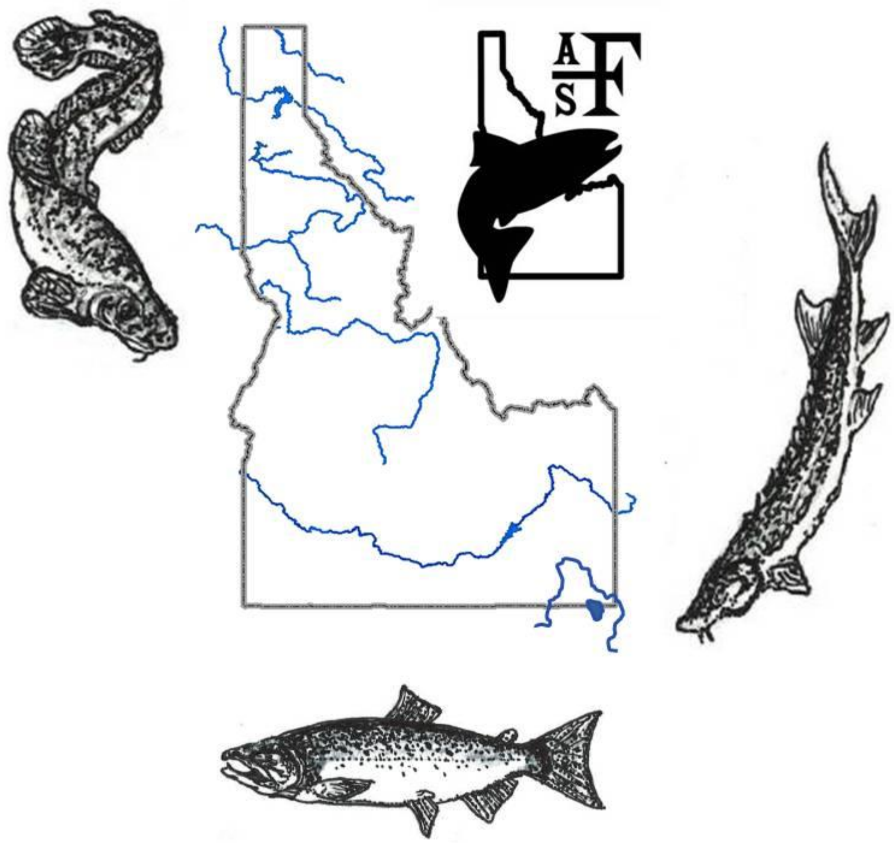
Idaho's large rivers:
History, Management and Restoration



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Abstracts

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Oral Presentation Abstracts (Alphabetized by Presenter)

Movement of Juvenile Burbot Stocked in a Tributary of the Kootenai River

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Burbot *Lota lota* in the lower Kootenai River have been the focus of extensive conservation efforts, particularly conservation aquaculture. Since 2009, approximately 63,000 juvenile Burbot have been released throughout the Kootenai River system. One of the primary release strategies has been small tributary releases. In October of 2012, the Idaho Department of Fish and Game installed a fixed passive integrated transponder (PIT) antenna on Deep Creek, a third order stream and major tributary to the Kootenai River, to evaluate movement of juvenile Burbot to the Kootenai River. Approximately 9,000 juvenile Burbot have been PIT tagged and released into Deep Creek since 2012, but few Burbot have been detected at the antenna. This raises questions about the survival, movement, habitat associations, and species associations of juvenile Burbot in Deep Creek. The objectives of this study were to (1) evaluate survival and movement, and (2) evaluate habitat associations and species associations of Burbot in Deep Creek. Additional fixed PIT tag antennas were installed on Deep Creek in October of 2014 prior to stocking. Fixed PIT tag antennas have detected Burbot and are providing data about movement of juvenile Burbot in the Deep Creek system. Future attempts to answer questions of survival, habitat associations, and species associations will include the use of mobile PIT tag antennas. Results of this study will help to ensure efficient and effective stocking methods, and will have broad application to other small tributaries in the Kootenai River basin.

Exploring responses of salmon to river restoration using simple food chain models

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With the declines of salmon populations, preservation and restoration have become essential practices for their management and conservation. We assume that the recovery of salmon will follow the restoration of freshwater habitat; however numerous examples exist where changes in physical conditions have had unexpected, including negative, consequences for target species. Mechanisms beyond fish-habitat relationships may help explain the response. For example, food web interactions may mediate fish response to changes in physical habitat. In addition, food webs can change without any significant alteration of physical habitat (e.g., species invasions/removals, nutrient addition). Consequently, understanding how fish populations might respond to restoration efforts will require holistic approaches that link the abiotic and biotic compartments of ecosystems. To address this need, we constructed a mechanism-based simulation model that explicitly links the dynamics of stream food webs to the life cycle of salmon, in-stream physical habitat and hydraulic conditions, and the composition of the adjacent riparian zone. Here, we used this model to explore the potential ecosystem response to alternative restoration strategies in a floodplain segment of the Methow River, Washington, a location of on-going restoration efforts aimed at recovering endangered salmon and steelhead populations. In particular, we present modeled runs for three distinctly different restoration strategies: (1) direct alternation of the food web via additions of marine derived nutrients (i.e., salmon carcasses), (2) restoration of riparian vegetation, and (3) reconfiguration of physical habitat, via floodplain reconnection. Finally, we conduct an additional simulation to explore the potential impact on the system of the introduction of an "invasive" fish. These simulations suggest that the system might be sensitive to these restoration alternatives, but that the desired response to river restoration can be easily compromised if the structure of the food web is altered; e.g., by the introduction or spread of invasive species. By mechanistically linking food web dynamics to physical habitat and riparian conditions, our model provides a tractable framework for exploring the potential consequences of different restoration and environmental change scenarios, information that can be used to generate hypotheses, plan field experiments, and ultimately guide river conservation efforts.

Restoration of Patterson Big Springs Creek: A Lesson in Habitat Connectivity for Chinook Salmon (*Oncorhynchus tshawytscha*)

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Patterson Big Springs Creek, a tributary to the Pahsimeroi River, is designated as critical habitat for Snake River spring and summer Chinook salmon (*Oncorhynchus tshawytscha*) and historically supported excellent spawning and rearing habitat for Chinook salmon. However, over the past several decades Chinook salmon access to spawning and rearing habitat has been limited in late summer due to low flows during irrigation season. Conservation efforts have focused on addressing fish entrainment, elimination of fish passage barriers, and restoring flows in the lower reach of Patterson Big Springs Creek. In the summer of 2008, instream flows of 15 to 25 cfs were restored into the lower 5.6 km of Patterson Big Springs Creek with the removal of the PBS-09 cross ditch, which diverted water from Patterson Big Springs Creek to the main stem of the Pahsimeroi River for irrigation uses. Restoring flows into the lower reaches of Patterson Big Springs Creek has provided access into under-utilized Chinook salmon spawning and early rearing habitat. Annual spawning ground and snorkel surveys are being conducted to document Chinook salmon distribution and abundance in Patterson Big Springs Creek. Snorkel surveys first documented juvenile Chinook salmon upstream of the P-09 cross ditch diversion in the summer of 2009. Adult Chinook salmon were initially observed upstream of the P-09 cross ditch diversion in 2008, the first year the diversion was closed. In 2014, a total of 117 adult Chinook salmon redds were documented in the 5.6 km stretch upstream of the P-09 cross ditch diversion yielding an estimated 20.9 redds per km. The story of restoration of Chinook salmon in the Patterson Big Springs Creek is still being told. The ongoing effort is largely due to the collaborative efforts of private landowners, Idaho Department of Fish and Game's (IDFG) Anadromous Fish Screens, Passage, and Habitat Program, along with multiple conservation partners.

Microhabitat Use by Native and Nonnative Fishes in the Kootenai River, Idaho

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The Kootenai River is one of Idaho's most unique and important resources. Like many other large rivers of North America, the Kootenai River and its catchment have undergone extensive water and land use alterations that have had deleterious effects on ecosystem function. The Kootenai Tribe of Idaho has been actively implementing a multi-year habitat rehabilitation program to restore self-sustaining, native wildlife populations. However, additional information is needed to further guide the design of habitat rehabilitation efforts in the Kootenai River. Our objectives were to describe microhabitat use by fishes, describe patterns in fish assemblage structure, and develop and test predictive models of resource use. Prepositioned areal electrofishing devices (A=0.80 m2) were used to sample fishes. Current was applied for 20 seconds following a 30 minute set time. Microhabitat conditions were measured within a 4 m2 area centered on the electrofishing anode. Across 162 sites, 327 fishes were collected representing four families and seven species. Logistic regression and cluster analyses were used to determine habitat associations among fish populations and overall assemblage structure. Results from this study provide information relating to specific habitat conditions selected by fishes in an attempt to maximize the benefit of the habitat rehabilitation program.

Identification of SNP markers for Parentage Based Tagging of Burbot *Lota lota* using restriction-site-associated DNA sequencing

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The trans-boundary (Idaho and Montana, USA and British Columbia, Canada) population of Burbot native to the Kootenai River basin once provide a popular sport and commercial fishery, and is culturally significant to the Kootenai Tribe of Idaho. However, the population has experienced significant declines over the last 30 years, due primarily to habitat loss and alteration caused by water storage and diversion. By the late 1990's, the population was considered functionally extinct, with estimates of fewer than 50 Burbot in the wild and little to no recruitment, prompting an on-going international recovery effort. As part of these recovery efforts, managers have been actively developing a hatchery supplementation program to re-build the population and support future harvest oriented fisheries. While supplementation breeding programs have the potential to rapidly rebuild depleted natural populations, careful genetic management is critical. In order to monitor genetic diversity and potential inbreeding in the broodstock and to provide Parentage Based Tagging of supplementation offspring, we developed a set (N = 93) of highly variable Single Nucleotide Polymorphic (SNP) genetic markers. This subset of 93 SNP markers were developed from a larger suite of 6,517 SNPs that were discovered using Restriction site associated DNA sequencing (RADSeq). This is a relatively new and cost-efficient technology that allows the rapid discovery of thousands of SNP markers in species that have not been extensively studied previously or for which little existing DNA sequence data exists. We demonstrated the accuracy of our SNP set for parentage by running a known parent/offspring dataset (N = 344/313, respectively) through a well-known genetic parentage software program. All 313 offspring accurately assigned to the correct parent pair. The SNP marker set provides a powerful new tool for managing broodstock and for monitoring and genetically tagging Burbot to track growth, post-release survival and movement of released individuals.

Improving Return-to-Creel of Hatchery Catchable Rainbow Trout in Idaho: Catchable Size at Release

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Idaho Department of Fish and Game (IDFG) hatcheries are integral to managing coldwater sport fishing opportunities in Idaho. Current hatchery production capacity and funding are not increasing, while demand for hatchery catchable trout remains steady or is increasing. Given the current economic climate for IDFG hatchery funding, efforts must be made to ensure that hatchery programs remain efficient while producing a quality product for Idaho anglers. Since 2011, IDFG has released over 140,000 T-bar anchor-tagged hatchery rainbow trout across 135 water bodies statewide, as part of a multi-year evaluation of exploitation rates. All tagged fish are measured for length (mm) with the goal of releasing catchable trout that average 254 mm (10 inches). Average total length of all standard catchable rainbow trout tagged since 2011 has been 256.1 ± 0.3 mm. We evaluated returns-to-creel based on length-at-release and from 200 mm to 305 mm there was roughly a 7% increase in catch rates for each 25 mm increase in length at release. A pilot study showed that the relationship between return rates and size appears to be static and is not dependent on the rank of fish within a given release. Therefore, IDFG has increased the average target size at release for a subset of catchables destined for larger, lotic water bodies from 10 inches to 12 inches. Without an increased budget or expanded rearing space, this size increase results in a roughly 40% decrease in production (quantity), but results in an overall increase in return to creel numbers, a higher percentage of the release being caught by anglers, and a better product for anglers. Future work will further evaluate the relationship between length-at-release and catch rates, and continue to explore rearing options that result in maximizing the rearing cost/return-to-creel relationship.

Changes in patterns of streamflow from unregulated watersheds in Idaho, Western Wyoming and Northern Nevada

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Recent studies have identified a pattern of earlier spring runoff across much of North America. Earlier spring runoff potentially poses numerous problems, including increased risk of flooding and reduced summer water supply for irrigation, power generation, and migratory fish passage. To identify changing runoff patterns in Idaho streams, streamflow records were analyzed for 26 U.S. Geological Survey gaging stations in Idaho, western Wyoming, and northern Nevada, each with a minimum of 41 years of record. The 26 stations are located on 23 unregulated and relatively pristine streams that drain areas ranging from 28 to >35,000 km^2. Four runoff parameters were trend tested at each station for both the period of historical record and from 1967 through 2007. Parameters tested were annual mean streamflow, annual minimum daily streamflow, and the dates of the 25th and 50th percentiles of the annual total streamflow. Results of a nonparametric Mann-Kendall trend test revealed a trend toward lower annual mean and annual minimum streamflows at a majority of the stations, as well as a trend toward earlier snowmelt runoff. Significant downward trends over the period of historical record were most prevalent for the annual minimum streamflow (12 stations) and the 50th percentile of streamflow (11 stations). At most stations, trends were more pronounced during the period from 1967 through 2007. A regional Kendall test for water years 1967 through 2007 revealed significant regional trends in the percent change in the annual mean and annual minimum streamflows (0.67% less per year and 0.62% less per year, respectively), the 25th percentile of streamflow (12.3 days earlier), and the 50th percentile of streamflow (11.5 days earlier).

Lives of the Snake River Steelhead Trout Populations

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Timing of adult return to freshwater is an important aspect of salmon life history. The majority of Columbia River steelhead are historically from the Snake River. A bimodal distribution of run timing of summer-run steelhead has been observed at Bonneville Dam (BON), the first barrier they cross during upstream migration. Snake River steelhead primarily return during the later mode (after August 25); hence, managers used this mode as an index of abundance for Snake River fisheries planning. Fish in the early mode (A-run) tended to be younger and smaller (<77.5 cm) than fish in the later mode (B-run). B-run fish were thought to spawn only in certain tributaries of the Snake River, whereas A-run fish spawn throughout the Columbia basin. But it is still unclear how life history, body size, and spawning distribution are correlated to the bimodal migration observed at BON. We revisit the A/B dichotomy in relation to population-level mean length and return timing. We correlate these characteristics to selected variables known to influence life history. We analyzed 5,628 individuals that spawned in 17 locations across the Snake River basin during the 2010-2012 runs. All locations produced adults <77.5 cm and adults that returned after August 25. The median lengths of all putative B-run populations were close to the criterion that was supposed to be a defining characteristic. In contrast, few A-run populations produced many adults >77.5 cm. Average proportion of 2-ocean fish was 52.1% for A-type populations and 82.0% for B-type populations. Years spent in freshwater and saltwater were positively correlated; therefore, average age at spawning is greater in populations that produce older smolts. Sex ratio was female biased but older populations tended to have a greater proportion of females spawning. We provide a nuanced view that relates better to population dynamics and current information needs. First, the A/B dichotomy is more of a gradient with characteristic endpoints. Second, life histories are apparently becoming more homogenous as A-run timing becomes later and B-run size becomes smaller. Third, the A/B dichotomy masks important diversity in terms of age structure, sex ratio, and spawn timing.

A Retrospective (circa 1800–2014) on Abundance, Spatial Distribution, and Management of Snake River Basin Fall Chinook Salmon

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Conservative estimates of the annual number of Fall Chinook Salmon *Oncorhynchus tshawytscha* adults that returned to the Snake River during the 1800s before major harvest by settlers began ranged from ≈ 408,000 to ≈ 536,000. Rampant perturbations over the first 75 years of the 20th century including dam construction eliminated the primary spawning aggregates in the spring-fed middle Snake River and a secondary spawning aggregate in the Clearwater River, while impounding the lower Snake River from its mouth to a point 224 kms upstream. Access to the Clearwater River was restored, but by 1975 the number of natural-origin adults estimated to have passed the newly constructed Lower Granite Dam had fallen to 1,000. The development of the Lyons Ferry State Fish Hatchery program began in 1976 with missions to conserve the genetic integrity of the population and meet a federally mandated adult return goal. After a promising start, that program and the secondary spawning aggregates were temporarily compromised by stray hatchery fish from a nearby basin in the late 1980s. An estimated 78 natural-origin adults passed upstream of Lower Granite Dam to spawn in the wild in 1990. The population was federally listed for protection in 1992. Recovery actions implemented cooperatively by Federal, private, State, and Tribal entities included major operational modifications to hydroelectric dams, water management for fish, reduced harvest, predator control, and an enhanced supplementation program involving Lyons Ferry, Nez Perce Tribal, Oxbow, Umatilla, Irrigon, and Dworshak hatcheries coupled with acclimated and direct releases of hatchery juveniles into the habitat. Estimated passage of natural-origin adults at Lower Granite Dam increased to a maximum of 21,114 in 2013 by which time evidence for density-dependent population growth had become apparent. This review shows that declines in native fish populations can be reversed under prevailing climatic conditions. Complications arise, however, when the carrying capacity of developed river landscapes has been greatly reduced below historical levels, and when views on recovery actions are not shared by management entities. In particular, disparate views of hatchery programs paired with conflicting federal mandates governing those programs can create divergent expectations of what constitutes recovery.

Lake Pend Oreille and the Clark Fork River: Yesterday and Today – Parts I and II

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The Clark Fork River is not only the historic home to Glacial Lake Missoula, but also the largest tributary to Lake Pend Oreille, and the largest river leaving the State of Montana. Stretching over 300 miles from the lake to its headwaters, the Clark Fork River drains almost all of the west side of the Continental Divide in Montana, along with parts of British Columbia and Idaho, encompassing almost 23,000 square miles and rising over 4,800 vertical feet. The Clark Fork is the historic home of the Pend Oreille and Salish people, and at that time the native fish assemblage included robust populations with limited species diversity. Many changes have occurred over the past 200 years; from the explorations of Lewis and Clark, the advent of the Copper Kings and the rail barons, irrigation and agricultural development, turn-of-the-century and post-war dam construction, to present day urbanization, the Clark Fork River was transformed.

The Avista's Clark Fork project area is located in the lower 70 miles of the river, which represents less than five percent of the overall Clark Fork River drainage. Upon agreement of our stakeholder group and submission to FERC, Avista began Settlement Agreement (SA) implementation in 1999. Listed as threatened under ESA in 1998, bull trout (Salvelinus confluentus) recovery became a key issue of the Clark Fork projects, and is the subject of a comprehensive Native Salmonid Restoration Plan included within the SA. Over the past fifteen years, many successes have been realized through the collaborative implementation of the SA, and the adfluvial bull trout stocks that anchor the lower Clark Fork population are considered to be stable to increasing. At the same time, efforts in support of this large river system mitigation program have not occurred without a fair share of setbacks and restarts, and several challenges still lay ahead.

Clearwater River steelhead at the reservoir/river interface: movement patterns and timing

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Historic data suggest Clearwater River steelhead population exhibited a wide range of over-wintering patterns within the Lower Snake and Clearwater Rivers. With completion of mainstem hydrosystem projects this migration corridor has been changed significantly. Current information collected at Lower Granite Dam gives us understanding of migration patterns and escapement as Steelhead leave the hydrosystem, but provides no data on Steelhead interaction with the upstream reservoir and fisheries prior to entering the free-flowing Clearwater River. In collaboration with Nez Perce Tribe Fishery Research Division and NOAA Fisheries staff, we radio tagged (gastric implant) 70 adult hatchery origin steelhead (63% adipose clipped) at Lower Granite Dam using the separation by code system at the adult fish trap from September 25, 2013 to March 28, 2013. All radio-tagged fish were from South Fork Clearwater River juvenile release groups. We collected tracking data from boat and vehicle as well as a fixed telemetry site that logged fish movements at the river/reservoir interface. The objectives of the study reported here were to: 1. Describe timing of escapement into the free flowing Clearwater River; 2. Describe residence time of steelhead in the Lower Granite Pool and in the slack water portion of the fishery in Idaho; and 3. To evaluate potential factors influencing fish movement out of the Lower Granite Pool. Of the 70 fish tagged at Lower Granite Dam, 63 (90%) were detected at the fixed telemetry site. Median passage of steelhead above the fixed site occurred on 11/6/2013. Reservoir residence time, defined as the number of days from initial tagging events to confirmation of movement above the fixed telemetry site ranged from one to 127 days (mean = 34 days, median = 6 days). There was much greater variation in reservoir residence time of fish tagged prior 10/23/2013 than in those fish tagged after that date with most later arriving fish entering the river after less than seven days. Twenty five fish spent more than 28 days in the Lower Granite Pool before moving upstream, indicating the reservoir is an important staging habitat for a substantial component of the hatchery steelhead population.

Using aerial imagery to predict occurrence and density of redband trout in a remote, desert landscape

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Stream and river habitat is influenced by natural and anthropogenic factors across multiple spatial scales. Because of this linkage across scales, remotely-sensed characteristics of stream systems are often useful predictors of aquatic species and assemblages. Our goal was to evaluate the use of aerial imagery as a tool for predicting the occurrence and abundance of redband trout (*Oncorhynchus mykiss gairdneri*) in northern Nevada and southwestern Idaho. We conducted a supervised, object-oriented classification of National Agricultural Imagery Program (NAIP) imagery to develop a 1-m resolution land cover dataset for our study area. Our focus was on accurately characterizing woody riparian vegetation because previous research has shown positive associations between woody riparian vegetation and redband trout. The land cover classification had an overall classification accuracy of 78%. Producer's error (false negatives) was 16% for woody vegetation, whereas user's error (false positives) was 30%. We used logistic and quantile regression models to show that percent woody vegetation in a 5-m stream buffer as classified from NAIP imagery, in addition to mean August temperature from a stream temperature model, were better predictors of redband trout occurrence and density than field-measured instream and riparian habitat. Quantile (90th) regression models also showed redband trout densities were higher when there was more woody riparian vegetation, but only when mean August stream temperatures were near 15°C. Our study shows how free, high resolution imagery can be used to characterize redband trout habitat across large remote desert landscapes that can be difficult to access for field surveys, as well as identify place-based restoration opportunities where land and water uses have negatively impacted riparian conditions.

Linkages between grazing indicators, habitat diversity, and fish diversity in Goose Creek

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Grazing reduces riparian vegetation and results in trampled and instable stream banks, which in turn leads to channel widening and sedimentation. Wide, shallow, sediment-laden stream channels lack instream habitat diversity important to stream fish communities. Our goal was to evaluate the effect of grazing on instream habitat diversity and fish diversity in Goose Creek, a Snake River tributary. We sampled fish and assessed instream and riparian habitat at 38 sites in Goose Creek, focusing on measures of instream habitat diversity and the grazing indicators of streambank alteration, streambank stability, and woody vegetation. We used multiple regression to show fish species diversity to be significantly and positively associated with diversity in substrate type, diversity in cover type, and variation in water depth and velocity. Although some components of habitat diversity were related to stream size, several measures of habitat diversity were also associated with streambank alteration, stability, and woody riparian vegetation characteristics. Our results show fish species diversity to increase in larger streams due to increases in hydraulic complexity related to increased habitat volume, but that riparian grazing can also negatively impact habitat diversity. These grazing impacts to habitat diversity, in turn, have negative consequences to fish species diversity in a watershed with a diverse species pool that includes several sensitive species. Connections between habitat diversity and grazing suggest that land management has the potential to limit the effects of grazing on fish diversity in the Intermountain West.

A hierarchical investigation of factors that influence the spatial ecology of juvenile Chinook salmon (*Oncorhynchus tshawytscha*) in the Yankee Fork Salmon River, Idaho, USA

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Ecologists are now emphasizing the use of more spatially continuous surveys for pattern detection because such approaches provide increased power to identify patchiness across multiple spatial scales. Stream fishes vary in size from embryo to adult, and associated with this variation in body size, exhibit complex life cycles and habitat-use patterns. These complexities challenge ecologists who are interested in understanding how fish abundance is linked to heterogeneous stream habitats. Nowhere is it more critical to understand these relationships, than for imperiled fish species with complex migratory life histories, such as Pacific salmon (*Oncorhynchus* spp). The majority of restoration efforts for Pacific salmon are now focused on improving freshwater rearing habitats. However, successful recovery of Pacific salmon will require that our restoration strategies are rooted in empirical understandings of fish-habitat relationships. In this study, we conducted a hierarchical and more spatially continuous investigation of factors that influence the variability in juvenile Chinook salmon (*O. tshawytscha*) abundance throughout the Yankee Fork Salmon River. We identified and georeferenced all valley segments, stream reaches, channel units, and sub-channel units in Yankee Fork and conducted single-pass electrofishing at the channel unit scale. A total of 840 channel units were identified, of which 140 were sampled for fish. Highest fish abundance was found in alluvial valleys whereas bedrock canyons had the lowest. Stream reach types explained the most variation in juvenile Chinook salmon abundance ($p < 0.05$); reaches with braided side channels contained the most fish, followed by pool-riffle and plane-bed reach types. Forced reach types had the lowest fish abundance. Juvenile Chinook salmon preferred pools over riffles ($p < 0.05$), but there was no difference among channel sub-unit types ($p > 0.05$). Fish abundance was spatially correlated at a distance of ~90m and this allowed us to develop a spatial model to predict fish abundance, with uncertainty, at un-sampled locations. Ultimately, our findings inform conservation and restoration activities, particularly as they are applied at intermediate (e.g., reach) scales.

Movement, Distribution, and Habitat Use of Westslope Cutthroat Trout in the South Fork Clearwater River Basin

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While many Westslope Cutthroat Trout (WCT) *Oncorhynchus clarki lewisi* populations in Idaho are robust and stable, population densities in some systems remain below management objectives. In most of those systems, such as in the South Fork Clearwater River (SFCR) system, environmental conditions (e.g., summer temperatures) are hypothesized to limit populations of WCT. Radiotelemetry and snorkeling methods were used to describe seasonal movement patterns, distribution, and habitat use of WCT in the SFCR during the summers of 2013 and 2014. Sixty-six tags were surgically implanted into WCT (170–405 mm) from 30 May–25 June, 2013 and 20 June–6 July, 2014. We attempted to track fish at least once a week through the summer and once a month during other seasons. Of the radio-tagged fish, 26 shed tags, died, or were not relocated during the summer. Mean minimum distance of movement by radio-tagged fish throughout the summer was 11,865 m (min–max; 110–38,822 m). Two distinct patterns of movement by WCT were observed in the SFCR. Twenty fish moved from the mainstem SFCR into tributaries as stream temperatures increased. Twenty-six fish persisted in the mainstem SFCR during the summer despite high daily maximum temperatures in 2013 (mean ± SE = 22.32 ± 0.15°C) and 2014 (mean ± SE = 21.52 ± 0.20°C). Snorkeling was conducted to better describe the distribution and habitat use of WCT in the mainstem SFCR. Sixty-two sites were snorkeled from 5–14 August, 2014. Twenty-seven WCT were observed in 13 sites and found at low densities (mean ± SE = 0.0003 ± 0.0001 fish/m2). Fish were not observed in sites where the maximum diel temperature exceeded 21.70°C (mean ± SE = 20.93 ± 0.14°C). Large boulders were also associated with WCT densities. Both radio-tagged fish that persisted in the SFCR during the summer and WCT observed during snorkeling were primarily distributed in mid-elevation reaches of the SFCR where temperatures were cooler than the lower and upper reaches.

Comparison of three aging structures for two Idaho sport fish: redband trout and bluegill

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Age is the basis for calculating many of the population parameters used to manage fish populations, which makes it vitally important to correctly age fish. We compared three aging structures; sagittal otoliths, pectoral fin rays, and scales for both Bluegill (*Lepomis marcrochirus*) and Redband Trout (*Oncorhynchus mykiss gairdnerii*) to determine if there was a difference in assigned-age or aging precision within each species. We sampled Bluegill from two lentic waterbodies (Atwood's Pond and Bruneau Dunes State Park Pond) and Redband Trout from two lotic waterbodies (Harris Creek and Mores Creek) in southwestern Idaho, USA. We found otoliths to be the most precise aging structure for both species from all sample sites. Fin rays did not differ significantly from otoliths in precision or assigned-age for Redband Trout. Fin rays were less precise than otoliths for both locations but did not differ in assigned age for Bluegill. Scales produced lower age estimates and were less precise for Redband Trout from both locations. Scales also produced lower age estimates for Bluegill from both locations. However, scales were found to be more precise than fin rays at Bruneau Dunes State Park Pond for Bluegill. Given these data, we suggest the use of otoliths as a quality aging structure for both Redband Trout and Bluegill. We further suggest that fin rays may be used as an alternate aging structure for Redband Trout but recommend someone undertake the task of validating fin rays before using them as a primary aging structure. We do not recommend the use of Fin rays for Bluegill or the use of scales for either species due to lack of precision lowered age estimation.

Chinook Carcass Recovery (Efficiency and Condition)

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Understanding carcass recovery efficiency allows us to address potential biases associated with size and sex recovery, determine rate of carcass decay, and establish escapement estimates based on recovery efficiencies. We planted 200 Chinook salmon (*Oncorhynchus tshawytscha*) carcasses in Red River, Idaho to determine efficiency in carcass recovery and carcass deterioration rates. Fish were planted during two events within two disparate habitat types; a meandering meadow reach and a canyon reach with high habitat complexity. Our initial assumption was that recoveries would be greater in the meadow habitat due to increased detectability. Carcasses were collected from Clearwater Fish Hatchery and transported to each study reach. Carcass length ranged from 43–101cm with a median of 76cm. Carcasses were fitted with jaw tags on either the right or left jaw to represent “male” or “female”, respectively. Only biological male carcasses were used since biological female carcasses were unusable due to the spawning process. “Males” were placed in deep pools, along stream banks, and in other complex locations, while “Females” were placed in riffles and runs at or below potential redd locations. Because carcasses were left in-stream for the entirety of the study, we were able to use photos at all plantings and recoveries to recorded individual carcass condition decline. Recovered carcasses were assigned a condition index value of 0-5 with 0 being total carcass decay and 5 being excellent carcass condition. Overall recovery was 66% in the meadow reach and 55% in the canyon reach. Male and female recoveries also varied amongst the different habitat types with “male” recovery being 70% in the meadow and 38% in the canyon and “female” recoveries being 48% in the meadow and 42% in the canyon. Paired t-Test results showed no significant difference between mean length of planted and recovered fish in either habitat. Mean condition index values for replicates one and two were 1.7 and 1.9 for the meadow reach, and 2.2 and 2.5 in for the canyon reach.

Saving One of Idaho's Large River Fish Icons: Kootenai River Burbot

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Burbot *Lota lota maculosa* populations of Kootenay Lake and Kootenai River once represented one of the most popular and robust fisheries for this species in North America. Their numbers diminished rapidly presumably due to physical habitat changes after the construction and operation of Libby Dam in 1972. Factors limiting recruitment were associated with major changes in winter temperature and discharge during spawning and egg incubation periods. Because of the widespread cultural and recreational importance of Burbot in the Kootenai River prior to the collapse, an international Conservation Strategy was developed by a community-based working group that outlined specific measures necessary to establish a self-sustaining population. With each passing year of poor recruitment, stock limitations were an increasing factor constraining restoration. Thus, a major effort to supplement the wild population through intensive culture began in 2005 through the collaboration with the Kootenai Tribe of Idaho, Idaho Dept. of Fish and Game, BC Ministry, and the University of Idaho Aquatic Research Institute. Burbot from Moyie Lake, B.C. were found to be of a similar phylogenetic group as the Kootenai River population and suitable as a donor stock. Subsequent research provided evidence that Burbot progeny from a lacustrine brood stock can successfully survive, grow, disperse, and spawn in a riverine environment. Going forward, a final step towards success will be to document any wild recruitment and determine the influence of in river conditions on spawn timing and egg hatching success. If suitable spawning conditions and habitat can be improved, hatchery recruits will be to the foundation to restore a naturally producing and self-sustaining population to the Kootenai River.

Does water still flow downhill? Managing flows and fish in Idaho's Large rivers

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The history of human-caused impacts to Idaho's large rivers is well known. Hydrographs, temperature profiles, sediment loads, flow volumes, nutrient loads and so on have all changed dramatically over the past one hundred-plus years. These changes have affected resident as well as anadromous fishes inhabiting or using the large rivers to complete parts of their life cycle. On the surface the most recognizable impact to river systems is dam construction. The construction of large earthen or concrete barriers on rivers results in complete ecosystem changes upstream of the dam and modified ecosystem characteristics downstream of the dam. Beyond the mainstem or large-river dams the impacts of barriers, water withdrawals and other activities on upstream tributaries are all carried into the downstream large-river environment. The nature of fisheries and fisheries management have adapted over time to these large-scale perturbations. Warm water for flat water fisheries exist on what were once free-flowing rivers upstream of dams. Management of water downstream of dams does provide some opportunities. Because the dams are a points of regulation fish managers have an interest in manipulating the quantity, quality and timing of water released to downstream areas to benefit fishery resources. These strategies are most prominent in efforts to enhance the survival of anadromous salmon and steelhead listed under the Endangered Species Act. Water moving from Idaho towards the ocean is managed to speed the movement of smolts downstream, control what areas are available to fish for spawning, change the temperature of the Snake River downstream of Idaho while also providing hydropower generation and flood control. Years of research and collaboration have led to the implementation of river management strategies that provide benefits to the fishery resources.

Modeling spatially explicit life history strategies in juvenile Snake River Fall Chinook Salmon

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Anthropogenic changes have recently and significantly altered the river system and spawning habitat of Snake River fall Chinook salmon. With these changes have, presumably, come changes to the selective pressures experienced by historical populations. The population has recently undergone major changes in juvenile life history expression, with a large proportion of the population adopting a longer freshwater rearing phase, compared to the historical norm of subyearling migration. Previous work has shown that these life history changes are spatially structured within the spawning areas and may be correlated with stream temperature. In addition, modeling has indicated that the yearling life history may confer higher fitness than other life history strategies. We apply a stage structured model of juvenile out-migration to explore the life history trade-offs of early migration. In particular we focus on the possibility that spatially explicit growth differences may be influencing migration timing. Understanding these life history changes, and modeling their fitness trade-offs, requires a solid understanding of the sources of juvenile fish within the basin. To do this, our work integrates microchemistry and growth analysis of otoliths into our modeling effort to constrain our understanding of movement patterns at multiple life history time points. Understanding the factors driving juvenile out-migration timing will help to target management actions and improve our understanding of the fitness trade-offs creating the observed changes in migration.

Of Olives and Carp: Interactive effects of two invaders on linked stream-riparian food webs

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Stream-riparian ecosystems are influenced by multiple invasive species that may interact, influencing one another and generating synergistic effects on food webs and ecosystem processes. We investigated the interaction between two nonnative species widespread in the western USA: common carp and Russian olive (RO), an invasive riparian tree. Deep Creek, Idaho was an International Biological Program site in the early 1970's; at that time carp were rare. Subsequently, RO was introduced and now forms a dense stand that we have previously shown caused substantial increases in allochthonous inputs and benthic organic matter. Since 1971, there has been an approximately 8-fold increase in carp biomass, and our analyses suggest this size of carp population could not have been sustained by food resources available pre-RO. Moreover, we have found nearly two-thirds of the gut contents of carp, on average, consists of RO material. These patterns are consistent with commensal facilitation of carp by RO. Results of a small-scale, experimental manipulation of carp in Deep Creek suggest this subsidized population may also directly consume and limit in-stream biomass of algae and macrophytes, Chlorophyll-a concentration increased ~3X when carp were excluded. Further, because of the dinitrogen-fixation associated with RO, we have previously shown RO may increase nitrogen-inputs, reduce nitrogen-limitation of primary producers, and possibly increase phosphorous demand. Carp are phosphorous-rich compared to native speckled dace, whose population has declined by ~80% for unknown reasons. Additional, preliminary results suggest that carp consuming nitrogen-rich olive material are excreting ~4X more N and thus may be amplifying the recycling and export of N from streams invaded by both species. The invasion of RO and subsequent facilitation of carp is characteristic of an 'invasional meltdown,' and the combination of interacting invaders appears to be driving changes in community structure and ecosystem function.

Supplementation with local, natural-origin broodstock may minimize negative fitness impacts in the wild

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While supportive breeding programs strive to minimize negative genetic impacts to populations, case studies have found that certain programs can cause reduced fitness of wild fish. However, initial results from a supportive breeding program for Chinook salmon in Johnson Creek, Idaho, have shown minimal genetic effects to the wild population. These results are believed to be due to reduced potential for domestication selection in the hatchery environment since only natural-origin fish are used as broodstock each year. To further investigate relative reproductive success (RRS) of ongoing supplementation in this system, additional pedigrees of both natural and hatchery-origin fish from five broodyears were tracked over two generations with molecular markers. Results with all individuals taken into account show that hatchery-reared females had no difference in fitness relative to natural-origin females (overall RRS = 1.03, $p = 0.55$), but hatchery-reared males had lower fitness than their natural-origin counterparts (overall RRS = 0.84, $p = 0.04$; jack male RRS = 0.91, $p = 0.05$). Since individuals that do not produce returning adult offspring have no direct genetic effect on the population, we also compared RS between the hatchery and natural-origin fish that contributed at least one offspring to the next generation and found that RS was not significantly different for either sex (female RRS = 1.05, $p = 0.99$; male RRS = 0.96, $p = 0.79$; jack male RRS = 1.24, $p = 0.35$). Additionally, RRS of hatchery-reared fish (H) that mated with natural-origin fish (HxN matings) were equivalent (RRS = 1.00, $p = 0.71$) to those between two natural fish (NxN), with HxH matings having lower overall RRS of 0.85 that was not statistically significant ($p = 0.43$). Results suggest that supplementation with 100% local, natural-origin broodstock may be a practice that can successfully boost population size with minimal negative genetic impacts to wild populations.

Summary of past and potential future conservation aquaculture release strategies for Kootenai River Burbot and White Sturgeon

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Conservation aquaculture at the Kootenai Tribe of Idaho's Twin Rivers Hatchery will begin in February 2015. During February, the new hatchery staff will initiate production of its first Burbot year class; and the first White Sturgeon culturing will begin in May-June 2015. With the addition of Twin Rivers Hatchery to the current Kootenai Tribal Sturgeon Hatchery, the Kootenai River Native Fish Conservation Aquaculture Program may provide increased production of Burbot and increased flexibility/adaptive management of White Sturgeon. Twin Rivers Hatchery will increase water supply capabilities with three intake sources (Kootenai River, Moyie River, and groundwater); improve water temperature control; increase live feed and rearing capacity to increase Burbot production; increase rearing capacity to reduce White Sturgeon rearing densities; and increase number of families for both species, allowing for incorporation of more wild adults to ensure proper genetic contributions to the restored populations. The facility also increases the flexibility of releasing and investigating multiple early life stages of the target species. This presentation will provide an overview of past release strategies for both species, and then will summarize potential alternatives using the capabilities of Twin Rivers Hatchery.

Imaging Sonar to Assess White Sturgeon Acipenser transmontanus in the Snake River

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Hydroacoustics are effective and non-invasive sampling methods to assess fish populations in rivers, reservoirs, and lakes. We are using imaging sonar, both fixed-location and mobile platforms, to assess White Sturgeon *Acipenser transmontanus* (WS) populations in the Snake River, ID. Fixed-location monitoring is currently being done using dual frequency identification sonar (DIDSON) to address concerns of potential WS entrainment through penstocks at C.J. Strike hydroelectric dam. Since 2007, we've recorded over 25,000 hours of DIDSON data in the forebay, detected over 300 sonar targets classified as WS (based on length and behavior), and observed one WS entrainment. These data are preliminary, but suggests the risk of WS entrainment through penstocks at C.J. Strike Dam is minimal. While an effective tool for monitoring entrainment, DIDSON sonar is often restricted in fisheries research due to range limitations and is best utilized on fixed-location platforms (i.e., stationary). Conversely, side-scan sonar (SSS) is mobile imaging sonar that provides the ability to quickly survey large areas and has many practical applications to inland fisheries research, including detection and identification of large fishes (e.g., sturgeons). We conducted a pilot survey in a 10 mile reach below C.J. Strike Dam to evaluate SSS as a potential method to assess WS abundance in the middle Snake River. Using a N-Mixture model, within a Bayesian framework, we modeled replicate count data from 10 sites to estimate WS abundance. Our median estimate of WS greater than 1 m in length (131; 95 % credible intervals [CI] 120-150) is thought to be reasonable based on prior mark-recapture assessments. Future efforts include ground-truthing measurements, survey design, and data analysis to establish a standardized methodology. Also, a comparative study between SSS and traditional mark-recapture assessment will be conducted. This pilot evaluation illustrates the potential of using SSS as a non-invasive method to quickly assess WS populations.

Restoring the Kootenai: A Tribal Approach to Restoration of a Large River in Idaho

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The Kootenai River Habitat Restoration Program (KRHRP) is a large-scale, ecosystem-based habitat restoration program to restore and maintain habitat conditions that support all life stages of endangered Kootenai River white sturgeon, burbot and other native fish. The Kootenai Tribe of Idaho is implementing the KRHRP within a 55-mile section of the Kootenai River in Idaho.

In 2009 the Tribe completed the Kootenai River Habitat Restoration Program Master Plan, which presented a framework for restoring native fish habitats and other ecosystem functions within existing constraints. The goals of the KRHRP are to restore river morphology, aquatic and riparian habitat, and to foster river stewardship. The Master Plan identified reach-specific habitat conditions that limited the success of Kootenai sturgeon, burbot and other native fish, and restoration strategies and treatments to address those limiting factors.

Since completing the Master Plan, the Tribe in collaboration with multiple agency partners (B.C. Ministry of Forests Land Natural Resource Operations, Idaho Department of Fish and Game, Montana Fish Wildlife and Parks, U.S. Fish and Wildlife Service, U.S. Army Corps of Engineers, Bonneville Power Administration) and a multi-disciplinary team of independent experts, has identified, prioritized, and designed a suite of KRHRP projects to be implemented over the next decade.

From 2011 through 2014 the Tribe completed construction of seven projects. Actions included: construction of large pool forming structures that direct flow from the river bank, create and/or scour pools, and create recirculation eddies; creation or enhancement of deep pools; construction of in-river and bank structures; side channel reconnection and floodplain creation or enhancement; riparian enhancement and buffer fencing; and placement of substrate patches along the river bottom to provide suitable substrate for spawning and early life stage survival of sturgeon. Projects planned for 2015/2016 will include actions listed above as well as construction of vegetated floodplain islands on top of existing gravel bars in the river channel to increase habitat complexity.

The KRHRP is a key component in the Kootenai Tribe's overall holistic approach to restore native fish and wildlife populations in the Kootenai River drainage and incorporates an adaptive management framework to guide design and implementation.

The Cold-Water Climate Shield: Delineating Refugia for Preserving Salmonid Fishes Through the 21st Century

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The distribution and future fate of ectothermic organisms in a warming world will be dictated by thermalscapes across landscapes. Marquis salmonine fishes like trout, salmon, char, and taimen have undergone broad declines over the last two centuries and depend on particularly cold environments at high elevations and latitudes. The extreme nature of those environments also precludes invasions by most nonnative species so identifying habitats capable of absorbing future climate change while still supporting native populations would resolve refugia critical for conservation planning. Using crowd-sourced biological datasets and high-resolution stream temperature scenarios, we delineate climate refugia across >250,000 stream kilometers in the Northern Rocky Mountains for two native trouts—Bull Trout and Cutthroat Trout. Even under an extreme late-century climate scenario and pessimistic assumptions about species invasions, refuge habitats with high probabilities of species occupancy occur for both species. Most refugia occur on federal lands (80% - 90%) where only a small portion has protected status (10% - 20%). Precise information about refuge locations should enable better protections but refuges could also provide a foundation for climate-smart conservation networks designed to maintain broader species distributions. Using cold water as a “climate shield” is generalizable to other cold-water species and geographic areas because it mines information from existing datasets and is built on nationally available geospatial data. Importantly, it creates a framework that can be updated with new data and the process of developing information from contributions by many individuals and resource agencies strengthens the social networks that will be needed to preserve cold-water salmonids through the 21st century.

The National Stream Internet Project

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Accurate, high resolution information does not exist for status and trend assessments of water quality and aquatic biotas throughout the 2,500,000 kilometers of rivers and streams across the United States. Without that information, prioritization of limited resources for conservation and management proceeds inefficiently. In recent decades, however, massive amounts of water quality, biological surveys, and habitat condition data have been collected by state, federal, tribal, and private organizations. Those data could be used to develop high-quality information if a nationally consistent analytical infrastructure existed. The Stream Internet Project is funded by the U.S. Fish & Wildlife Service's Landscape Conservation Cooperatives program to develop that national infrastructure. When complete, the project will facilitate convenient application of sophisticated spatial statistical models designed specifically for data measured on stream networks (spatial models are described at the SSN/STARS website: http://www.fs.fed.us/rm/boise/AWAE/projects/SpatialStreamNetworks.shtml). The spatial network models can be applied to databases characterized by clustered locations, which provides a strong incentive to develop comprehensive, interagency databases. The spatial models outperform traditional statistical techniques and enable predictions at ungaged/unmonitored sites, which facilitates development of high-resolution status maps for full river networks (to see a regional application of Stream Internet technologies, visit the NorWeST website: http://www.fs.fed.us/rm/boise/AWAE/projects/NorWeST.html). As better information is developed for streams and rivers, it will enable more efficient use of conservation resources and empower managers to be more effective resource stewards.

Predation Rate of American White Pelicans on Stocked Catchable Rainbow Trout in Idaho Reservoirs

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In southern Idaho, growth of two American White Pelican *Pelicanus erythorhynchos* nesting colonies since the early 1990s generated concerns about whether pelican predation is impacting angler catch rates of catchable-sized hatchery Rainbow Trout *Oncorhynchus mykiss* (hereafter catchables) stocked in Idaho waters. To evaluate this question, pelican predation rate (i.e., the proportion of stocked catchables consumed by pelicans) was estimated for 20 stocking events over three years at various southern Idaho waters, and compared to angler catch (i.e., the proportion of stocked catchables caught by anglers). We PIT-tagged (to monitor bird predation) and anchor-tagged (to monitor angler catch) 5,863 catchables and stocked them in the spring. At the same time, we also directly fed 1,073 PIT-tagged fish (euthanized beforehand) to pelicans across all study waters. After the juvenile pelicans fledged in the fall, we recovered 523 PIT tags (from 334 stocked catchables and 189 fed catchables) from the two nearest pelican nesting colonies (at Lake Walcott and Blackfoot Reservoir). Forty-two percent of the recovered tags from stocked fish were attributed to Double-crested Cormorant *Phalacrocorax auritus* predation. The difference in recovery rates of stocked and fed tags allowed us to estimate PIT-tag recovery efficiency, which enabled us to estimate the total pelican predation. Subsequent estimates of pelican predation averaged 17% and ranged from 0-48%. Angler exploitation averaged a similar rate of 19% and ranged from 0% to 82%. In general there were inverse, wedge-shaped relationships between distance from the nearest nesting colony and tag recovery efficiency, and between pelican predation and angler catch of hatchery catchables. Our findings suggest that in waters where pelican predation is concentrated in southern Idaho, pelicans are exploiting as many catchables as anglers are, and these two entities are in direct competition for this resource.

Natural origin abundance and productivity response to Chinook salmon supplementation in Johnson Creek

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Since 1998, the Nez Perce Tribe of Idaho has supplemented the Johnson Creek natural summer Chinook spawning aggregate with hatchery-reared Chinook. The Tribe's Johnson Creek supplementation program adheres to a strategy designed to artificially stimulate increases in natural origin spawner abundance by augmenting the total number of spawners on the spawning ground. Thus far, the relative success of the program has been inferred using within-stream, origin-specific paired comparisons of abundance and productivity and through genetic comparisons of relative reproductive success. More recently, we evaluated the efficacy of supplementation to provide a demographic boost in Johnson Creek using temporally based statistical comparisons of escapement and productivity. Examining abundance and productivity shifts across pre- and post-supplementation periods in contrast to eight comparable, yet untreated, reference populations allowed for fluctuating environmental conditions while judging program success.

Habitat Use of Non-Native Burbot in a Western Non-Wadeable River

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Burbot *Lota lota* were illegally introduced into the Green River drainage, Wyoming in the 1990s. Burbot have the potential to alter the food web in the Green River, thereby negatively influencing socially, economically, and ecologically important fish species. Therefore, fisheries managers of the Green River are interested in implementing a removal program for Burbot. Unfortunately, relatively little is known about the habitat use of non-native Burbot in lotic systems, severely limiting the effectiveness of any removal effort. The objective of our study was to identify habitat features related to the presence and relative abundance of Burbot using hurdle models. A total of 260 Burbot was collected during 207 sampling events in the summer and autumn of 2013. Regardless of the season, large substrate (e.g., cobble, boulder) best predicted the presence and relative abundance of Burbot. In addition, our models indicated that the occurrence of Burbot was inversely related to mean current velocity. The efficient and effective removal of Burbot from the Green River largely relies on an improved understanding of the influence of habitat on their distribution and relative abundance.

Population Dynamics of Burbot in the Green River of Wyoming

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Burbot *Lota lota* is a picivorous fish species that was illegally introduced to the Green River of Wyoming in the 1990s. Burbot have the potential to alter fish assemblage structure of the Green River through competition and predation. Because of the potentially deleterious effects of Burbot, managers of the Green River are interested in monitoring and eventually suppressing the Burbot population. Unfortunately, little information is available regarding population demographics for Burbot in the Green River. Without baseline information, the efficacy of future management of Burbot in the Green River will be difficult to evaluate. Therefore, our objectives were to describe age structure, growth rates, and age-specific mortality of Burbot in the Green River. Demographic information was used to predict the response of the Burbot population to varying levels of suppression. Mean back-calculated lengths at age of Burbot were estimated using a Fraser-Lee method and age structure was estimated using an age- length key. Growth was described using a von Bertalanffy model and total annual mortality was estimated using a weighted catch curve. The effects of suppression on the Burbot population were predicted using a female-based Leslie matrix. Results from this study will provide baseline information for management of Burbot in the Green River.

The Monarch of Large River Icons – Idaho's White Sturgeon

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In Idaho, White Sturgeon *Acipenser transmontanus* are distributed primarily in two large rivers – the Snake River upstream to Shoshone Falls, including the lower Salmon River tributary and the Kootenai River. White Sturgeon populations have declined in Idaho for a variety of reasons but primarily due to extensive anthropogenic alteration to riverine habitat from dams, flow regulation and agricultural returns. The ESA federally-listed Kootenai River white sturgeon (now fewer than 1000 wild adults) has been recruitment limited since the early 1970s, shortly after construction of Libby Dam, and declining because of spawning over low quality sand-silt substrates and loss of ecosystem function. Only the very long lifespan of the White Sturgeon has forestalled its extinction in the Kootenai River. Snake River White Sturgeon are classified critically imperiled under State management. The Snake River is extensively regulated to provide water for agriculture, hydropower, municipalities, and flood control with almost half of its estimated volume diverted for agricultural purposes, resulting in significant reductions in the natural flow and water quality. Most of the nine reach populations between Lower Granite Dam and Shoshone Falls consist of remnant wild adults with little or no recruitment. Two exceptions are self-sustaining populations of about 4,000 fish in the Bliss and Hells Canyon reaches that exhibit demographic and genetic differences between the middle and lower Snake River reaches. Management of these Core Conservation populations emphasizes maintaining viability and preservation of genetic integrity and diversity. Conservation aquaculture is utilized in both river systems. The Kootenai White Sturgeon aquaculture program aims to prevent extinction of the population, preserve its existing gene pool, and rebuild a healthy age class structure until habitat restoration measures allow for natural sustainability. In the middle Snake River, stocking occurs in recruitment limited reaches to maintain population abundance and sport fishing opportunity. Research and monitoring has increased general understanding of White Sturgeon recruitment, but specific factors affecting year class strength is still poorly understood and continues to limit natural restoration. The extent of habitat improvements possible in a highly altered large river also remains uncertain.

Spatially Continuous Fish Sampling

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The 2008 Biological Opinion identified tributary habitat restoration as a means to offset mortality imposed on anadromous salmonids by the Federal Columbia River Hydropower System. Evaluating whether these habitat restoration actions actually improved the freshwater productivity of anadromous salmonids necessitated the development and implementation of novel sampling designs to explicitly link fish density, abundance, and survival to habitat restoration. Generally these designs focus on estimating fish abundance and survival within tributary habitat prior to emigration past commonly used monitoring infrastructure such as rotary screw traps. Beginning in 2009 we utilized a generalized random tessellation stratified (GRTS) design to distribute fish and habitat sampling efforts throughout the Lemhi River watershed. While this strategy was successful at generating habitat status and trend information, it was less successful at generating unbiased and precise estimates of fish density and abundance. Simulations suggested that GRTS-based sampling would have to be increased by 300% in order to obtain desired precision, and targeted field experiments demonstrated that 50% or more of marked fish moved out of GRTS reaches prior to the recapture event, potentially introducing substantial bias in subsequent estimates. Beginning in 2013 we implemented a spatially continuous fish sampling design that incorporates mark/recapture or depletion at GRTS sites, thus maintaining the time series of data relevant to the GRTS design. Results to date have demonstrated that the GRTS estimates are conservative when applying them to areas that were not sampled, and its uncertainty comes from changes in site response rather than standard error. Spatially continuous fish sampling's uncertainty comes from the standard error which we are able to propagate to areas with similar geomorphic habitat type. By taking this approach, we increase the precision of fish density and abundance estimates and vastly reduce the potential for bias accompanying site-based sampling. Furthermore, we were able to increase marking by 77% relative to site-based sampling, allowing for passive fish relocation that supports habitat associations. In 2013, we were able to sample fish across ~135 kilometers of mainstem and tributary habitat for the same cost as sampling ~15 kilometers using GRTS survey efforts in prior years.

One-year and two-year retention rates for PIT-tags in three body locations and VIE tags for wild trout of spawning size

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Tagging fish is a common method to identify individuals or groups of fish, but the utility of tags can be compromised if tags are shed or deteriorate over time. We evaluated retention rates for three injection sites of passive integrated transponder (PIT) tags and for visual implant elastomer (VIE) tags in stream-dwelling Cutthroat Trout *Oncorhynchus clarkii* and Rainbow Trout *O. mykiss* of spawning size. In three streams in southeastern Idaho, 2,893 fish ≥150 mm (total length) were marked with VIE in the lower jaw, and PIT tagged in the (1) body cavity, (2) muscle tissue immediately posterior to the cleithrum, or (3) muscle tissue immediately ventral to the dorsal fin. Both VIE and maxillary clips provided additional marks to identify study fish and year tagged. Retention of PIT tags was highest in the dorsal musculature location for one year at large (93%), followed by the cleithrum (82%), and the body cavity (72%).Small sample sizes precluded an evaluation of 2yr retention rate for PIT tags. Overall retention of VIE tags was 96% and retention of maxillary clips was 93%. The likelihood of a PIT tag being encountered by an angler harvesting the fish for consumption was highest for the dorsal musculature location (67%), followed by cleithrum (60%) and body cavity (4%) locations. Implications for tagging location choice and type are discussed.

Identifying and Analyzing False Positives, Misreads, and General Weirdness in PIT Tag Detection Data

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PIT tags, like active (e.g., radio and acoustic) tags, can generate large volumes of data. Unlike active tag technologies, however, PIT tag data sets are rarely filtered to exclude, or even identify, errant or suspicious data points. In the Columbia Basin, raw PIT tag detection data are incorporated directly into an open database and shared with a multitude of researchers. There is no formal protocol to review and censure these detection data by the data providers, and so data consumers must develop their own methods for identifying and rejecting erroneous data. Recognizing anomalous data points, and assessing the impacts of those anomalies, is critical to establishing and maintaining confidence in the vast amounts of PIT tag detection data automatically recorded and reported from hundreds of sites throughout the Columbia Basin.

Genetic stock identification (GSI) to evaluate stock-of-origin from a mixed sample of kelt steelhead sampled at Lower Granite Dam, Snake River Basin

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Steelhead trout that experience post-spawn survival and downstream migration are known as kelts. Individuals that subsequently complete one or more repeat spawning migrations typically achieve greater lifetime fecundity, and help to maintain genetic diversity in populations by increasing overlap among generations. However, rates of post-spawn survival are known to be highly variable among populations and may affect overall demographic stability. We used a suite of 192 single nucleotide polymorphism (SNP) loci and genetic stock identification (GSI) to estimate stock proportions of kelt steelhead sampled at Lower Granite Dam (LGD) during downstream migration in each of six years (2009-2014). Reference baseline populations were delineated into10 reporting groups based on demographic and genetic similarities. Kelt stock proportions were then estimated by individually assigning each kelt from the LGD mixtures to stock of origin in the baseline. Our results show that stocks with predominantly “B-run” steelhead from upper and south forks of the Clearwater River, and South Fork Salmon River consistently represented a small proportion (9.5%; n=391/4,171) of all sampled natural-origin kelts, while their associated assignment probabilities (mean prob=0.84) were the highest observed. The estimated proportion of B-run steelhead in total escapement was significantly greater (2009-2011; 36%) than the estimated B-run kelt proportions, supporting the theory that larger fish have low post-spawn survival relative to smaller (“A-run”) steelhead. The upper Salmon River reporting group (historically A-run) accounted for the majority of all natural-origin kelt assignments (25%) over the six year period. By comparison, 68% of all sampled hatchery kelts (n=1,565/2,288) were assigned to the upper Salmon. Using a combination of parentage based tagging and GSI methods we identified a high rate of mis-assignment of upper Salmon River hatchery steelhead to tributaries of the lower Clearwater, lower Salmon and lower Snake rivers. Significant gene flow among stocks likely contributes to the low-moderate assignment probabilities observed for natural-origin kelts assigned to several A-run reporting groups. These results will help inform managers on the relative population abundances of kelt steelhead in regions of the Snake River.

Socio-Economic and Environmental Factors Influence the Relevance of Natural Resource

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Global factors and increasing challenges of urban life affect the ability of our youth and citizens to understand the natural environment. Increasing numbers are mentally and physically disconnected from the natural environment, and constrained by economic realities including decreasing median household wealth. Demographic factors including the browning of America will influence future decisions affecting the management of natural resources. Fishery and other management agencies are populated with people that are no longer reflective of the current demographic characteristics of our citizens. Creative and relevant outreach efforts are needed to engage all citizens to understand the critical components that support the life systems all of us depend. How can we increase the public awareness of global and local factors that affect our food, water, and air? Effecting these changes will require committed professionals working locally, regionally, and internationally. I discuss tools that can be useful to illustrate the spiritual, ecological and social benefits of reconnecting people to their environment.

Asian Clams Can Pose a Significant Threat to Aquatic Resources Updates on the Lake Pend Oreille Infestation and Management

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Asian clams (*Corbicula fluminea*) are listed as aquatic invasive species in most states. Originally introduced into the U.S. in Washington, the species is now distributed widely and is very common in the lower Snake River and Columbia River systems. In spite of their wide riverine distribution, little is known of their effect on the ecosystem, and competition with native mollusks. In the Columbia River, the clams are nuisance to water irrigation systems and power plants. In high numbers in lacustrine environments Asian clams can create nuisance algal blooms and degraded water quality. The clam shells also provide a localized concentration of calcium that can enhance zebra or quagga mussel establishment. An introduction of Asian clams was ignored in Lake Tahoe and Lake George, and now both lakes have aggressive Asian clam treatment programs that are very costly. In Idaho, the Department of Agriculture found a small population of Asian clams in Lake Pend Oreille in 2012 in the vicinity of East Hope. Since this time, we have partnered with the Department of Agriculture and others to study the distribution and potential methods of control. We are in the process of using tools adapted from Lake Tahoe to use non permeable barriers to isolate the infestations, and experimentally test some control measures. We report our progress and outreach efforts in this research.

Snake River Restoration: Restoring River Processes and Native Habitats

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The Middle Snake River geomorphology was largely shaped by large catastrophic floods associated with the breaching of Lake Bonneville approximately 10,000 years ago. Relatively recent Euroamerican settlement of the region over the past century initiated significant alterations relative to the fish community, habitat fragmentation, hydrographs, and sediment/nutrient loading and transport. The Snake River is now a highly managed, altered system with a flow and sediment regime incapable of maintaining natural river processes important for native fauna and their habitats. Idaho Power is proposing to take aggressive measures downstream of CJ Strike Dam to reduce excessive agricultural derived sediment and nutrients, modify the physical features of the river, and improve riparian habitat on tributaries to the Snake River. The overall goal of the program is to improve water quality and improve habitat conditions by restoring riverine processes through implementation of landscape scale restoration measures. Excessive agricultural sediment and nutrient loading to the Snake River near Grandview, Idaho will be reduced through a program to fund conversion of flood irrigation practices to pressurized sprinkler systems. The channel morphometry of the Snake River, from Walter's Ferry through Marsing, Idaho, will be modified by enhancing existing river features including islands, inset flood plains, and emergent wetlands. The channel features will be designed to decrease channel width, increase channel depth, and increase water velocities under the current diminished flow regime. The channel features will create essential habitat characteristics such as diversity of water velocity, depth and river substrate. It will also restore hyporheic connectivity with the water column. Restoration of native riparian plant communities along newly created shorelines will also be part of this program. In addition to physical habitat benefits through restored river processes, the actions will also reduce thermal loading to the river. Reduction of thermal loading to the river will also be accomplished through riparian enhancements on tributaries which will also be implemented providing improvements to flows and habitats within the tributaries and the Snake River. Key aquatic species expected to benefit from this program include Snake River Physa (*Physa natricina*), white sturgeon (*Acipenser transmontanus*), mountain whitefish (*Prosopium williamsoni*), bull trout (*Salvelinus confluentus*) and redband trout (*Oncorhynchus gairdneri*) and other native fishes. Water quality improvements within this section of river should also translate to benefits downstream of Hells Canyon Dam for fall Chinook salmon (*O. tshawytscha)* and steelhead (*O. mykiss*).Pilot-level implementation of these actions is currently underway, with initial on-the-ground actions planned for 2015. The full program is expected to be implemented over the next 25 years.

The Salmonid Population Viability Project: Estimating Viability across Broad Regions under Changing Climates

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Government agencies and NGOs involved in fish conservation regularly conduct conservation planning to identify populations which are at risk or secure, and to target locations where management interventions can provide the greatest conservation benefit. Although ideally this planning would be guided by formal population viability analyses (PVA) to determine the probability that each population will persist, with and without management actions, in practice most conservation planning relies on indirect surrogates of viability such as extent of stream habitat occupied or patch size. This is due primarily to a lack of accessible, data-driven methods for PVA that can be used across broad spatial scales. We developed a new statistical Spatio-Temporal Population Viability Model (ST-PVM), based on the classic Ricker model, that combines fish sampling data with remotely-sensed data to deliver simultaneous estimates of carrying capacity, inter-annual variability, and viability for many populations across large areas. Remotely-sensed spatial covariates describe habitat size and quality, while temporal variability is modeled as a function of variables such as temperature and flow. Importantly, the approach can leverage information from well-sampled areas to extrapolate to poorly sampled or even un-sampled populations, under current and future climates. We conducted a pilot study of Lahontan cutthroat trout (LCT; *Oncorhynchus clarkii henshawi*), a federally threatened subspecies of cutthroat trout native to the Great Basin. We assembled data from 38 populations of LCT sampled between 1 and 12 times between 1992 and 2013. The model proved successful in generating simultaneous estimates of extinction probability and carrying capacity for all populations that were reasonable matches to independent estimates; we discuss plans for further model refinements, including incorporation of non-native trout, as well as exploration of different management scenarios (e.g., barrier removal) and estimation under climate change. This new modeling framework fills a crucial gap, connecting population ecology relying on extensive field collections with landscape ecology methods that rely on broad-scale Earth observations, and has broad applicability for conservation planning and management by making range-wide quantitative PVA approachable for many taxa of conservation interest.

Effects of Harvest Regulations on Population Dynamics of Lake Trout in Priest Lake, Idaho

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Lake Trout *Salvelinus namaycush* have been introduced widely throughout the western United States to enhance recreational fisheries. Although Lake Trout can provide a desirable trophy component, high predatory demand can create challenges for management of yield and trophy fisheries alike. Lake Trout were introduced to Priest Lake, Idaho, during the 1920s, but remained at low abundance until the introduction of *Mysis diluviana* in the 1960s. The subsequent decline of the popular kokanee *Oncorhynchus nerka* fishery was attributed to increased survival of young Lake Trout due to mysid introduction. By the 1990s, Lake Trout dominated the recreational fishery in Priest Lake. Although Priest Lake has experienced drastic changes in the fish community, little fishery-independent information is available. The objective of this study was to better understand the dynamics of the Lake Trout population in Priest Lake using an age-structured population model. A Lake Trout mark-recapture study was conducted in spring 2013. Structures for ageing were also collected to estimate population age-structure, growth rates, and mortality rates. Maturity status and fecundity were estimated during a supplemental autumn sampling event, prior to peak spawning. A Leslie matrix population model was constructed using these demographic data and data from the literature. The model was used to assess population growth rates under several management strategies, including Lake Trout removal efforts of varying intensity and different harvest regulations (e.g., slot limits). The model will allow managers to quantitatively assess management strategies and inform management actions for Lake Trout in Priest Lake. This research also contributes to the broader understanding of nonnative, exploited Lake Trout populations in the western U.S.

Trophic Structure of the Fish Assemblage in Priest Lake, Idaho

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Understanding energy flow and trophic interactions in lentic ecosystems can help direct management decisions regarding water quality, fish stocking, and harvest regulations. Increasingly, stable isotope ratios of carbon and nitrogen have been applied in studies of food webs and trophic ecology. Stable isotopes can provide both qualitative and quantitative measures of trophic structure. In this study, we evaluated the trophic structure of the fish assemblage in Priest Lake, Idaho. In addition to describing relationships within the fish assemblage, we also evaluated Lake Trout *Salvelinus namaycush* diet composition. Carbon and nitrogen isotopic signatures were analyzed for 11 members of the fish assemblage, two size classes of *Mysis diluviana*, and zooplankton. Fish tissue was collected in the spring of 2014 using bottom-set and floating gill nets and electrofishing. Zooplankton and mysid samples were collected in spring 2014 using vertical net tows. All samples were analyzed for δ13C and δ15N by the Washington State University Stable Isotope Core Laboratory using standard methods. Overall trophic structure was assessed using stable isotope biplots. Principle prey of Lake Trout were identified using mixing models. The results of this research will allow managers to better understand the interactions among the fish assemblage in Priest Lake, particularly for Lake Trout.

The Effects of Specific Gravity on Inventory Methods for Hatchery Rainbow Trout

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Many fish production facilities utilize the water displacement method to quantify populations of fish for inventory, transport loading and stocking purposes. The displacement method is directly affected by the specific gravity of the fish biomass being measured. Specific gravity is defined as the ratio of the mass of a body to the mass of an equal volume of water. Currently, many fish production facilities assume a specific gravity value of 1.00. The purpose of this study was to attempt to discover any observable trends in the actual specific gravity of Rainbow Trout used in hatchery production for stocking purposes. Study groups consisted of 50 fish samples with replicates for each study group. Study groups were obtained from triploid Rainbow Trout production lots that averaged 3", 6" and 10" in length. These size classes represent typical requested stocking sizes where the displacement method is commonly utilized for transport loading. Study groups were sampled for individual length, weight and the volume of water displaced. The variance of specific gravity values from the assumed 1.00 value was analyzed among study groups. Analysis was also performed on the variance of specific gravity values between size classes.

White Sturgeon Diets: They are what eat, which is a little bit of everything!

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As any fisherman can attest, white sturgeon can be notoriously picky eaters contrary to their reputation as indiscriminant bottom feeders. Surprisingly little is known about sturgeon food habitats, particular in Columbia River reservoirs which have substantially altered the aquatic community. In February and March of 2009, gastro-intestinal tracts (GIT), were collected from white sturgeon taken in the fishery Zone 6 tribal fish commercial fishery the Columbia River. A total of 196 samples were collected from The Dalles (n=60), Bonneville (n=66) and John Day (n=70) reservoirs, respectively. Samples were analyzed by general categories such as fish, invertebrates, plant material, non-food items (i.e. rocks and sticks). Sorted items were counted and weighed to the nearest tenth of a gram. When possible, materials were keyed to the species level and enumerated to whole animals. Analyses revealed a diverse diet including a variety of organisms. Differences in food items among reservoirs may be related to differences in habitat condition and sturgeon population densities in each reservoir.

Aquifer Management and River Flows

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River flows are often influenced, sometimes significantly, by the management of hydrologically-connected aquifers. Aquifers that are being drawn down may result in reduced spring-flow contributions to river flows. Likewise, an aquifer where ground water levels are rising may result in increased spring-flow contributions to river flows. The Eastern Snake Plain Aquifer (ESPA) underlies more than 10,800 square miles of southern Idaho and is one of the most productive aquifers in the world. The ESPA is in direct hydrologic connection with the Snake River, which is southern Idaho's major river system. The Snake River alternately contributes water to, and receives water from the ESPA. Between about 1900 and 1952, approximately 17 million acre-feet of water were added to aquifer storage due to the construction and operation of "leaky" canals and irrigation systems on the Eastern Snake River Plain using water from the Snake River and its tributaries. This resulted in a "supercharged" aquifer with raised ground water levels and increased spring flows. Since 1952, however, due to increasingly efficient canal and irrigation operations, drought cycles, and large-scale ground water pumping, 12 million acre-feet of water have been lost from aquifer storage. This has resulted in declining ground water levels and declining spring flows. This has resulted in numerous water-use conflicts that threaten the viability of Idaho's economy. Because spring flows from the ESPA comprise a major part of Snake River flow downstream of the Thousand Springs area, declining spring flows from the ESPA pose a significant challenge for the maintenance of Snake River flows. These factors have led the State of Idaho, in cooperation with numerous partners, to undertake management efforts to stabilize aquifer levels and spring flows.

Technical developments providing improved downstream passage of diadromous fish through use of barrier and collection nets and floating surface collectors at high-head dams

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The Skagit River annual adult sockeye returns plunged to a low of just ninety-nine fish in 1985, imperiling the stock. Puget Sound Energy enacted a number of strategies to support the watershed's fish populations. By 2012, forty-eight thousand returning fish were counted. The presenters company, worked closely with PSE designing two barrier nets to divert and collect down-steam migrating salmon. The success of these systems has been proven in fish passage counts, installation and maintenance cost, and customer satisfaction. Following PSE's investment in this barrier netting system, and with other system improvements, by June of 2014, over one million downstream migrating salmon were counted, with returns of sixty to one hundred thousand adult fish expected. This presentation will discuss recent successful technology developments which have improved fish passage survival at this and other facilities and provided reduced impingement and entrainment at several installations in North America.

We will provide an introduction to high-tech barrier nets, their design, material and construction and their use with floating collection systems in order to create solutions for improved downstream fish passage.

We will review of successful applications of local, regional and national barrier and collection systems for five different species. We will discuss the planning and engineering considerations which should be made prior to deployment including considerations for unique environmental concerns including; flow velocity, debris, temperature, pool fluctuation, and wave energy.

Project Documentation: the Key to our Future and the Story of our Past

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Aquatic monitoring programs in the Pacific Northwest have developed based on organizational and jurisdictional needs and objectives. The Pacific Northwest Aquatic Monitoring Partnership (PNAMP) was created to facilitate collaboration and coordination of the diverse monitoring programs within the region. PNAMP and regional partners have identified documentation as a best practice for data management.

The benefit of adequate documentation is in knowing what others are doing. This allows us to make the best use of limited resources and ensure we're offering the most accurate portrayal of the health of our streams, watersheds, and their inhabitants. To support partners, PNAMP has developed a suite of complementary web tools, MonitoringResources.org, designed to assist practitioners in documenting how, when, where, and why data are collected. With standard documentation, practitioners can document details once, easily update yearly, and share their work many times. These tools can also link to outside information systems (e.g., project tracking systems, databases, metadata repositories) for automated updating. This all allows funders and managers to review existing and proposed work in order to better understand gaps and redundancies in regional monitoring.

The tools can help focus partnerships and promote greater understanding of the monitoring programs in the region through a standard process for documenting collection and analysis methods and details about your spatial and temporal study design. PNAMP's tools are also designed to manage monitoring sites, and create a sample design. The information that is documented or produced is integrated to allow users to engage in more efficient planning. Long term storage of information will preserve yearly documentation, making it easy to find details of how the data were collected and analyzed in the future. Standard documentation supports information sharing between monitoring programs in the region, allowing us to leverage dwindling funds for higher quality data.

Interactions between Fluctuating Reservoir Water Levels and Bull Trout (*Salvelinus confluentus*)

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Ecology Fluctuations in reservoir water levels alter habitat in tributaries that traverse the dewatered areas of reservoirs (varial zones). Adfluvial fish including the threatened bull trout (*Salvelinus confluentus*) must migrate through these varial zones to reach their spawning areas and to return to the reservoir. Aquatic habitat surveys in varial zones and upstream reference zones of eight regional reservoirs showed less cover as well as higher velocities and higher embeddedness in the varial zones. Six of the eight tributaries surveyed contained shallow deltas at the confluence of tributary and reservoir. Fish travel speeds based on radio telemetry in one of two tributaries investigated with tagged fish (Middle Fork Boise River) were not significantly different within or between reference and varial zones for upstream and downstream migrations. Fish travel speeds in the second, smaller tributary (Trail Creek) were significantly different overall between zones during downstream migration (higher in varial zone), but not upstream migration. Remote cameras on Trail Creek documented avian predators concentrated in the shallow delta area where bull trout traveled slowly, often with their backs out of the water. Mortality rates of radio tagged bull trout as they traveled through the relatively short (max 1,250 m) varial zone of Trail Creek in a single night averaged 19.6%. Increasing the reservoir water level prior to downstream migration of bull trout after spawning could flood the shallow deltas, improving habitat and decreasing mortality.

Evaluation of the standardized electrofishing project for the Upper Colorado River Endangered Fish Recovery Program

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Evaluation of the standardized electrofishing project for the Upper Colorado River Endangered Fish Recovery Program. The Upper Colorado River Endangered Fish Recovery Program has established standardized electrofishing to monitor progress of its efforts. During August 2014, 5 boats and 4 rafts (units) were brought to a workshop in Grand Junction, Colorado, to evaluate standardization. All boats used two 9-inch-diameter (23-cm) spheres as anodes and the hull as cathode; rafts used one 9-inch sphere and two sets of three or four droppers as cathodes. Each unit was assigned three half-mile (0.8 km) segments on the nearby Colorado River. Water temperature was 21.3-24.1 °C; ambient conductivity 844-1270 µS/cm. All units used 60-Hz pulsed DC at 20% duty cycle and initially set current (amperes) according to standardized guidance, making adjustments as needed thereafter. Results indicated that threshold currents averaged 10.2 A (21.5% CV) for rafts and 21.2 A (19.5% CV) for boats, no overlap in amperes between boats and rafts. Twenty-three species and 505 fish were caught with species per segment ranging from 2 to 10 and fish per segment 2 to 36; there were no significant differences in species or fish per segment among units ($P > 0.05$). Only two species were sufficiently abundant to extend statistical analysis: flannelmouth sucker *Catostomus latipinnis* (241) and bluehead sucker *Catostomus discobolus* (104). ANOVA (unit versus segment) of catch per segment for both species gave non-significant results ($P > 0.05$). Therefore, we concluded that the standardized protocol achieves comparability among the units tested but large variance in catch data will require lower confidence levels, larger samples or non-parametric methods to detect real change in populations over time and among locations.

Managing livestock grazing in riparian areas on public lands in the 21st century.

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Managing livestock disturbance in riparian zones in a manner that protects streams and cold water fish while allowing foraging opportunities is an important aspect of sustainable public land management. While the last 20 years we have seen substantial progress in how land management activities such as timber harvest and road construction have been modified to maintain riparian areas, there have been few changes in how livestock are managed. I will track changes in thought of how livestock should be management on federal lands over the last 25 years. I will use these trajectories to purpose how we might best manage livestock in areas with native salmonids in the future.

Stock Assignment of Fluvial Rainbow Trout *Oncorhynchus mykiss* in the Kootenai River, Idaho Using Otolith Microchemistry: Lessons Learned and Future Directions

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Fluvial Rainbow Trout, *Oncorhynchus mykiss*, populations in the Kootenai River, Idaho have long-been speculated to be recruitment-limited due to lack of suitable spawning habitat as well as various anthropogenic alterations to the river. Historical studies have suggested that tributaries in Montana provide large numbers of out-migrant recruits to the mainstem Rainbow Trout population, and these recruits are thought to seed the majority of the mainstem adult population, both in Idaho and Montana. However, little work has been done to evaluate the natal origins of catchable, adult Rainbow Trout in the mainstem river, which, when coupled with historical out-migrant estimates from respective tributaries, can provide information on relative survival that has direct application to management targets. An otolith microchemistry pilot study was initiated in November 2012 and completed in May 2014. The pilot study addressed two questions: (1) could tributaries to the Kootenai River be differentiated from one another using strontium isotopes derived from otoliths of pre-outmigrant young-of-year (YOY) Rainbow Trout and (2) could adult Rainbow Trout collected from the mainstem river be assigned back to natal tributary based on otolith strontium signatures? Five YOY Rainbow Trout were collected from 11 different tributaries to the Kootenai River in November 2012, and 29 adult Rainbow Trout were collected from a reach in the mainstem Kootenai River during fall 2013. Results indicated that 9 of 11 tributaries had strontium signatures that could be differentiated from one another (based on otoliths from YOY Rainbow Trout). Of the 29 captured adults, all but one could be assigned back to tributary of origin. Thirty-nine percent of the captured adults originated in Idaho tributaries, 39% in Montana tributaries and 21% from the mainstem Kootenai River. Furthermore, relative contributions from various tributaries were not consistent with historical out-migrant estimates. Results from this pilot study confirm the potential utility of this method in freshwater systems, and they provide valuable information on study design needs and considerations for any manager or researcher considering using this technique.

Competition Between Wild Trout and Stocked "Catchable" Trout: Literature Review and Thoughts on a Long-Standing Debate

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Few issues in the wild trout management arena have proven more controversial or longstanding than the dialog regarding potential negative competitive effects of catchable trout stocking programs on lotic wild trout populations. Here, I define wild trout as fish that are progeny of adult trout spawned without human intervention and catchable trout or “catchables”, as stocked trout of sufficient size (about 200 mm total length) to be caught immediately after being released. I review the literature on competitive interactions between these two groups of fish in streams and discuss potential reasons for differing perspectives regarding results of past competition studies. There are few resident fish competition studies that incorporated manipulative designs. Two of the most influential catchable:wild competition studies in the literature were presented at Wild Trout III with the authors reaching opposite conclusions. Researchers directly evaluating competitive interactions between catchable trout and wild trout using “strong” manipulative treatment and control designs have not concluded that stocking catchables results in population-level impacts. The largest such competition study yet conducted and reported in some detail here found that the abundance, recruitment to age 1, survival, growth, and condition of wild Rainbow Trout *Oncorhynchus mykiss* were all unaffected by stocking catchable trout. Despite the lack of consistent empirical support confirming the existence of a competitive effect from stocking catchables on wild trout, professional dialog in the literature and certainly at professional meetings often appears to assume that the competition hypothesis has been rigorously supported. I discuss possible reasons for the dichotomy of views regarding interpretation of results from catchable-wild trout competition studies, ultimately concluding that the best explanation lies in the sociology of science and our inability to remove humanity (and hence values) from ourselves as scientists. It is indeed possible that the next well designed manipulative study of the competition issue will show a meaningful, population-level effect. Until then, the wild trout community should rethink the widespread belief that stocking hatchery catchables results in meaningful competitive effects on wild trout.

Stable isotope analysis of fish liver in food web studies: a methods investigation

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Understanding fish diet is essential to effectively manage fish populations, especially those facing the dual threats of climate change and cultural eutrophication that may alter lake food web dynamics. Stable isotope analysis (SIA) is becoming an increasingly powerful tool to examine diet, predator-prey relationships, competition, and community feeding ecology. The use of liver in carbon (C) and nitrogen (N) SIA diet studies shows great promise, but methods need further refinement. The purpose of this study is to (1) assess the relationship between C:N ratios and δ13C in the livers of rainbow trout (*Oncorhynchus mykiss*), brook trout (*Salvelinus fontinalis*), largemouth bass (*Micropterus salmoides*), and golden shiner (*Notemigonus crysoleucas*) sampled during the growing season in Twin Lakes, WA; (2) determine if mathematical normalization equations can be developed to account for lipid content; and (3) determine C and N isotopic fractionation in hatchery-raised trout liver and white muscle relative to that of hatchery feed. These key SIA methods investigations ensure best methods are used to determine fish diet in future studies. Additionally, we believe mathematical lipid normalization equations derived from this study can reduce effort associated with liver SIA, improving the economy and ease of application.

The Effect of Turbulence in Hydropower Dam Fish Passageways on Pacific Lamprey Passage

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Pacific Lampreys (*Entosphenus tridentatus*) are an anadromous parasitic lamprey found in the northern Pacific Ocean. They migrate up the Columbia River and into its tributaries to spawn. Although, Lower Columbia Dams have fish passageways that are designed for anadromous salmon and steelhead, the passageways are not easily passable for Pacific Lamprey. It has been suggested that the serpentine weirs within the fish passageways are a barrier for Pacific Lamprey. Consequently, a Lamprey dedicated passage systems have been designed and installed on the dams to provide passage and an experimental flume has been designed to study the conditions within the serpentine weirs. Here, we present the design of the new Lamprey passageways installed and the John Day Dam and the first results of the flow properties within the serpentine structure. Fish count data shows that the lamprey dedicated passageways prevent a challenge for the Lamprey. Serpentine flume experiments were designed to have three different weir lengths, a turbulence treatment, and three different flows. The velocities through the weir in the flume are similar to those experienced within the serpentine weirs, maximum of approximately 1.2 m/s. An automated acoustic doppler velocimeter (ADV) has been employed to measure velocity and turbulence within the flume on a grid at three different depths near the flume bottom. The ADV data has been completed and is presented in this presentation. Passive integrated transponder (PIT) tags have been utilized to determine passage of the Lamprey through the obstacles within the flume. Lamprey have been studied within the flume with dual frequency identification sonar (DIDSON) cameras to monitor behavior and reactions to varying turbulence in specific areas of interest within the flume.

Coeur d'Alene River Restoration

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North Idaho's Coeur d'Alene River began with conditions "teeming with fish" and became the heart of thriving timber and mining industries. Post Falls Dam was built downstream, and farms developed in its floodplain. Upstream, the mining industry became one of the world's leading producers of silver, lead, and zinc. Unfortunately, early practices disposed of mine-related wastes into Coeur d'Alene River tributaries and metals contamination became widely distributed. These metals injured water quality, sediments, vegetation, and aquatic life. As a result, the Coeur d'Alene River became "practically devoid of fish fauna, bottom fauna, or plankton organisms" (M.M. Ellis, U.S. Bureau of Fisheries, 1940). Intensive land use practices of the past also impacted the Coeur d'Alene River's watershed, floodplain and river itself.

Fortunately, land use practices advanced, remediation and natural resources restoration are underway in the Coeur d'Alene Basin, and conditions in the Coeur d'Alene River are improving. Ongoing efforts include state, federal, tribal, industry, and private landowners at a large scale. The Bunker Hill Mining and Metallurgical Superfund Site is being cleaned up by the Environmental Protection Agency and others. Besides the cleanup, other projects are being led by Avista Utilities, the local Conservation District, and many other agencies and stakeholders.

An interagency group of natural resource trustees, the Restoration Partnership, recently initiated large-scale restoration of the Coeur d'Alene Basin. Through Natural Resource Damage Assessment (NRDA) and litigation, federal, tribal, and state natural resource trustees settled with parties responsible for mine waste contamination and associated injuries to natural resources and the services they provide. The combined settlements will be used to restore the injured natural resources in the Coeur d'Alene River and elsewhere in the Basin according to a restoration plan being prepared with public involvement. Streams and native trout are some of the draft plan's focal resources. Once approved, the Restoration Partnership will further galvanize improvements to the Coeur d'Alene River and contribute more than $100 million into natural resources restoration in the Basin. With successful collaborative efforts, the next 100 years of the Coeur d'Alene River's future will be even more rich and diverse than the last.

Effects of groundwater management on hydrologic regimes in the Snake River Basin, and implications for water and fisheries management

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The downstream hydrologic effects of surface-water storage and diversions have been well understood for two decades, and fisheries professionals have incorporated this understanding into fisheries management and restoration actions. However, the effects of groundwater management on surface hydrologic regimes are not as widely understood, limiting the ability of fisheries professionals to evaluate the effects of groundwater management actions on fish and their habitats. In the Snake River Basin, where groundwater and surface water are highly connected, groundwater seepage incidental to irrigation has been a major driver of regional hydrology since the late 19th century. At spatial scales ranging from small tributary basins to the entire upper Snake River basin, only about 40% to 50% of total irrigation withdrawal from streams and rivers is consumptively used; the remainder recharges local and regional aquifers, returning to the surface system down-gradient as seeps and springs. Diversion and storage of the spring freshet, in combination with groundwater return flows, has shifted hydrologic regimes of the Snake River and its tributaries from dominance by snowmelt runoff to dominance by groundwater. Although this shift has had well documented negative consequences for native species, increased groundwater influence has had positive effects on important nonnative sport fisheries and has created or enhanced spring and wetland habitats used by native and nonnative plants and animals. Increased irrigation “efficiency” and increased groundwater pumping over the past 60 years have decreased groundwater recharge, prompting enactment of State-level policies that promote managed aquifer recharge and administer surface and groundwater rights as a single system. Paradoxically, increases in irrigation efficiency have resulted in decreased streamflows, through a combination of decreased return flows and increased consumptive use. Fisheries professionals currently face a “waterscape” that is rapidly increasing in hydrologic, administrative, and legal complexity. Effects of water-management actions often have effects on fisheries that are unintended and non-intuitive. Detailed, site-specific hydrologic analysis is becoming increasingly needed to evaluate effects of water-management actions on fisheries in the Snake River basin.

Accuracy and precision of Kokanee age estimates from four different structures

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Kokanee age estimation is most commonly done by examining hard structures. The choice and preparation of hard structures for ageing Kokanee varies. However, the accuracy and precision of estimates from the selected technique is generally not evaluated. We evaluated three commonly used structures (scales, whole otoliths, and sectioned otoliths) for ageing Kokanee. Additionally, we included sectioned pectoral fin rays because they are an effective structure for ageing other fish species. Our goal was to determine which structure provided the most accurate and precise age estimates for Kokanee. For each structure, we compared three readers' age estimates from 151 known-aged Kokanee from Lake Pend Oreille. Additionally, each reader assigned a confidence rating of 0 (no confidence) to 3 (absolute confidence) to each structure. For the initial independent examinations, exact agreement among all three readers ranged from 42% for sectioned otoliths to 74% for scales. Accuracy (A) and mean coefficient of variation (CV) of the age estimates was highest for scales (A = 94%; CV = 6.0%) followed by fin rays (A = 88%; CV = 9.2%), whole otoliths (A = 79%; CV = 13.7%), and sectioned otoliths (A = 74%; CV = 17.9%). Mean confidence rating was significantly higher for scales ($\bar{x}$ = 2.40) than for pectoral fins ($\bar{x}$ = 1.79), whole otoliths ($\bar{x}$ = 1.72), and sectioned otoliths ($\bar{x}$ = 1.81). Scales provided the most accurate and precise age estimates, and we recommend using them to age Kokanee. Ages estimated from sectioned pectoral fin rays were nearly as accurate as those from scales and the CV did not significantly differ between the two structures. Therefore, pectoral fin rays also provide a reasonable age estimate for Kokanee.

Challenges in Monitoring a Large River Overwintering Fluvial Bull Trout Population

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Idaho Power Company began relicensing studies for the Hells Canyon Hydroelectric Complex in 1998. Bull trout (*Salvelinus confluentus*) were known to occur in the Snake River below Hells Canyon Dam, but little was known about their distribution, abundance, or life history. Idaho Power biologists have experimented with multiple sampling methods over the past 16 years in an effort to collect bull trout population data through the reach, but limited access, large whitewater rapids, the presence of other listed species, and the size of the river made the use of many common sampling techniques ineffective or impractical. An early effort to radio tag bull trout revealed their susceptibility to angling during the overwinter period. Following multiple years of rod and reel catch-per-unit-effort (relative abundance) monitoring of the population, index reaches were established and a mark/recapture monitoring approach was developed. Future monitoring will involve PIT-tagging as many individuals as possible annually during the overwinter period by rod and reel sampling and through ongoing Nez Perce Tribe and Oregon Department of Fish and Wildlife anadromous fish trapping efforts in the Imnaha River basin during the spring and fall migrations. Annual reencounter data from a PIT-tag antenna network in the Imnaha River Basin and from angling and trapping will be used to estimate bull trout abundance, survival, and intrinsic rate of increase (λ). Population metrics will be used to evaluate population trends and status relative to the U.S. Fish and Wildlife Service's Revised Bull Trout Recovery Plan for the Imnaha River Core Area.

Evaluating the Kokanee Growth Response to Nutrient Restoration in Dworshak Reservoir, Idaho.

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Nutrient restoration has been successful in stimulating production and efficiency of lower trophic levels in Dworshak Reservoir. Research has shown that Kokanee prefer to consume Daphnia over 0.8 mm in length. In Dworshak Reservoir, the density and biomass of Daphnia this size were twice as high during restoration years than during non-restoration years. However, factors affecting Kokanee growth have not been rigorously tested in the reservoir. Mean annual growth of Kokanee was estimated by first back-calculating length-at-age from scales. Growth estimated using this method was similar to mean annual growth estimated from trawl surveys for years in which comparisons could be made. Kokanee growth was greater on average for restoration years, and summing the mean growth advantage for all age classes suggests an increase of 26 mm TL through age-2. A combination of linear fixed-effects and mixed-effects models were then used to test the importance of several factors, including age, abundance, nutrient addition, and food availability, on annual growth. Mean annual growth was negatively correlated to abundance for age-1 and age-2 fish, but not age-0 fish. Mean growth was also positively correlated with the mean biomass of Daphnia for age-1 and age-2 fish, but not age-0 fish. Mean Daphnia biomass was consistently the most important factor in predicting annual growth. Our results suggest that Kokanee growth in Dworshak Reservoir has been improved as a result of increased food availability due to nutrient restoration.

Hybrid zone structure in westslope cutthroat trout and rainbow trout in Northern Rocky Mountain headwater streams

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The introduction of nonnative rainbow trout into locations supporting indigenous populations of westslope cutthroat trout has been regarded as an ecological disaster. Some have argued that, in the absence of direct suppression of rainbow trout or physical barriers to its continued spread, genomic extinction of westslope cutthroat trout is inevitable. Hypothetically, all such mixed populations will become hybrid swarms, in which the genes of both species are randomly distributed among individuals and pure parental fish are absent. Using a panel of 69 single nucleotide polymorphisms largely diagnostic for each species, we evaluated the patterns of hybridization between westslope cutthroat trout and rainbow trout at 193 headwater sites in northern Rocky Mountain streams, including locations in which both species were native. Of the nearly 3,700 fish genotyped, 82% were genetically pure or weakly introgressed westslope cutthroat trout, 5% were genetically pure or weakly introgressed rainbow trout, and only 2% of fish showed nearly equal contributions of genes from both species. At nearly all sites, the distribution of introgression was non-random and generally dominated by parental forms of one species. These patterns did not differ between sites in the Clearwater River in Idaho, in which rainbow trout were native, and in northern Idaho and western Montana, in which rainbow trout were introduced, similar to patterns involving cutthroat trout and rainbow trout elsewhere in western North America. This implies substantial resistance to genetic replacement of westslope cutthroat trout by rainbow trout in headwater streams.

Apparent Fish-Assemblage Changes in Idaho Rivers

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Nearly 60 fish taxa are known to have been introduced into Idaho rivers. Over half of these may be classified as game fishes. Additional taxa are being identified through molecular analysis. A number of recent fish detections have been made in large Idaho rivers that challenge our beliefs concerning taxa occurrence. Research in Wyoming indicates phenotypic traits of the Snake River Sucker *Chasmistes muriei* occur in Jackson Lake and have the potential to occur in Palisades Reservoir. Sand Roller *Percopsis transmontana* are again being detected in the Snake River near Lewiston. Green Sunfish *Lepomis cyanellus* have now been documented in the Boise River and hybridization of dace *Rhinichthys sp*. in the Boise River appears to be occurring as well. These selected observations may have implications for management of large rivers in Idaho.

Lamprey drag force modeling for use in design of Lamprey Passage Structures (LPS)

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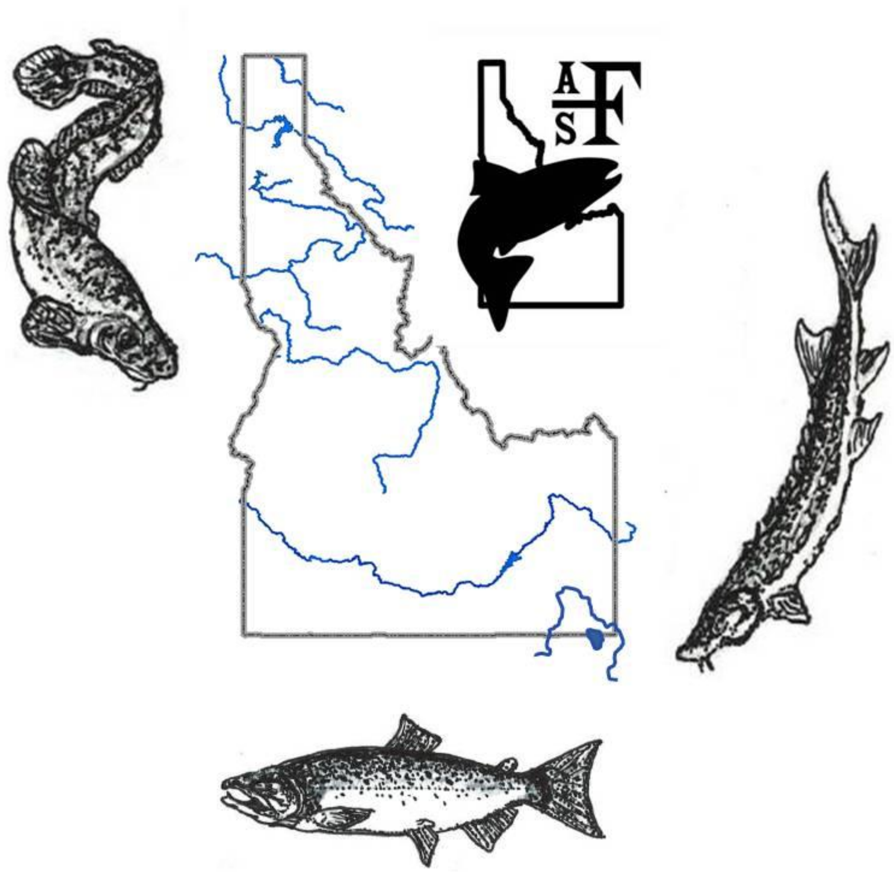
Lamprey drag force modeling for use in design of Lamprey Passage Structures (LPS) Pacific Lamprey (Entosphenus tridentatus) Passage Structures (LPS) provide an alternative route to existing fishways by exploiting the natural climbing behavior of the Pacific Lamprey. Designs of LPS are frequently site-specific and thus require deviation from past designs which can affect the passage efficiency. Pacific lampreys are unique in that they employ saltatory swim behavior and climbing when confronted with velocities above the critical swim speed. Moreover, lamprey may climb surfaces when flow depths are thin, including vertical faces with sheeting flow. While behavioral research investigating climbing performance identified the interaction between climbing performance, slope and discharge (Reinhardt et al. 2008), the underlying hydraulic forces remain unknown, thus preventing generalization to additional designs. We investigated varying slopes and discharges to explore the underlying hydraulics of Pacific Lamprey climbing behavior. Our investigation assessed the dead drag forces at four levels of static submergence: fully submerged (120 mm), equally submerged (40 mm), partially submerged (15mm), and skin flow (5mm) for a 50th percentile Pacific Lamprey model. We then used the results to estimate the coefficients of drag for each case, and then applied the results to predict when the fish would fail to pass. Our results indicate that design and optimization of the LPS systems will benefit by using a drag force model instead of a velocity model because the drag force model more closely correlates with the behavioral studies of Pacific Lamprey passage with varying slope and discharge.

Poster Abstracts

Idaho's large rivers:
History, Management and Restoration



artwork by Kelly Lepla

IDAHO CHAPTER
2015 ANNUAL MEETING

Boise Centre
Boise, Idaho
March 3-6

Poster Presentation Abstracts (Alphabetized by Presenter)

Stream Habitat Restoration: A Low-Cost, Low-Impact Method of Installing Large Woody Debris (LWD)

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Placement of wood into streams is a widely used restoration technique that increases aquatic complexity in treated reaches. This type of restoration typically involves the use of heavy equipment, which increases construction costs and can result in significant impacts to the adjacent area. In the fall of 2014, twenty-four large woody debris (LWD) structures were installed by hand in Bloom Creek, Idaho to improve in-stream habitat and channel complexity. This low-impact method was chosen because Bloom Creek is a small, low gradient system that does not require the larger diameter LWD that is typically installed by an excavator. Instead, smaller diameter LWD was installed by hand with little to no disturbance at a much lower cost. These structures will increase the in-stream habitat complexity and improve Steelhead Trout (*Oncorhynchus mykiss*) habitat by creating juvenile rearing habitat and improving water quality. A pneumatic post pounder and air compressor were used to drive 3-4" wooden posts to a depth of 60 -90cm into the stream bed pinning the LWD pieces together forming a structure. Eighteen structures were placed in-stream to constrict the flow of water resulting in channel scour, pool formation and sediment transport. Six structures were built for bank stabilization. Cost per structure was $630 less than previous projects that used heavy equipment for structure installation in neighboring reaches. Future monitoring of these structures in the summer of 2015 will evaluate the effectiveness of this technique for improving in-stream habitat.

Using aerial imagery to quantify change in riparian habitat and beaver occurrence, 1991-2013, related to improved grazing practices

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Loss of herbaceous and woody riparian vegetation and concomitant increase in water temperature are some well-documented effects of annual hot season grazing by livestock in western US streams. One such region historically grazed throughout the summer months on an annual basis is the water-poor high desert Susie Creek drainage in northeastern Nevada. Beginning in 1990, prescriptive grazing practices designed to limit frequency and duration of hot season grazing were implemented across different grazing allotments on public and private lands in an effort to restore the stream/riparian system. Our current analysis quantifies change in riparian vegetation and other features since implementation of the management regimes. We conducted landcover classification of the approximately 500 km2 drainage area using high resolution aerial photography for two timeframes: an object-oriented supervised classification of 1991 photos and a Normalized Difference Vegetation Index (NDVI) classification of 2013 National Agricultural Imagery Program (NAIP) photos. Area of each landcover class, limited to the lateral extent of the valley floor and floodplain as calculated with a Valley Confinement Algorithm (VCA), was quantified and then compared between the two years. Additionally, we performed visual inspection of the imagery to quantify occurrence of beaver dams in each year. Our results demonstrate substantial increase in riparian vegetation and extensive beaver establishment across the drainage over the 22-year period indicating the importance of well-managed grazing to maintenance of intact riparian habitat.

Investment in Mentoring to Promote Diversity in Conservation Professions

Elizabeth Braker[1], Christine M. Moffitt[2,3], Kerri Vierling[3], Courtney Conway[2,3], and Michael Quist[2,3]
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The Doris Duke Conservation Scholars Program (DDCSP) at the University of Idaho is a multi-institution initiative funded by the Doris Duke Charitable Foundation designed to recruit and mentor undergraduates with a demonstrated interest in cultural diversity and environmental conservation. Our scholars participate in a two-year long program that includes a research summer experience followed by an agency/tribal summer internship the next year. In the summer of 2014 two of the scholars conducted benthic surveys of Lake Pend Oreille to determine the extent of the aquatic invasive species, the Asian clam (*Corbicula fluminea*), and three conducted field work on terrestrial wildlife. During the academic year, the cohort of scholars engaged in a group project focused to communicate conservation to a diverse audience in a relevant fashion. This coming summer they will head to internships at locations from Hawaii to Alaska and Idaho. At the completion of the program, the students will have gained hands on experience in fish and wildlife science, and have established a strong network of support to continue careers in environmental conservation. Through this program, we hope to increase the number of culturally diverse and inclusive natural resource professionals and enhance environmentally informed decision-making in a culturally rich society.

Genotyping-in-Thousands by sequencing (GT-seq): A cost effective SNP genotyping method based on custom amplicon sequencing

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Genotyping-in-Thousands by sequencing (GT-seq) is a method that uses next generation sequencing of multiplexed PCR products to generate genotypes from relatively small panels (50-500) of targeted SNPs for thousands of individuals in a single Illumina HiSeq lane. This method uses only unlabeled oligos and PCR master mix in two thermal cycling steps for amplification of targeted SNP loci. During this process, sequencing adapters and dual barcode sequence tags are incorporated into the amplicons enabling thousands of individuals to be pooled into a single sequencing library. Post sequencing, reads from individual samples are split into individual files using their unique combination of barcode sequences. Genotyping is done with a simple perl script which counts amplicon specific sequences for each allele and allele ratios are used to determine genotypes. We demonstrate this technique by genotyping 2,068 individual steelhead trout (*Oncorhynchus mykiss*) samples with a set of 192 SNP markers in a single library sequenced in a single Illumina HiSeq lane. Genotype data were 99.9% concordant to previously collected TaqMan™ genotypes at the same 192 loci but call rates were slightly lower with GT-seq (96.4%) relative to Taqman (99.0%). Of the 192 SNPs, 187 were genotyped in ≥ 90% of the individual samples and only 3 SNPs were genotyped in less than 70% of samples. This study demonstrates amplicon sequencing with GT-seq greatly reduces the cost of genotyping hundreds of targeted SNPs relative to existing methods by utilizing a simple library preparation method and massive efficiency of scale.

One fish, two fish, red fish, blue fish; genetic results identify the origin of Chinook salmon in an "extirpated" population in central-Idaho

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An objective of the Shoshone-Bannock Tribes' (Tribes) Crystal Springs Fish Hatchery is to contribute to the recovery of the threatened Snake River Spring/Summer Chinook Salmon Evolutionarily Significant Unit (ESU) by reintroducing and rebuilding a locally adapted population of summer-run Chinook salmon (*Oncorhynchus tshawytscha*) in Panther Creek, Idaho. Despite being classified as extirpated by the Interior Columbia River Basin Technical Recovery Team (ICTRT), recent information suggests a Chinook salmon population has been established in Panther Creek; however, the origin of these fish was unknown. Therefore, the U.S. Fish and Wildlife Service (USFWS) in collaboration with the Tribes conducted a mixed stock analysis (MSA) to determine the likely origin of Chinook salmon collected in Panther Creek in 2010. Results indicated that the collections made in 2010 primarily originated from the South Fork Salmon River major population group (MPG), and were likely derived from South Fork MPG strays or reserve Chinook salmon transplanted from the McCall Fish Hatchery in 2001 by Idaho Department of Fish and Game for a consumptive fishery. In 2011, the Tribes collected juvenile Chinook salmon from Panther Creek to further evaluate the genetic characteristics of the naturally reproducing population found there.

An Update on Snake River Sockeye Salmon Production at Springfield Fish Hatchery

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The Idaho Department of Fish and Game's Springfield Fish Hatchery is an important new tool in the recovery of Snake River Sockeye Salmon. Sockeye Salmon culture operations at Springfield have been underway since the brood year 2013 eyed eggs arrived on station in December 2013. Provided is an update and summary of Springfield Fish Hatchery's year one production goals, current inventory and production specific data for the brood year 2013 Sockeye Salmon. Additionally, hatchery specific milestones to date and production objectives for the upcoming brood years will also be summarized.

Distribution and life cycle of the giant salmonfly (*Pternonarcys californica*) in the Portneuf Valley, Idaho

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In rivers around the west, including those in Idaho, one of the most ecologically important insects is *Pternonarcys californica*, the giant stonefly commonly called the "salmonfly." Salmonfly emergence events, which occur after the larvae have reared for 2-3 years, are the bread and butter of fabled trout fisheries centered in the Snake River basin, and are known to provide key sustenance to migratory birds; the spring arrival of a many of these in Idaho occurs just in time for feeding on adult salmonflies before nesting. However, there is surprisingly little known of the basic life cycle and factors limiting the distribution of this insect. We are conducting investigations in the Portneuf watershed to describe the current distribution of salmonflies and their life cycle characteristics. Throughout 2013, we conducted monthly sampling of a population in Mink Creek, a tributary of the Portneuf, to track the growth and development of three distinct cohorts through the seasons and pinpoint emergence (which occurred in early May). In addition, in fall 2014 we conducted surveys along tributaries and the mainstem Portneuf in the valley surrounding Pocatello and compared our observations to similar surveys conducted in the 1970's. Despite changes in policies (e.g., Clean Water Act) and some practices since, we found no evidence of any changes in salmonfly distribution; they continue to be constrained to a few tributaries (same as those occupied in 1970's) and were entirely absent from the mainstem Portneuf River in this area. In other watersheds of the region, it is the larger, downstream habitats that sustain the most productive salmonfly populations, making their complete absence from the lower Portneuf River a striking contrast. A number of factors (singly or in tandem) might be responsible, including chronically high levels of sediment observed in this section, along with high temperatures and low oxygen levels that occur in late summer principally owing to low flows driven by water withdrawals. These insects may represent "keystones" to the restoration of recreational ecosystem services like trout fishing to this section of the Portneuf, and to the conservation of such opportunities along other rivers of our region.

A thermal map for all Idaho streams

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The diverse topography of Idaho, where elevations range from 710 – 12,662 feet, creates an equally diverse stream thermalscape. It is now possible to accurately describe that thermalscape for all Idaho streams using the significant amounts of stream temperature data the aquatics community within the state has amassed in past decades. As part of a larger regional effort, the NorWeST project funded by the Northern Pacific and Great Northern LCCs has developed a comprehensive, interagency stream temperature database for Idaho that consists of data from 4,888 unique sites and 12,755 summers of monitoring effort. Those data were used with spatial statistical network models to develop an accurate (r2 ~ 90%; RMSE < 1 ˚C), high-resolution (1 kilometer) stream temperature model, which was then used to predict consistent sets of historical and future climate scenarios for the 100,000 kilometers of stream in Idaho. This poster depicts a historical composite scenario that represents average August temperatures from 1993-2011. The data for stream climate scenarios are available as ArcGIS shape files for download from the NorWeST website (www.fs.fed.us/rm/boise/AWAE/projects/NorWeST.html). Daily summaries (min/max/mean) of the temperature data used to develop the temperature model are also available through the website if permission was given for their distribution. All data distributed through the website are attributed to the original source agency and contributing biologists/hydrologists in metadata files. Similar stream temperature maps and databases have been developed for Oregon and western Montana, or are in development for Washington and Wyoming. More details regarding the NorWeST project are described here www.greatnorthernlcc.org/features/streamtemp-database.

Kootenai Tribe of Idaho's Kootenai River Native Fish Conservation Aquaculture Program

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Kootenai River white sturgeon and burbot were keystone species in the Kootenai River and are of immeasurable cultural importance to the Kootenai Tribe of Idaho. These native fish once sustained an important Tribal fishery as well as a recreational fishery. The Kootenai Tribe started a sturgeon conservation aquaculture program in 1988 to preserve an adequate demographic and genetic base for a healthy future population. Kootenai sturgeon were subsequently listed as endangered under the ESA in 1994. Kootenai River burbot are functionally extinct. The Kootenai Valley Resource Initiative completed a Burbot Conservation Strategy in 2005 in lieu of an ESA listing. A multilateral conservation agreement was developed to support reintroduction and recovery of burbot. The Tribe has operated a successful sturgeon conservation aquaculture facility since 1989. In 2014 construction of a second hatchery to produce sturgeon and burbot was completed. The conservation aquaculture program is part of a larger integrated ecosystem-based approach that includes habitat restoration and nutrient additions. The goals of the Kootenai sturgeon conservation aquaculture program are: prevent extinction of by preserving locally adapted genotypes, phenotypes, and associated life history traits; restore a healthy age class structure to enhance demographic and genetic viability; and reestablish a sturgeon population capable of future Tribal Treaty subsistence and cultural harvest. The goal of the burbot conservation aquaculture program is to reestablish a native burbot population in the lower Kootenai River capable of future Tribal Treaty subsistence and cultural harvest and sport harvest once the population reaches sustainable levels. The Tribe's Native Fish Conservation Aquaculture Program is transboundary in nature with sturgeon and burbot releases occurring in the U.S. and Canada. Freshwater Fisheries Society of B.C. provided a failsafe facility until 2014 and raised a portion of the Kootenai sturgeon for release in Canada. Burbot broodstock come from Moyie Lake in Canada. Both programs are adaptively managed through Annual Production Review meetings facilitated by the Tribe and attended by the B.C. Ministry of Forests Land Natural Resource Operations, Idaho Department of Fish and Game, Montana Fish Wildlife and Parks, U.S. Fish and Wildlife Service, U.S. Army Corps of Engineers, and Bonneville Power Administration.

Climate Shield Cold-Water Refuge Streams for Cutthroat Trout

Dan Isaak, Mike Young, Dave Nagel, Dona Horan, Matt Groce
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Climate change and species invasions raise fears of Cutthroat Trout extinction from much of its historical range this century. Using crowd-sourced biological datasets and high-resolution NorWeST temperature scenarios, we delineate invasion resistant climate-refuge streams for Cutthroat Trout across Idaho, Montana, and eastern Oregon. This poster shows the probability of juvenile Cutthroat Trout occurrence under two climate scenarios (1980s and 2040s) within 6,784 discrete stream habitats where the average temperature is <11ºC (cold enough to preclude Brown Trout and Rainbow Trout). Cutthroat Trout probabilities were predicted from four variables (habitat size, slope, mean temperature, and Brook Trout abundance) in a logistic regression model developed from 566 cold-water streams with known occupancy status (present or absent). Classification accuracy of the model was 85% (AUC = 0.88) and its application to the universe of cold-water streams revealed 2,184 with Cutthroat Trout occurrence probabilities >0.9 in the 1980s scenario. An average of 10 kilometers of cold-water stream was needed to meet that probability threshold, but stream lengths could be as short as 2 kilometers depending on stream slope, minimum temperature, and Brook Trout prevalence. In the 2040s scenario, the number of >0.9 stream habitats declined to 917 but Cutthroat Trout would persist in some areas even with pessimistic assumptions about widespread Brook Trout invasions. Most invasion resistant climate-refuge streams occur on federal lands (80% - 90%) where only a small portion currently has protected status (13% - 15%) in Wilderness Areas or National Parks. Better protection of refuge streams could help ensure the persistence of Cutthroat Trout this century and these streams could also provide a foundation for strategic conservation networks designed to maintain broader species distributions.

Climate Shield Cold-Water Refuge Streams for Bull Trout

Dan Isaak, Mike Young, Dave Nagel, Dona Horan, Matt Groce
U.S. Forest Service
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Climate change and species invasions raise fears of Bull Trout extinction from much of its historical range this century. Using crowd-sourced biological datasets and high-resolution NorWeST temperature scenarios, we delineate invasion resistant climate-refuge streams for Bull Trout across Idaho, Montana, and eastern Oregon. This poster shows the probability of juvenile Bull Trout occurrence under two climate scenarios (1980s and 2040s) within 3,750 discrete stream habitats where the average temperature is < 11ºC (cold enough to preclude Brown Trout and Rainbow Trout). Bull Trout probabilities were predicted from four variables (habitat size, slope, minimum temperature, and Brook Trout abundance) in a logistic regression model developed from 512 cold-water streams with known occupancy status (present or absent). Classification accuracy of the model was 78% (AUC = 0.83) and its application to the universe of cold-water streams revealed 225 with Bull Trout occurrence probabilities >0.9 in the 1980s scenario. An average of 50 kilometers of cold-water stream was needed to meet that probability threshold, but stream lengths could be as short as 16 kilometers depending on stream slope, minimum temperature, and Brook Trout prevalence. In the 2040s scenario, the number of >0.9 stream habitats declined to 68 but Bull Trout would persist in some areas even with pessimistic assumptions about widespread Brook Trout invasions. Most invasion resistant climate-refuge streams occur on federal lands (80% - 90%) where only a small portion currently has protected status (13% - 15%) in Wilderness Areas or National Parks. Better protection of refuge streams could help ensure the persistence of Bull Trout this century and these streams could also provide a foundation for strategic conservation networks designed to maintain broader species distributions.

Does State and Federal Regulation of Suction Dredging in Idaho Adequately Protect Aquatic Resources?

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Placer mining (that is, mining of stream channels and other alluvial deposits) for gold is an activity which can adversely affect aquatic organisms and their habitat, as is abundantly illustrated by the degraded condition of reaches of the Yankee Fork of the Salmon River, Feather River, Crooked River, and many smaller sites in Idaho. The large-scale placer mining methods for gold evident on the Yankee Fork, et al., are likely only of historical and restoration concern, but miners currently use small suction dredges and other small-scale placer mining methods in many streams in Idaho. Both State and Federal regulations in Idaho substantially restrict suction dredging locations, timing, and methods. More than 300 miners obtained Idaho Department of Water Resources ""recreational"" dredging permits in 2014. The activities of these miners are also legally, if not always successfully, constrained by Federal Clean Water Act regulations administered by the Environmental Protection Agency. In addition, the 1872 Mining Law authorizes placer mining on Federal public lands managed by the U.S. Forest Service and Bureau of Land Management, but that law (and ensuing statutes and regulations) allow these agencies to condition mining activities to protect natural and cultural resources, interference with other public land activities, etc. This poster describes the methods used by small-scale suction dredgers in Idaho, the most likely direct effects on individual fish and other aquatic organism and on aquatic organism populations, and likely and potential short and long-term effects on stream channels and riparian areas. I also explain the gantlet of laws and regulations that a prospective suction dredging miner in Idaho would navigate in an attempt to be fully compliant in his activities. The poster also describes locations in Idaho where suction dredging occurs and is concentrated, and identifies streams of particular concern for mining regulators.

Steelhead Escapement Monitoring Using a Resistance Board Weir in Joseph Creek, Washington/Oregon

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Steelhead (*Oncorhynchus mykiss*) in the Snake River basin were listed by NOAA Fisheries as a threatened species under the Endangered Species Act (ESA) in 1997. Joseph Creek, located in the Grande Ronde River subbasin, contains a threatened A-run summer steelhead population that has been identified as a population for management and recovery planning under the ESA (ICTRT 2007). The Joseph Creek system contains approximately 373 km of stream habitat and a watershed that encompasses 1,435 km2. Natural origin (NOR) adult steelhead escapement monitoring was conducted in Joseph Creek using a resistance board weir from 2011 to 2013. NOR steelhead escapement to the Joseph Creek weir ranged from 1,701 to 1,912 fish over the study period. Coefficient of variation associated with the escapement estimates ranged from 0.5% to 22%. NOR steelhead upstream migration occurs from January or February and exhibits a protracted migration pattern through late May. The major pulse in upstream movement occurs during March of each year. NOR steelhead downstream migration was observed from early March to mid-May/early June over the study period. Age at return of NOR adult steelhead was represented by four age groups; age II through age V. The majority of NOR male steelhead returned at age III (47.8% to 74.7%) as a 1 ocean fish (51.4% to 77.7%). The majority of NOR female steelhead returned at age IV (56.7% to 76.5%) as a 2 ocean fish (55.9% to 74.7%). The percentage of NOR steelhead ≥ 78 cm in fork length, B-run size fish, has ranged from 1.6% to 2.8% over the study period. Nine different life history characteristics were identified from scale aged NOR steelhead. The estimated hatchery origin composition (2.2% to 3.8%) documented a low level of hatchery straying into Joseph Creek. NOR female steelhead sex composition has ranged from 56.1% to 67%. Smallmouth bass ranging in size from 23.5 cm to 50.2 cm have been captured annually in the upstream trap and have been observed foraging on NOR steelhead smolts. Managers need to understand the impact of smallmouth bass, an exotic species, on threatened juvenile steelhead.

Determining food web relationships that may limit the quality of the Kokanee (*Oncorhynchus nerka*) fishery in Buffalo Lake, WA

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Buffalo Lake, located on the Colville Confederated Tribes Reservation in north-central Washington State, is currently managed with the primary goal of maintaining sustainability of a naturally reproducing Kokanee fishery, and a secondary goal of providing quality Largemouth Bass and stocked Rainbow Trout fisheries. In mixed fishery systems, complex food web interactions can be a limiting factor affecting the quality of the fishery. For example, by influencing food resource availability, Kokanee and hatchery Rainbow Trout competitive interactions, brought on by excess stocking, reduces the viability of both fisheries. Furthermore, compensation and predation pressures between warmwater fish species such as Largemouth Bass and Black Crappie can diminish the quality of the Kokanee fishery. In examining food web relationships through seasonal stomach content analysis of all fish species in Buffalo Lake, we worked to identify completive interactions and predation potentials that may limit the quality of the Kokanee fishery.

Methods used by the Shoshone-Bannock Tribes to conduct a Chinook salmon (*Oncorhynchus tshawytscha*) reintroduction project in Yankee Fork Salmon River, Idaho

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The Shoshone-Bannock Tribes (Tribes) initiated a Chinook salmon (*Oncorhynchus tshawytscha*) reintroduction project in Yankee Fork Salmon River, Idaho to meet Tribal harvest and conservation objectives. The Yankee Fork of the Salmon River is an important spawning and rearing stream for Chinook salmon. Historically, the system supported a large Tribal Chinook salmon fishery, but this fishery dwindled as the number of Chinook salmon returning to the Yankee Fork declined due to anthropogenic impacts within the basin (e.g., dredge mining) and out-of-basin (e.g., hydropower). In order to achieve Tribal harvest and conservation objectives, the Tribes utilized a combination of artificial propagation and monitoring techniques. The Tribes installed a rotary screw-trap in the Yankee Fork mainstem to monitor and evaluate yearling and sub-yearling juvenile Chinook salmon emigrating from the Yankee Fork. In addition, the Tribes installed and operated a picket weir in Yankee Fork for the purposes of managing the adult Chinook salmon return. Pole Flat weir was installed to enumerate all adult Chinook salmon that enter the watershed. All fish trapped at Pole Flat weir were directly released above the weir after biological data was collected. Further, the Tribes worked cooperatively with IDFG to outplant excess hatchery-origin fish trapped at Sawtooth Fish Hatchery to bolster natural production within Yankee Fork. Live adults and carcasses of Chinook salmon used for broodstock at Sawtooth were outplanted into Yankee Fork as part of a nutrient enrichment study. Beginning in August, extensive spawning ground surveys were conducted in Yankee Fork and its major tributary, West Fork, to determine spawn timing, redd enumeration and distribution, abundance of live fish, and to collect carcasses for biological information. Overall, the Yankee Fork Chinook salmon project is designed to incorporate habitat restoration, harvest management, and artificial propagation to achieve the long term goal of returning 2,000 adults to meet Tribal harvest and conservation objectives.

Population genetic structure of Yellowstone and Bonneville cutthroat trout in a contact zone

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Subspecies designations in cutthroat trout have been the subject of recent molecular investigations, as resolving the relationships between populations of cutthroat trout is important for their effective management and conservation. Previous research using mtDNA data suggested a lack of genetic divergence between Bonneville and Yellowstone cutthroat trout subspecies. Our aim is to use microsatellite data to refine the relationship between populations of Bonneville and Yellowstone cutthroat trout in the subspecies contact zone in order to better understand distinct population segments. We collected samples from 22 populations of cutthroat trout from the upper Snake River and northern Bonneville Basin. Our sampling was focused on areas in which the populations were not genetically distinct based on watershed boundaries and mtDNA haplotypes. We use diversity at ten nuclear microsatellite loci to determine if contemporary genetic patterns support divergence between Bonneville and Yellowstone cutthroat trout subspecies based on geographic boundaries and nuclear DNA markers.

Homing vs. Straying: Spawning Patterns of Fluvial Yellowstone Cutthroat Trout in the South Fork of the Snake River

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The South Fork of the Snake River (SFSR) is home to a robust population of fluvial Yellowstone Cutthroat Trout, (YCT) *Oncorhynchus clarkii*. Four main tributaries of the SFSR (Palisades Creek, Rainey Creek, Pine Creek, and Burns Creek) have been recognized as critical spawning areas for fluvial YCT by the Idaho Department of Fish and Game. Electrical and waterfall barrier weirs have been installed in order to protect the genetic integrity of fluvial YCT in these tributaries from introgression with Rainbow Trout *Oncorhynchus mykiss*. Since 2001, fewer fluvial YCT have returned to spawn in Rainey Creek compared to the other tributaries. The objective of this study was to determine the patterns of homing and straying of fluvial YCT within the tributaries of the SFSR system. Homing was defined as an adult that returned to the same tributary over multiple years during the spawning season, whereas straying adults entered multiple tributaries over multiple years. We recaptured 852 fluvial YCT that returned multiple times to tributaries during the spawning season. Of these fish, >98% demonstrated patterns of homing. Rainey Creek had only one recaptured adult that was a repeat spawner during this study; this is consistent with recent patterns of low abundance of fluvial YCT in this tributary. Strong patterns of homing in fluvial YCT in the SFSR suggest that bolstering the YCT stock in Rainey Creek could potentially enhance fluvial YCT spawning in this tributary, provided that habitat (e.g. spawning or juvenile rearing habitat) is not a limiting factor.

Effects of Gill-Net Trauma, Barotrauma, and Deep Release on Post-Release Mortality of Lake Trout

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Post-release mortality violates assumptions of many fisheries studies, thereby biasing parameter estimates and reducing efficiency. We evaluated effects of gill-net trauma, barotrauma, and deep-release treatment on post-release mortality of Lake Trout *Salvelinus namaycush*. Lake Trout were captured at depths up to 60 m with gill nets in Priest Lake, Idaho and held in a large enclosure for 10–12 days. Post-release mortality was the same for control and deep-release treated fish (41%). Mixed-effects logistic regression models were used to evaluate effects of intrinsic and environmental factors on the probability of mortality. Presence of gill-net trauma and degree of barotrauma were positively related to the probability of post-release mortality. Smaller fish were also more likely to suffer post-release mortality. On average, deep-release treatment did not reduce post-release mortality, but effectiveness of treatment increased with fish length. Of the environmental factors evaluated, only elapsed time between lifting the first and last anchors of a gill-net gang (i.e., lift time) was significantly related to post-release mortality. Longer lift times were associated with lower post-release mortality rates. Our study suggests that post-release mortality may be higher than previously assumed for Lake Trout because mortality continues after 48 hours. In future studies, post-release mortality could be reduced by increasing gill-net lift times and increasing mesh size used to increase length of fish captured.

Who Followed "Following Fishes": A report on the "Following Fishes" lesson plan pilot project

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The mission of the Anadromous Fish Committee of the Idaho Chapter of the American Fisheries Society (ICAFS) is to advance knowledge and appreciation of Idaho's anadromous fish resources and the aquatic habitats upon which they depend; and promote the use of sound science towards conservation and recovery of the fishery resource for its use and enjoyment by all. Outreach to school students can be an effective means to accomplish that mission. "Following Fishes" is a high school science lesson incorporating anadromous fish biology and the technology used to manage anadromous fishes in the Columbia River basin. To address the State of Idaho's goal of bringing technology into the classroom, the lesson uses two publicly accessible databases, Columbia River DART (Data Access in Real Time) and the Columbia Basin PIT Tag Information System (PTAGIS). Students are required to interpret graphs and extrapolate data to answer questions about fish movement and interactions with Idaho's water resources. These activities align with several Idaho Content Standards for Biology. A pilot project including lesson development and distribution of 75 lesson packets was funded for the spring 2014 semester by ICAFS and the Idaho Department of Fish and Game (IDFG). There is not a publicly accessible list of science teachers statewide so contacting teachers proved to be difficult. Of the roughly 330 secondary schools in Idaho, 113 had webpages listing contact information for teachers. Biology teachers in these schools were contacted and 56 agreed to participate in the pilot project by teaching the lesson and providing feedback. Twenty-five teachers taught the lesson to over 700 students and provided feedback in the form of a survey and e-mail or phone conversations. It is not known if the other 31 teachers did not teach the lesson, or have yet to return the survey, even after several reminders. Of those who responded, 92% said they will use the lesson again, 96% reported that students responded in a positive manner, and 87% agreed that the lesson correlates well to Idaho State Standards. The next step is to make "Following Fishes" easily accessible by publishing on the ICAFS and IDFG websites.

Adult Salmon Escapement Monitoring in the Secesh River Idaho using Dual Frequency Identification Sonar

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Dual Frequency Identification Sonar (DIDSON) was used in the Secesh River from 2004 to 2014 to determine natural origin adult Chinook salmon *Oncorhynchus tshawytscha* escapement. DIDSON technology was selected because it provides a non-invasive method for escapement monitoring that avoided listed species trapping and handling incidental mortality, and fish impedance related concerns. High frequency DIDSON sonar files were collected during the entire salmon migration period. The convolved samples over threshold (CSOT) motion detection algorithm were used to reduce original daily file size by 6.5% to 91.5% resulting in a substantial decrease in reviewer time. To obtain accurate and precise escapement information the raw daily salmon passage data was adjusted for equipment downtime, file reader errors, and file processing errors. Estimated salmon escapement at the Secesh River DIDSON monitoring site ranged from 223 fish to 1,383 fish, with a coefficient of variation range of 1% to 10.8%. Natural origin spawner abundance for the entire Secesh River ranged from 205 to 1383. The 10 year geometric mean spawner abundance in the Secesh River is 643 salmon. The Secesh River salmon population is not viable according to the ICTRT (2007) abundance criteria of a 10 year geometric mean value of 750 spawners. Three underwater optical cameras were used as the independent method for validation (species identification) of DIDSON target counts. Of 7,758 optical camera recorded salmon passages that were observed in the validation zone, 16 of the corresponding DIDSON targets were incorrectly recorded as salmon during DIDSON file review (16/7,758 = 0.21% positive error). In this application, DIDSON proved to be a reliable and minimally intrusive means to generate unbiased and relatively precise estimates of adult escapement.

Juvenile Kootenai River White Sturgeon survival analysis using Program Mark

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The Kootenai River White Sturgeon *Acipenser transmontanus* population is comprised mainly of old adults and significant recruitment has not occurred since the 1970s. Research to date suggests that egg and/or larval suffocation, predation, and/or other mortality factors associated with these early life stages contribute to persistent recruitment failure. The reliance on hatchery-reared fish to maintain this population has prompted a need for detailed information on population size and annual survival, and how the population is influenced by hatchery source and individual attributes of released fish. The objectives of this survival analysis include: 1) making sampling recommendations to meet population closure assumptions; 2) providing updated estimates of annual survival as a function of age class; 3) explore the influence of individual covariates and hatchery on annual survival; and 4) provide a virtual population analysis to estimate juvenile abundance. This analysis provides the first age-specific estimates of annual survival for the Kootenai White Sturgeon. Estimates of age 1 survival have declined from 90% in 1992 to below 20% since 2003 for unknown reasons. This pattern has likely resulted from a combination of changes in capture techniques, increases in sturgeon density, and possibly other factors. One clear message is that size at release should be kept as large as possible. The source of fish for stocking was also an important predictor of age 1 survival with fish reared in British Colombia having significantly greater survival than those reared in the Kootenai Tribal Hatchery. Analyses of the influence of release season showed that this is an important predictor of annual survival with spring > summer > fall > winter. Annual survival of spring released sturgeon is 40% greater than survival of fish released in summer. Limiting future releases to spring appears to result in significantly greater survival to age 1 and should be a priority if annual survival is a recovery goal. Finally, this research suggests that the current juvenile sturgeon population is comprised or around 12,000 individuals, with the population slowly declining over the past several years. Continued survival and abundance modeling is paramount to the continued success of this recovery investigation.

Columbia Basin Steelhead Reconditioning Studies

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The Kelt Steelhead Reconditioning and Reproductive Success Evaluation Project is a research, monitoring, and evaluation project funded through the Columbia Basin Fish Accords. The project studies and evaluates two broad topics with respect to post-spawn steelhead, first it assesses reconditioning processes and strategies, and second, it measures reproductive success of artificially reconditioned kelt steelhead. The goal of the project is to develop and evaluate novel approaches to restoring steelhead in the Columbia River Basin.

Precision of Hard Structures for Estimating the Age of Burbot

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Burbot *Lota lota* are the only freshwater member of the family Gadidae and have suffered population declines throughout much of their native distribution. Management agencies tasked with monitoring Burbot populations often rely on age and growth data gleaned from calcified structures (e.g., otoliths, fin rays). Although otoliths have been identified as reliable ageing structures for Burbot, they require that fish be sacrificed. Due to the conservation status of many Burbot populations, identifying effective non-lethal ageing structures is warranted. Brachiostegal rays, pectoral fin rays, and dorsal fin rays were compared to sagittal otoliths to evaluate the precision and readability of non-lethal structures for estimating the age of Burbot. All structures were sectioned and independently read by two readers. Between-reader precision, the relationship between readability and precision of age estimates (i.e., confidence ratings), and differences in age estimates among hard structures were evaluated. By identifying the best non-lethal ageing structure, conservation efforts for Burbot will gain insight into understanding the age distribution and dynamic rate functions without the need to sacrifice fish.

Reactions to Declining and Displaced Populations of Plains Topminnow

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The historic range of Plains Topminnow covers most of the state of Nebraska. In response to declining numbers in populations a brood stock has been successfully collected, reared, and stocked in efforts to reestablish and monitor populations. Different Stocking densities and sampling methods have been tested and assessed after allowing the populations to establish for four cohorts. Success assessments for both stocking densities and sampling methods have been quantified, leading to the management phase of Nebraska Plains Topminnow populations. Future objectives include a statewide management plan that will identify the preferred habitat thresholds, limitations for species persistence, levels of conservation actions, and specific drainage assessment protocol.

Differences in Nutrient Input Type Determine Annual Fish Growth in Idaho's Yankee Fork

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Losses of allochthonous salmon biomass and associated benthic bioturbation have necessarily followed declines in Pacific salmon returns to historic spawning streams in the Western United States. To simulate annual nutrient pulses from spawning salmon, fisheries managers and restoration professionals have developed remediation protocols in which pelletized, 'salmon analog' fish meal or adult salmon carcasses are added to streams. However, both salmon carcass analog (SCA) and carcass additions to streams are unable to simulate the benthic disturbance of natural Chinook salmon nest-digging behavior. In four tributaries of the Yankee Fork of the Salmon River in central Idaho, we conducted mark-recapture surveys to measure average changes in fish biomass between 3 treatment types: SCA pellets, adult salmon carcasses, live adult Chinook salmon (naturally spawning), and a control. We constructed an in-stream before-after manipulative control (BACI) experiment in order to detect a response in seasonal fish biomass accumulation to manipulations in nutrient input type. We conducted electrofishing surveys twice in July 2014, and once in October 2014. In the two July samplings, fish were weighed, measured and marked with sub-dural PIT tags. In the Fall, all recaptured fish were identified by PIT code and re-weighed. Through these repeated measures, we evaluated the effects of nutrient manipulations on changes in total fish biomass, and on growth of individual species, primarily Chinook salmon (*Oncoryhnchus tshawytscha*), bull trout (*Salvelinus confluentus*), steelhead (*Oncorhynchus mykiss*), and sculpin (*Cottus*). Our ability to replicate treatments was limited by the number of similar streams within our study reach, and we therefore evaluated significance of our results using Randomized Intervention Analysis (RIA). RIA was specifically designed for unreplicated ecosystem-scale manipulations such as this. It enabled us to disprove null hypotheses of no change to each manipulated reach by comparing one reference condition to nutrient manipulations. Differentiating between responses in fish production following common nutrient remediation treatments will aid the Shoshone-Bannock tribe and other fisheries managers in developing more effective restoration protocols.

Development of SNP genetic markers for estimating population size and parentage based tagging application

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As part of its fish population monitoring program, the Idaho Power Company monitors the health and abundance of Shoshone sculpin populations endemic to the Hagerman Valley, ID. Through a collaborative project between the IPC, the Idaho Department of Fish and Game, and the Columbia River Inter-Tribal Fish Commission, we utilized cost-efficient, Restriction-site-Associated DNA sequencing (RAD-Seq) technology to rapidly discover single nucleotide polymorphic (SNP) genetic markers for future population monitoring. We sequenced 12 individuals sampled from each of 11 locations across the species range. Sequencing generated on average 26,502 number of high quality single reads per individual, with each read averaging ~100 base pair in length. Alignments of reads from all samples with high quality sequence scores produced 33,558 unique loci. Among these loci, 148,519 variable and 9,892 informative SNPs were found. Loci containing informative SNPs will be chosen for further evaluation and a selected few will be chosen for screening across a broader set of individuals. The SNPs identified from this screening should allow more accurate genetic estimates of effective population size and the genetic “tagging” of individual fish for movement and survival studies. Finally, these SNPs should also provide additional parentage based tools for biologists if translocation and/or reintroduction efforts are deemed necessary in the future.

Population genetics of Columbia River Redband Trout, Oncorhynchus mykiss gairdneri, in Dry Creek, Idaho

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The Columbia River redband trout (*Oncorhynchus mykiss gairdneri*) is native to the Columbia River Basin east of the Cascades. The genetic structure of many redband trout populations throughout the region has been influenced by introgression with hatchery stocks (coastal rainbow trout) and by isolation due to migration barriers. Dry Creek is a small tributary of the Boise River which flows across the boundary of the central Idaho mountains and the Snake River plain. The creek is located approximately 6-km north of Boise and is characterized by large seasonal fluctuations in temperature and stream flow. Dry Creek's ecotonal complexity and proximity to Boise make it an ideal setting for long-term ecological monitoring. The objective of our research was to continue a genetic monitoring program of the Dry Creek redband trout population. During 2012, 2013, and 2014, fin clips were taken from 352 redband trout collected throughout the Dry Creek watershed. Genetic analyses of fin clips were carried out at the Idaho Department of Fish and Game, Fish Genetics Laboratory in Eagle, Idaho. Each fish was genotyped at 186 single nucleotide polymorphisms (SNPs), used by IDFG for genetic stock identification and determining range-wide relationships among rainbow trout/steelhead populations. Genetic data were used to monitor: 1) sex ratios; 2) genetic purity; 3) genetic differentiation between trout collected above and below the Bogus Basin Road culvert; 4) population-level genetic diversity; and 5) spatial distribution of related individuals in an attempt to better assess trout movement in the watershed. Given the recent establishment of a conservation easement for upper Dry Creek, the continued monitoring of this population should assist efforts to design an effective watershed management plan.

Population Characteristics of Largemouth Bass in Hayden Lake, Idaho: Influence of Environmental and Biological Factors on Growth and Recruitment

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Largemouth Bass *Micropterous salmoides* is a widespread and recreationally-important species throughout North America. Largemouth Bass are not native to Idaho, but have been legally introduced in many waters throughout the state to diversify angling opportunities. Many Largemouth Bass fisheries are specifically managed for quality angling (i.e., good catch rates and size structure). Hayden Lake is one of North Idaho's most unique resources and supports a popular Largemouth Bass fishery. The Largemouth Bass population in Hayden Lake is managed under a restrictive bag limit (2 fish daily bag) and minimum length limit (none > 16 inches). Recent sampling efforts have confirmed anecdotal evidence suggesting that size structure of Largemouth Bass has declined in Hayden Lake, thus raising concerns about the effectiveness of current angling regulations. We evaluated size structure and population characteristics (i.e., age structure, growth, recruitment, mortality), and described the influence of several environmental and biological variables on growth rates and recruitment dynamics of Largemouth Bass in Hayden Lake. A repeated-measures mixed-effects model was used to evaluate the influence of factors effecting growth rates where we treated age as a fixed effect and year as a random effect in the model. Year-class strength was indexed using the residual technique whereby estimates were obtained from a catch curve. Estimates of annual growth increment and year-class strength were then used as the response variables in subsequent modeling exercises. An information theoretic approach was used to select the best multiple regression model that explained the most variability in growth and recruitment. This research will help to inform management of Largemouth Bass in Hayden Lake as well as in other quality Largemouth Bass populations throughout the Pacific Northwest.

Worldwide patterns of invertebrate drift production in lotic ecosystems with implications for drift-feeding fishes

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Invertebrates that are carried by water currents in streams and rivers often form a primary food supply for many types of lotic fishes. Understanding what factors influence invertebrate drift production is essential to determining food availability for drift-feeding fishes. We conducted a literature review and compiled all published studies of daytime invertebrate drift from streams and rivers worldwide to determine how primary geography features influence drift abundance. Drift abundance was significantly related to geographic latitude, with streams at more northern and southern locations from the equator having the highest levels of abundance. Streams and rivers at higher elevation also tended to higher levels of drift abundance. Similarly, areas with higher mean annual temperature had higher levels of invertebrate drift abundance, even after controlling for all other factors in the analysis. Geographic variation in invertebrate drift abundance may partly explain the preponderance of drift-feeding fishes at northern latitudes in comparison equatorial areas.

Evaluating Single Nucleotide Polymorphisms for assessing movement and reproductive success of rainbow trout *Oncorhynchus mykiss* in the Buffalo River, Idaho and their contribution to the Henrys Fork fishery

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The Buffalo River is located in the Upper Snake River basin in Idaho and Wyoming and is a major tributary to the Henrys Fork River, which supports one of the most renowned rainbow trout fisheries in the world. However, for decades a dam and hydroelectric project on the Buffalo River impeded migration of rainbow trout between it and the Henrys Fork River. A fish ladder was installed at the dam in 1996, and fish passage was further improved with modifications in 2006. Since these improvements, significant seasonal migration of rainbow trout between the Buffalo River and the Henrys Fork has been documented. However, it is not yet known the extent to which the Buffalo River is contributing rainbow trout to fisheries in the Henrys Fork River. Genetic tools are increasingly being used to monitor the effectiveness of fish passage projects, both to document the movement of fish, as well as their reproductive success. The initial objective of this study was to assess the power of an existing set of 192 rainbow trout Single Nucleotide Polymorphic genetic markers for Parentage Based Tagging of rainbow trout adults captured during upstream migration on the Buffalo River. If sufficient genetic variation exists, future research will sample juvenile fish in the Buffalo River, juvenile fish captured migrating from the Buffalo River and adults in the Henrys Fork Fishery. This work should assist managers in better understanding fluvial versus resident life-histories in the Buffalo River and to assess the relative importance that Buffalo River rainbow trout contribute to one of the most important rainbow trout fisheries in the state.