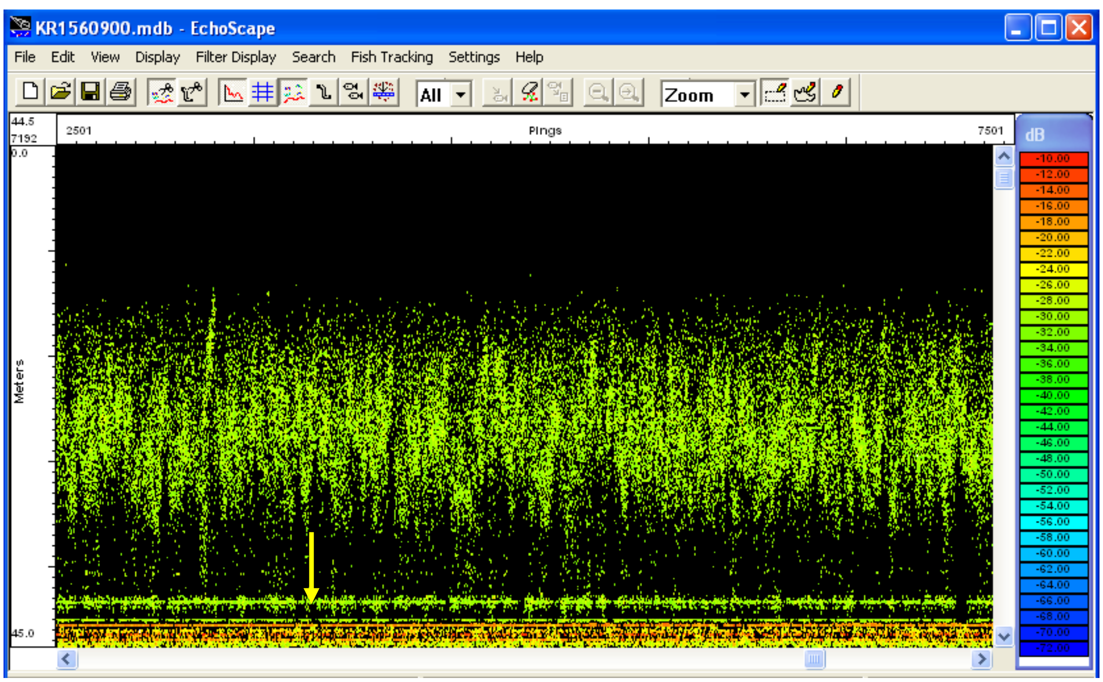

Figure 7. Echogram from the Klickitat River smolt monitoring deployment, June 5, 2009 with a threshold of -36 dB. Yellow arrow indicates the range at which the bottom substrate was first encountered (i.e., 42 m). Significant acoustic noise is still evident between 20-35 m.

Figure 8. This riffle, approximately 50 m upstream of the sampling site, was the likely source of entrained air (i.e., 'noise') that precluded hydroacoustic sampling of smolt at the Klickitat River sampling site.

4.0 DISCUSSION

For hydroacoustics to be a suitable assessment tool for measuring smolt outmigration on the Klickitat River, the echo voltage returns from the smallest length fish of interest must exceed the background noise level echo amplitudes. Excessive levels of entrained air, resulting from upstream turbulence, increased the background noise to a level that severely inhibited our ability to detect smolt-sized fish. Environmental conditions observed at the sampling site on June 4-5, 2009, precluded effective hydroacoustic resolution smolt-sized fish across the Klickitat River, and the evaluation was subsequently terminated.

The -45 dB on-axis minimum echo detection threshold initially evaluated at the site would allow detection of fish as small as 90 mm in length (based on the Love 1977 relationship), when monitored in +/- 15 degrees of side aspect. However, the measured background noise levels across the river were observed to exceed -36 dB, equivalent to an estimated minimum fish detection length of 250 mm. This was not considered acceptable for the purposes of resolving individual smolt passing the site.

Flow conditions at the level of discharge during the site visit appeared to be laminar and with little indication of entrained air or subsurface turbulence at the selected sampling location. River discharge, taken from the USGS website at that time, was reported as 1680-1690 ft^3 per second (gage height = 5.01-5.02 feet). River discharge at the time of deployment for the feasibility study had increased to 2640-2710ft^3(gage height=5.8-5.85 feet). The flow characteristics observed at the study site during the site visit unfortunately were not retained under the higher river flows observed in June. A small rapid, approximately 50 m upstream of the transducer, appeared to be the major source of the entrained air, and the resulting background noise levels in the river were higher than the minimum detection size required for smolt monitoring (Figure 8).

The use of horizontally-aimed fixed hydroacoustic methods proved to be unsuitable for monitoring smolt passage on the Klickitat River at the monitoring site evaluated during the 2009 feasibility study. Rivers are inherently “noisy” acoustic sampling environments (relative to lakes and marine environments) due to factors such as entrained air bubbles and the necessity of placing the acoustic volume in a constrained area, close to the surface and bottom boundaries, and background acoustic noise levels were sufficiently high to be limiting for monitoring smolt-sized targets during the 2009 study.

Results from the 2009 feasibility study suggests that hydroacoustic assessment methods may still be a viable tool for adult salmon return monitoring on the Klickitat River. It is generally easier to count larger adult fish using acoustics in a river system than smaller fish, as larger fish are better reflectors (return higher echo signal strengths) than do smaller fish. River discharge on the Klickitat River during the late summer and fall are also typically lower (i.e., <1000 cfs) than those observed during June. The methodology for counting salmon escapement in rivers is also well established and has been widely applied since the late 1980’s. Hydroacoustic studies designed to estimate adult salmon escapement typically employ on-axis echo detection thresholds of between -30 dB to -36 dB, which were potentially achievable at the evaluated Klickitat River feasibility site, particularly under lower flow conditions. The sampling site selection issues identified during the 2009 hydroacoustic smolt evaluation study would also apply to potential application of the technique for adult salmon counting. These issues include ease of access, equipment security, and potential conflicts with other user groups on the Klickitat River.