

## **IGNITE Presentation Abstracts**

### **PELICAN MANAGEMENT AND YELLOWSTONE CUTTHROAT TROUT RECOVERY ON THE UPPER BLACKFOOT RIVER: WHERE WE WERE, WHERE WE ARE, AND WHERE WE ARE GOING**

Arnie Brimmer

Idaho Department of Fish and Game

Historically, the upper Blackfoot River was one of the most productive systems for Yellowstone Cutthroat Trout and supported a fishery of annual harvest yields in excess of 15,000 fish. This high level of angler exploitation was unsustainable and resulted in the collapse of the fishery in the early 1980's. Subsequent research supported changes in angling regulations to "no harvest" in the early 1990's. Within two Yellowstone Cutthroat Trout generations, the fishery had begun to recover. This improvement coincided with the arrival of American White Pelicans in 2002. Since then, Yellowstone Cutthroat Trout adult spawner abundance has declined and remains depressed. In 2009, an American White Pelican Management Plan was developed by the state to address high predation rates on Yellowstone Cutthroat Trout by American White Pelicans. Since then, American White Pelican predation rates of adult spawners in the lower river have been reduced from 30% to less than 5%. Unfortunately, predation on Yellowstone Cutthroat Trout occupying the upper river on the Blackfoot River Wildlife Management Area is still of concern. Predation rates in this section of the river remain at 38% or above. The management activities that we have used successfully on the lower river have proved largely ineffective upriver. Follow along with me as I describe our current and future plans to reduce predation rates on up-river Yellowstone Cutthroat Trout.

### **PRESPAWN MOVEMENTS OF ADULT PACIFIC LAMPREY IN THE CLEARWATER RIVER BASIN**

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<sup>1</sup>U.S. Fish and Wildlife Service, <sup>2</sup>Nez Perce Tribe

The Clearwater River Drainage in Idaho supports one of the furthest inland populations of Pacific lamprey, *Lampetra tridentata*. Lamprey typically return to freshwater, overwinter, and spawn the following spring, but little is known about the migratory behavior or spawning locations in Idaho. Citing declining larval lamprey densities and poor dam passage, the Nez Perce Tribe began supplementing select tributaries in 2006 with returning adults captured at Lower Columbia River Dams (termed "translocation") to boost larval production and pheromone attractants. This study had two main objectives: 1) use radio telemetry to identify spawning areas and spawn timing in the Lochsa River, a system where volitional migrants (i.e. not translocated) spawn, and 2) assess the movements of translocated adults released in the mainstem Clearwater River below typical release tributaries. Twenty-nine translocated fish were radio-tagged, divided into two release groups (Clearwater and Lochsa), and released on 04 March. Most of the Lochsa fish moved slowly upriver and stayed in the mainstem within the current known distribution of larval densities. Most of the Clearwater fish moved quickly upstream and 80% entered the South Fork Clearwater River, a system with both larval production from volitional and translocated adults. No fish in either group entered tributaries and spawning likely occurred from mid-June to early August, which is much later than coastal populations. All

fish made nighttime migrations during descending limbs of peaks in the hydrograph. The South Fork Clearwater River is potentially a strong attractant for volitional migrants.

## **FACTORS INFLUENCING TROUT GROWTH IN HIGH MOUNTAIN LAKES**

Jordan Messner, Kevin Meyer

Idaho Department of Fish and Game

Idaho has over 3,000 high mountain lakes across the state, nearly all of which were historically fishless. Trout have been stocked in high mountain lakes in Idaho for over a century. The goal of early stocking programs was primarily to establish fisheries where they did not previously exist. Currently, about 700 of these lakes are regularly stocked with trout, most of which are on a standard rotation of stocking every 2 to 3 years. Managers adjust stocking densities and frequencies to maximize the quality of fisheries, with two important metrics being trout growth and body condition. We surveyed 88 high mountain lakes in east-central Idaho in 2015-2017 to evaluate fish growth and condition, and measured several environmental conditions in an attempt to explain variability in trout growth among lakes. The best general linear model explaining variation in trout growth indicated that length-at-age four was higher at lower elevation lakes with a higher shoreline development ratio, lower fish abundance, higher conductivity, more littoral habitat, a pH closer to neutral, and farther from trailheads. The best general linear model explaining variation in fish condition indicated that fish of a given length were heavier at lakes with a southern aspect, with lower fish abundance, higher conductivity, a pH closer to neutral, and closer to trailheads. These results indicate that lake productivity (elevation, conductivity, pH, aspect, shoreline development, and littoral habitat), fish abundance, and distance to trailheads are the most important factors to consider in predicting trout growth in high mountain lakes. Although more research is needed, this information will be helpful to managers when developing stocking strategies to maximize angler satisfaction for high mountain lake fisheries.

## **CONTRIBUTED PRESENTATION ABSTRACTS**

\* = Student Presenter

### **HIGH SPEED SPILLWAY PIT-TAG DETECTION**

Steve Anglea, Alex Artyukhov

Biomark

Increased passage of juvenile salmonids through spill at Snake River hydroelectric facilities decreased the number of fish passing into the juvenile bypass facility at Lower Granite Dam. Detections of PIT-tagged fish in the juvenile bypass system are used to determine migration timing and partition fish into in-river and bypass groups for estimating a suite of survival metrics. Regional fish managers wanted the ability to directly monitor fish passing through spill. Spill Bay 1 at Lower Granite Dam was identified as the location to install a spillway PIT-tag detection system due to the relatively shallow water, < 1.5 m deep, and high relative abundance of fish passage. Water in Spill Bay 1 travels at approximately 21 m/sec.

Biomark, with funding from the Bonneville Power Administration, and in coordination with NOAA Fisheries, developed a reader and designed antennas to be installed in Spill Bay 1 at Lower Granite Dam. The reader is capable of driving antennas at significantly higher current than traditional Biomark readers, providing adequate read range and read speed for this application. The various reader processes (i.e., Exciter, Auto-tuner, Detector and CPU) are housed in separate modules to optimize performance. The flat-plate antennas were to provide a more consistent detection range across the width of the antennas. The antennas were arranged on the ogee to provide duplicate detection among rows of antennas. Each of the 11 antennas is controlled by a separate FS3001 reader and the exciter frequencies of all readers are synchronized to eliminate interaction among reader/antenna pairs.

### **POND AND PLUG RESTORATION PROJECTS ON KALISPEL ABORIGINAL LANDS IN NORTH IDAHO**

Eric Berntsen

Kalispel Tribe Natural Resources Department

Stream restoration efforts, particularly within meadow systems, increasingly rely on 'pond and plug' type methods in which (a) alluvial materials are excavated from the floodplain, forming ponds; (b) excavated alluvial materials are used to plug incised channels and (c) smaller dimension channels are restored to the floodplain surface (Hammersmark 2008). This presentation will describe the design, implementation, and evaluation of two pond and plug restoration projects on Kalispel Aboriginal Lands in North Idaho.

## **PHASE 1: UPPER COLUMBIA FISH PASSAGE & REINTRODUCTION**

Thomas Biladeau<sup>1</sup>, Kevin Malone<sup>1</sup>, Stephen Smith<sup>1</sup>, Jill Hardiman<sup>2</sup>, Casey Baldwin<sup>3</sup>, Conor Giorgi<sup>4</sup>

<sup>1</sup>Coeur d'Alene Tribe Fisheries, <sup>2</sup>USGS, <sup>3</sup>Colville Confederated Tribes, <sup>4</sup>Spokane Tribe of Indians

The Upper Columbia United Tribes (UCUT), with support from the United States Geological Survey (USGS) and the Washington Department of Fish and Wildlife (WDFW), have completed an extensive investigation into the reintroduction of anadromous fish to accessible habitats upstream of Chief Joseph and Grand Coulee dams. In 2019 UCUT compiled these investigations into a comprehensive Phase 1 report, synthesizing results from the various studies into one document. Individual components of the report include a risk and donor stock assessment, evaluations of riverine and reservoir habitats, options for potential fish passage facilities at both dams, as well as life cycle modeling of various management scenarios and survival assumptions. Upper Columbia populations of Summer Chinook and Sockeye were selected as the top candidates for donor stocks, given their availability and disease histories. Selection of these donor stocks is further supported by the quantity and condition of habitats in the region.

## **RELATIONSHIPS BETWEEN MIGRATION TIMING, DOWNSTREAM TRAVEL TIME, JUVENILE AND ADULT SURVIVAL, AND AGE-AT-RETURN FOR AN UPPER-COLUMBIA RIVER BASIN HATCHERY POPULATION**

William Bosch<sup>1</sup>, Shubha Pandit<sup>1</sup>, Gabriel Temple<sup>2</sup>, Donald Larsen<sup>3</sup>, Mark Johnston<sup>1</sup>, David Fast<sup>1</sup>

<sup>1</sup>Yakama Nation Fisheries, <sup>2</sup>Washington Dept. of Fish and Wildlife, <sup>3</sup>NOAA Fisheries Science Center - Seattle

Pacific salmon abundance is now heavily reliant on hatchery production, and hatchery culture and management practices greatly influence release size and juvenile migration timing. These factors in turn influence important demographic characteristics in returning adults. A better understanding of the relationships between juvenile characteristics and subsequent survival to adulthood for Pacific salmon could yield recommendations that benefit future populations. We analyzed a large data set of more than 450,000 PIT-tagged spring Chinook juveniles detected exiting Cle Elum Supplementation and Research Facility (Yakima River, Washington, USA) acclimation sites over twelve brood years (2003-2014; juvenile migration years 2005-2016; adult return years 2006-2019). Except in very low flow years (drought conditions), flows did not appear to affect the date that juveniles chose to voluntarily exit acclimation sites. A slight but significant relationship was observed between fork length at PIT-tagging and voluntary exit timing of fish from acclimation sites, with larger fish migrating earlier than smaller fish. Fish that left acclimation sites earlier had longer travel times to downstream detection sites than fish that migrated later. Earlier migrating fish had slightly lower detection rates as juveniles at downstream dams than later migrating fish. Among fish surviving to adult return, earlier juvenile migrants were larger at release, had a higher probability of surviving, and returned at younger ages whereas later juvenile migrants were smaller at release, had lower probability of surviving, and returned at older ages. Our results support additional research into growth and thermal regimes at hatcheries that seek to release smolts better conditioned to survival and reproduction in the wild and that return as older, larger adults.

## **WHO ARE YOU? WE REALLY WANT TO KNOW: A GENETIC ANALYSIS OF LOWER CLEARWATER RIVER STEELHEAD**

Brett Bowersox<sup>1</sup>, John Hargrove<sup>1,2</sup>

<sup>1</sup>Idaho Department of Fish and Game, <sup>2</sup>Pacific States Marine Fish Commission

Accurate monitoring of wild steelhead abundance and genetic composition in areas that overlap with hatchery steelhead is of management and conservation importance. Lower Clearwater River steelhead are managed in a wild fish management area with no hatchery stocking in tributaries; however Dworshak Hatchery operates on the mainstem Clearwater River within population bounds. We collected genetics of wild, juvenile steelhead from nine lower Clearwater River tributaries to evaluate patterns in diversity, genetic stock identification assignment, and level of genetic differentiation and overlap with Dworshak hatchery steelhead. Overall levels of genetic diversity were similar across collections and comparable to elsewhere in the Snake River basin. Genetic stock identification revealed the majority of samples were attributed to either the lower Clearwater River or South Fork Clearwater River genetic stocks with limited contribution from the lower Snake River. Tributaries in close spatial proximity displayed the highest genetic similarity to Dworshak Hatchery compared to tributaries located at greater distance. Results from this study document out of basin genetic stock and hatchery influence to varying degrees within the lower Clearwater River wild steelhead stock. Further investigations to document annual variation in results and adult steelhead spawning distribution will provide needed detail to patterns observed in this study.

## **ESTIMATING HISTORICAL SOCKEYE SALMON ABUNDANCE USING NITROGEN BUDGETS AND STABLE ISOTOPES**

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Idaho State University

Idaho's sockeye salmon (*Oncorhynchus nerka*) have been virtually extirpated due pressures from a number of factors including commercial harvest, the development of the hydropower system, and the introduction of non-native species. Since the Snake River Sockeye Salmon were listed as an endangered species in 1991, there have been extensive management efforts aimed at restoring these populations. However, with limited understanding regarding the number of sockeye salmon that historically used Idaho lakes for spawning, there is a need for a frame of reference to inform current and future attempts at restoration and management. Anadromous salmon have a high proportion of stable isotope  $^{15}\text{N}:^{14}\text{N}$  relative to other nitrogen sources, and therefore the analysis of sediment  $\delta^{15}\text{N}$  has proved to be an effective means of constructing historical population estimates of anadromous salmon. We are refining lake nitrogen budgets, informed by stable isotopes, to quantify past sockeye salmon abundance; we are applying this framework to a suite of sediment cores from Idaho Lakes. A range in the abundance of Idaho's Sockeye salmon is evaluated for a suite of current and past conditions and suggests that the historical abundance of sockeye salmon in this watershed may be higher than previously derived population estimates.

## **EVALUATION OF COMMERCIAL AND FORMULATED DIETS FOR JUVENILE AND SUB-ADULT STAGE BURBOT (*LOTA LOTA MACULOSA*) CULTURE**

Timothy Bruce<sup>1</sup>, Sinem Gulen<sup>1</sup>, Luke Oliver<sup>1,2</sup>, Jie Ma<sup>1</sup>

<sup>1</sup>Department of Fish and Wildlife Sciences, University of Idaho, <sup>2</sup>The Aquaculture Research Institute, University of Idaho

Burbot (*Lota lota maculosa*) are a promising new species for cold water aquaculture and offer a delicate white-flesh fillet for consumers. Burbot culture may have the potential to be incorporated into existing trout production facilities and diversify product offerings. For commercial burbot culture to succeed, optimal diet formulations for the juvenile and subadult grow-out stages must be discerned. Two feeding trials were conducted at the University of Idaho to evaluate the effect of different dietary formulations on the growth performance of juvenile and sub-adult burbot, under intensive culture. Four dietary treatments were evaluated, Europa (commercial), Oncor (commercial), a formulated marine-like diet (Burbot 1; B1), and a formulated trout-like diet (Burbot 2; B2). Juvenile growth results indicated a difference in relative growth (RG;  $P=0.001$ ), specific growth rate (SGR;  $P=0.001$ ), and thermal growth coefficient (TGC;  $P=0.001$ ) among the marine blend dietary treatments, with the fish fed B1 and Europa performing better than the B2 and Oncor diets. This is indicative of a preference for marine-type diets during the juvenile burbot life stage. Growth results also demonstrated a difference in protein efficiency ratio (PER;  $P=0.001$ ) among the diets, with the fish fed Europa exhibiting the lowest protein utilization rate. Sub-adult growth results showed no differences in RG ( $P=0.814$ ), SGR ( $P=0.814$ ), and tank biomass gain ( $P=0.727$ ). Thus, it appears that sub-adult burbot are more tolerant of the rainbow trout-like formulation at this life stage. These preliminary study results indicate that burbot may require a marine-type diet during the juvenile life stage. Sub-adult burbot could possibly be transitioned onto a trout-like diet at the onset of adulthood and potentially reduce on-farm operating costs associated with providing fish with a more expensive commercial marine diet.

## **A REMOTELY SENSED BIOENERGETIC EVALUATION OF THE LEMHI RIVER, ID**

Richie Carmichael<sup>1</sup>, Daniele Tonina<sup>2</sup>, Ernest Keeley<sup>3</sup>, Rohan Benjankar<sup>4</sup>

<sup>1</sup>Biomark, <sup>2</sup>University of Idaho CER, <sup>3</sup>Idaho State University, <sup>4</sup>Southern Illinois University

Characterizing the role of lateral and off-channel habitat in anthropogenically altered river systems is an integral piece in restoring threatened and endangered salmonid populations. Currently, our ability to assess the benefit of side channels and lateral habitat has been restricted to the channel unit and reach scale due to limitations in sampling, modeling and ecological complexity, and computation. To further understand the impacts of channel simplification, water use, and river enhancement through restoration, we developed a novel approach to drift foraging bioenergetics modeling that utilizes 2-dimensional numerical flow modeling supported by validated bathymetric light detection and ranging at the watershed scale. We applied this technique to juvenile Chinook salmon in the upper Lemhi River of Eastern Idaho, taking advantage of publicly available drift invertebrate, fish capture, and temperature data to populate the model. We compared four unique river reaches, each roughly one kilometer long, modeled at two temporal scenarios of summer low flow and fall flow post-irrigation season. From this, we can assess how variable channel morphology, hydraulics, and water use may impact the growth potential and habitat suitability for juvenile Chinook salmon. We found that stream segments with greater

amounts of off channel habitat provided larger areas of suitable habitat with increased growth potential, most notably in the fall when diversions close and temperatures begin to drop.

## **CONNECTING WITH NONSCIENTIFIC AUDIENCES THROUGH SOCIAL MEDIA STORYTELLING**

Sara Cassinelli

Idaho Department of Fish and Game

"Everybody has a great story to tell, even the science community. According to Pew Research Center, seven in ten Americans use social media to connect with one another, engage with news content, share information, and entertain themselves. Fisheries professionals have an opportunity to communicate their science and share experiences on a variety of social media platforms. This presentation will provide examples of what makes great social media posts on major platforms such as Facebook, Twitter, and Instagram; and explain how storytelling and great visuals connect and engage with nonscientific audiences. Whether you use social media or not, you will learn what types of content resonate with audiences and how you can help support fisheries communications efforts."

## **FIT-BITS FOR FISH: USING ACCELERATION BIOTELEMETRY TO CHARACTERIZE STEELHEAD TROUT REPRODUCTIVE BEHAVIOR IN A SPAWNING STREAM AND ADULT PACIFIC LAMPREY MIGRATION AT A FISHWAY BOTTLENECK**

Christopher Caudill<sup>1</sup>, Nathaniel Fuchs<sup>2</sup>, Sarah Hanchett

<sup>1</sup>University of Idaho, <sup>2</sup>Washington Division of Fish and Wildlife

Acceleration biotelemetry is an emerging technology allowing information on the movement patterns of fishes to be obtained in real-time and remotely, i.e., without recovery of an archival tag. Here, we present two case studies applying prototype and early-production commercial radio-telemetry tags transmitting acceleration data every 5 s. In the first study, reproductively mature steelhead were tagged and monitored while spawning in the wild with the primary goal of estimating female oviposition rate during spring snowmelt run-off conditions. In a second study, we monitored movement patterns and time-budgets in adult Pacific lamprey at a known bottleneck near the top of a fishway at Bonneville Dam in an effort to identify potential mechanism(s) causing failed passage attempts. In both studies, tagged fish were video-taped in semi-natural conditions to correlate behaviors to acceleration records, develop classification criteria for inferring behavior from acceleration time-series, and validate the classification prior to the release of at-liberty animals. Acceleration biotelemetry holds promise for providing detailed information on fish activity, movement, energy and thermal budgets, spawning behavior, and habitat use to address a broad spectrum of research and monitoring objectives.

## **EVALUATION OF ANGLER HARVEST, CATCH RATES, AND SATISFACTION IN COMMUNITY POND FISHERIES**

Luciano Chiaramonte, Kevin Meyer, Benjamin Holen

Idaho Department of Fish and Game

Urban and community trout fishing ponds are valuable recreational resources for anglers across America because of their ease of access and often-regular stocking frequency. Effective management of these fisheries requires knowledge of how bag limit, stocking frequency, stocking density, and angler effort affects catch rates of catchable-sized Rainbow Trout and angler satisfaction in the days after stocking. We conducted creel surveys at ponds that varied in all of these factors to assess the importance of each. Preliminary data show that angler catch rates averaged 0.53 fish/hr at ponds with a two-trout bag limit and 0.75 fish/hr at ponds with a six-fish limit. Anglers reported being somewhat or highly satisfied 80% of the time at two-trout limit ponds and 79% of the time at six-trout limit ponds. Despite the four fish difference in bag limits, 80% of anglers harvested  $\leq 2$  fish at six-trout limit ponds. Angler-reported tags indicated days-at-large of stocked trout was 27 days at two-fish ponds and 17 days at six-fish ponds. Angler tag returns suggested that, on average, total use (trout harvested + trout caught-and-released) was 33% and 56% at two- and six-fish ponds.

### **STAGE 0 RESTORATION: WHAT IS IT, AND WHY IS IT IMPORTANT TO FISH?**

Brian Cluer<sup>1</sup>, Paul Powers<sup>2</sup>

<sup>1</sup>NOAA Fisheries, <sup>2</sup>Deschutes National Forest

Stage 0 is a geomorphic concept that links multi-threaded branching channel networks interacting with floodplains to the more common single-thread forms disconnected from their floodplain, that we've been managing and restoring for decades. The term comes from an expanded channel evolution model that describes the pre-disturbance condition of alluvial valleys that has been forgotten over the past century of domesticating the land. Alluvial valleys filled with alluvium can not be explained by the streams that now occupy them, or the common natural channel design that is the target for most restoration. Stage 0 also describes a suite of physical processes and associated ecosystem benefits that are climate resilient and historically provisioned abundant and elastic wildlife populations, including salmon. This presentation will give a brief overview of the scientific background and geomorphic foundation for the stream evolution model of Cluer and Thorne 2013, and explore the habitat and ecosystem benefits of restoring Stage 0 conditions to alluvial valleys.

### **SALMON WERE MADE TO MOVE: DOWNSTREAM REARING IN IDAHO STOCKS OF CHINOOK SALMON AND STEELHEAD**

Timothy Copeland<sup>1</sup>, Marika Dobos<sup>1</sup>, Michael Ackerman<sup>2</sup>

<sup>1</sup>Idaho Dept of Fish & Game, <sup>2</sup>Biomark, Applied Biological Services

The classic view of stream-type salmon was that early emigrants were viewed as poor competitors that did not contribute appreciably to the population, whereas successful individuals resided in their natal reaches until smoltification. Recent work has shown there is more diversity in successful

juvenile rearing patterns than previously thought. These patterns are important considerations for effective conservation and restoration. Conceptually, there are several reasons why individuals would take advantage of suitable habitat downstream, especially for steelhead. I present selected case studies of Chinook Salmon and steelhead populations to illustrate the extent and contrast in patterns of downstream rearing in Idaho. In general, most juvenile spring/summer Chinook Salmon leave their natal reaches before winter and smolt the following spring. Significant winter mortality has been observed for these fish but they often survive to adult return better. Seasonal patterns are more ambiguous for steelhead but successful smolts have been documented spending up to three winters in downstream habitats. The importance of downstream rearing to steelhead populations seems to depend on elevation and hydrology. The foregoing patterns have implications for restoration strategies. Restoration in natal reaches provides stability, which is important to preserve the target population. Natal reach restoration can increase productivity by reducing movement costs to the population because individuals are less exposed to risk. Alternatively, it could produce more robust emigrants that perform better when they go downstream. Restoration downstream can provide greater opportunities for population growth, which is important for recovery. Downstream restoration effectively increases connectivity and allows the population to expand the resources it can access. Downstream restoration may decrease winter mortality or address known or suspected constraining reaches. These examples show that a robust conservation program should consider multiple strategies in order to protect and recover target populations.

## **EFFECTS OF ANNUAL STREAMFLOW ON NATIVE SALMONID POPULATIONS IN THE NORTH FORK BOISE RIVER**

Timothy D'Amico, John Cassinelli

Idaho Department of Fish & Game,

Idaho Department of Fish and Game (IDFG) fisheries staff conducts snorkel surveys to assess populations of salmons, trouts and other species across the state. Previous studies found relative fish densities were correlated with stream discharge. In IDFG's Southwest Region, snorkel surveys are conducted on the North Fork Boise River (NFBR), among other streams. During 2017-2019, IDFG Region 3 fisheries staff conducted snorkel surveys on the NFBR to assess gamefish populations. We will use findings from this study to inform future snorkel survey methods in the Southwest Region.

## **IN-STREAM EGG INCUBATORS PRODUCE HATCHERY CHINOOK SALMON WITH SIMILARITIES AND DIFFERENCES FROM NATURAL JUVENILES.**

Lytle Denny<sup>1\*</sup>, Keats Conley<sup>1</sup>, Jonathan Ebel<sup>1</sup>, John Hargrove<sup>2</sup>, Wyatt Petersen<sup>1</sup>

<sup>1</sup>Shoshone-Bannock Tribes, <sup>2</sup>Idaho Department of Fish and Game

Supplementation of fish at the egg stage is a low-cost alternative to hatchery rearing, presumed to improve adaptation to local natural conditions. The Shoshone-Bannock Tribes began supplementing Chinook Salmon (*Onchorynchus tshawytscha*) in Panther Creek, Idaho, at the eyed-egg stage in 2014. Chinook Salmon eggs were artificially fertilized and reared to the eyed stage in-hatchery, then outplanted in custom-made in-stream incubators (egg boxes) for volitional release and natural rearing. Using data from three brood years, we evaluated the efficacy of this supplementation program solely in terms of juvenile production: we related juvenile

production to egg box placement and retrieval, assessed the relative contribution of egg box-produced juveniles to overall juvenile abundance, and compared the performance (length, condition, dispersal distance, and survival) of egg-box versus natural-origin juveniles. Brood year and box placement within the stream (distance upstream) were the best predictors of whether or not an egg box was retrieved from its original location. Meanwhile, the condition of the box (i.e., intact, damaged, missing) was the best single predictor of juvenile production. Supplemented eggs represented an estimated 42%, 50%, and 42% of total egg deposition in Panther Creek in brood years 2014, 2015, and 2016, respectively. Parentage analysis revealed that egg boxes contributed 6% to 22% to 35% of parr production for the respective brood years when normalized to the estimated egg deposition—less than the egg-to-parr production estimated for natural redds. As fall parr, egg box progeny differed from natural fish in terms of their length and dispersal behavior, but were of similar length and condition at their emigration from Panther Creek and exhibited no significant difference in downstream survival through the Federal Columbia River Power System. Collectively, our results provide useful insights to fisheries managers interested in initiating or refining egg supplementation programs.

## **LONG-TERM TRENDS IN ABUNDANCE OF MOUNTAIN WHITEFISH IN THE CLEARWATER RIVER BASIN, IDAHO**

Hunter Distad<sup>1</sup>, Robert Hand<sup>1</sup>, Brian Knoth<sup>1</sup>, Jason Fortier<sup>2</sup>

<sup>1</sup>Idaho Department of Fish and Game, <sup>2</sup>Pacific States Marine Fisheries Commission

Mountain Whitefish *Prosopium williamsoni* are an important component to recreational fisheries throughout Idaho but there has been a general lack of information on the species' trends in abundance over time. We evaluated trends in Mountain Whitefish abundance and population size structure in the four major drainages in the Clearwater River Basin (Lochsa, North Fork Clearwater, Selway, and South Fork Clearwater rivers) using a long-term (>25 years) snorkel dataset. We developed criteria to reduce effects of sampling variability because sampling effort was not consistent across space and time. Data suggest a declining trend in relative abundance of Mountain Whitefish in main-stem reaches of the Lochsa, South Fork, and Selway rivers since the early 2000's. Concurrently, there was a shift in the size structure of the Mountain Whitefish population within the South Fork Clearwater tributaries. We observed a decline in both mean proportion and occupancy rate of Mountain Whitefish fry and an increase in the proportion of larger individuals (>305mm) since the early the early 2000's. Overall, trend data showed that Mountain Whitefish abundance is declining across most of the Clearwater River basin which suggests out of basin drivers may be negatively impacting these populations. An analysis of these trends in relation to trends in large-scale environmental indices would help us better understand the influence of these factors on Mountain Whitefish abundance in the region. The results suggest that Mountain Whitefish populations in the Clearwater River basin are currently decreasing in abundance, but the factors affecting population trends are poorly understood.

## **ESTIMATING JUVENILE SURVIVAL AND RECRUITMENT OF STEELHEAD DESPITE COMPLEXITIES IN EARLY LIFE HISTORY MOVEMENT AND REARING HABITAT USE**

Marika Dobos, Timothy Copeland, Brett Bowersox, Eric Stark

Idaho Department of Fish and Game

Recruitment and survival are key to understanding population dynamics. However, early life history complexities of wild steelhead *Oncorhynchus mykiss* make it difficult to examine effects of variations in age at emigration. A multi-state release-recapture model was recently developed to examine cohort survival across multiple migration years and ages at emigration from Fish Creek, Idaho, 1996–2018. Survival increased with age and differed by season. Mean survival was highest for age-4 fish across seasons (0.767; SE = 0.077). Mean survival for age-3 fish was 0.619 (SE = 0.044), for age-2 fish was 0.445 (SE = 0.027), and for age-1 fish was 0.263 (SE = 0.026). Survival across all ages was lower for summer tagged fish. Total number of smolts varied from 4,085 to 29,712. Smolts per spawner varied from 17 to 1,272 (mean = 232; SE = 62). Recruitment asymptotes at 57,800 juveniles from Fish Creek and 14,626 smolts. Differential survival by age and season in which juveniles entered the main stem river reflects the diversity in early life history strategies present in the Fish Creek steelhead population. Indications of density dependence in natal tributary and main stem river habitat indicate limiting factors in rearing habitats important for maintaining life history diversity.

## **KOOTENAI TRIBE OF IDAHO ENDANGERED WHITE STURGEON EDUCATIONAL OUTREACH TO ELEMENTERY STUDENTS**

Mark Elliston, Brian Michaels, Shawn Young

Kootenai Tribe of Idaho

Kootenai River White Sturgeon *Acipenser transmontanus* are endangered. Recovery efforts in the Kootenai River system started in 1989. Lack of suitable habitat has led to natural recruitment failure which has created an uphill battle towards recovery. Kootenai River White Sturgeon are an isolated population in the Kootenai River System. They are important culturally, ecologically and recreationally to the Kootenai Tribe of Idaho and the local community as well as the river system. A general background will be presented detailing what the Kootenai Tribe of Idaho has accomplished with their innovative and adaptive management efforts to ensure the Kootenai River White Sturgeon have the greatest possible chance at survival. As part of the tribal sturgeon program, I will share my thoughts and experiences for establishing a great entry level educational program that can be fun, popular, and exciting to the youth and local community. By increasing awareness and stimulating young minds, the educational program invites students to express new thoughts and ideas to preserve the future of the Kootenai River White Sturgeon and our programs. After all, "Education is the most powerful weapon" {Nelson Mandela}. Consequently, we believe education is not only the first step but the greatest tool in the battle for conservation.

## **NORTHERN PIKE SUPPRESSION IN COEUR D'ALENE LAKE: BENEFITS AND CHALLENGES OF A LOCALIZED STRATEGY**

Jon Firehammer

Coeur d'Alene Tribe

The Coeur d'Alene Tribe's Fisheries Program, in collaboration with the Idaho Department of Fish and Game, has been implementing a localized Northern Pike (NP) suppression effort in Coeur d'Alene Lake since 2015 to promote the recovery of native Westslope Cutthroat Trout (WCT) populations. This presentation illustrates the realized benefits and challenges associated with such an approach. Since the inception of Windy Bay suppression efforts, adfluvial WCT originating from the Lake Creek watershed have exhibited a four-fold increase in return rates. In 2019, approximately 500 spawners were estimated to have ascended Lake Creek, which was the most recorded over the monitoring program. Though the number of NP removed from Windy Bay declined by over 80% over the first four years of suppression, the number removed in 2019 exceeded that removed in the first year, and in conjunction with a young age distribution, alluded to a compensatory response. Suppression efforts were expanded to the southern end of the lake in 2019, in which a total of 1409 pike were removed. Exploratory gillnetting in combination with radio telemetry revealed that spawning aggregations of NP were more widespread than in Windy Bay. However, the fall distribution of NP in the southern end was markedly different than that found in the spring and concentrations of NP were primarily limited to a few locations, suggesting that fall suppression may be equally or more effective than spring efforts in depleting this population. Radio-telemetry also identified spawning aggregations in backwater habitats outside of the targeted suppression area in the southern end, suggesting that some NP may engage in seasonal spawning migrations and may not be susceptible to spring netting efforts. Plans are currently being developed to propose habitat modifications to these apparent centers of pike production to limit their accessibility to migratory adults.

## **UTILIZING CONSERVATION AQUACULTURE FOR BONNEVILLE CUTTHROAT TROUT IN IDAHO**

Bryan Grant, Wayne Fowler

Idaho Department of Fish and Game

In 2007, the Idaho Department of Fish and Game implemented a conservation strategy to help restore native Bonneville Cutthroat Trout *Oncorhynchus clarkii utah* within the Thatcher Management Unit of the Bear River basin in southeast Idaho. The work was initiated because a primary objective described in the Idaho Department of Fish and Game's management plan for the conservation of Bonneville Cutthroat Trout is to supplement or reestablish populations in areas with low abundance or vacant habitat. Since 2007, approximately 2,400 wild Bonneville Cutthroat Trout have been collected for broodstock purposes. In 2010, conservation aquaculture operations were initiated at the Grace Fish Hatchery. These operations still continue and have resulted in the successful production and release of over 190,000 fish to assist with supplementation or reestablishment programs within the management unit. Post-release sampling events and angler reports indicate that Bonneville Cutthroat Trout abundance has increased in the Thatcher Management Unit. The conservation aquaculture techniques developed for this management unit provide a template for the development of similar techniques that can be utilized in other management units throughout the range of the subspecies in Idaho.

## **ESTIMATING THE ABUNDANCE OF CHINOOK SALMON REDDS WITH THE USE OF DRONES**

Eric Geisthardt<sup>1</sup>, Conor McClure<sup>2</sup>, Greg Schoby<sup>2</sup>

<sup>1</sup>Pacific States Marine Fisheries Commission, <sup>2</sup>Idaho Department of Fish and Game

Unmanned aerial vehicles (UAVs) were first integrated into the Idaho Department of Fish and Game's aerial counts of Chinook Salmon (*Oncorhynchus tshawytscha*) redds in 2017, replacing helicopter surveys on two tributaries in the Upper Salmon River Basin. The following year (2018), UAVs were further integrated into aerial counts, replacing helicopter surveys on 10 tributaries and 13 transects along the mainstem Salmon River via manual flights. This past year the same 10 tributaries and 13 transects along the Salmon River were surveyed using UAVs, but we transitioned from manual flights to mostly autonomous flights. The purpose of this study is to evaluate and refine methods for using UAVs to conduct aerial redd counts in Idaho. Aerial UAV redd counts were paired with ground counts for analysis when possible, as ground redd counts are generally considered to be the closest to a true census. Pre-programmed flight plans were used to survey transects where feasible. Manual flights occurred in areas where it was not feasible to program flights or where it made sense logistically. We compared UAV aerial redd counts with ground redd counts conducted in four streams throughout the Salmon Region in 2018 and 2019 using different methodologies to evaluate factors affecting redd sightability and net error in aerial surveys. We evaluated net error, costs, safety, post processing, and survey efficiency of UAV redd counts over both years. Results indicate that all UAV redd counts consistently underestimate redd abundance, much like helicopter surveys, while sightability and net error varied across individual streams and between survey methods. This study provides insight into ways in which UAVs may be most effectively integrated into annual Chinook redd counts.

## **CREEL CHECK STATIONS AND FISH TAGGING: ESTIMATING ANGLER EFFORT AND HARVEST IN THE UPPER BIG LOST BASIN**

John Heckel, Josh McCormick

Idaho Department of Fish and Game

Creel check stations and "Tag You're It" were conducted simultaneously throughout the upper Big Lost River basin in 2019 to collect data on angler effort, angler use, catch rates, and harvest. Check station personnel interviewed 222 anglers from May through October. Angler effort was estimated at  $11,775 \pm 4,975$  hours (estimate  $\pm$  95% CI) and the highest amount of effort occurred in the Upper Big Lost River (i.e., 5,470 hours). Fly anglers contributed 80% of total effort, followed by bait anglers at 11%, and lure anglers at 8%. Data collected from creel suggests that catch rates were 1.40 fish/hour, and we estimated that anglers caught  $16,408 \pm 8,874$  fish, all species combined. Based on creel, estimated harvest out of the total catch for all anglers was 8%, with bait anglers reporting 38% harvest, lure anglers at 13%, and fly anglers at 1%. The average reporting rate of tagged hatchery trout in the upper Big Lost basin was  $28\% \pm 17\%$  (mean  $\pm$  SD). Total angler use, which included fish harvested and caught-and-released, was 22% and ranged from 5% to 40%, with the highest amount of use in the East Fork Big Lost River (i.e., 40%). Estimated exploitation (i.e., from tag returns of hatchery trout) was 10% and ranged from 1% to 34%. Total angler use for Rainbow Trout was 29% and for Cutthroat Trout was 18%. Exploitation for Rainbow Trout was 21% and exploitation for Cutthroat Trout was 4%. Although estimates of harvest from creel and fish tagging were similar, our creel estimate of harvest included both wild and hatchery trout, whereas our estimate of exploitation included only hatchery trout. Our results suggest that creel check

stations can be used for estimating angler effort and harvest. In addition, results from check stations and fish tagging suggest that harvest is low in the upper Big Lost River basin.

## **INVESTIGATING FALL CHINOOK SALMON LIFE-HISTORY DIVERSITY USING INNOVATIVE ANALYTICAL TECHNIQUES ON A LONG-TERM OTOLITH CHEMISTRY DATASET**

Jens Hegg<sup>1</sup>, Kat Gillies-Rector<sup>1</sup>, Brian P. Kennedy<sup>1</sup>, Paul Chittaro<sup>2</sup>, Richard Zabel<sup>2</sup>

<sup>1</sup>University of Idaho, <sup>2</sup>NOAA - NWFSC

Fall Chinook salmon in the Snake River inhabit a heavily anthropogenically modified river system. Historically, the population was adapted to early juvenile outmigration due to high summer temperatures which precluded summer residence in the lower river. However, Fall Chinook salmon currently inhabit a much different river system. The placement of multiple hydropower dams has blocked access to upstream spawning areas, changed the hydrological regime of the free-flowing river, and created new reservoir habitats with different temperature regimes and trophic dynamics. During the past 20 years the population has undergone a shift in juvenile outmigration life history, with a large proportion of the population now following a late-outmigrating (yearling) life history in contrast to the historically predominant early (sub-yearling) outmigration timing. The causes of this life-history shift, and the source locations of these early migrants, were unknown. Further, traditional sampling and tracking methods were not sufficient to investigate these changes. Using a 15-year dataset of otolith microchemistry from Snake River Fall Chinook salmon we investigate the geographical distribution of yearling migrants and the downstream movement patterns among fish from throughout the river system. Answering these questions required development of new methods, combining otolith chemical data with growth and environmental data and advancing the state-of-the-art in statistical analysis for otolith movement analysis. These integrative methods provide new insight into the spatially explicit conditions which drive migratory changes and downstream movement timing within this population.

## **HABITAT USE AND PRODUCTION OF JUVENILE BONNEVILLE CUTTHROAT TROUT IN THREE TRIBUTARIES TO BEAR LAKE**

Megan Heller<sup>1,2\*</sup>, Michael Quist<sup>1,2,3</sup>, Jeffrey Dillon<sup>4</sup>, Carson Watkins<sup>4</sup>, Arnold Brimmer<sup>4</sup> Scott Tolentino<sup>5</sup>

<sup>1</sup>Department of Fish and Wildlife Sciences, University of Idaho, <sup>2</sup>Idaho Cooperative Fish and Wildlife Research Unit, University of Idaho, <sup>3</sup>U.S. Geological Survey, <sup>4</sup>Idaho Department of Fish and Game, <sup>5</sup>Utah Division of Wildlife Resources

Land-use disturbances and associated losses in habitat quantity and quality negatively effected the Bonneville Cutthroat Trout (BCT) *Oncorhynchus clarkii* utah population in Bear Lake in the early 1900s. Bear Lake BCT follow an adfluvial life history strategy and without access to suitable spawning habitat, the population of wild BCT was nearly extinct by the early 1950s. In response to the decline in abundance of wild fish, supplementation of the population with hatchery BCT began in 1973. The production of wild BCT was minimal until conservation efforts shifted towards improving fish habitat in addition to the stocking of hatchery fish. The proportion of wild BCT in Bear Lake was only 7% in 2002. After habitat improvements began in the spawning tributaries, the proportion of wild fish increased. By 2017, nearly 70% of BCT in annual population surveys were wild fish. As a result, anglers have shown interest in the opportunity to harvest wild fish. However,

gaining a more comprehensive understanding of the ecology and population dynamics of BCT in the Bear Lake watershed is necessary before changes are made to the management of the fishery. The ecology of juvenile BCT in tributaries to Bear Lake is poorly understood, and most data are unpublished or anecdotal. The objective of this study was to assess production, occurrence, distribution and relations to habitat characteristics of BCT in three tributaries to Bear Lake. Fish and habitat characteristics were sampled from 48 sites on three tributaries from June-October 2019. Results from this study will provide information to help identify critical data gaps on the fundamental ecology of wild BCT.

## **OUT OF STATE, BUT NOT OUT OF MIND: HYDRO-SYSTEM OPERATIONS AND IDAHO ANADROMOUS FISH**

Jay Hesse

Nez Perce Tribe

All Snake River Basin anadromous fish experience the lower Snake and Columbia mainstem migration corridor as juveniles and adults. That mainstem habitat has been significantly altered by hydro-system development impacting fish with what some have call “a litany of insults.” How dams are operated (individually and collectively) influence the behavior and survival of salmon and steelhead. Water flow, passage route, predator risk, and water quality are actively managed, but what we manage for and the efficacy of those actions are routinely debated. “Out-of-State” survival (SARs), recently around 1%, must be increased to 2-6% (averaging 4%) to achieve regional goals of healthy and harvestable salmon and steelhead populations. Realizing 2-6% SARs is function of ocean and in-river conditions. Current efforts to manage and opportunities to change in-river conditions will be discussed.

## **RESTORING BONNEVILLE CUTTHROAT TROUT IN THE BEAR RIVER DRAINAGE IN IDAHO-UTAH**

Ryan Hillyard<sup>1</sup>, Carson Watkins<sup>1</sup>, Scott Tolentino<sup>2</sup>

<sup>1</sup>Idaho Department of Fish and Game, <sup>2</sup>Utah Division of Wildlife Resources

Bonneville Cutthroat Trout *Oncorhynchus clarkii utah* (BCT) have declined in distribution and abundance over the past century due to impacts such as, water diversion, grazing, timber harvest, road building, hybridization with Rainbow Trout and competition with nonnative species. During the late 1900s and early 2000s, efforts were implemented to identify existing populations and their geographic distribution. In Idaho, there were a number of populations that were targeted for population enhancement. The status of BCT in Idaho has improved. Increases in abundance and distribution of BCT have resulted from focused efforts conducted by a myriad of partners. Here we describe two restoration stories: 1) Implementation of a captive broodstock program that facilitated re-establishment and supplementation of wild BCT in the Bear River in Idaho, and 2) The collaboration between private industry, government agencies and NGOs to restore a unique stock of adfluvial BCT in the Bear Lake system, Idaho-Utah. These restoration examples demonstrate the value of collaborative partnerships across disciplines to restore fish populations.

## **Genomic resources for reintroduced Coho salmon (*Oncorhynchus kisutch*) in the upper Columbia and Clearwater Rivers**

Rebekah Horn, Shawn Narum

Columbia River Inter-Tribal Fish Commission

For species that have been extirpated from parts of their range, conservation managers often reintroduce individuals to these areas in hopes of restoring populations to pre-decline conditions. Coho salmon (*Oncorhynchus kisutch*) were listed as extirpated in the mid-1990s in the interior reaches of the Columbia River watershed. Starting in the late 1990s, the Columbia River Treaty tribes were successful in starting re-introduction programs that have established Coho salmon stocks in the Upper Columbia and Clearwater Rivers. As part of these programs, meta-data for each spawned fish are collected, including a fin clip used for genetic analysis. The genetic analyses can be used to assign offspring to their parents, classify a broodstock's age class structure, and characterize the genetic diversity and fitness within and among years. Genomic scans of returning Coho salmon can also be used to link phenotypic characteristics that may confer adaptive potential of fish to their re-introduced habitats. Genetic data for five Coho salmon hatcheries from 2015-2018 has revealed larger genetic differentiation among brood years compared to among hatcheries. Genetic diversity among hatcheries and brood years does not vary significantly. Among the five hatcheries, returning offspring can be assigned back to their parents at a variable rate, from 33% of offspring to over 97%. On the Wenatchee River in Washington, genome-wide association tests revealed three genomic regions that are associated with fish return location within the basin and may confer greater potential for steeper and longer migration distances. Lastly, genomic data was used to develop two SNP markers that can differentiate male and female Coho salmon that assign sex with an over 99% accuracy rate. The combination of genetic measurements available through routine collection of broodstocks will continue to aid with the re-introduction and expansion of Coho salmon programs in the upper Columbia and Clearwater Rivers.

## **STATUS AND SUCCESS OF CONSERVATION AQUACULTURE USED TO RESTORE KOOTENAI RIVER BURBOT**

Nathan Jensen, Brycen Lunger, Riley Jones, Shawn Young

Kootenai Tribe of Idaho

Burbot *Lota lota maculosa* were once abundant in the Kootenai/ay River Basin; Idaho USA and British Columbia Canada, where they provided cultural, recreational, and commercial fisheries. Beginning in the 1970's, habitat loss and hydro-power operations lead to extirpation of Burbot populations. A multi-agency program lead by the Kootenai Tribe of Idaho (KTOI), the University of Idaho Aquaculture Research Institute (UIARI), the British Columbia Ministry (BCM) and Idaho Department of Fish and Game (IDFG) has resulted in development of a program to conserve and monitor a native strain of Burbot being used to restore populations on a basin-wide scale. From 2009 to present, the program transitioned from UIARI laboratory-scale production to larger-scale production at a new KTOI Tribal fish hatchery. The Kootenai Tribe of Idaho Native Fish Conservation Aquaculture Program now supports Kootenai River Burbot conservation aquaculture and IDFG and BCM complement the program with in-river post-release monitoring and evaluation. Annual hatchery Burbot releases have been variable (ranging 40,000 – 750,000 beginning 2015); however, a pre-determined restoration goal of 17,500 spawning adults has been achieved. The new facility

was designed to annually produce 125,000 6-month old Burbot averaging 100 mm total length and 5 – 10 g. Current population estimates of adult Burbot in-basin exceed 50,000. The program is now also supporting experimental releases of early life stages (e.g., eggs, larvae) into river, floodplain, side-channel, and lake habitats to further evaluate environmental constraints that remain. The information gained from early life stage releases; through collaboration with IDFG and BCM monitoring programs, may help guide future habitat restoration projects within basin. The overarching goal of the program is to restore self-sustaining, naturally recruiting populations for cultural and recreational use. In general, this presentation will highlight the progression of conservation aquaculture method developments and program research support now being used to understand recruitment bottlenecks.

### **CROSS-PROTECTION OF A LIVE-ATTENUATED COLDWATER DISEASE IMMERSION VACCINE AGAINST NOVEL FLAVOBACTERIUM SPP. AND CHRYSSEOBACTERIUM SPP.**

Evan Jones<sup>1\*</sup>, Jie Ma<sup>1,2</sup>, Timothy Bruce<sup>1,2</sup>, Ponnerassery Sudheesh<sup>2,3</sup>, Christopher Knupp<sup>4</sup>, Thomas Loch<sup>5</sup>, Kenneth Cain<sup>1,2</sup>

<sup>1</sup>Department of Fish and Wildlife Sciences, University of Idaho, <sup>2</sup>Aquaculture Research Institute, University of Idaho, <sup>3</sup>Florida Department of Agriculture and Consumer Services Bronson Animal Disease Diagnostic Laboratory, <sup>4</sup>Michigan State University Department of Fisheries and Wildlife, <sup>5</sup>Michigan State University Department of Pathobiology and Diagnostic Investigation

Flavobacterial infections in fish cause major losses to production stocks and have severe economic implications within the aquaculture industry. For salmonid producers, a common threat within this genus is *F. psychrophilum*, the causative agent of bacterial coldwater disease (BCWD). Recent advancements in BCWD disease management have included a live-attenuated vaccine that provides cross-protection from an array of *F. psychrophilum* strains. Additionally, there are other emerging and virulent family Flavobacteriaceae strains that have been of interest in coldwater aquaculture. Novel, virulent Flavobacteriaceae family isolates previously isolated and identified in diagnostic cases were used to determine the cross-protective ability of the live-attenuated *F. psychrophilum* vaccine. Vaccine protection was tested against 3 novel Flavobacteriaceae isolates that had previously demonstrated virulence in rainbow trout (*Oncorhynchus mykiss*). Vaccinated fish developed significantly higher *F. psychrophilum*-specific antibody titers 8 weeks post-vaccination relative to a mock-vaccinated group ( $P < 0.001$ ). Fish were challenged with two *Chryseobacterium* spp. (S25 and T28), a *Flavobacterium* spp. (S21), a mixed combination of equal parts S21:S25:T28 strains, and a standard virulent *F. psychrophilum* CSF259-93 strain. With respect to vaccination, the vaccinated group challenged with CSF259-93 had a relative percent survival (RPS) of 94.44% compared to the control fish ( $P < 0.001$ ). Interestingly, vaccinated fish also had a high RPS (85.18%) following the mixed Flavobacteriaceae infection. Fish challenged with the single novel Flavobacteriaceae strains did not demonstrate significant protection from the vaccine. Results indicate that the live-attenuated *F. psychrophilum* vaccine provides indirect protection against mixed infections with novel Flavobacteriaceae, and that it will be applicable and efficacious in production operations experiencing diverse flavobacterial infections.

## **VOLITIONAL SPAWNING AND EGG INCUBATION PRACTICES USED IN THE RECOVERY OF KOOTENAI RIVER BURBOT**

Riley Jones, Nate Jensen, Shawn Young

Kootenai Tribe of Idaho

Burbot *Lota lota maculosa* were once abundant in the Kootenai/ay River Basin; Idaho USA and British Columbia Canada, where they provided important cultural, recreational, and commercial fisheries. Beginning in the 1970's, cumulative effects of habitat loss and hydro-power operations lead to an extirpation of Burbot populations. A multi-agency cooperative program lead by the Kootenai Tribe of Idaho (KTOI), the University of Idaho Aquaculture Research Institute (UIARI), the British Columbia Ministry (BCM) and Idaho Department of Fish and Game (IDFG) has resulted in development of a program to conserve, restore and monitor a native strain of Burbot now being used to rebuild and restore populations on a basin-wide scale. From 2009 to present, the program transitioned from UIARI laboratory-scale production to larger-scale production at a new KTOI Tribal fish hatchery. The Kootenai Tribe of Idaho Native Fish Conservation Aquaculture Program now operates the hatchery to support Kootenai River Burbot conservation aquaculture and IDFG and BCM complement the program by means of in-river post-release monitoring and evaluation. Current population estimates of adult Burbot in the basin exceed 50,000, which has led to the implementation of Kootenai River Burbot as a source of brood stock for the program. This new brood stock source has produced more than 39 million eggs over the course of three years of the program. The eggs collected from the Kootenai River Burbot have been used for multiple research projects, experimental larval releases, and to bolster juvenile production for Idaho and Canadian releases. This presentation will go in depth on the aquaculture practices that have led to the success of the Kootenai River Burbot as a brood stock source, including aquaculture system design, volitional spawning, and egg incubation practices.

### **Life history diversity of a recovering Salmon River Chinook population**

Brian Kennedy<sup>1</sup>, Jens Hegg<sup>1</sup>, Lytle Denny<sup>2</sup>, Joseph Snapp<sup>2</sup>

<sup>1</sup>Department of Fish and Wildlife Sciences, University of Idaho, <sup>2</sup>Shoshone-Bannock Tribes

Successful recovery of a migratory population requires an understanding of the strategies adopted by individuals that are reproductively successful and how they map onto features of the landscape they occupy. Salmon populations in the Panther Creek basin have suffered the same challenges as those throughout the Snake River with the added challenge of an extensive mining legacy over the last 60 - 80 years. Intensive rehabilitation of the habitat and water quality occurred in the late 1990's and spring Chinook salmon have naturally recolonized. The Shoshone-Bannock Tribes have begun an intensive monitoring effort with a weir for adult collection and PIT antennas for juvenile tracking. Additionally, the tribes' redd surveys have improved our understanding of spawning distributions while providing tissues of spawned adults. We have been improving our understanding of the behaviors of juvenile fish and the fates of these different life histories using Sr isotope records in the otoliths of those successfully returning fish. Based upon the unique geology of the basin, Sr isotopes alone provide a spatially explicit record of locations and emigration from Panther Creek as well as outmigration timing and behavior through the Snake River. Water samples were collected to expand out our map of Sr isotopic variation in the Salmon River basin. Juveniles were collected from 6 sites within the basin to confirm stable and consistent signatures with water Sr isotope signatures. Seventy-five natural-origin adults were collected from across 3

return years. Natal origins of adults were precise to within 4 regions of Panther Creek that each shared between 20 and 40% of the successful adult returns in the basin. Most individual represented a single overyearling outmigration strategy with little use of downstream habitats other than Panther Creek. The implication for this in comparison to other Salmon River populations will be discussed.

## **20 YEARS OF CHINOOK SUPPLEMENTATION USING ALTERNATIVE STAGES (PARR AND PRESMOLTS) - DID IT WORK?**

Mike Kosinski, Sherman Sprague

Nez Perce Tribe

The goal of the Nez Perce Tribal Hatchery Spring Chinook supplementation program was to recover naturally spawning fish and provide harvest in the Clearwater River subbasin. Novel fish culture practices using the "NATURES" rearing approach combined with releasing juveniles at the parr and pre-smolt rather than smolt stage produced hatchery fish that more closely mimicked the size and behavior of natural fish. Two streams, Lolo Creek and Newsome Creek, received pre-smolt releases and Meadow Creek in the Selway River basin received parr releases. Extensive monitoring and evaluations using adult weirs and rotary screw traps provided hatchery and natural comparisons of adult and juvenile performance measures. Results demonstrated that emigration timing were similar for hatchery compared to natural juveniles. Overall survival to Lower Granite Dam (LGR) of hatchery juveniles was significantly lower than that of natural juveniles. However, survival to LGR hatchery presmolts that overwintered in the release streams and emigrated as smolts was similar to that of natural smolts. Although adult returns were poor for both hatchery and natural Chinook salmon from these streams, the age composition of hatchery adults was similar to naturals, with relatively few jacks and a higher proportion of age 5 adults compared to production hatchery programs. Four generations of supplementation evaluations have demonstrated that the abundance boost associated with the release of hatchery fish has not been accomplished. We will provide recommendations for the future.

## **HOW DO SILVER CARP POPULATION DEMOGRAPHICS IN A LARGE RESERVOIR IN WESTERN KENTUCKY COMPARE TO OTHER U.S. POPULATIONS?**

Allison Lebeda<sup>1\*</sup>, Dalton Lebeda<sup>2</sup>, Tim Spier<sup>3</sup>, Jessica Morris<sup>4</sup>

<sup>1</sup>Pacific States Marine Fisheries Commission, <sup>2</sup>U.S. Geological Survey, <sup>3</sup>Murray State University,

<sup>4</sup>Kentucky Department of Fish and Wildlife

Invasive species continue to threaten aquatic ecosystems in the United States. Silver Carp *Hypophthalmichthys molitrix* have successfully infiltrated much of the Mississippi River Basin, including Kentucky Lake – a large mainstem reservoir of the Tennessee River in western Kentucky. Although Silver Carp have been present in Kentucky Lake for at least two decades, until recently, very little was known about the population. This makes it difficult to predict the potential impact of Silver Carp on native species. Silver Carp were sampled from Kentucky Lake using gill nets, cast nets, boat electrofishing, and commercial fishing. We examined population demographic data for Silver Carp within Kentucky Lake by measuring total length, weight, and gonad weight. Additionally, we removed a pectoral fin ray for aging. Of the sampled Silver Carp, 83% were between 700-1000 mm and 90% of aged carp were from the 2010, 2011, 2012, or 2015 year-classes.

Furthermore, Silver Carp in Kentucky Lake grew quickly to large sizes and were in excellent condition. The capture of young-of-the-year Silver Carp suggests that natural reproduction is occurring in Kentucky Lake. In conclusion, we found Silver Carp in Kentucky Lake to be larger sized, faster growing, in similar condition, and similarly aged to Silver Carp in other populations within the Mississippi River Basin. These data are among the first to examine population characteristics of Silver Carp in a large reservoir and may serve as a model for other large ecosystems such as the embayments of the Great Lakes.

## **SCIENCE THROUGH STORYTELLING: BEYOND THE DATA**

Anna Lindstedt

Friends of the Teton River

"You (and/or your team) spent a lot of time in the field collecting data points, samples, and public feedback; entering that data, and organizing it. But how do we take data from a spreadsheet to telling a great story?"

Science and storytelling have a lot in common. They both aim to bring issues of importance to the forefront, to reach a wider audience and have an impact on our understanding. However, the ability to make research findings comprehensible for the general public is a major challenge for most scientists, especially without formal training in communications. This presentation will share techniques for effectively communicating watershed research and fisheries data with non-experts using key communication tools and strategies that will help to tell your science story including:

- Distilling the data and translating it into a message that will reach your intended audience.
- Incorporating imagery to explain information that is complex; using techniques to help audiences "visualize the data."
- Reframing how we tell our scientific stories from the "what" to the "why" to better connect people with science and research; and
- Moving "beyond the data" to share its relevance across disciplines.

How we communicate about complex issues strongly influences how people will engage on these issues. Your research findings are valuable. Let's share them through great storytelling!

## **ENCOUNTER RATES OF WILD STEELHEAD IN IDAHO**

William Lubenau<sup>1,2\*</sup>, Michael Quist<sup>1,2,3</sup>, Brett Bowersox<sup>4</sup>, Timothy Copeland<sup>4</sup>, Josh McCormick<sup>4</sup>

<sup>1</sup>Idaho Cooperative Fish and Wildlife Research Unit, University of Idaho, <sup>2</sup>Department of Fish and Wildlife Sciences, University of Idaho, <sup>3</sup>U.S. Geological Survey, <sup>4</sup>Idaho Department of Fish and Game

Steelhead *Oncorhynchus mykiss* are ecologically, economically, culturally, and recreationally important in the Pacific Northwest and Idaho. Due to a decline in wild steelhead abundance that has resulted in federal protection, recreational fisheries are supported by hatchery-supplemented stocks. In the mark-selective steelhead fisheries in Idaho, adipose-clipped steelhead may be harvested, but adipose-intact fish must be immediately released. Nevertheless, the potential

influence of recreational fisheries on wild fish is poorly understood and is a function of the abundance of wild fish, how many are encountered by anglers (i.e., encounter rate), and the mortality rate of fish directly resulting from being caught and released. Historical estimates of wild steelhead encounter rates are derived from a series of calculations using the number of wild and hatchery steelhead passing Lower Granite Dam, the number of hatchery steelhead harvested, and the number of hatchery steelhead caught and released. Currently, managers assume hatchery fish and wild fish have equal encounter rates, which is an assumption that may or may not be valid. We sampled, tagged, and released 1,221 adult steelhead at Lower Granite Dam with T-bar anchor tags to apply novel methods to estimate hatchery and wild steelhead encounter rates in Idaho. Tagged fish distributed upstream and moved into fisheries where some were caught and reported by anglers. The tags were labeled with US\$0, \$25, \$50, \$100, and \$200 to estimate non-reporting. Tagged fish were reported from the Clearwater, Snake, Salmon, Little Salmon, and Grande Ronde rivers.

### **COLLECTING KOOTENAI RIVER ADAPTED, HATCHERY PRODUCED BURBOT FOR BROODSTOCK AT THE KOOTENAI TRIBE OF IDAHO'S HATCHERY 2- TWIN RIVERS HATCHERY**

Brycen Lunger, Nathan Jensen, Shawn Young, Riley Jones

Kootenai Tribe of Idaho

Burbot *Lota lota maculosa* were once abundant in the Kootenai/ay River Basin. Beginning in the 1970's, cumulative effects of habitat loss and hydro-power operations lead to an extirpation of Burbot populations. A multi-agency cooperative program lead by the Kootenai Tribe of Idaho (KTOI), the University of Idaho Aquaculture Research Institute (UIARI), the British Columbia Ministry (BCM) and Idaho Department of Fish and Game (IDFG) has resulted in development of a program to conserve, restore, and monitor a native strain of Burbot now being used to rebuild populations on a basin-wide scale. From 2009 to present, the program has used a within-basin lake populations brood to seed the Kootenai River Burbot Conservation Aquaculture Program. While the genetic variability of the "founder" Lake has been successfully captured and time on the lake is limited, KTOI is now turning to hatchery produced fish in-river for broodstock. With the pre-determined restoration goal of 17,500 spawning adults being achieved, the program collects pre-spawn river-adapted adults from the Kootenai River to supply the Burbot program with gametes. KTOI in Co-operation with IDFG, now collect adults in January using shallow ( $\leq 10\text{m}$ ) hoop nets as part of the IDFG annual M&E efforts. In general, KTOI transports adult Burbot ( $>400\text{mm}$ ) to Twin Rivers Hatchery, where they are sorted by size (small $<550\text{mm}$ >large) and sex using ultra-sound. Adults are held in 10-foot circular tanks and water temperatures are manipulated to mimic the Kootenai River. Adults are not fed in-hatchery prior to spawning. The target spawning population per year is 200 burbot ( $>400\text{mm}$ ), Seasonal weather conditions and the narrow window of time to collect pre-spawn burbot during annual migrations make collecting adult burbot difficult and unpredictable. This presentation will highlight the methods used to collect Kootenai River Burbot for use as broodstock at the Kootenai Tribe of Idaho's – Twin Rivers Hatchery.

### **THE SEARCH FOR FRESHWATER MUSSELS IN THE LOWER BOISE RIVER**

Dorene MacCoy<sup>1</sup>, Matt Laramie<sup>2</sup>

<sup>1</sup>City of Boise, <sup>2</sup>U.S. Geological Survey

The City of Boise is investigating the presence of native freshwater mussels in the lower Boise River to provide background information for future Idaho negotiated rulemaking for ammonia aquatic life criteria. Idaho's current ammonia water quality standards are based on the 1999 Environmental Protection Agency (EPA) recommended criteria for the protection of early life stages of salmonids. In 2013, the EPA updated the freshwater ammonia aquatic life ambient water quality criteria to incorporate additional scientific studies. Several of the new studies looked at the toxicity of ammonia to life stages of freshwater mussels in the family Unionidae and found them to be more sensitive than salmonids. Many states, including Idaho, have several implementation options to adopt EPA recommended criteria. These limits will be incorporated into Idaho Pollutant Discharge Elimination System (IPDES) discharge permits. Lower ammonia limits may require costly water renewal facility upgrades for municipalities. Identifying the presence of freshwater mussels is critical in identifying ammonia discharge permit limits for IPDES and for future municipal utility operations.

There are three unionid species found in the Snake River and tributaries; these are *Anodonta* sp. (Floaters), *Margaritifera falcata* (Western Pearlshell), and *Gonidea angulate* (Western Ridged). Although there have been several macroinvertebrate sampling events in the mainstem lower Boise River since the early 1990's, no freshwater mussels have been documented. The City of Boise is using several strategies to search for freshwater mussels that included an intensive search for mollusks in a dewatered section of the lower Boise River in 2018, a geographical information system (GIS) based analysis of potential mussel habitat, and a focused survey using visual assessments and environmental DNA (eDNA) sampling techniques. This presentation will discuss each of these monitoring strategies and present any available results.

### **EVALUATION OF EARLY LARVAL WEANING OF LIVE FEED FOR BURBOT (*LOTA LOTA MACULOSA*)**

Moureen Matuha\*, Luke Oliver, Joseph Evavold, Jie Ma, Timothy Bruce, Kenneth Cain

Department of Fish and Wildlife Sciences and Aquaculture Research Institute, University of Idaho

Burbot (*Lota lota maculosa*) are the only freshwater gadoid fish, with potential as an aquaculture production species. A dietary weaning study was conducted in burbot larvae to investigate if the period of providing live feeds could be reduced within the early production phase. Burbot larvae (7 days post hatch [dph]) with an average body wet weight of 0.2mg and total length of 5.7mm, were reared with green water, live feed items (rotifers, *Artemia* spp.), artificial *Artemia* sp., and dry diets) and growth performance and survival were monitored for 70 days (8-78 dph). Fish were divided into six groups: a positive control group (standard weaning protocol) exclusively fed *Artemia* spp. and groups negative control (fed dry diet alone), treatment 1 (fed live *Artemia* spp.), treatment 2 (fed rotifers), treatment 3 (fed rotifers, live *Artemia* spp., artificial *Artemia* sp.) and treatment 4 (control group; fed rotifers, live *Artemia* spp.), prior to weaning onto dry diets. Larvae in control group yielded the highest survival rate (23%) by 78dph, followed by standard weaning protocol fish (22%) and treatment 3 larvae with survival rate (14%). On 78dph, the survival rate for all groups was at a similar level  $P < 0.001$ . Larvae fed artificial *Artemia* sp. reduced the live feeding time by 17 days when compared with larvae in the control group. All the larvae in treatment 1 died by 23dph and no larvae survived by 78dph in treatment 2. Average total length per fish was higher for fish in the control group (~50mm) & positive control treatment ~48mm, followed by fish fed artificial *Artemia* sp. (~36mm) by day 78dph. The total average length recorded in fish across treatments showed no differences ( $P < 0.001$ ). Study results indicate a potential for artificial *Artemia* sp. as a live feed substitute, thus reducing the live-feeding period for commercial burbot culture.

## **MOVEMENT AND HABITAT USE OF YELLOWSTONE CUTTHROAT TROUT AND UTAH CHUB IN HENRYS LAKE, IDAHO**

Darcy McCarrick<sup>1\*</sup>, Michael Quist<sup>1,2</sup>, Jeffery Dillon<sup>3</sup>, Brett High<sup>3</sup>

<sup>1</sup>Idaho Cooperative Fish and Wildlife Research Unit, University of Idaho, <sup>2</sup>U.S. Geological Survey,

<sup>3</sup>Idaho Department of Fish and Game,

Yellowstone Cutthroat Trout (YCT) *Oncorhynchus clarkii bouvieri* have high ecological and economic value. In many YCT fisheries, managers are tasked with balancing angler satisfaction and fish conservation. Trying to balance these two needs is typified at Henrys Lake, Idaho. Henrys Lake is a popular trophy trout fishery, but surveys have revealed changes in catch rates and body condition of YCT in recent years. These trends suggest that conditions in the lake may be becoming less favorable for YCT. A variety of factors have been hypothesized to explain these patterns, including direct and indirect effects of introduced Utah Chub (UTC) *Gila atraria*. The influence of UTC on YCT is largely unknown, but they typically have negative effects on salmonids in systems where they have been introduced. To better understand YCT and UTC interactions, 50 YCT and 50 UTC were radio-tagged in June 2019 to describe movement and habitat selection of YCT and UTC in Henrys Lake. Fish were located via mobile tracking and fixed receivers from June to November 2019. In general, fish were located in nearshore habitats. Yellowstone Cutthroat Trout were typically in deeper, colder water with low macrophyte density and UTC were in shallower, warmer water with high macrophyte abundance. As water temperatures increased, some YCT were observed in the center of the lake in relatively deep water (i.e., > 4 m). A few fish were located in Duck, Howard, and Targhee creeks throughout the summer. However, temperature sensors on the radio tags revealed that the majority of fish were in water temperatures that were similar to the rest of the lake. These data provide insight about movement patterns and habitat selectivity of YCT and UTC in Henrys Lake and can be used to inform management decisions for fishery improvement and YCT conservation.

## **EFFECTS OF CATCH-AND-RELEASE MORTALITY ON AN IDAHO STEELHEAD POPULATION**

Joshua McCormick, Marika Dobos, Brett Bowersox, Timothy Copeland

Idaho Department of Fish and Game

Low numbers of returning adult hatchery- and wild-origin steelhead *Oncorhynchus mykiss* to the upper Snake River basin in Idaho has led to the closure of several popular fisheries in recent years. Fishery closures were a result of concerns about achieving hatchery broodstock needs, but also to minimize effects on wild steelhead due to catch-and-release mortality. Although several studies have provided estimates of catch-and-release mortality on individual steelhead, little to no literature has been published on the population-level effects of catch-and-release fisheries. The objective of this study was to evaluate the effect of catch-and-release mortality on the long-term abundance and sustainability of a steelhead population in Idaho. An integrated population model was built using juvenile and adult abundance data collected for more than 20 years from a rotary screw trap and an adult weir in the Fish Creek watershed. The effect of the catch-and-release fishery was relatively small on projected adult, and smolt abundance, as well as measures of population viability, even in the presence of relatively high catch probabilities. Results from the model will be used to manage fisheries in future years if low returns of steelhead persist.

## **DEBRIS IN OUR RIVERS (THE LARGE WOOD KIND)**

Jeanne McFall

RIVHAB, PLLC

The advancement of American settlement westward resulted in rapidly changing landscapes with altered river morphology and floodplains. Beginning with beaver harvest for fur trapping, through gold mining, logging, and railroad construction, the rush of western life caused detrimental clearcutting of streamside timber and confinement of rivers that dramatically changed our landscapes. The removal of trees initiated massive biological response and severely impacted water quality, fish health, and available habitat. In general, our society spent over 100 years removing wood from channels to improve navigation, water conveyance, and transportation (Roni et al, 2014). Now, putting wood back into rivers is one of the most common restoration techniques used to improve habitat and restore floodplains. Although controversial at times, adding wood to our rivers encourages natural processes that lead to improved water quality and fisheries. My discussion will include various techniques and lessons learned from multiple project locations throughout Idaho where we've been supplementing high quantities of felled trees. Specific goals of wood loading include decreasing predation, improving refugia, reconnecting floodplains, improving hydraulic complexity and lateral habitat, and increasing pool quality and quantity. Water quality benefits include decreased stream temperatures and sediment loading through the restoration of natural channel processes. Project examples will include varied construction and anchoring methods, challenges of working in water, and impacts of "littering" wood in our rivers.

## **KOOTENAI RIVER WHITE STURGEON NATURAL SPAWNING AND INCUBATION EXPERIMENT**

Brian Michaels, Daniel Craig, Dan Aitken, David Weaselhead

Kootenai Tribe of Idaho

In 1988 the Kootenai Tribe of Idaho (KTOI) recognized the lack of White Sturgeon natural recruitment and started an experimental aquaculture facility to reverse population decline. The Kootenai River Native Fish Conservation Aquaculture Program (KRNFCAP) began rearing fish during 1990-1992; and then shortly after, the Kootenai River White Sturgeon *Acipenser transmontanus* was listed as an endangered species in 1994. Using standard practices and procedures such as hormone injection of the female, de-adhesion of eggs using fullers earth, and using McDonald jars for incubation, the KRNFCAP has been successful in raising juvenile white sturgeon since 1997. Although standard practices have been successful, recent studies have reported some negative effects, such as exacerbating spontaneous autopolyploidy. During 2019, KTOI staff experimented with new protocols and techniques such as natural spawning and incubation techniques. First we attempted volitional spawning by placing one female with five males in a 15' circular tank. Then we attempted a more natural incubation technique by using natural river rock substrate in 8' rectangular tanks. Typically, with standard techniques, fertilized eggs are de-adhesed to allow tumbling in McDonald jars for 10 days; however, with more natural techniques, we allowed the naturally adhesive fertilized egg to remain so, allowing eggs to adhere to substrate. Immediately after fertilization we released the eggs directly over the substrate. We also attempted different size substrate, different placement of substrate; and various spray bar

placement in each tank. In general, this presentation will highlight and compare our standard in-hatchery spawning methods with our natural spawning and incubation methods.

## **IS THERE A HARVESTABLE SURPLUS OF BULL TROUT (*SALVELINUS CONFLUENTUS*) IN LAKE PEND OREILLE, IDAHO?**

Nicole Mucciarone<sup>1,2</sup>, Matthew Corsi<sup>1</sup>, Josh McCormick<sup>1</sup>, Erin Roche<sup>1</sup>, Ken Bouwens<sup>1</sup>, Paul Kusnier<sup>3</sup>

<sup>1</sup>Idaho Department of Fish and Game, <sup>2</sup>Pacific States Marine Fisheries Commission, <sup>3</sup>Avista Corporation

Historically, Lake Pend Oreille in Idaho supported a renowned world-record Bull Trout (*Salvelinus confluentus*) fishery. Due to conservation concerns, the bull trout fishery was closed to harvest 1996, and in 1998 Bull Trout were listed as threatened range-wide under the Endangered Species Act. Since the harvest closure, multiple habitat improvements and management strategies have been implemented throughout the Lake Pend Oreille watershed with the goal of benefiting Bull Trout conservation. This includes 15 years of suppression of non-native Lake Trout (*S. namaycush*) via angling and gillnetting. In order to evaluate the status of the Lake Pend Oreille Bull Trout population, we developed a life-stage based integrated population model (IPM) using several years of capture-mark-recapture and redd count data. The objective of this project was to develop a management tool that can be used to monitor population demographics and assess the potential response of this population to various management and harvest scenarios. We utilized Bayesian inference and generated survival estimates using a multi-state open population model. These estimates were used in conjunction with redd count data in order to estimate annual abundance and assess various management scenarios. We found that abundances varied over time, and population growth rates oscillated around a mean geometric lambda of 0.99. Additionally, we found that under current management strategies this population could sustain an additional annual adult mortality of 5% through 2025 without a population decline. Furthermore, decreasing direct Bull Trout mortalities from gillnetting bycatch may provide an additional harvestable surplus. This project not only provides novel survival estimates for an adfluvial population of Bull Trout, but also contributes a valuable management tool that can be used to assess current and potential future management strategies in Lake Pend Oreille, Idaho.

## **LOCALLY ADAPTED PHENOTYPES OF STEELHEAD IN THE COLUMBIA RIVER BASIN**

Shawn Narum

Columbia River Inter-Tribal Fish Commission

Anadromous species such as steelhead trout (*Oncorhynchus mykiss*) undergo long-distance migrations across geographical regions that consist of highly heterogeneous habitats. This may lead to local adaptation and signatures of adaptive variation associated with phenotypic traits that may be distinct across broad aquatic landscapes. Extensive genomics research in steelhead has revealed strong signals of local adaptation in steelhead throughout the Columbia River. Genome scans have identified that balancing selection maintains variation for phenotypic traits such as arrival timing to spawning grounds (premature vs. mature) and age-at-maturity (1-ocean vs. 2-ocean) in steelhead throughout the Columbia River. Genes of major effect have been identified for these two traits and development of markers from these candidate genes enable

monitoring of phenotypic and genetic variation in natural populations or hatchery-reared stocks. This is a promising approach to maintain a broad portfolio of phenotypic diversity in steelhead that can buffer against exploitation and increase species persistence in disturbed ecosystems.

## **POPULATION TRENDS OF REDBAND TROUT IN THE OWYHEE MOUNTAINS, IDAHO**

Cynthia Nau

Idaho Department of Fish and Game

Interior Redband Trout (*Oncorhynchus mykiss gairdneri*) are native to the lower Snake River basin but currently exist largely in fragmented populations. As a result, numerous petitions have been made to protect Redband Trout under the Endangered Species Act in all or portions of their range. Documentation and understanding of population trends are therefore imperative in the future management and evaluation of this species' status. Idaho Fish and Game (IDFG) has conducted multiple comprehensive surveys of Redband Trout throughout their range in the state but in the southwest region, sampling has been sporadic and inconsistent. In 2016, IDFG began a renewed effort to track distribution and population trends of Redband Trout in the Owyhee Mountains of southern Idaho. One of the focal watersheds in this on-going project is Jordan Creek, a tributary of the Owyhee River, which has been surveyed by IDFG sporadically since 1977 using both multi-pass depletion population estimates and standardized electrofishing surveys documenting presence or absence of Redband Trout. This study seeks to determine population trends over time by comparing historic sampling multi-pass depletion estimates to the similar systematic sampling that occurred on Jordan Creek in 2019. In addition to the Redband trend analysis, Brook Trout prevalence in the watershed is also being evaluated. This information will be instrumental in assessing Redband Trout population trends in the watershed and informing future management decisions.

## **TRIPLOID INDUCTION IN CULTURED BURBOT (*LOTA LOTA*) USING THERMAL AND HYDROSTATIC SHOCK**

Luke Oliver\*, Jie Ma, Timothy Bruce, Joseph Evavold, Kenneth Cain

University of Idaho

The feasibility of triploid induction for burbot (*Lota lota*) was determined following a series of hydrostatic (pressure) and thermal (heat) shock treatments. Hydrostatic shock treatments were designed to test a range of variables including 1) duration of shock; 2) timing of shock (post-fertilization); and 3) shock pressure. Shock times post-fertilization and shock duration were varied by degree minutes ( $^{\circ}\text{C}$  minutes). A hydrostatic shock of 8,500psi at 180 $^{\circ}\text{C}$  minutes post-fertilization for 10 $^{\circ}\text{C}$  minutes yielded the highest percent triploid induction (100%) and survival (95%) relative to the controls. Duration of pressure-shock longer than 10 $^{\circ}\text{C}$  minutes at 8,500psi and higher, resulted in 100% pre-hatch mortality. A reduced shock pressure (7,500psi) resulted in a high percent triploidy (100%), but pre-hatch larval survival was 65.5% at a shock duration of 30 $^{\circ}\text{C}$  minutes. Thermal shock treatments included: duration of shock, timing of shock, and shock temperature. Triploid induction and survival were greatest following a thermal shock of 16 $^{\circ}\text{C}$  at 120 $^{\circ}\text{C}$  minutes post-fertilization for 500 $^{\circ}\text{C}$  minutes. This resulted in 96.6% triploidy and 57.4% survival relative to control groups. Shock temperatures above 16 $^{\circ}\text{C}$  generally resulted in a higher percent triploid induction but lower survival. Results presented here confirm that triploid induction in burbot

is possible. Further work is needed to confirm scale up potential, survival dynamics, sterility of triploid burbot, and changes in growth performance. Production of sterile burbot may increase opportunities for culturing burbot in areas where escapement may be a concern or when growth is inhibited due to reproductive maturation.

### **WHAT HAPPENS TO THE LITTLE ONES? MOVEMENT, DISTRIBUTION, AND HABITAT SELECTION OF JUVENILE CHINOOK SALMON IN THE UPPER SALMON AND LEMHI RIVERS, IDAHO**

Nick Porter<sup>1</sup>, Tulley Mackey<sup>1</sup>, Michael Ackerman<sup>1</sup>, Gordon Axe<sup>2,3,4</sup>, Richard Carmichael<sup>1</sup>, Kevin See<sup>1</sup>

<sup>1</sup>Biomark, <sup>2</sup>Fish Ecology Division, Northwest Fisheries Science Center, <sup>3</sup>National Marine Fisheries Science, <sup>4</sup>NOAA

Chinook salmon *Oncorhynchus tshawytscha* have two evolutionarily distinct life history types: ocean-type and stream-type. Within the stream-type lineage, there exists two juvenile migratory tactics; those leaving their natal tributaries as subyearlings prior to winter (presmolts) and those emigrating from their natal areas 1 year after emergence (smolts). A gap in knowledge exists in the life history of juveniles regarding overwintering movement, distribution, and habitat use. Currently, I am in the third-year of a four-year study using new technology to determine overwinter survival and habitat selection of juvenile Chinook salmon. In October 2019, 282 presmolts in the Lemhi River were implanted with 0.3 g radio transmitters to monitor movement and distribution over the 2019-2020 winter in the Salmon River. While the current years data is still being collected, previous data showed estimates from a Cormack-Jolly-Seber model of 7 fish making it to the Riggins areas of the Salmon River with an overall transition probability of 1.4%. Transition probabilities dropped 15% upon entering a slack water area and again 16% upon entering the wilderness section of the Salmon River. As this shows I hope to identify areas of interest for survival of overwintering juvenile Chinook. Currently, I am starting the initial year of a two-year study in the Lemhi River to observe habitat use of overwintering smolts through weekly relocations of radio tagged fish. The current years data is still being collected and will be analyzed in April of 2020. I have one additional year of data collection in 2021, upon which I will consolidate my data and produce a comprehensive report. The habitat use information will allow for more informed decisions when implementing habitat restorations, and movement and survival results will aid in addressing gaps in the literature that is critical for the successful management of juvenile salmonids.

### **RESTORING DEPOSITIONAL VALLEYS TO STAGE 0**

Paul Powers<sup>1</sup>, Brian Cluer<sup>2</sup>

<sup>1</sup>US Forest Service, <sup>2</sup>NOAA

This methodology breaks away from traditional stream restoration approaches that focus on creating a stable channel pattern, profile and dimension through the balance of the mean annual sediment load (Lane's balance) to maintain the constructed in-channel habitats. In contrast, the Stage 0 methodology used by the USFS in PNW, is based on the pre-manipulation state (Stage 0) defined in the Cluer and Thorne Stream Evolution Model (Cluer and Thorne 2013). This restoration methodology uses historic valley surfaces and geomorphic controls, referred to as the Geomorphic Grade Line (GGL), as the target elevation of both the low flow shallow

groundwater elevation and base flow wetted area (Powers et al. 2018). The primary goals of Stage 0 design are maximum floodplain connectivity at all discharge levels and the ability of the river valley to adjust and shape itself in response to watershed scale drivers. Rather than designing channels that are connected to the floodplain at a channel forming discharge, valley surfaces are activated and maintain a base flow water surface that is at or near the valley floor elevation. The fluvial valley is then able to develop a complex network of anastomosing flow paths, wetlands and diverse aquatic habitats in response to watershed and valley scale process drivers. The continued evolution of the river valley including aquatic habitats and riparian vegetation are in response to watershed drivers and not predetermined. Flow paths and riparian forests are allowed to develop and be lost through time as the site responds to disturbance, sediment (bedload and suspended) sorting and colonization of biological drivers.

### **JOHNSON CREEK – 25 YEARS OF CHINOOK SUPPLEMENTATION USING NATIVE FISH ONLY – DID IT WORK?**

Craig Rabe, Jason Voge, Ryan Kinzer, Doug Nelson, Travis Hodsdon

Nez Perce Tribe

The Johnson Creek Artificial Propagation Enhancement project has been actively supplementing spring/summer Chinook in Johnson Creek Idaho since 1998. A hallmark of the program has been its exclusive use of natural origin adults for its hatchery broodstock. We contrast and compare abundance, survival, and productivity data from Johnson Creek, the Secesh River, and the South Fork Salmon River to provide treatment x reference comparisons that ultimately demonstrate the effectiveness of the program at providing a demographic boost to the population.

### **FILLING KNOWLEDGE GAPS FOR A THREATENED SPECIES: AGE AND GROWTH OF GREEN STURGEON IN THE SACRAMENTO RIVER**

Marta Ree<sup>1,2</sup>, Michael Quist<sup>1,2,3</sup>

<sup>1</sup>Idaho Cooperative Fish and Wildlife Research Unit, University of Idaho <sup>2</sup>Department of Fish and Wildlife Sciences, University of Idaho , <sup>3</sup>U.S. Geological Survey

"Information on life-history traits of threatened and endangered fishes is critical to their conservation. Recruitment, longevity, mortality, and growth are necessary both in population modeling and developing management plans. However, for many species this information is lacking or incomplete, complicating population recovery and status monitoring of imperiled species. Green Sturgeon *Acipenser medirostris* are a species of concern throughout their range due to uncertainty of population status. Green Sturgeon spend much of their life-history in the marine environment and can be found along Pacific nearshore waters from Mexico to the Bering Sea. Though, spawning is limited to short reaches in only a few rivers in Oregon and California, including the Sacramento River, making the species vulnerable to habitat loss and climate change. Green Sturgeon of the Sacramento River (southern distinct population segment; sDPS) were listed as threatened under the Endangered Species Act in 2006, yet still no information exists on the age-structure and growth of this anadromous sturgeon species. The purpose of this study was to provide basic population information through age determination and growth analyses of Green Sturgeon of the sDPS. The results from this study will aid conservation efforts for Green Sturgeon and inform recovery plans.

## **NATIVE FISH CONSERVATION: A LONG-TERM COMMITMENT ON UPPER PRIEST LAKE**

Rob Ryan

Idaho Department of Fish and Game

The Idaho Department of Fish and Game and agency partners have worked for two decades to conserve native fishes in Upper Priest Lake, Idaho. Non-native species introduction, habitat degradation, and recreational fishery management are all challenges influencing conservation goals. Lake Trout expansion in the Priest Lake system was and continues to be a primary concern relative to persistence of Bull Trout and Westslope Cutthroat Trout. Removal of Lake Trout from Upper Priest Lake has occurred since 1998 in an effort to reduce their impacts on native fishes. Gill nets have been used to remove 150 to 5000 Lake Trout annually from Upper Priest Lake. Lake Trout catch rates associated with removal efforts have declined over the last decade, suggesting their abundance is now lower. In response, Bull Trout abundance, indexed using annual redd counts, demonstrated a positive trend over the same period. In addition, recent monitoring has indicated that Westslope Cutthroat Trout are abundant and well-distributed in tributary streams and are moderately abundant in Upper Priest Lake. Combined, these population responses suggest that native fishes have benefited from Lake Trout removal efforts. However, sustaining these populations in Upper Priest Lake will require a long-term commitment to Lake Trout removal. Continued implementation of this management program has strong public support, but is challenged by available funding. Fishery managers plan to investigate modified approaches that may allow for more efficient removal of Lake Trout in the future.

## **SEX REVERSAL TRIALS ON WALLEYE, AN EXAMPLE OF INTERAGENCY AQUACULTURE COOPERATION**

Dan Schill<sup>1</sup>, Liz Mamer<sup>1</sup>, Alan Johnson<sup>2</sup>, Aaron Andrews<sup>3</sup>, Jason Vajnar<sup>3</sup>, Daric Schneidewind<sup>3</sup>

<sup>1</sup>Idaho Department of Fish and Game, <sup>2</sup>Iowa Department of Natural Resources, <sup>3</sup>Kansas Department of Wildlife, Parks and Tourism,

Development of All-female Walleye broodstocks could improve angler satisfaction in Midwest states while creation of YY Male Broodstock could assist with exotic Walleye eradication in Western states. We fed fry feed top-coated with either Estradiol (E2) or Methyltestosterone (MT) at the Rathbun and Meade Hatcheries in Iowa and Kansas. At 171-176 dph, 255 and 181 fish were euthanized and necropsied from the Meade and Rathbun facilities, respectively. Phenotypic sex ratios for control groups were 53.1% Female, 43.8% Male (1 unknown) from Meade and 57.4% Female and 41% Male (1 unknown) at Rathbun. Phenotypic sex calls suggest successful recipe development for sex-reversal in both directions. The proportion designated phenotypic or intermediate females in the three E2 treatment trials at 171-176 dph ranged from 96.3 to 98.4%. The number of fish designated as either males or presumed males in the two MT trials at that time were 94.0 and 98.4%. Remaining study fish from both hatchery facilities were subsequently transferred to the Milford Hatchery in Kansas to be reared further to confirm the above sex ratios. At 332dph, a total of 32, 29 and 35 fish from three E2 treatment groups were killed and examined histologically yielding 100% female sex ratios for all three groups. Based on both necropsy-derived phenotype calls and subsequent confirmatory histological results, this study yielded two recipes for successful feminization of male walleye. More recent examination of histological samples of the MT groups suggests that the promising results noted above may not have been on target, though the results are hindered by small sample size. Combining existing fish culture, research

and genetics experience from multiple state agencies could prove effective for rapid and efficient development of desirable broodstocks for use in fisheries management.

## **MAPPING RIPARIAN HABITAT WITH DRONE AND SATELLITE DATA TO INCREASE MONITORING EFFICIENCY**

Amanda Stahl<sup>1\*</sup>, Alexander Fremier<sup>1</sup>, Laura Heinse<sup>2</sup>

<sup>1</sup>Washington State University, <sup>2</sup>Palouse Conservation District

Riparian habitat restoration benefits fish by reducing contaminants, lowering water temperatures, contributing to aquatic food webs and increasing habitat heterogeneity. Emerging remote sensing technologies offer the opportunity to rapidly map vegetation for increased monitoring efficiency at watershed scales. Drone- and satellite-based sensors that detect near-infrared (NIR) wavelengths can be used to measure “greenness” and thus distinguish among vegetation types, bare ground, senescent vegetation, water, or impervious surfaces. Traditional (RGB) images from drone-mounted cameras can also be processed to map the 3D structure of vegetation. We tested the applicability of drone and freely available Sentinel-2 satellite images for mapping riparian habitat over multiple time scales – decades, years and seasonally. Using both greenness and 3D structure, we identified and mapped riparian habitat characteristics at site to watershed scales. We collected images with two quadcopters (3DR Solo and DJI Matrice 210) at 9 sites across Whitman County, Washington. We used an NIR camera (Micasense RedEdge) to detect vegetation greenness and an RGB camera (GoPro Hero 4) to collect images for 3D structure. We compiled each set of drone images into a georeferenced mosaic so that greenness and the 3D structure of trees and shrubs could be compared across dates. We used Google Earth Engine and ArcGIS to acquire and analyze Sentinel-2 data for the HUC-8 watersheds that overlap with Whitman County. Seasonal and annual patterns of greenness in Sentinel images collected in July-October 2016-2019 enabled us to distinguish natural vegetation from agricultural land cover. Greenness values from Sentinel data can be cross-validated with values from the drone-mounted NIR camera. We demonstrate the usefulness of Sentinel and drone data for mapping and comparing riparian habitat condition through time at multiple scales. These datasets can help address a range of management questions related to restoration monitoring, habitat mapping, change detection, and watershed-scale ecosystem condition.

## **INSTREAM VIDEOGRAPHY OF STREAM-DWELLING BULL TROUT (*SALVELINUS CONFLUENTUS*) IDENTIFIES SPATIAL AND TEMPORAL RANGES OF RESOURCE EXPLOITATION**

Zane Stephenson\*

Idaho State University

Food availability is a primary factor influencing the abundance of many animal populations. However, the spatial and temporal extent to which foraging animals are able to exploit prey is rarely quantified but is directly related to how much food is available for consumption. Our research investigates the foraging behavior of Bull Trout (*Salvelinus confluentus*) to better understand when, where, and what this species consumes. Over a typical growing season. We measured patterns of invertebrate abundance during the day and night, and measured the rate and location of foraging attempts by individual bull trout in three headwater tributaries of the Pahsimeroi River in eastern Idaho, USA. In-stream videography was used to capture foraging behavior and video analysis quantified foraging attempts per minute during the day and night.

Our data will quantify foraging rates to estimate rates of energy consumption and identify whether bull trout are predominately a diurnal, drift-feeding predator, or if they can exploit prey from benthic sources and during nocturnal periods. A better understanding of the foraging behavior of this threatened species will likely aid in conservation and restoration efforts.

## **AGE AND GROWTH OF GREEN SUCKERS IN THE TETON RIVER DRAINAGE**

Drew Suchomel<sup>1\*</sup>, Brett High<sup>2</sup>, Eric Billman<sup>1</sup>

<sup>1</sup>BYU-Idaho, <sup>2</sup>Idaho Department of Fish and Game

Recent studies support a reclassification of populations of the Bluehead Sucker (*Catostomus discobolus*) in the Upper Snake River and Northern Bonneville drainages as the Green Sucker (*Pantosteus virescens*). While the Bluehead Sucker has been studied extensively in the Colorado River drainage, the Green Sucker has been studied less, with most studies focusing on distribution. Our objectives were 1) compare age and growth of Green Suckers between the Teton River and South Fork Teton River 2) to compare age and growth of male and female Green Suckers in the South Fork Teton River 3) to estimate annulus formation using seasonal growth patterns of juveniles. We captured Green Suckers in the Teton River and South Fork Teton River from 2015 to 2019 using a fish trap, minnow traps, seine nets, and electrofishing. We determined age from thin-sections of pectoral fin rays. We used back-calculated length-at-age to build Von Bertalanffy growth models and we used AIC model selection to determine differences in model parameters between groups (i.e. sites and sex). The  $L_{\infty}$  parameter was the only model parameter to differ between sites and between sexes. The South Fork Teton River population had a mean maximum length approximately 80 mm longer than the Teton River population. Females within the South Fork Teton River had a mean maximum length approximately 100 mm longer than males. We estimated that Green Suckers in the South Fork Teton River formed the first annulus between 60-80 mm and formed the second annulus between 125-140 mm. This study provides information about population dynamics of Green Suckers that will inform management and conservation of this species.

## **ESTIMATING CHANNEL CATFISH EXPLOITATION, REPORTING RATE, AND TAG LOSS USING DART TAGS AT MILNER RESERVOIR, IDAHO**

Joe Thiessen<sup>1</sup>, John Anderson<sup>2</sup>

<sup>1</sup>Idaho Department of Fish and Game, <sup>2</sup>Idaho Power Company

Milner Dam is an irrigation diversion completed in 1905, which provides water to the Milner-Gooding Canal, Twin Falls Canal, and North Side Canal systems. Construction of the dam created Milner Reservoir; a 760 hectare Snake River impoundment located near Burley, Idaho. Idaho Power Company (IPC) stocks approximately 20,000 Channel Catfish *Ictalurus punctatus* annually since 1997, in an effort to provide recreational fishing opportunity in the reservoir. Angler exploitation for Channel Catfish within the reservoir is unknown. Idaho Department of Fish and Game (IDFG) and IPC evaluated angler exploitation and use between 2016 and 2019 using dart tags attached posterior to the dorsal spine. We tagged 1,050 Channel Catfish each year of the evaluation, with 18% of the fish receiving double tags and an additional 18% containing \$50 reward tags. Tag loss ranged from 0.26 to 0.31, and reporting rate averaged  $0.74 \pm 0.01$  (90% CI)

over the three-year study. Exploitation and total angler use across all study years (90% CI) was  $0.09 \pm 0.02$  and  $0.12 \pm 0.01$ , respectively. Our findings suggest that Channel Catfish in Milner Reservoir are likely underutilized. Collecting age structures to develop estimates of total annual mortality would determine the sustainability of additional Channel Catfish harvest at Milner Reservoir. Additional work should include finding a feasible tagging method for Channel Catfish that reduces tag loss and still produces high reporting rates.

## **“DOCTOR, MY EYES- TELL ME WHAT YOU SEE?”: SOURCES AND MAGNITUDE OF ERROR IN SALMON REDD COUNTS**

Russ Thurow<sup>1</sup>, Claire McGrath<sup>2</sup>

<sup>1</sup>U.S. Forest Service, <sup>2</sup>NOAA

Redd counts are widely used to estimate population parameters for salmonid fishes, yet the reliability of counts has rarely been rigorously evaluated. Biologists often incorrectly assume that detection probability (the relationship between counts and actual redd abundance), is constant and known; and that bias in counts is constant across space and time. Unless empirically measured, however, unanticipated variation in detection probability can result in erroneous inferences, particularly when detection probabilities vary systematically with covariates. We investigated factors influencing the precision and bias associated with Chinook salmon redd counts in central Idaho, across multiple years and escapement levels. We measured actual or baseline redd abundance via intensive, repetitive multiple-pass surveys and assessed the precision and bias of independent counts by comparing them to the baseline, and by estimating redd detection probabilities. We evaluated and modeled the influence of variables associated with environmental conditions, redd density and other redd characteristics, and observer experience. The models we developed apply to a range of conditions and may be useful for predicting detection probabilities and for deriving unbiased estimates of redd abundance and distributions. These models may also be applicable for adjusting the bias in extant redd counts. Our approach may inform users to help avoid incorrect conclusions about population trends and to achieve stronger inferences from redd counts.

## **TRENDS IN ANGLER SPENDING AND VALUATION OF EXPERIENCE IN THE HENRY'S FORK WATERSHED**

Rob Van Kirk<sup>1</sup>, Kamberlee Allison<sup>1</sup>, Cliff Nowell<sup>2</sup>

<sup>1</sup>Henry's Fork Foundation, <sup>2</sup>Weber State University

The economic value of recreational fishing is used by management agencies and conservation organizations to prioritize resource expenditure and develop policy. However, year-to-year variability in fishing quality confounds comparison across years. The Henry's Fork Foundation, Idaho Department of Fish and Game, Weber State University, and Friends of the Teton River conducted a survey of angler use and spending in the Henry's Fork watershed to compare with previous surveys. We used standard counts to estimate effort on Henry's Lake in 2016 and the Henry's Fork in 2017 and mark-recapture to estimate effort on the Teton River in 2018. Total angler spending was the product of daily trips and spending per day, as estimated from survey responses. The survey instrument also asked anglers about additional willingness to pay for their experience and how fishing improvements would change their effort. Over the watershed, the number of angler trips in 2016-2018 was down 8% from that observed by IDFG in 2003. After adjusting for inflation,

spending per angler per trip was \$320 in 2003 and \$255 in 2016-2018, resulting in a decrease in annual spending from \$59 million in 2003 to \$43 million. However, angler effort was 80% lower on Henry's Lake in 2016 than in 2003 due to poor fishing. Adjusting for that difference produced current spending estimates—around \$55 million per year—similar to those observed by IDFG in 2003 and by John Loomis in 2004, despite different methodologies. Anglers were willing to pay an additional \$160 per trip for their current experience versus \$90 reported by Loomis in 2004. The majority of anglers reported they would not change their fishing effort with improvements to access and facilities, but 55% reported they would spend more days fishing if their catch rate doubled, illustrating the sensitivity of economic valuation to angling experience.

## **JOHNSON CREEK – COMPARING NATURAL AND SUPPLEMENTED LIFE HISTORY PERFORMANCE**

Travis Hodsdon, Craig Rabe, Jason Vogel, Ryan Kinzer, Doug Nelson

Nez Perce Tribe

The Nez Perce Tribe has been supplementing spring/summer Chinook in Johnson Creek, Idaho since 1998. The key to the Tribe's success in recovering the Johnson Creek spawning aggregate from extirpation has been its exclusive use of natural origin Chinook in its hatchery broodstock, which program proponents contend has provided a demographic boost that hasn't adversely affected the life history characteristics of the endemic stock. In this talk, we compare juvenile and adult life history characteristics of natural origin Chinook from Johnson Creek to those of an unsupplemented population in the Secesh River, and to those of the supplemented Johnson Creek fish.

## **BIODIVERSITY OF COTTUS IN WESTERN NORTH AMERICA: A MOLECULAR PERSPECTIVE ON THE SCULPINS OF THE INTERMOUNTAIN WEST**

Michael Young<sup>1,2</sup>, Rebecca Smith<sup>1,2</sup>, Kristy Pilgrim<sup>1,2</sup>, Dan Isaak<sup>2,3</sup>, Kevin Mckelvey<sup>1,2</sup>, Michael Schwartz<sup>1,2</sup>

<sup>1</sup>NGC, <sup>2</sup>Rocky Mountain Research Station <sup>3</sup>BSSG

The taxonomy of sculpins (*Cottus*, *Cottidae*) remains one of the last major unresolved puzzles in the systematics of North American freshwater fishes. Therefore, we began an effort to clarify the evolutionary history and taxonomy of sculpins from across western North America using molecular tools. First, we crowd-sourced collection of specimens (n = 8,191 and counting) via outreach to biologists in the western U.S. and Canada, and compiled the results of those collections on a webpage ([https://www.fs.fed.us/rm/boise/AWAE/projects/fish\\_tissue\\_collection.html](https://www.fs.fed.us/rm/boise/AWAE/projects/fish_tissue_collection.html)). Second, we sequenced two mitochondrial and two nuclear genes of specimens from most basins in the West, and applied standard phylogenetic techniques to assess patterns of diversity. Those analyses revealed five discrete species complexes of sculpins, each composed of an array of lineages of which only some were accorded taxonomic recognition despite relatively deep phylogenetic divergence among most or all groups. In the intermountain West, lineages of Paiute (*C. beldingii*), shorthead (*C. confusus*), and Columbia (*C. hubbsi*) sculpin exhibited discordant phylogeographic patterns, indicating profound differences in life histories, divergence times, or generation times, although each group concealed extensive cryptic diversity indicative of the need for comprehensive taxonomic revision of these fishes. Next-generation sequencing is underway to support that effort.

## **STRATEGIC AND NOVEL USE OF THE KOOTENAI RIVER NATIVE FISH CONSERVATION AQUACULTURE PROGRAM TO RESTORE WHITE STURGEON AND BURBOT**

Shawn Young, Nathan Jensen, Sue Ireland

Kootenai Tribe of Idaho

The Kootenai River White Sturgeon *Acipenser transmontanus* and Burbot *Lota lota maculosa* were once abundant in the Kootenai/ay River Basin in Idaho and Montana, USA, and British Columbia, Canada. Historically, the native fishes provided important cultural resources for indigenous peoples, and remain so today throughout the basin despite significant population decline. In 1988, the Kootenai Tribe of Idaho recognized the lack of White Sturgeon natural recruitment and started an experimental aquaculture facility to determine the feasibility of using wild broodstock to artificially spawn and rear year classes to reverse population decline. The Kootenai River Native Fish Conservation Aquaculture Program (KRNFCAP) began rearing fish during 1990-1992, and has been successfully releasing annual year classes since 1997. Following the Sturgeon program, a formal Burbot program feasibility evaluation was initiated in 2003. Since its inception, the conservation aquaculture program has boosted the Burbot abundance estimates from 50 adults in 2002 up to 50,000 adults. The KRNFCAP is part of multi-agency and stakeholder collaboration, and is one component of the greater Kootenai Ecosystem Restoration.

The KRNFCAP is guided by an annual adaptive management framework. As part of a large collaboration, the conservation hatcheries are used to 1) avoid extirpation and rebuild the species abundance to jump-start natural recruitment, and support culture and recreational harvest; 2) spawn, rear, and release early life stages across habitat types/conditions to determine causes of recruitment failure; and 3) spawn, rear, and release fish in a manner that supports post-release monitoring, research, and evaluations. The presentation will provide a summary of current aquaculture practices that have succeeded in simultaneously rebuilding fish abundance while supporting post-release monitoring and evaluation that guides adaptive management of the program.

## **HOW HATCHERY SUPPLEMENTATION AND ADAPTIVE MANAGEMENT CONTRIBUTED TO INCREASED ABUNDANCE AND NATURAL SPAWNING OF SNAKE RIVER FALL CHINOOK SALMON**

William Young, Bill Arnsberg, Drew Wickard, Scott Keller

Nez Perce Tribe

This presentation will provide a review of the Snake River fall Chinook salmon hatchery supplementation program, focusing on use of adaptive management to promote changes in the program over time. Declines in the historically abundant Snake River fall Chinook salmon population resulted from dam construction blocking the major spawning habitats of the middle Snake River above Hells Canyon. Among the efforts implemented to conserve and restore fall Chinook in the remaining habitat, hatchery supplementation played a key role. Implementation of hatchery supplementation strategies was influenced by adaptive management and the coordinated efforts of multiple Federal, State, Private, and Tribal agencies. In addition, policy priorities and legal agreements were influential to the evolution of the hatchery program over time. A significant program change occurred in the mid 1990's where the strategy to release all hatchery juveniles below Lower Granite Dam was altered to include the release of hatchery

subyearling and yearling juveniles from multiple locations of the accessible spawning areas of the Snake and Clearwater Rivers above Lower Granite Dam. Since that time adult abundance and redd counts in the Snake and Clearwater Rivers have increased dramatically. Adult abundance increased from an annual average of 1,000 adults prior to 1998 to approximately 40,000 adults from 2005 to present. Natural-origin returns have also increased significantly from a low of 78 in 1990 to high of 21,000 in 2013 and currently make up nearly 30% of the total return. Although the effects of hatchery supplementation, compared to other restoration actions, are difficult to accurately assess, it likely played a major role in the increased abundance observed over the last ten years, suggesting that the supplementation efforts have had a positive effect on abundance of both hatchery- and natural- origin Snake River fall Chinook.

## **POSTER ABSTRACTS**

\* = Student Presenter

### **TRANSLOCATION OF WESTERN PEARLSHELL MUSSELS**

Megan Blackham<sup>1\*</sup>, Emma Brandon<sup>1</sup>, Cosette De Ferrari<sup>1</sup>, Lee Mabey<sup>2</sup>, Eric Billman<sup>1</sup>

<sup>1</sup>BYU – Idaho, <sup>2</sup>US Forest Service

Freshwater Mussels are among the most endangered species in North America. Although they suffer increasingly from habitat degradation, the heavy machinery required to improve stream habitat pose a direct threat to mussels during construction though related improvements to water quality may be beneficial. However, little is known about the success rate of translocating Western Pearlshell (*Margaritifera falcata*). The objective of this project was to translocate Western Pearlshell from Tincup Creek, Idaho, prior to the initiation of a stream restoration project. In 2018 and 2019, we used plexiglass bottom buckets to survey predetermined sites for Western Pearlshell prior to restoration. When mussels were found during surveys, they were double-tagged with vinyl tags, measured, and relocated to a previously restored reach. Additionally, in 2019 we surveyed for mussels that had been translocated to six sites the previous year. In 2018 we surveyed 1,771 m of stream and translocated 408 Western Pearlshell ranging from 22 – 78 mm with 80% of the mussels being  $\geq 50$  mm. In 2019 we translocated 80 mussels from a 748-m reach that had not previously been surveyed, and we translocated 52 mussels from an 843-m reach that was surveyed in 2018. Mussels ranged from 29 – 88 mm with 83% of the mussels  $\geq 50$  mm. In 2019, we recaptured Western Pearlshell at two of the six sites where mussels were translocated in 2018. At these two sites, we recaptured 102 mussels, or 58% of those released at the sites. Of the recaptured mussels, 11 mussels had lost one tag; we did not find any untagged mussels at these sites. Translocation was most successful at sites with predominately riffle and run habitat with gravel and cobble substrates.

### **DISTRIBUTION OF PILOSE CRAYFISH IN THE BIG LOST RIVER, LITTLE LOST RIVER, AND BIRCH CREEK BASINS IN IDAHO**

Hannah Bluth<sup>1\*</sup>, Bart Gamett<sup>2\*</sup>, Noelle Zenger<sup>1</sup>, Eric Billman<sup>1</sup>

<sup>1</sup>BYU – Idaho, <sup>2</sup>U.S. Forest Service

Pilose Crayfish (*Pacifastacus gambelii*) is an endemic species in the Upper Snake River drainage that has experienced substantial range decline. Until recently, crayfish had not been documented in the Lost Streams of Idaho. In 2014, Pilose Crayfish were found at a site in the Big Lost River near Mackay. Our objective was to determine Pilose Crayfish distribution in the Big Lost River, Little Lost River, and Birch Creek basins. We sampled for crayfish using kick nets and minnow traps in August 2019. We selected 25 sites representing a variety of aquatic habitats (15 sites in the Big Lost River, 5 sites in the Little Lost River and 5 sites in Birch Creek). We captured crayfish at two sites in the Big Lost River. Thirty-one Pilose Crayfish were captured at a site 8.5 km downstream of Mackay Reservoir and one Pilose Crayfish was captured at a site 23 km downstream of Mackay Reservoir. We did not find crayfish in any other sites in the study. Our results indicate that the distribution of Pilose Crayfish within the study area is limited to the Big Lost River downstream of Mackay Reservoir. Pilose Crayfish in the Big Lost River may represent a remnant population of the species or may be the result of an introduction from individuals collected from the Snake River. Additional studies in the Big Lost River are necessary for finer resolution on the distribution of Pilose Crayfish and to understand potential threats to this species.

## **WHAT IS THE NATIVE DISTRIBUTION OF RAINBOW TROUT AND RELATED SUBSPECIES IN WESTERN NORTH AMERICA?**

Tyler Breech\*, Ernest Keeley, Janet Loxterman

Idaho State University

Although rainbow trout (*Oncorhynchus mykiss*) are known to be native to western North America, natural biogeographic barriers and the widespread introduction of this species into many areas outside of their native range has created uncertainty in determining the native range and extent of trout populations. In order to better understand the native distribution of rainbow trout and determine whether populations are native and/or hybridized with native populations, we present a proposed map of the historical range of rainbow trout and related subspecies before any documented translocations were undertaken. Additionally, we pin-point potential sampling locations for a future study to examine the phylogenetic divergence among rainbow trout populations throughout the historical native range.

## **PHOTOPOINT MONITORING TO EVALUATE PROJECT EFFECTIVENESS ON THE YANKEE FORK POND SERIES 3 PROJECT**

Darby Byington<sup>1</sup>, Bart Gamett<sup>1</sup>, Caselle Wood<sup>2</sup>, Jim S. Gregory<sup>3</sup>

<sup>1</sup>U.S. Forest Service, <sup>2</sup>Trout Unlimited, <sup>3</sup>Lost River Fish Ecology, Inc.

The Yankee Fork is located in Central Idaho and is a large tributary to the Salmon River. Between 1940 and 1952, a dredge mined nearly six miles of the Yankee Fork. This obliterated the river, riparian vegetation, and floodplain and significantly reduced the ability of the Yankee Fork to support fish. In 2010, an interdisciplinary team initiated a large-scale effort to improve fish habitat in the Yankee Fork by restoring areas impacted by the dredging to a more natural condition. The Yankee Fork Pond Series 3 Project was the first project to be implemented as a result of this effort. This project, which was implemented in 2012, included eliminating mine tailings and dredge ponds and replacing them with a natural floodplain and side channel. Prior to project implementation, a series of photo points were established to monitor the effectiveness of the project. These photo points have been re-photographed every year and show the substantial changes that have occurred as a result of the work.

## **LOW HEAD OXYGENATORS AT DWORSHAK NATIONAL FISH HATCHERY: A GASSY SITUATION**

Sara Dimick<sup>1</sup>, Jeremy Pike<sup>2</sup>

<sup>1</sup>U.S. Fish and Wildlife Service, <sup>2</sup>Nez Perce Tribe

Established to mitigate losses of steelhead trout (*Oncorhynchus mykiss*) and Chinook salmon (*Oncorhynchus tshawytscha*), Dworshak National Fish Hatchery (DNFH) is located below Dworshak Dam at the confluence of the mainstem and the North Fork Clearwater Rivers. Dworshak Dam regulates water outflow, as "spill", for downstream water temperature, flood risk management, and seasonal weather needs. Water travels through spillways on the face of the dam into the North Fork Clearwater River. Spilled water supersaturates with nitrogen gas (N<sub>2</sub>), which can have adverse effects on fish health. Pumped at DNFH, North Fork water is the source used for outdoor raceway Chinook rearing. To reduce nitrogen supersaturation and total dissolved gas (TDG),

vacuum degassing towers were in place. In recent years, the ability of the degassing towers to decrease TDG to optimal rearing conditions has fallen short with the fluctuation of spill from the dam. In addition to vacuum degassing at the source, DNFH purchased 15 Low Head Oxygenators (LHOs) in 2017, one for each raceway of one Chinook bank and a bulk oxygen tank. LHOs increase the amount of oxygen in the water, while simultaneously driving off the harmful N<sub>2</sub>. Through weekly N<sub>2</sub> sampling and adjustment of oxygen injection, the hatchery is better able to combat N<sub>2</sub> spikes from changing spill flows. After success with the original 15 LHOs, DNFH purchased an additional 15 LHOs in 2018 for the remaining raceways. Continued monitoring of N<sub>2</sub> and TDG allows for additional refining of this new hatchery equipment and will help improve Chinook rearing overall.

### **FRESHWATER MUSSEL INVESTIGATIONS IN IDAHO**

John Erhardt, Doug Nemeth, Fran Mullens, Michael Murray

U.S. Fish and Wildlife Service

Freshwater mussels are an integral component in many aquatic ecosystems but their populations are declining rapidly throughout North America. In Idaho, basic biological information such as distribution and abundance of native mussels is limited. The U.S. Fish and Wildlife Service's Idaho Fish and Wildlife Conservation Office (IFWCO) provides dedicated effort to examine mussel distribution, abundance, and behavior to better understand mussel species status and promote aquatic ecosystem conservation. Current objectives of the IFWCO mussel investigations project are to 1) document the presence and distribution of mussel species in Idaho's 14 ecological sections, 2) determine and monitor mussel abundance and demographics in the 14 ecological sections, 3) develop and assess methodologies for assessing abundance and recruitment, and 4) assist with mussel salvage and conservation efforts during stream restoration projects. During 2019 statewide surveys, the IFWCO documented freshwater mussels in 17 out of 30 waterbodies surveyed and counted over 15,000 individuals during Phase 1 index surveys of relative abundance. IFWCO also completed Phase 1 index sampling in the Lolo Creek watershed (Clearwater River basin) and documented mussels in 81% of the sampled drainage. Quantitative Phase 2 demographic sampling (quadrats with excavation) will be conducted during 2020 in representative mussel aggregations identified during Phase 1 surveys. Phase 1 surveys will continue in different ecological sections during 2020.

### **THE ROLE OF NETWORK CONNECTIVITY AND COMPLEXITY IN SUSTAINING BIODIVERSITY OF A WILDERNESS RIVER**

Laurel Faurot\*, Sawyer Finley, Colden Baxter

Idaho State University

Here we describe a planned study of the role of network complexity and connectivity in maintaining aquatic biodiversity in a wilderness river network in central Idaho. Big Creek, a tributary of the Middle Fork Salmon River, has been the focus of extensive aquatic monitoring and research. These studies have shown that large disturbances (e.g. high severity fire, landslides, avalanches, debris flows) have different ecological consequences in this large, connected network than in more common settings in which aquatic habitat is fragmented and homogenized. Network complexity and connectivity may be partially responsible for the resilience of the native,

co-evolved species present, and could be crucial to their persistence through future challenges such as climate change. We plan a study of stream food webs and the biodiversity of fishes and invertebrates at four tributary confluence complexes along Big Creek. Complexes are areas where multiple tributaries enter the mainstem in close proximity, creating localized network heterogeneity contrasting long, homogenous stretches of stream without tributary input. We will analyze how habitats, biodiversity, and food webs within each combine; how whole complexes compare to non-complex areas; and how all complexes and non-complex areas combine to influence diversity and food web characteristics at larger scales in the network. Broadly, we hypothesize that tributary complexes create patch-mosaics of habitats and food webs within this river network. More specifically, we hypothesize that complexes act as domains of increased habitat heterogeneity, biodiversity, productivity, and species interactions, each of which may contribute to community stability. To test these hypotheses, we will utilize long-term monitoring datasets and comparisons of stream habitat, fish and macroinvertebrate assemblage diversity and composition, and food web characteristics between tributary complexes and non-complexes. Finally, we will evaluate the effect of network complexity and connectivity on these metrics at different spatial scales via a novel simulation-aggregation analysis.

### **REACHING SIZE: UTILIZING LIMITED WATER AND REARING SPACE, AND OPTIMIZING FEED STRATEGIES TO MAXIMIZE GROWTH OF DWORSHAK B-RUN STEELHEAD**

Angela Feldmann

U. S. Fish and Wildlife Service

Dworshak National Fish Hatchery (DNFH) raises 2.1 million B-Run Dworshak Steelhead (SST) annually at a target release size of 5.8 fish per pound (200 mm). Steelhead broodstock are collected over the entire run (October to April) and spawning occurs from January into April to incorporate the full genetic spectrum of the run into future releases as part of the mitigation goal. Reaching the target size at release is not a problem for most of our egg takes except for our latest take, which has the shortest rearing time to achieve our target size. This poster describes how creative use of our limited warm disease-free water and nursery space, changing up our ponding strategy, and adjusting how and what we feed this group of fish has allowed us to close the size gap and (hopefully) hit our size goal for this group of Brood Year 2019 steelhead.

### **WESTERN PEARLSHELL MUSSELS AS LONG TERM ENVIRONMENTAL RECORDS**

Brianna Frazee<sup>1\*</sup>, Jens Hegg<sup>1</sup>, Brian Kennedy<sup>1</sup>, Diane Evans Mack<sup>2</sup>, Wesley Keller<sup>3</sup>

<sup>1</sup>University of Idaho, <sup>2</sup>Idaho Department of Fish and Game, <sup>3</sup>Nez Perce Tribe

Western pearlshell mussels (*Margaritifera falcata*) are a long-lived native bivalve in western streams with a robust calcified shell. Once numerous, their numbers have declined with the loss of salmonid species, a required host for their parasitic larval stage, as well as anthropogenic changes to river system and decreases in water quality. With life spans of 60 to 100 years their shells may record important environmental information within their microstructure and chemistry. This information could provide a valuable bank of knowledge for understanding past river conditions and information useful for mussel conservation. However, western pearlshell mussels are poorly studied and few standard methods exist for examining the structure and chemistry of mussel shells. Using mussel shells collected on the South Fork Salmon River, the goal of this project was to develop

methods and investigate the sclerochronological and chemical data which can be recovered from mussel shells. We describe methods for sectioning, visualizing, and digitizing mussel shells for analyzing growth patterns and preparation for microchemical and isotopic analysis. In the context of our results, we discuss the potential of western pearlshell mussels as a long-term record of chemical and physical processes in Idaho rivers, and the potential of this data to inform mussel conservation and other ecological processes.

## **SALMON IN IDAHO: DWORSHAK NFH HURDLES CHALLENGES IN THE RACE TO BEAT THE EFFECTS OF CLIMATE CHANGE**

Aidan Frye<sup>1</sup>, Jeremy Sommer<sup>2</sup>, Jeremy Pike<sup>2</sup>

<sup>1</sup>U.S. Fish and Wildlife Service, <sup>2</sup>Nez Perce Tribe

Changes in climate have affected survival of Salmonids from the Clearwater River Basin during ocean rearing. Warmer river temperatures downstream during migration creates a thermal barrier to fish movement. As a result, returns of Salmonids to the Clearwater River has declined, compared to historical averages.

Dworshak National Fish Hatchery (DNFH) is located below Dworshak Dam at the confluence of the mainstem and the North Fork Clearwater Rivers. The facility operates to mitigate losses of steelhead trout (*Oncorhynchus mykiss*) and Chinook salmon (*Oncorhynchus tshawytscha*). Dworshak Dam regulates water outflow through three hydroelectric generators and as "spill" for downstream water temperature, flood management, and seasonal needs. Water travels through spillways on the face of the dam into the North Fork Clearwater River, the primary water source for the facility. Releases of reservoir water for downstream temperature augmentation creates cold water temperatures for holding adults. The cold temperatures create challenges for growth in early rearing of juveniles.

Obtaining enough eggs to meet broodstock needs is another hurdle. The fish ladder runs continuously and in some years, basin coordinators implement hook and line supplementation. Egg transfers from other facilities are more frequent. The number of spawning events in a season increased from an average of four to an average of seven. Managing temperature units of so many groups is a new challenge faced at DNFH. There is constant refinement and adaptation with the times for methods of meeting brood, egg incubation, rearing juveniles, and overall success of the hatchery's programs.

## **POPULATION DYNAMICS OF BROOK TROUT IN BUSTER LAKE**

Courtnie Ghere, Conor McClure, Kayden Estep

Idaho Department of Fish and Game

Buster Lake is a lowland lake located 16 kilometers west of Challis, Idaho and supports a naturally reproducing population of Brook Trout *Salvelinus fontinalis*. On July 8, 2019, Buster Lake was sampled using two paired gillnets, 46m long, 2 meters deep; panels of 19mm, 25mm, 32mm, 38mm, 51mm, and 64mm bar-measure mesh, one sinking and one floating. A total of 68 Brook Trout was sampled. Total length and weight was collected for each fish. Saggital otoliths were collected from 49 Brook Trout. Otoliths were mounted into bullet molds with epoxy and then

sectioned to 0.762 mm using a low speed saw. Age was estimated from sectioned otoliths using a compound microscope. Mean back-calculated lengths at age was calculated. Proportional size distribution and relative weight was also calculated. Information from this study was used to describe the population dynamics of the Brook Trout in Buster Lake. Findings from this study will be used to guide future management decisions for Buster Lake. Furthermore, information from this study and similar studies may help managers determine future stocking schedules in other nearby waterbodies. Additional investigation can be done to determine the diet of these fish to better understand the ecology of fish in this lake.

## **STATUS OF AMPHIBIANS IN MOUNTAIN LAKES: CURRENT TRENDS AND EMERGING THREATS**

Katherine Gillies-Rector, Robert Hand, Joe DuPont

Idaho Department of Fish and Game

Introduced salmonid predators have long been recognized as a major threat to the population structure and persistence of montane, lake-dwelling amphibians. Some species, such as Columbia Spotted Frogs (CSF) are resistant to fish predation due to their short aquatic larval stage, whereas Long-toed Salamanders (LTS) may be particularly at risk to fish predation because of their prolonged aquatic rearing. In metapopulations where some lakes contain salmonid predators, adjacent fishless ponds may serve as refugia and source populations for vulnerable amphibians. However, fishless refugia may be at greater risk from climate change-induced habitat alterations such as increased wildfire and rates of lake desiccation. Initial results from a long-term monitoring effort of 74 lakes the Bitterroot Mountains of Northern Idaho confirm that amphibian responses to fish predators vary between species. Columbia Spotted Frog occurrence does not respond to fish presence ( $p=0.36$ ) while LTS occurrence is strongly related to fish presence ( $p<0.05$ ). Since 2000, 22% of study lakes have been exposed to wildfire, of which 47 % were small, fishless lakes. Data from this study show no population declines in continuously monitored populations of either species, however detection power is limited by data availability and impacts of recent fires may not manifest at the population level for nearly a decade. While no trends have emerged from available data, compounding effects of predation and habitat stressors may precipitate future population declines, and should be monitored accordingly.

## **MICROPLASTICS EXPOSURE IN RESERVOIR-REARING CHINOOK SALMON (*ONCORHYNCHUS TSHAWYTSCHA*) IN THE SNAKE RIVER, USA.**

Katherine Gillies-Rector<sup>1</sup>, Katherine Strickler<sup>2</sup>, Michael Meyer<sup>2</sup>

<sup>1</sup>University of Idaho, <sup>2</sup>Washington State University

Hydroelectric infrastructure in rivers create a variety of threats to movement and survival of salmonid species. Juvenile salmon are particularly impacted by dam complexes that result in passage mortality, and adjacent reservoirs where reduced water velocity, invasive predators, and introduced prey species all increase energetic costs and reduce survival. Microplastic pollution is an emerging threat to freshwater fish species, and dam complexes have been shown to affect the concentration of microplastics in the water column and sediment. Microplastics potentially impact reproduction and growth in freshwater fish species, but until now the occurrence and level of microplastic exposure in juvenile salmonids rearing in reservoirs has not been studied. We compared microplastics contamination in tissues from juvenile fall Chinook salmon collected in

Lower Granite Reservoir (n=19) and the upstream free flowing Snake River (n=34) in Idaho, USA. We found microplastics in gill, stomach, and muscle tissue from fish originating in both river and reservoir habitat. Fish originating in the reservoir habitat had higher concentrations of microplastics (0.29 MP/mg) than fish originating in the free flowing river (0.13 MP/mg). These findings suggest that microplastic exposure in juvenile salmonids may be a function of river regulation.

## **ASSESSMENT OF SOCIAL INTERACTION ON UPSTREAM MOVEMENT OF ADULT PACIFIC LAMPREY (*ENTOSPHEBUS TRIDENTATUS*) ON THE LOWER COLUMBIA RIVER**

Breanna Graves\*, Sarah Hanchett, Christopher Caudill

University of Idaho

Pacific lamprey, *Entosphenus tridentatus*, are an ancient fish that date back to over 450 million years and were historically distributed around the Pacific Rim. Pacific lamprey have become a species of concern due their rapidly declining numbers and low passage success over large hydropower dams. The ability of Pacific lamprey to climb has enabled the development of lamprey-specific passage structures. However, passage success through dams remains low for lamprey and previous radio-telemetry studies have indicated high turn around rates still occur as well as many lamprey bypassing the lamprey specific structures. Many migratory species move in large groups and social interactions within groups can alter migratory movement decisions. There is little known about the social interactions that influence the migratory behaviors of fishes, including the climbing and swimming behaviors of Pacific lamprey. Understanding social interactions in Pacific lamprey could lead to a better understanding of their navigational abilities through large hydropower dams. This project assesses the social interactions of Pacific lamprey by implementing a series of experimental trials and the results have the potential to inform future fish passage engineering design. Additionally, lamprey ascent times were recorded as they climbed a lamprey passage structure at the Bonneville Dam. In these studies, we present the results of the influences of social cues on Pacific lamprey motivation to depart and engage in upstream movement through a large hydropower dam.

## **JUVENILE AGE VALIDATION OF SNAKE RIVER SOCKEYE SALMON**

Karen Gregory<sup>1\*</sup>, Micah Davison<sup>1</sup>, Jesse McCane<sup>2</sup>, Leslie Reinhardt<sup>1</sup>, Tyler Zumwalt<sup>1</sup>

<sup>1</sup>Pacific States Marine Fisheries Commission, <sup>2</sup>Eagle Genetics Laboratory

Population age structure is an integral part of anadromous salmonid management and is commonly assessed using scale samples. Scale age validation is essential for determining the accuracy of scale lab ageing procedures. The Nampa Research Anadromous Ageing Laboratory (NRAAL) ages Chinook salmon and steelhead juveniles and adults throughout the state of Idaho. NRAAL started ageing Snake River Sockeye Salmon from Redfish Lake Creek in 2017. For these samples, abnormal salmonid scale characteristics were very commonly present. These characteristics, combined with being a new species to age, confirmed the need for evaluation of ageing accuracy of juvenile Sockeye scales. The goal of this project was to test the NRAAL's scale ageing accuracy by using juvenile Sockeye freshwater ages known from Parental Based Tagging (PBT). Juvenile Sockeye genetic and scale samples were collected from Redfish Lake Creek. Scales were aged by NRAAL, and genetic samples were processed by the Eagle Genetics lab to obtain known brood years via PBT techniques. We then compared NRAAL scale ages for

2017 and 2018 to their paired PBT brood years. We saw an 87.3% agreement for both years combined. Through NRAAL's prior juvenile validation study using steelhead, scale freshwater age agreement was 93% with PBT known ages. This shows our accuracy with ageing Sockeye, as a new NRAAL species, is less accurate than the ageing of juvenile steelhead. NRAAL strives for a 90% ageing accuracy, often using PIT tags to obtain validated known ages of adults. Furthermore, NRAAL's accuracy on adult scale ages compared to PIT tags is 97% for steelhead and Chinook saltwater ages. For juveniles however, validating known ages is much more difficult, and this project highlights the additional application that PBT offers by possessing validated ages of wild subsets of juvenile salmonids. Having known ages for juveniles and knowing scale ageing accuracies enables improvements to be applied to existing ageing guidelines. This will improve the accuracy for NRAAL staff when ageing Sockeye scales or other new species in the future. We would like to look at the re-ageing of years 2010-2019 to determine an agreement with scale ages against PBT over a longer temporal scale, in order to further make scale ageing accuracy assessments and lab improvements as necessary.

### **USING QUALITATIVE AND QUANTITATIVE MODELS TO EXPLORE STREAM CONNECTIVITY OUTCOMES FOR STAKEHOLDERS AND YELLOWSTONE CUTTHROAT TROUT**

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Two primary threats to native fishes worldwide are habitat degradation and invasive species. Stream habitat fragmentation divides metapopulations and may lead to local extinction. In many systems, including the Teton River drainage in eastern Idaho, fish passage barriers block migratory pathways for native salmonids. However, these same barriers may also prevent invasion from non-native fish species that have negative interactions with native species. In the Teton River drainage, invasion of non-native salmonids, including rainbow trout (*Oncorhynchus mykiss*), brook trout (*Salvelinus fontinalis*), and brown trout (*Salmo trutta*), is patchy and dependent on the connectivity of individual streams to the rest of the network. Managers and conservation groups in the Teton River drainage prioritize native Yellowstone cutthroat trout (*Oncorhynchus clarkii bouvieri*), but decisions that change connectivity or address non-native species have uncertain ecological and social outcomes and affect not only streams and fish but also irrigation, angling, and other stakeholder interests. For example, it is not clear if there may be a connectivity threshold beyond which migratory life histories of native Yellowstone cutthroat trout would be restored. In turn, if this large-bodied, fecund life history type were restored, could it mitigate the negative impacts of non-native species? Similarly, little is known about how reestablishing connectivity would affect stakeholder interests beyond fish conservation. In this project, I will use a combination of qualitative mental modeling and quantitative scenario modeling to examine 1) the suite of plausible connectivity scenarios in the Teton River drainage; 2) stakeholder perceptions of the outcomes of restoring connectivity across a variety of ecosystem services; and 3) the impacts of the different identified scenarios on Yellowstone cutthroat trout populations and their interactions with non-native species. The results from this project may help inform management of in-stream barriers, non-native species, and native trout in the Teton River drainage.

### **EFFECTS OF UPSTREAM LAKES ON DOWNSTREAM NUTRIENT AND BIOFILM COMPOSITION IN THE UPPER SALMON RIVER WATERSHED, CENTRAL IDAHO**

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Nutrient dynamics of interconnected lake and stream ecosystems are complex, and often exhibit strong seasonal and spatial variability. While lakes and rivers are often studied independently, there may be an increased need to understand the impacts that they have on one another as anthropogenic disturbance, such as the development of the hydropower system, often create lentic environments that interrupt lotic systems. Additionally, dam building may alter nutrient flux in stream-lake systems that historically received a nutrient subsidy in the form of anadromous salmon. While it is understood that lakes have far-reaching effects on the nutrient dynamics of their watersheds, there are relatively few studies using isotopes to assess these impacts. This study took place in the Upper Salmon River Watershed, in Central Idaho, and focused on six stream-lake systems that historically served as spawning habitat for Snake River Sockeye. We quantified seasonal changes in nutrient concentration (N & P), but also in nitrate and biofilm  $\delta^{15}\text{N}$  between systems with and without an upstream lake. Our goal is to gain a better understanding of the historical role of the nutrient contribution by spawning sockeye, and the role that lentic habitats play in the nutrient transformation and limitation in an alpine watershed. We observed significantly higher concentrations in total nitrogen downstream of a lake, but significantly lower concentrations of dissolved inorganic nitrogen. Additionally, preliminary data indicates that there is a strong degree of nitrogen limitation in systems downstream of a lake, and that this limitation may be driving cyanobacterial dominance and associated Nitrogen Fixation leading to a lighter  $\delta^{15}\text{N}$  below a lake.

### **PREDICTING THE DISTRIBUTION AND ABUNDANCE OF SALMONID FISHES IN THE UPPER SNAKE RIVER USING SPATIAL AND NON-SPATIAL STATISTICAL MODELS**

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Estimating the range and extent of a species is a critical element of developing management and conservation plans. With the advent of large-scale species occurrence databases and remote sensing technologies, the ability of researchers to predict the distribution of focal taxa has been greatly enhanced in recent years. Accounting and controlling for spatial auto-correlation is a commonly applied technique in determining the effect of large-scale environmental factors in predicting the distribution of terrestrial organisms. For many fish species, however, their distribution is confined to a network of streams and rivers that cannot easily be modeled using traditional methods applied in terrestrial habitats. We used the Spatial Tools for the Analysis of River Systems (STARS) and the Spatial Stream Networks (SSN, R package) to create and test the efficacy of spatial-corrected and non-spatial-corrected models in predicting the probability of occurrence and abundance of trout species in the upper Snake River watershed. Our study illustrates the importance of considering spatial auto-correlation in modeling species distributions patterns over large geographic areas.

## **TWO DECADES OF BULL TROUT INDEX REACH SPAWNING SURVEYS ON FOUR NORTH FORK CLEARWATER RIVER TRIBUTARIES: OBSERVATIONS AND POTENTIAL CAUSES OF VARIATION IN ABUNDANCE AND TIMING**

Dan Kenney, Pay Murphy

U.S. Forest Service

Forest Service biologists began redd counts and other observations of spawning bull trout on specific reaches of 2 tributaries of the upper North Fork Clearwater River in 1994, adding third and fourth index reaches in 2000 and 2001; observations have continued through 2019. Although portions of all of the index reaches were substantially modified by placer miners in the late 19<sup>th</sup> and early 20<sup>th</sup> centuries, substantial recovery of aquatic habitat has occurred because of passive restoration during the last 60-70 years, with cumulative redd counts in the reaches often exceeding several dozen. Bull trout which spawn in these reaches are primarily individuals of a migratory life history--originally fluvial, but likely predominantly adfluvial since the construction of Dworshak Dam. In addition to observations of bull trout and redds, Forest Service biologists have collected water temperature data in the index reaches during the same time period. Given projections of warming water temperatures in bull trout patches in the upper North Fork (Isaak et al. 2015), data are reviewed to determine whether spawn timing in the index reaches has changed during the survey decades. Water temperature and Idaho Department of Fish and Game data in other North Fork Clearwater River tributaries are also examined to shed light on whether fluctuations in counts are likely controlled by local or larger-scale factors.

## **EPIGENETIC VARIATION AS A POTENTIAL MECHANISM FOR GENERATING PHENOTYPIC PLASTICITY IN LOCALLY ADAPTED ECTOTHERMS**

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Idaho State University

Local adaptation can improve survival through selection for characteristics with fitness-related responses to environmental change, and as a result, has important implications for determining the range and extent of a species distribution. However, adaptive variation can also arise from other mechanisms, such as phenotypic plasticity, or the ability of one genotype to produce multiple phenotypes. Determining the contribution of local adaptation can be done by quantifying adaptive generation variation from contrasting environmental conditions. Defining the relative contribution of phenotypic plasticity is much more difficult, as plasticity can arise from a variety of sources, one of which being epigenetic variation. Epigenetic variation has been shown to influence local adaptation at the population level through population-environment interactions. The most well-understood mechanism of epigenetic variation is DNA-methylation, a form of gene regulation that acts in response to environmental stress. Previous studies have shown ecotypic variation in DNA-methylation, but few have attempted to quantify epigenetic variation in natural populations. Therefore, we developed a study to test levels of DNA-methylation in Rainbow Trout (*Oncorhynchus mykiss*) from contrasting environments. In this presentation we present a plan to sample populations from cold montane and warm desert streams on repeated intervals over the summer where tissues samples will be collected for epigenetic analysis. Levels of DNA-methylation (percent methylation) will be quantified using bisulfite sequencing and genomic context of Single Methylated Variants (adaptive regions of the epigenome) will be identified using Next Generation Sequencing. A linear mixed model analysis will be used to test for environmental

associations in adaptive SMVs. We hypothesize that percent methylation will be differential between desert and montane populations. Since the fitness cost of maladaptive epigenetic variation is relatively low when compared to the cost of maladaptive genetic variation, we predict that epigenetic variation may be favored under environments where thermal regimes are more unstable.

## **POPULATION DYNAMICS OF WESTSLOPE CUTTHROAT TROUT IN THE MIDDLE FORK SALMON RIVER, IDAHO**

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Population dynamics information is necessary for fisheries managers to adequately manage a fishery. Age and growth estimates of a fish population from data collected at an instance in time can provide a snapshot of fish population dynamics. Additionally, tracking age and growth through time helps managers determine trends. Age and growth information for Westslope Cutthroat Trout *Oncorhynchus clarkii* captured in the Middle Fork Salmon River, Idaho, has been collected and reported sporadically since the late 1960s. In July 2019, Westslope Cutthroat Trout were sampled (n = 315) on the Middle Fork Salmon River via hook and line surveys from Boundary Creek to the confluence with the Salmon River. Total length was documented for each fish and ranged from 152 mm to 419 mm. Average total length was 267 mm (SE = 3). Sagittal otoliths were collected from a subsample of fish (n = 67). Otoliths were mounted in epoxy, sectioned (0.762 mm), and viewed under a compound microscope to estimate age, growth, and mortality. Additionally, catch rates (fish/angler hour) and proportional size distribution were calculated and further used to describe the population. Ages ranged from age-3 to age-8. This study adds to the existing knowledge of Westslope Cutthroat Trout in the Middle Fork Salmon River, and will help guide future management decisions.

## **SPATIAL VARIABILITY, HABITAT SELECTION AND DYNAMICS OF SCULPIN POPULATIONS IN AN IDAHO RIVER RELATIVE TO SYMPATRIC JUVENILE STEELHEAD ABUNDANCE**

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Optimal habitat selection is important for fish to meet the necessary ecological requirements needed to maximize growth rates, avoid predators, and successfully reproduce. As flows decrease and temperatures warm, the density of both conspecifics and competing species can have an impact on habitat quality with consequences for growth, survival, and movements. Within the context of a long-term juvenile steelhead (*Oncorhynchus mykiss*) research effort, we focused on the spatial variability of sculpin (*Cottidae*) densities across a watershed and how habitat selection changes over the summer season at the habitat unit (HU) scale across six sites in the Lapwai Creek basin. We hypothesized that sculpin densities would be highest in riffles across all sites, but the abundance of juvenile steelhead would modify this density gradient within sites. HU's were identified (pool, riffle, run) and physical measurements in 100-meter stream reaches were quantified. Single-pass electrofishing was conducted to collect sculpin and all sympatric species within the 100-meter reaches. Fish were enumerated and measured at each site five times

throughout the growing season. Results were interpreted in the context of previous results on habitat selection, biomass, and survival of sympatric steelhead.

Sculpin were most often found in run and riffle habitats. Connectivity of habitat, demonstrated by minimum depth of stream, steelhead density, and relative stream temperature were strong predictors of sculpin density. Our results provide a better understanding of the dynamics of sculpin populations and their potential interactions with salmonid species.

### **VARIATION IN ENERGETIC HABITAT QUALITY BETWEEN DESERT AND MONTANE STREAMS: IMPLICATIONS FOR REDBAND TROUT PERSISTENCE IN SOUTHWESTERN IDAHO**

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Bioenergetic analyses can reveal the degree to which salmonid growth is limited by invertebrate density and size structure as well as physical habitat constraints on habitat quality through effects of water temperature, depth and flow. Redband trout (*Oncorhynchus mykiss gairdneri*) have experienced reductions in abundance and geographic range as the result of the compounding effects of habitat alteration, fragmentation and stream-flow diversion. Redband trout in southwestern Idaho currently persist in contrasting desert and montane conditions characterized by highly differing temperature and flow conditions. We used a bioenergetic model as a way of estimating redband trout adaptability to environments that are predicted to change dramatically under climate change scenarios. We conducted monthly sampling of invertebrate drift, and habitat transects for wetted width, depth, and current velocity. Surveys were conducted in July and October to assess redband trout abundance as well as PIT tagging fish to assess growth rates and overwinter survival. Our preliminary analyses will compare how habitat quality varies between desert and montane environments across the growing season in order to determine the extent to which energetic habitat suitability may be limiting for redband trout populations. Assessing differences in energetic habitat quality in desert and montane streams currently occupied by redband trout will allow for a better understanding of the interactions between habitat conditions and population dynamics as well as simulations of potential future conditions under climate change scenarios.

### **DEVELOPING A FRAMEWORK FOR ASSESSING ADAPTIVE CAPACITY IN REDBAND TROUT USING AGENT-BASED MODELS**

Travis Seaborn, Christopher Caudill

University of Idaho

Adaptive capacity is the ability of the population to persist as environments change. It is determined both by genetic diversity and the interaction between genetics and environment (i.e., phenotypic plasticity). *Oncorhynchus mykiss* displays high variation in phenotypes within and among populations, and thus understanding how genetic diversity and phenotypic plasticity contribute to adaptive capacity is important for conservation and management of *O. mykiss* populations. The goal of this research was to understand how individual-level variation in genetics and plasticity define the adaptive capacity of a species in stream environments at the landscape scale using spatially-explicit agent-based demographic-genetic models of individual Redband

Trout (*O. mykiss gairdneri*). We created a Redband Trout model in Big Jacks and Little Jacks Creeks in southern Idaho using demographic parameters from the literature and the program CDMetaPop. The focus of the initial model simulations was stream reaches where average August temperatures exceed 20.6 C, a temperature which is the Arrhenius breakpoint temperature. We ran models using projected stream temperature data through 2099 under three scenarios 1) static environmental conditions 2) warming climate 3) warming climate with the adaptive loci. By simulating the presence of the adaptive allele, population sizes no longer declined, although this was dependent on the amount of dispersal. Similarly, the rates of homozygosity and counts of the adaptive allele were heavily influenced by the amount of movement of individuals, highlighting the potential roles of movement behavior, connectivity, and habitat heterogeneity on the landscape. Next steps for model construction include incorporation of genetically determined phenotypic plasticity to evaluate relative contributions of plastic and adaptive responses to climate change. The model will then be applied to new regions and a variety of environmental change scenarios relevant to the management and conservation of the species, including the roles of assisted migration and habitat restoration.

## **GENETIC AND MORPHOMETRIC TOOLS TO IDENTIFY SPECIES DIVERSITY OF CATOSTOMID FISHES IN THE INTERMOUNTAIN WESTERN UNITED STATES**

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Idaho State University

A comprehensive description and understanding of the distribution of species is critical for evaluating and monitoring the conservation status of natural populations. Native catostomid fishes of the Intermountain western United States have been a subject of taxonomic debate for decades due to overlapping ranges, similar morphology between species, and limited sampling efforts. Recent studies have investigated the taxonomy and classification of the bluehead sucker (*Catostomus discobolus*), a species of conservation concern in the Columbia, Bonneville, and Colorado River drainages and proposed that populations in the Snake River and Bear River watersheds should be reclassified as a new species, the green sucker (*Pantosteus virescens*). However, range overlap with morphologically similar populations of mountain sucker (*Catostomus platyrhynchus*) and upper Colorado River populations of bluehead sucker have created uncertainty in establishing which species occupy adjacent watersheds and how to distinguish them. In our study, we plan to examine variability in morphology and genetic structure of populations across watersheds to determine the range, extent, and morphological characteristics of catostomid fishes. We apply morphometric and genetic techniques to evaluate the appropriateness of the proposed reclassification. Digital landmarks, linear-based measurements of morphological characters, and meristic counts will be used to quantify differences among species and populations. We will also apply molecular techniques, including analysis of mitochondrial DNA loci and single nucleotide polymorphisms (SNPs) to determine whether systematic genetic divergence exists between populations. Preliminary morphometric data analyzed via principal component analysis and two-factor ANOVA suggest that bluehead suckers in the Colorado River system are distinct from those in both the Snake River and Bear River watersheds. Detailed geographic sampling of these populations will help clarify range boundaries and determine whether diagnostic morphological characteristics exist between species in adjacent watersheds and areas of overlapping species ranges.

## POPULATION DYNAMICS OF UTAH SUCKERS IN SOUTH FORK TETON RIVER, IDAHO

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Utah Sucker (*Catostomus ardens*) are a common and widespread species in the Upper Snake River drainage, however little is known about their population biology. Our objective was to determine spawning phenology, age, sexual maturity, growth, and annual mortality of Utah Sucker in South Fork Teton River. We captured Utah Suckers in a fish trap on the South Fork Teton River from April - June in 2018 and 2019. We removed pectoral fin rays to determine age of fish in 2019. We then used age data to estimate sexual maturity, von Bertalanffy growth models, and annual mortality. In 2018, we captured 1,204 Utah Suckers in the trap while we captured 982 Utah Suckers in 2019. The peak of the spawning run (most fish per day) was between 20 April - 30 April in 2018 and 2019. The mean age in 2019 was approximately 10 years with the youngest being 2 years and the oldest Sucker being 28 years. The smallest mature sucker was 360 mm; approximate age of suckers at this length was age-10 for males and age-12 for females. Utah Sucker exhibited dimorphic growth with females having a larger mean maximum length (562 mm; SE = 8.85) compared to males (532 mm; SE = 9.26). Other growth parameters ( $K = 0.18$ , SE = 0.01;  $t_0 = 0.38$ , SE = 0.16) did not differ between males and females. Annual mortality was estimated to be 17.9% for Utah Suckers between age 9 and 19 in 2019. This study provides basic life history of Utah Sucker which has not been previously documented. By comparing these parameters through time and across populations of this common and widespread species, we can gain a better understanding of how habitat conditions may be affecting species that are rare or that have a limited distribution.