Lake Roosevelt Kokanee Immigration Project

Final Project Report

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I. Executive Summary

Due to the minor contribution of hatchery kokanee to the Lake Roosevelt creel, the absence of documented shoreline spawning, and the open water habitat use of this species, the Washington Department of Fish and Wildlife (WDFW) concludes that the effects of an additional one-foot drawdown will not directly affect kokanee at the shoreline. Indirect effects may occur with the loss of zooplankton and fish through entrainment, and access to tributaries for spawning. Mitigation resources for fish loss should be used to continue to identify the contribution of wild origin fish to the lake and understand immigration timing and size from fish entraining from Canadian reservoirs and entering Lake Roosevelt. Additionally, fish and zooplankton entrainment at Grand Coulee Dam should be quantified to determine impacts. Mitigation should not include the addition of more hatchery origin fish unless future studies on Lake Roosevelt find recruitment success for localized stocks and releases.

II. Introduction

Kokanee supplementation efforts have been ongoing on Lake Roosevelt since the late 1980's with little success. The artificial production program has worked closely with research biologists to design and implement studies to test alternative stocking strategies including size at release, release timing, rearing differences (net pen vs. direct releases), release locations, and different stock origin releases.

Historic and current studies have reported few hatchery origin kokanee (adipose fin clipped) in the creel (Lee personal communication)[1] and the majority of the limited escapement to the hatchery facility and spawning tributaries were precocious yearlings or 2-year old adults (McLellan et al. 2004). Wild origin kokanee (no fin clips) have been reported in the creel in much higher proportions than hatchery kokanee. Three wild origin stocks have been identified as contributors to the Lake Roosevelt fishery, the San Poil River Stock, and two stocks from the upper Columbia River in Canadian waters (Norns Creek in the Arrow Lakes and Meadow Creek in Kootenay Lake) (Kassler and Loxterman 2006). Due to the success of the Canadian stock kokanee in Lake

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1 A weeklong winter test fishery on Lake Roosevelt from 2002 through 2005 yielded an average of only 13.6% hatchery origin (n = 17) fish caught; the remaining fish were from a wild origin (n = 125) (Spokane Tribe of Indians (STI), unpublished data). A genetic study conducted by the Lake Roosevelt Fishery Evaluation Program indicated that the majority of unmarked kokanee in Lake Roosevelt were comprised of San Poil River and upper Columbia River stocks, indicating immigration from Canada (Loxterman and Young, Washington Department of Fish and Wildlife (WDFW) unpublished data). This study indicated that the greater part of unmarked kokanee was not from wild produced hatchery origin fish and that kokanee immigration occurs from Canadian waters, probably due to entrainment from the Kootenay and/or Arrow Lakes.

Roosevelt, understanding kokanee immigration is important and may alter Lake Roosevelt hatchery strategies to mimic time, size, and location of release.

In 2004, former governor Gary Locke unveiled the Columbia River Initiative (CRI; later referred to as the Columbia River Water Management Program (CRWMP)), a plan for a new water management program for the Columbia River (WSDOE 2004). The plan was designed to issue new water rights while improving river flows for fish populations. As a result of the CRWMP, water would be withdrawn from Lake Roosevelt by an additional 0.3 m (one foot) for downstream water demands (see the Study Area section for definition of normal drawdown regimes). The effects of the proposed drawdown on the benthic and littoral aquatic community are unknown.

The effects of the drawdown on shoreline-spawning adult kokanee have been a concern of biologists in the past; however, Lake Roosevelt researchers have concluded that shoreline spawning is minimal to absent, and if it exists, does not produce a significant number of recruits to the fishery (Jason McLellan and Chris Donley, WDFW Biologists and Chuck Lee, STI, personal communication)[2]. The above information leads WDFW to conclude that shoreline spawning does not exist in high enough densities to be affected by an additional one-foot drawdown on Lake Roosevelt.

However, loss of water equates to loss of freely suspended zooplankton, the primary food source for limnetic fish species such as kokanee (Baldwin and Polacek 2002; Polacek and Shipley 2006). WDFW is concerned that the drawdown will cause loss of secondary production, and therefore fish, from the lake through entrainment.

Mitigation for the loss of fish through artificial production is an option; however, success of these programs is low, so stocking additional hatchery kokanee in Lake Roosevelt will have little to no impact on the fishery. The substantial portion of non-hatchery kokanee in the Lake Roosevelt fishery needs to be examined to determine the contribution of immigrant kokanee to the fish community.

The objective of this project was to understand the timing and size distribution of kokanee entering Lake Roosevelt from upstream waters of Canada and Idaho. Since wild origin upriver kokanee are more successful than hatchery kokanee in Lake Roosevelt, results from this study could heavily impact the current hatchery release practices to mimic immigration timing and size, ultimately maximizing recruitment of kokanee to the creel and escapement to egg collection facilities.

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[2] Lakewide kokanee collection efforts by Eastern Washington University (EWU) from 1999 through 2004 have yielded no spawning kokanee over shoreline habitats. Additionally, during fall walleye (*Sander vitreus*) recapture events by EWU from 1997 through 2001, no shoreline spawning kokanee were observed (Jason McLellan, personal communication). STI fall littoral gill netting and electrofishing surveys conducted for the past several years have recorded few individual adult kokanee in Lake Roosevelt (Lee et al. 2003). On Banks Lake, WA, shoreline-spawning congregations of kokanee are sampled in the fall (Polacek and Shipley 2005) using the same sampling protocol used by Lake Roosevelt biologists.

III. Study Area

Franklin D. Roosevelt Lake (Lake Roosevelt) is a Columbia River reservoir created in 1941 by the construction of Grand Coulee Dam (GCD) at river kilometer 960 (Figure 1). The reservoir covers approximately 33,000 ha at a full pool elevation of 393 m (1,290 ft) above mean sea level and is managed as a National Recreation Area by the National Park Service. The dam was built for hydropower generation, flood control, and water storage for irrigation in the Columbia Basin Reclamation Project. The 10-year mean (1990-1999) drawdown was 12 m with a maximum drawdown of 24 m occurring in 1997 (DART 2007) and daily fluctuations in elevation are common (Figure 2). The reservoir reaches 241 km upstream from GCD, is generally 1-3 km wide, and has a maximum depth of 122 m. Water retention times are short (12-80 days) and the zooplankton community is more typical of a large river than a lake or reservoir (Black et al. 2003). Annual flows range from 60,000 to 130,000 cfs (DART 2007) depending on season and accumulative snow pack in the winter months (causing spring run-off) (Figure 3).

The study area was located at the Little Dalles and an area near China Bend of the Columbia River, approximately 12 miles south of the U.S. and Canadian border (Figure 4). The Little Dalles is a confined, narrow canyon (~100 m wide), experiencing depths greater than 50 m and discharge up to 8,500 m^3/s (Figure 3). Water levels in the Little Dalles can drop up to 8 m or greater as water elevations of Lake Roosevelt decrease in the spring for flood control.

IV. Planning and Implementation

In 2006, the WDFW received funds from the Washington Department of Ecology (Ecology) to implement a trapping study above Lake Roosevelt to evaluate the timing and size of kokanee immigrating from upstream waters (Project #06-1262-05). The contract began in May 2006; however, May through September was spent obtaining permits, logistical planning and trap removal, transport, and placement.

The first month (September 2006) of “on the ground” work was spent removing the screw trap from outlets below Moses Lake and transporting the disassembled pieces to Kettle Falls. Once in Kettle Falls, the trap was assembled and towed for 4.5 hours up the lake to just south of the sampling site. Repairs were made to the trap before its placement in the Little Dalles section of the upper Columbia River.

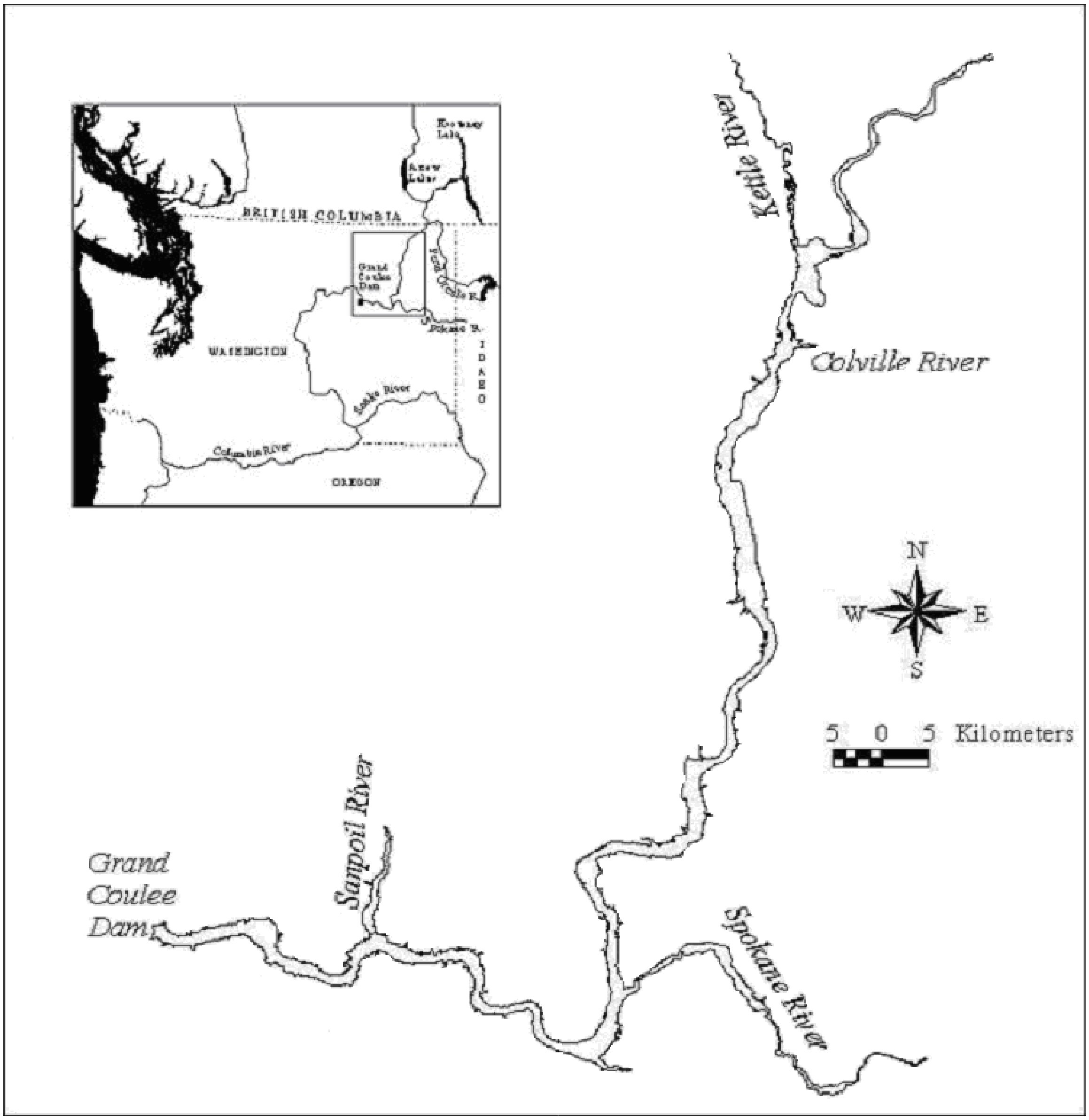

Figure 1. Map of Lake Roosevelt and its relative location in Washington State.

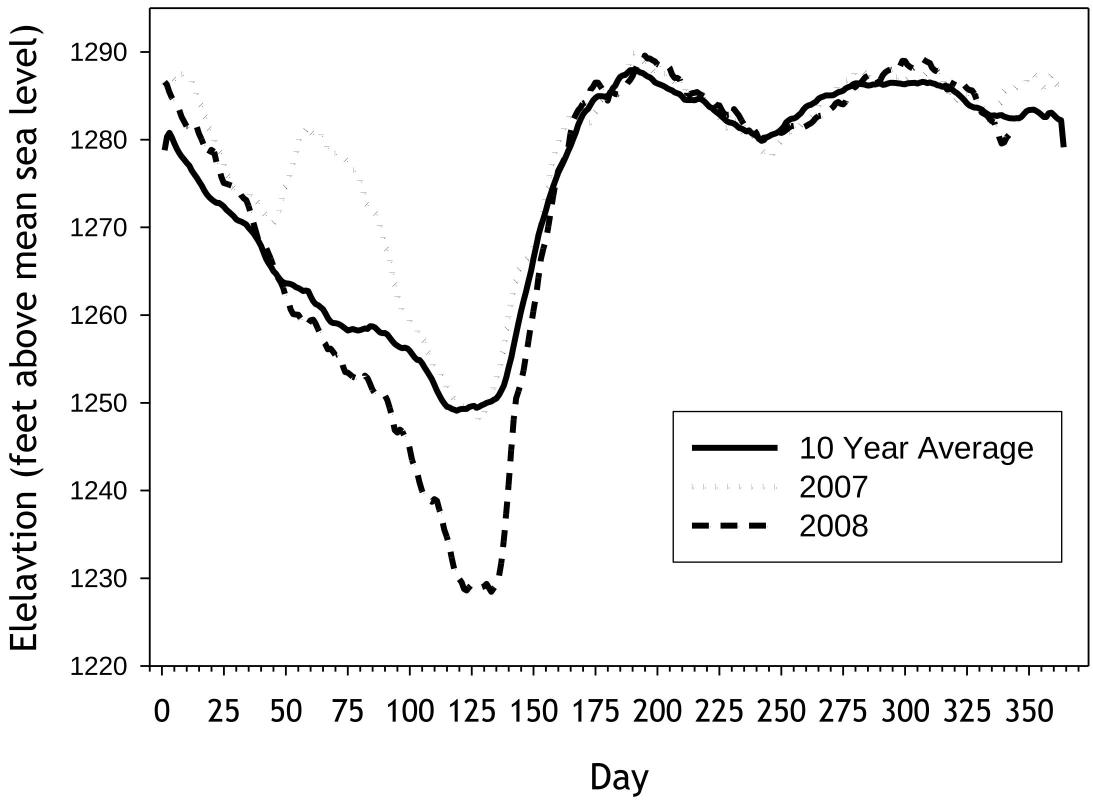

Figure 2. The annual mean water elevation at Grand Coulee Dam at Lake Roosevelt, Washington for 2007, 2008, and the 10-year average. http://www.cbr.washington.edu/dart/dart.html

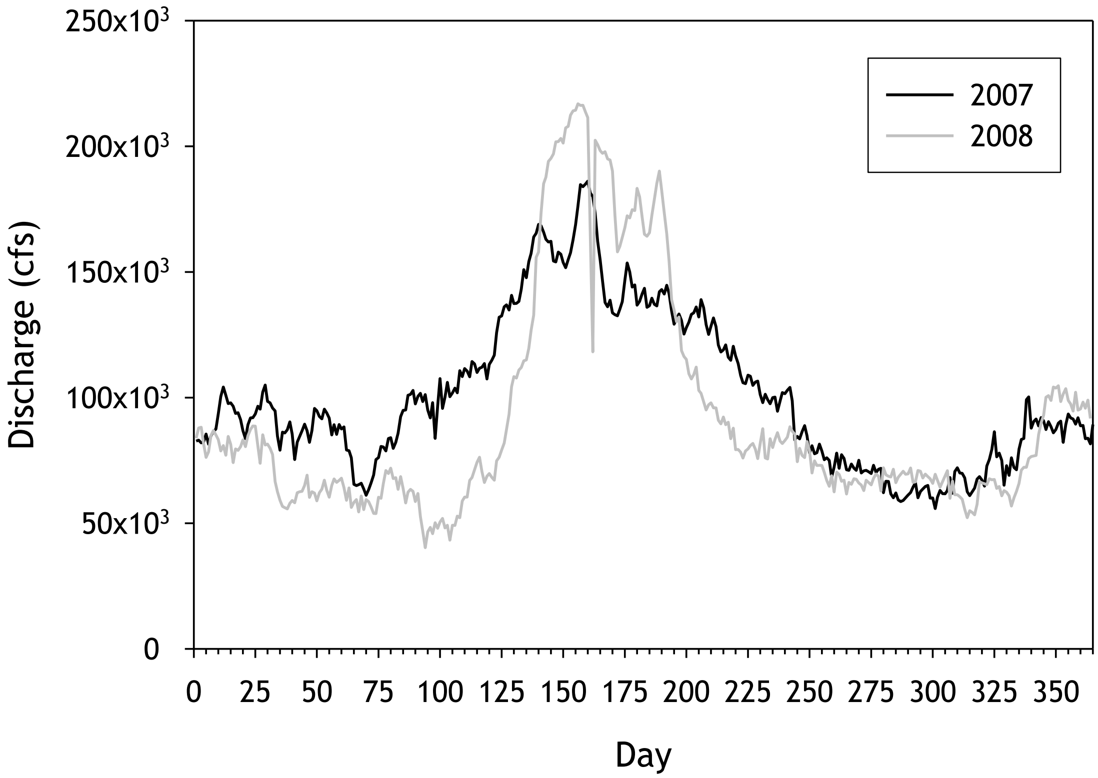

Figure 3. Daily mean discharge of the Columbia River at the United States and Canadian border for 2007 and 2008.
http://www.cbr.washington.edu/dart/dart.html

Figure 4. Map of the Columbia River Basin and location where screw trapping occurred (indicated by the arrow).
http://www.nwd-wc.usace.army.mil/report/colmap.htm

V. Methods

Two 2.4 m (8-foot) screw traps housed on 9.8 X 4.6 m (32 X 15 foot) pontoons were used to sample fish entering Lake Roosevelt from upstream reservoirs (Figure 5). The traps were secured to a large floating drum near the China Bend section of the Columbia River, approximately 22.5 river kilometers south of the United States/Canada border (Figure 6). The traps sampled the top 1.2 m of the water column, which equated to a total sample area of 2.323 m^2 for each trap. The trap was checked by boat in the morning and evening each day.

Captured fish were identified to species, measured and weighed, fin clipped to identify recaptures, and released. Capture efficiency tests were conducted (when at least 10 fish were captured) at different flow regimes to determine the proportion of fish sampled by the trapping gear. Fish were fin clipped and released both directly in front of the trap and approximately 200 meters above the trap, and recaptures were recorded as a ratio of total marked to total recaptured.

Total catch and flows were stratified and analyzed in one-week blocks to reduce the chance of over estimating species-specific temporal catch. During trap checks, triplicate water velocity measurements (m/s) were taken at the opening of the trap to calculate the volume of water sampled (m^3/s), and a laser range finder was used to measure the wetted width of the river. Volumetric expansion (from the surface to 1.2 m) was used to estimate the total number of fish that passed by the trapping site where,

$$E_t = \frac{Nc_t}{\left(\frac{Nv_t}{Qt_t}\right)}$$

E_t = the number of fish passing by the trapping site at time (t),
Nc_t = the number of each species caught in the trap at time (t),
Nv_t = the volume (m^3/sec) of water sampled by the trap at time (t), and
Qt_t = the total discharge (m^3/sec) at the trapping site at time (t).

The ratio of fish captured for the given volume of water (fish density) sampled will be reported for each species for comparisons with other trapping projects, where,

$$F/V = \frac{Nc_t}{Nv_t}$$

F/V = Fish species versus water volume ratio,
Nc_t = the number of each species caught in the trap at time (t), and
Nv_t = the volume (m^3/sec) of water sampled by the trap at time (t).

Figure 5. The screw traps were located approximately 3.2 kilometers north (upstream) of the China Bend boat launch on the upper Columbia River, Washington.

Figure 6. The two 8-foot screw traps used to sample fish moving downstream in the Upper Columbia River, approximately 22.5 kilometers south of the United States/Canada border.

VI. Results

We began fishing the trap on October 23, 2006, and fish were captured within minutes of deployment. Since the beginning of trapping through September 2008, the trap(s) have fished for 9,753 hours and sampled a total of 87,517,540 m^3 of water, resulting in a total catch of 1,895 fish; comprised of 479 bluegill, 437 sucker *spp.*, 360 speckled dace, 351 northern pikeminnow, 110 rainbow trout, 65 sculpin, 34 kokanee, and 104 individuals of other species (Table 1). Catch of bluegill over time showed a bi-modal distribution, with peaks in weeks 3 (November 6-8, 2006) and 48 (October 9-11, 2007). Catch for northern pikeminnow was relatively consistent with a spike in week 92 (July 28-August 1, 2008), while the catch of speckled dace peaked in week 25 (April 9-12, 2007) (Figure 7). The catch of suckers increased dramatically in week 96, with 319 individuals captured in a three-day period (August 26-28, 2008). Total catch was the highest in August 2008 (n = 423), April 2007 (n = 210), and November 2006 (n = 201), and lowest in May 2008 with 2 fish captured (Figure 8).

Fish densities were computed to fish per 1,000,000 m^3 of water for comparisons to other trapping projects. Density estimates were dependent on total catch, resulting in bluegill (5.13/1 million m^{-3}), sucker spp. (4.18 1 million m^{-3}), northern pike minnow (3.39 1 million m^{-3}), and speckled dace (3.83 1 million m^{-3}), representing the highest fish densities. Kokanee density was 0.36/1 million m^{-3} of water (Table 2).

The screw trap sampled 1.0% to 1.5% of the top 1.2 meters of water at the sampling locations in the Little Dalles and China Bend. Volumetric expansion resulted in an estimate of 188,612 fish that passed the sampling site in the top 1.22 meters of water from October 13, 2006 to September 30, 2008. This is a rough estimate since the traps were fixed in one location and fish movements may have been higher or lower in different areas of the river. Volumetric estimates representing total discharge was not extrapolated since sampling did not exceed 1.2 meters from the surface. We estimated that 4,077 kokanee passed the trapping site in the top 1.2 meters, which equated to 4% of a kokanee release that occurred in Onion Creek in May 2007 (approximately 1.6 to 2.4 kilometers upriver of the trapping location).

Fish movement was most likely due to operations at upper river dams and hatch timing for juvenile fishes. Using linear regression analysis we looked for correlations between monthly catch and three parameters: water temperature, discharge, and surface elevation. No strong correlations existed and none of the tests indicated a significant relationship at the 95% confidence level ($P \leq 0.05$). It is worth noting, however, that catch vs. temperature indicated the closest positive correlation, with a near significance value of P = 0.07) (Figure 9). This parameter is most closely correlated due to the relationship between temperature and fish egg development/hatching.

Table 1. The number, frequency, and mean length (mm) for each fish species captured in the screw trap(s) on the upper Columbia River, WA, from October 13, 2006 through September 30, 2008.

Species	**Number Caught**	**Frequency (%)**	**Mean Length (mm)**
Black Crappie	1	0.1	--
Bluegill	480	24.5	35
Bridgelip Sucker	7	0.4	69
Carp	3	0.2	
Chiselmouth	4	0.2	49
Kokanee	34	1.7	218
Largemouth Bass	3	0.2	70
Longnose Dace	11	0.6	51
Longnose Sucker	43	2.2	259
Northern Pikeminnow	353	18.0	48
Other (non identified)	30	1.5	--
Peamouth	17	0.9	39
Rainbow Trout	116	5.9	71
Redside Shiner	16	0.8	58
Sculpin	65	3.3	41
Smallmouth Bass	4	0.2	52
Speckled Dace	367	18.8	57
Suckers (other)	387	19.8	44
Tench	2	0.1	41
Walleye	6	0.3	273
Yellow Perch	7	0.4	89
Totals	**1,956**	**1.0**	**63**

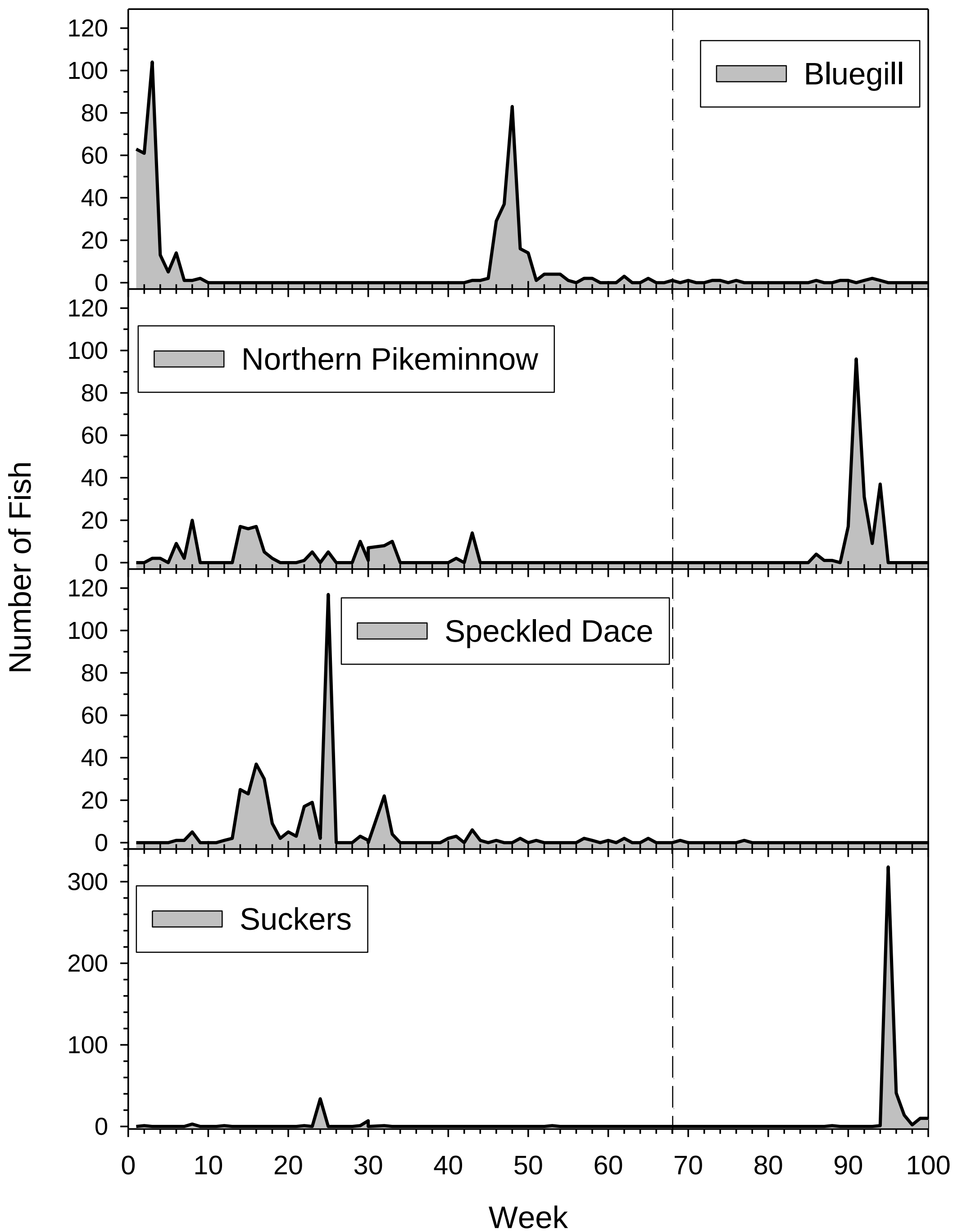

Figure 7. The total catch of bluegill, northern pikeminnow, speckled dace, and sucker *spp*. (the most common captured species) for each sampling week from October 13, 2006 through September 30, 2008 on the upper Columbia River, 12 miles south of the United States/Canada border. The dashed line represents the week when both traps were placed near China Bend.

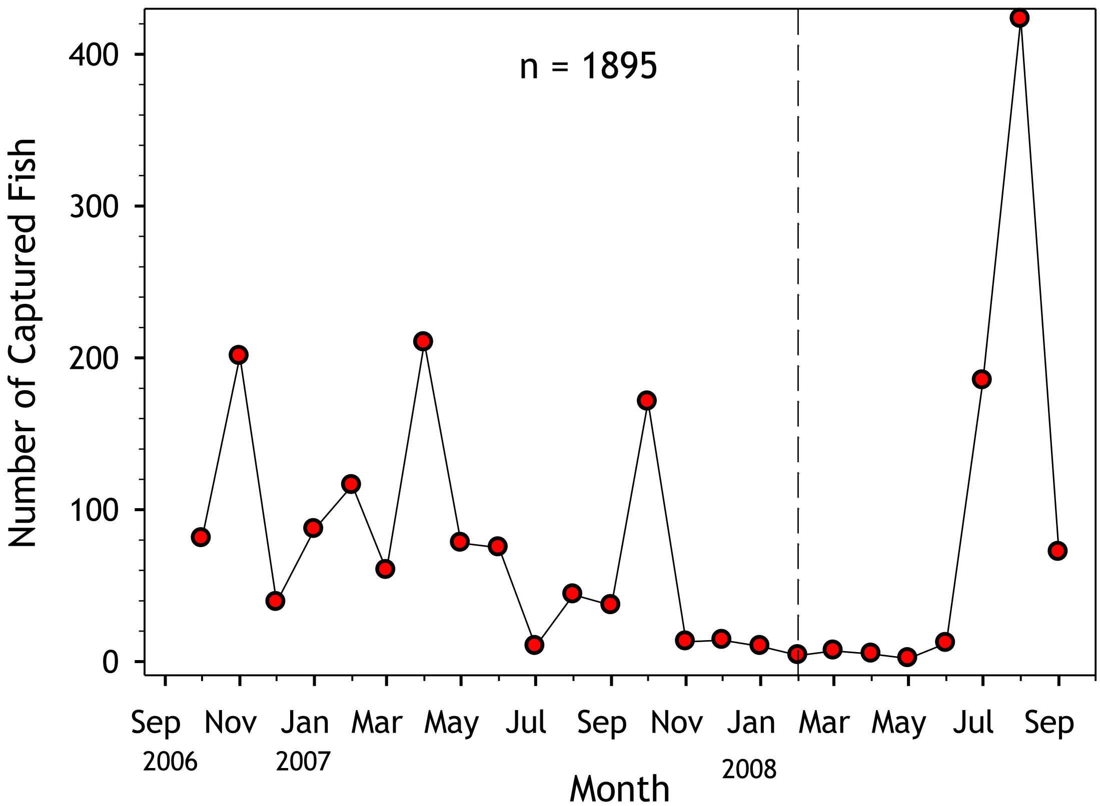

Figure 8. The number fish captured with the screw trap(s) for each month of sampling from October 24, 2006 to September 30, 2008, in the upper Columbia River, Washington. The dashed line represents the week when both traps were placed near China Bend.

Table 2. The density (fish/1,000,000 m3) of each species collected in the top 1.22 meters (4 feet) of water in the upper Columbia River (12 miles south of the United States/Canada border). Density is a ratio of catch to the total volume of water sampled by the trap.

Species	**Density (fish/1,000,000 m^3)**
Black crappie	0.01
Blue gill	5.13
Bridgelip sucker	0.08
Carp	0.00
Chiselmouth	0.04
Sculpin	0.72
Kokanee	0.36
Largemouth bass	0.03
Longnose dace	0.01
Longnose sucker	0.46
Northern pikeminnow	3.39
Peamouth	0.18
Rainbow trout	1.22
Redside shiner	0.17
Speckled dace	3.83
Smallmouth bass	0.04
Sucker (unidentified)	4.18
Walleye	0.06
Yellow perch	0.08
Grand Total	**20.39**

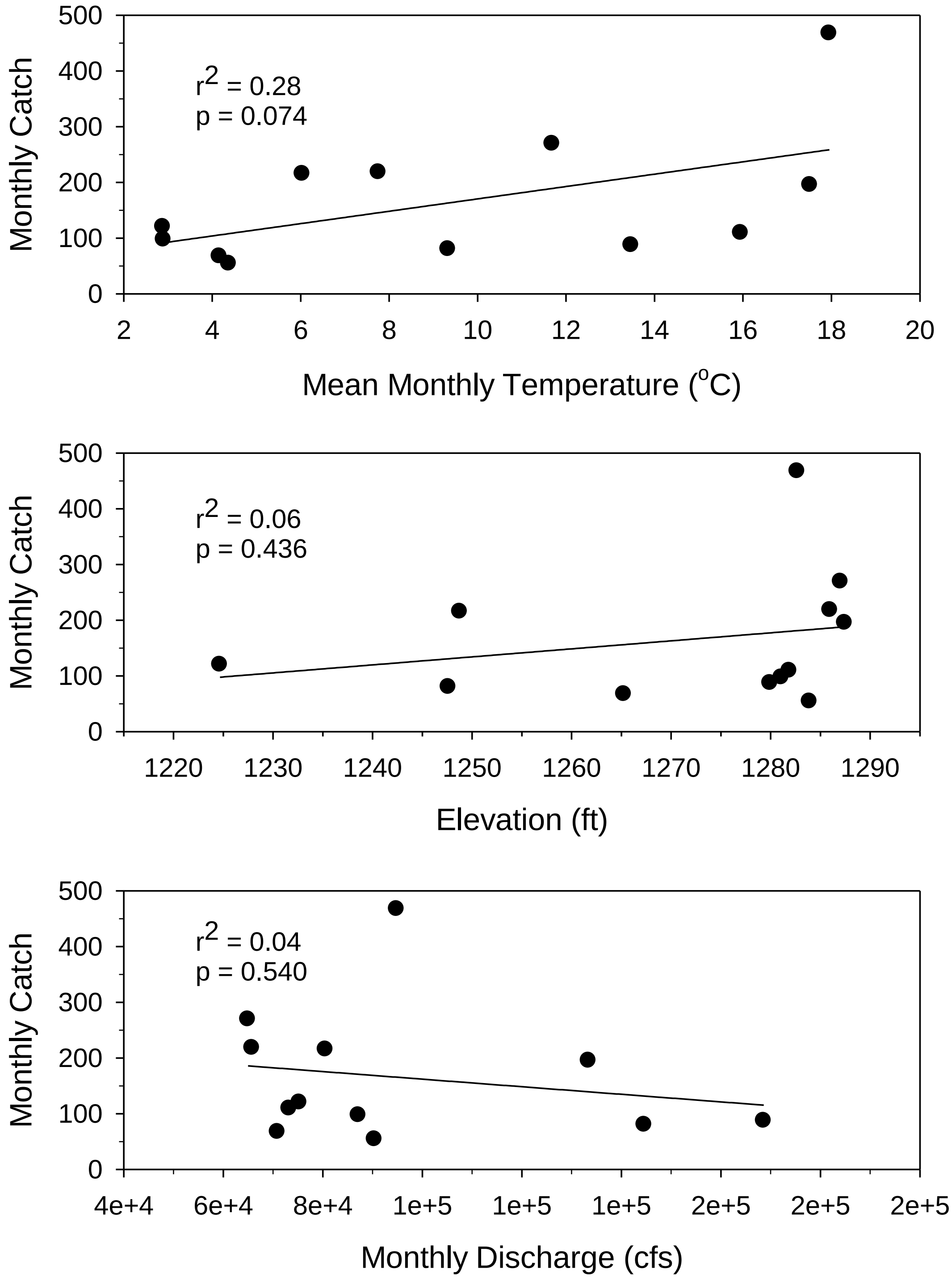

Figure 9. Regression analysis results for monthly catch versus temperature, elevation, and discharge for the screw-trapping project on the upper Columbia River, Washington.

VII. Discussion

Mechanical problems halted sampling for more than three weeks in early December 2006. The main shaft extending through the cone that attaches the cone to the frame via a pillow block shattered. We ordered another shaft and transported a welder and gear via a boat to the trap for repairs. A second gear failure occurred on 6/18/2007 when the entire frame snapped, causing extensive trap damage. Budgetary constraints limited our ability to repair the trap until 9/17/2007. A 1.5 x 1.5 meter trawl net was fished from behind the trap until the trap was fixed. The net sampled the same volume of water as the screw trap and was fished from the surface to 1.5 meters deep. In order to repair the screw trap, we ordered a new cone, live box, and wear sleeve, and hired Kaiser Welding to build a new support frame. The trap was disassembled and re-assembled in Kettle Falls (September 14, 2007). One week later, the trap was towed back to the trapping location and deployed.

In December 2007, a second screw trap was built by Kaiser Welding, assembled on the lake on February 4, 2007, and towed to the Little Dalles section of the river. Since access to the traps during low elevations was too dangerous, we moved both traps downstream and fastened them to a large drum at the log collection facility near China Bend (Figure 1). This location represented a wide area of the river with a mean depth of approximately 15 meters. Although total catch at this location was initially lower, we believed that this location was more conducive for capturing kokanee.

The primary objective of this project was to sample the kokanee that enter Lake Roosevelt from upstream reservoirs such as the Kootenay and Arrow Lakes. Since a portion of wild stock kokanee were found to be from Canadian lakes (Kassler and Loxterman 2006) and are successful in Lake Roosevelt, it was of interest to local biologists and hatchery managers to understand the time and size when fish move downstream (most likely entrained from Keenleyside Dam) into the lake. We captured kokanee during the study period; however, these fish were of hatchery origin as a result of plants in Onion Creek, approximately one mile upstream from the study site. Only two wild kokanee were collected. This could be attributed to several factors: 1) kokanee densities were too low to detect by trapping, 2) kokanee did not follow the currents sampled by the trap, 3) kokanee traveled deeper than 1.2 m (the maximum sampling depth of the screw trap), and/or 4) relative to historic numbers, few kokanee entrained from upriver reservoirs during the study period.

Fish density was extrapolated across the top 1.2 meters of the river to estimate the number fish passing the trap(s). On average, the traps sampled 1.0% to 1.5% of the top 1.2 meters of water and approximately 0.08% of the total water volume in the river channel. Assuming homogenous fish distribution (vertically and horizontally) and expanding fish densities to the total unsampled water volume yields much higher estimates of fish passing the trapping site. For example, estimates for kokanee are nearly 51,000, which equates to almost 51% of the kokanee released near Onion Creek. This estimate seems plausible, as we know that kokanee can hold for extended periods just south of the Little Dalles canyon and predation on kokanee by walleye exists in this section of the river (Baldwin et al. 2003), equating to an unknown rate of mortality before reaching the trapping site. Future studies should utilize a fixed hydroacoustic array to determine spatial and temporal fish locations in the water column and provide the evidence for homogenous fish distribution.

Total catch varied by species and timing, and was not consistent between the two years. Species such as bluegill and speckled dace were captured when the trap was placed in the Little Dalles section of the river (against the cliffs), but not captured when the traps were moved to the middle of the river at China Bend. In contrast, the catch of northern pikeminnow and sucker *spp*. increased when the traps were moved to China Bend. This could be a spatial effect due to trap placement or a temporal effect where species composition and abundance varied year to year. Long-term trap placement at China Bend would allow us to accept or reject the spatial effect theory. Reducing the variation of temporal catch of specific species would occur with multiple years of trapping.

Trap efficiency testing was not conducted on a regular basis due to low instantaneous catch rates and logistic restraints. Future studies should work with local fish hatcheries to obtain fish for efficiency testing. Predatory impacts during efficiency testing should be considered in future trapping studies in this section of the river.

Data collection projects on large lotic systems can be problematic, leading to periods when sampling cannot be conducted. During this project period, we experienced various issues that made our trapping efforts difficult. Large logs and woody debris are common when water elevations increase in the spring and can damage traps upon impact. The high and turbulent water velocities that occur in the early spring can cause high cone revolution rates, thus damaging the trap. This study should be treated as a pilot project for future attempts to operate screw traps in the upper Columbia River.

VIII. Acknowledgements

We would like to thank the Washington State Department of Ecology for funding this project as part of the Columbia River Water Management Program (CRWMP). We greatly appreciate the help of Eric Weatherman and crew of Columbia Navigation for donating their time and equipment to help assemble the screw trap. We thank Mitch Combs (WDFW) for logistical support, and the project technicians Aulin Smith, Kevin Vaillancourt, Josh Rogala, Josh McLellan, Fritz Wichterman, and Greg Rodman for operating the trap and collecting the data used in this report. We acknowledge Josh Harmon for his help during trap deployment and for conducting welding repair. Lastly, we thank the Bruner family for providing lodging, storage, and land access to the trapping site.

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