

Monitoring Aquatic Macro-Invertebrates to Assess Stream Health
Lake Creek Lodge Restoration Project, Deschutes River Basin, Oregon

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Introduction

Euro-American settlement in the western US has contributed to substantial aquatic/riverine habitat modification. Hydroelectric dams constructed for energy production created vast irrigation impoundments, transforming many Pacific Northwest rivers from raging torrents hosting numerous anadromous fish populations to placid chains-of-lakes struggling to support remaining migratory fish runs. Although western river modification has provided critical resources for human populations, anthropogenic influences of these actions have had significant ecological impacts on aquatic ecosystem structure and function. Pre-dam Columbia River and its tributaries historically hosted all five species of Pacific salmon: Coho, Chinook, Sockeye, Pink, and Chum in addition to Steelhead trout (*Oncorhynchus mykiss iridis*). Prior to Euro-American settlement, estimates of anadromous fish migration into the Columbia River Basin are as high as sixteen million individuals per year (Ambrose 1996). In 2006, approximately 1.6 million anadromous fish passed through Bonneville Dam, the first in a series of thirteen dams on the mainstem Columbia and Snake Rivers (ACE 2007). Only six Pink and 121 Chum salmon migrated above Bonneville Dam in 2006 (ACE 2007).

The Deschutes River and its tributaries are important spawning and rearing habitat for Columbia River anadromous fish. The Pelton/Round Butte Hydroelectric Dam Complex on the Deschutes River eliminated anadromous fish passage to the Upper Deschutes Basin and its tributaries, including Lake Creek, by the early 1960's. These species are extirpated from the Upper Deschutes Basin.

The Pelton/Round Butte Dam Complex fifty-year license came due for renewal in 2003. The relicensing process creates opportunities to implement a wide variety of programs that benefit fish, wildlife, and recreation as well as preserving history and native culture (PGE 2006). Determining the appropriate balance among various interests is challenging and in some instances leads to conflicts or lengthy court battles with outcomes that may satisfy no one (PGE 2006).

The Pelton/Round Butte Dam Complex owners [currently, two-thirds owned by Portland General Electric (PGE), headquartered in Portland, OR, and one-third owned by the Confederated Tribes of the Warm Springs Reservation of Oregon (CTWS)] and a wide variety of government and non-government organizations representing various stakeholders chose to take a collaborative approach. The stakeholders reached agreement on the future operating conditions, long-term resource protection, mitigation, and enhancement measures as related to Upper Deschutes Basin anadromous fish reintroduction plans. After 19 months of dialogue, an unprecedented 22 organizations signed the relicensing accord on July 13, 2004 (PGE 2006). As part of the agreement, significant funding was made available for restoration projects within the Upper Deschutes Basin in preparation of reintroduction efforts of anadromous fish in 2008.

Lake Creek Lodge is a private property on lower Lake Creek near Camp Sherman,

OR surrounded by Deschutes National Forest. Before the Pelton/Round Butte dams blocked fish passage, both Chinook and Sockeye salmon migrated from the Columbia up the Deschutes into the Metolius River. Many of these Chinook spawned in Lake Creek and in the Metolius River near Lake Creek. Sockeye continued their migration up Lake Creek to Suttle Lake, where they spawned in the lake and in Link Creek, a small tributary. Lake Creek spans six miles between Suttle Lake and the Metolius River, therefore, each reach along this short tributary is important in sustaining local fisheries (UDWC 2006). Moreover, Forest Service land adjacent to upper Lake Creek is important Elk (*Cervus elaphus*) winter range and birthing habitat (Allen personal comm.).

Lake Creek is currently violating the Federal Clean Water Act (1977) and is subsequently listed as a 303(d) impaired waterway mainly due to unnaturally high water temperatures and reduced dissolved oxygen levels (UDWC 2006). A restored Lake Creek can provide important spawning/rearing habitat and act as a transportation corridor for reintroduced anadromous fish in addition to providing high quality conditions for resident Salmonidae like endemic Redband rainbow trout (*Oncorhynchus mykiss gairdneri*) and ESA-listed Bull trout (*Salvelinus confluentus*).

Since the 1930's, a large diversion pond flanked with concrete and rock retaining walls dominated the Lake Creek Lodge reach. The creek's main channel was straightened and moved to the side of the pond. In 2004, the Upper Deschutes Watershed Council, headquartered in Bend, OR, entered into a partnership with Lake Creek Lodge, Deschutes National Forest, and the US Forest Service to restore fish and wildlife habitat by replacing the retaining walls and pond with a more natural stream channel (LCL 2007). The Lake Creek Lodge Restoration Project includes 725 feet of stream channel

restoration. The project was completed in late winter of 2007.

Monitoring protocol of the project's effectiveness addressing Lake Creek's potential for hosting viable populations of reintroduced anadromous fish includes annual macro-invertebrate sampling and identification. Macro-invertebrates are aquatic insects that are visible without a microscope. Aquatic insects are numerous, have short life cycles, and are directly affected by changes in water chemistry and flow. These factors coupled with the relative ease of sampling, makes macro-invertebrates excellent indicators of aquatic ecosystem health. There is also more species diversity in aquatic insect communities than more highly visible organisms such as fish. A change in aquatic insect species composition is relatively easy to detect and can be used to assess stream decline or recovery (NPS 2003).

This document presents our methods, results, and discussion points regarding the 2007 macro-invertebrate sampling at the Lake Creek Restoration Project site.

Methods

Sampling Protocol. Our data will be used in watershed management and restoration. Therefore, we implemented tested and standardized procedures that will ensure our data fits the needs of this project and is comparable with similar sites and projects. The methods used by the Oregon Department of Environmental Quality (DEQ) and Washington (state) Department of Ecology (DOE) have developed parallel with the protocols used by the Federal Environmental Protection Agency (EPA), allowing for broad comparability and use of macro-invertebrate data in the Pacific Northwest (Adams 2004). We followed the step-by-step macro-invertebrate collection protocol used by Oregon DEQ. Our study was based on the Xerces Society's "Stream bugs as

biomonitors: Guide to Pacific Northwest macro-invertebrate monitoring and identification.”

Xerces recommends monitoring macro-invertebrates in late summer (July 15-September 30), when aquatic insects are most restricted in their habitat and most stressed by any unfavorable stream conditions (Adams 2004). Oregon DEQ scientists examining data from spring, early summer, and late summer samples found that at the same sites, only the late summer collections clearly differentiated between impacted and unimpacted sites (Adams 2004). We sampled Lake Creek on June 28, 2007. Although our date was slightly early in the sampling season, stream conditions in Lake Creek at that time are similar to conditions later in summer (Shinderman personal comm.).

Study Sites. We sampled six sites within the Lake Creek Lodge reach (two of which were double sampled) in addition to one site upstream and one site downstream of the project area for a total of ten collections. Sampling occurred in shallow, fast riffles approximately one to two feet deep. Riffles are prime habitat for macro-invertebrates as they are well oxygenated and usually cooler than shallow pools and runs. Individual riffle sample sites were determined by Matt Shinderman, PhD of Oregon State University.

Sampling. Each riffle was delineated into nine grids. We randomly selected one grid within each riffle to sample. In double sampled riffles, target grids were predetermined to avoid collecting in grids directly adjacent to one another.

A 500-um D-frame kicknet was used to collect samples. The kicknet was stabilized just downstream from the target grid. Large cobble rocks within one foot upstream of the kicknet were hand scoured to collect insects fastened to cobble substrate. After which,

we disturbed remaining substrate with our boots to four inch depth. The contents of the kicknets were then emptied into plastic tubs (approximately 30" x 20") and covered in several inches of water. Kicknets were thoroughly rinsed and inspected to ensure complete collection of the sample. Using a magnifying glass, large macro-invertebrate-free vegetation and debris was removed and the remaining sample was filtered through a 500-um sieve. We stored the samples in 32 ounce Nalgene bottles, labeled, and preserved with 95% alcohol solution. When we returned to the lab, the Nalgene bottles were dumped into a large plastic tray, and water was added. Contents were swished to suspend invertebrates, and then the water was poured through the soil sieve, leaving rocks and other heavy debris behind. The decanting was repeated a total of ten times, and then the debris left behind was discarded and invertebrates were stored in alcohol.

Sub-Sampling. Due to the vast amount of sample material, which included large quantities of fine vegetation and pebbles, we sub-sampled our collection. A wooden-framed sampling tray (15" x 12.5") covered with a wire screen and fine mesh for filtering was implemented. Within the sub-sampling tray, a grid was outlined in 2.5" squares and numbered accordingly. The project reach samples were then poured into the sub-sampling tray and evenly dispersed over the tray screen through water action. A random number was generated to correspond to individual squares in the sub-sampling tray. The randomly selected square material was removed from the sub-sampling tray and placed in Petri dishes for sorting and identification using tweezers, dissecting microscopes, and the Xerces Society's guide to macro-invertebrate species identification book. Unused samples were labeled, preserved, and stored for future study. Samples from the upstream and downstream off-project sites were not analyzed due to time constraints and will be

processed at a later date.

We divided identified and sorted macro-invertebrates into four orders: Ephemeroptera (mayflies), Tricoptera (caddis flies), Plecoptera (stoneflies), and “other” (order Coleoptera and various worms). Each order was separated and stored in capped test tubes filled with 95% alcohol solution. We stopped our inventory at 500 individual macro-invertebrates, as this is a widely accepted sample size (EPA 2002).

Results

We chose to focus our attention on Ephemeroptera (E), Tricoptera (T), and Plecoptera (P) orders because of their sensitivity to stream conditions and viability to act as stream health indicators. The Others (O) inventory can be useful in determining the ratio of sensitive macro-invertebrates (E, T, P) with more tolerant species (O).

Out of 502 individual macro-invertebrates identified from the project reach samples, E comprised 24.7% (124/502), T 13.3% (67/502), P 6.6% (33/502), and O 55.4% (278/502). In other words, sensitive species composed 44.6% of samples and tolerant species 55.4%.

Discussion

Standing alone, our results do not determine if Lake Creek Lodge’s restoration project has influenced the stream’s decline or recovery. Consequently, comparison of our data to baseline data prior to restoration may show if the restoration project has increased the population ratio of sensitive macro-invertebrate species to tolerant species indicating Lake Creek is may be recovering. Data from pre-restoration samples taken within the Lake Creek Lodge reach on September 6, 2006 showed E, P, and T comprised 22.6% (102/451) and O the remaining 77.4% (349/451) (Orr personal comm.).

Comparing pre- and post-restoration data sets reveal that sensitive macro-invertebrates have increased substantially in the months since the project was completed. However, long-term macro-invertebrate monitoring must continue, as this single comparison does not definitively assess the stream's recovery. The September 2006 sampling included multiple collections above and below the Lake Creek Lodge reach (four sites each). We were unable to study and identify macro-invertebrates from our collections at these sites due to time constraints.

Further examination of June 2007 samples is needed as well as a more thorough comparison of the complete data sets. Full comparison may reveal important information. For example, water conditions above and/or below the project reach may have independently improved causing sensitive aquatic species ratios to increase in these reaches. Secondly, the project site may be exhibiting an increase in target species due to abnormal population increases as conditions dramatically improved within the project reach. Sensitive species populations may decline as resources become scarce to a yet to be discovered balance (relaxation effect). A third theory may be the timing of pre- and post-restoration sampling (September vs. June) is affecting population ratios. Fourth, sample comparisons may be more accurate if collected at the same temporal and spatial conditions annually (or more frequently) and over a much longer period (five to ten years). Fifth, a heterogeneous monitoring plan should include direct measurements and comparison of stream chemistry, flows, and turbidity throughout the year to attempt to understand the physiognomy of Lake Creek. Lastly, non-point source influences may be affecting target species community composition. These alternative theories and recommendations need further investigation.

Conclusion

Many aging Pacific Northwest dams are slated for modification or removal in an effort to restore and increase native anadromous fish populations. Most notably are the scheduled removal of two dams on the Elwha River, Olympic Peninsula, WA; two dams on the Sandy River east of Portland, OR; and the dam on Hood River flowing from the north slope of Mount Hood, OR into the Columbia River. All three of these rivers historically hosted robust salmon and steelhead runs. However exciting dam removal and/or modification may be, important restoration work will be needed to ensure success increasing anadromous fish habitat and ultimately their populations.

The Lake Creek Lodge Restoration Project, the planned reintroduction of sea-run fish into the Upper Deschutes Basin, and the unprecedented cooperation shown in the Pelton/Round Butte relicensing agreement may prove to be valuable examples for the Pacific Northwest region.

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