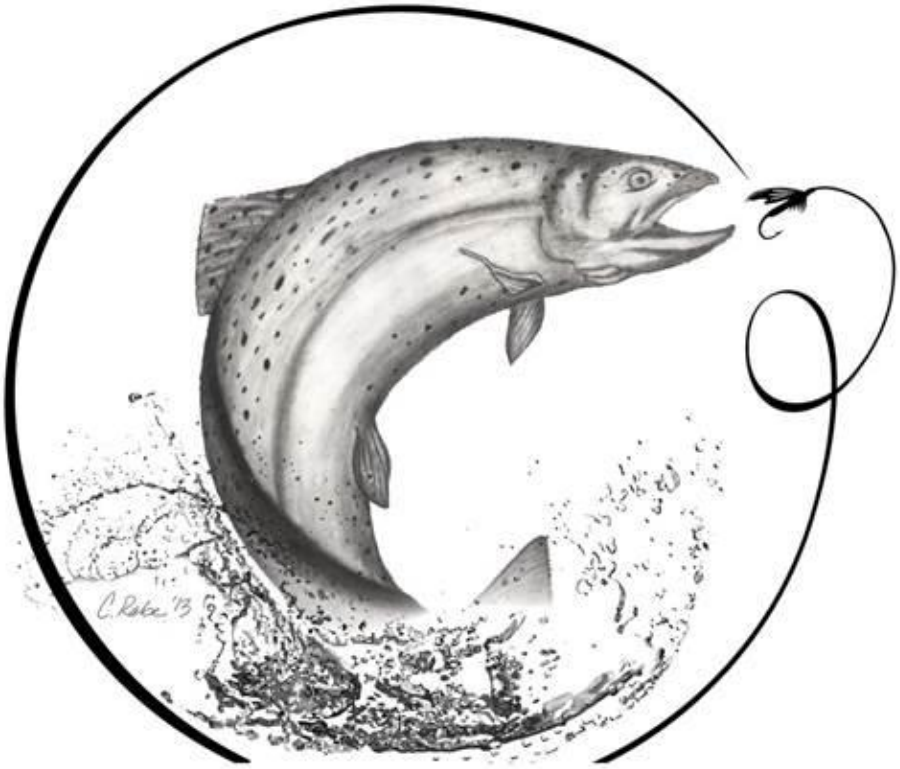
Stream Connectivity in Fisheries Management: Fix It, Break It, or Leave It?



AFS IDAHO CHAPTER

2014 ANNUAL MEETING

Shilo Inn
Idaho Falls, Idaho
February 10-13, 2014

Program and Abstracts

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Schedule At A Glance

Monday, Feb. 10

6:00 am - 8:00 am	Complimentary breakfast in hotel restaurant
7:00 am- 7:00 pm	Registration –Convention Center Lobby
8:00 am - 5:00 pm	Workshops
5:00 pm- 6:30 pm	ExCom Meeting- Temple View
7:00 pm- 8:00pm	Volunteer Meeting
6:00 pm - 9:00 pm	Welcome Social

Tuesday, Feb. 11

6:00 am - 8:00 am	Complimentary breakfast in hotel restaurant
7:00 am - 6:00 pm	Registration – Convention Center Lobby
8:00 am - 12:00 pm	Welcome and Plenary Session
12:00 pm - 1:35 pm	Committee Breakout Meetings (Boxed lunches)
1:40 pm - 4:00 pm	General Session
4:30 pm - 5:30 pm	Spawning Run
6:00 pm - 10:00 pm	On-site Student/Professional Social (Pizza and beverages)

Wednesday, Feb. 12

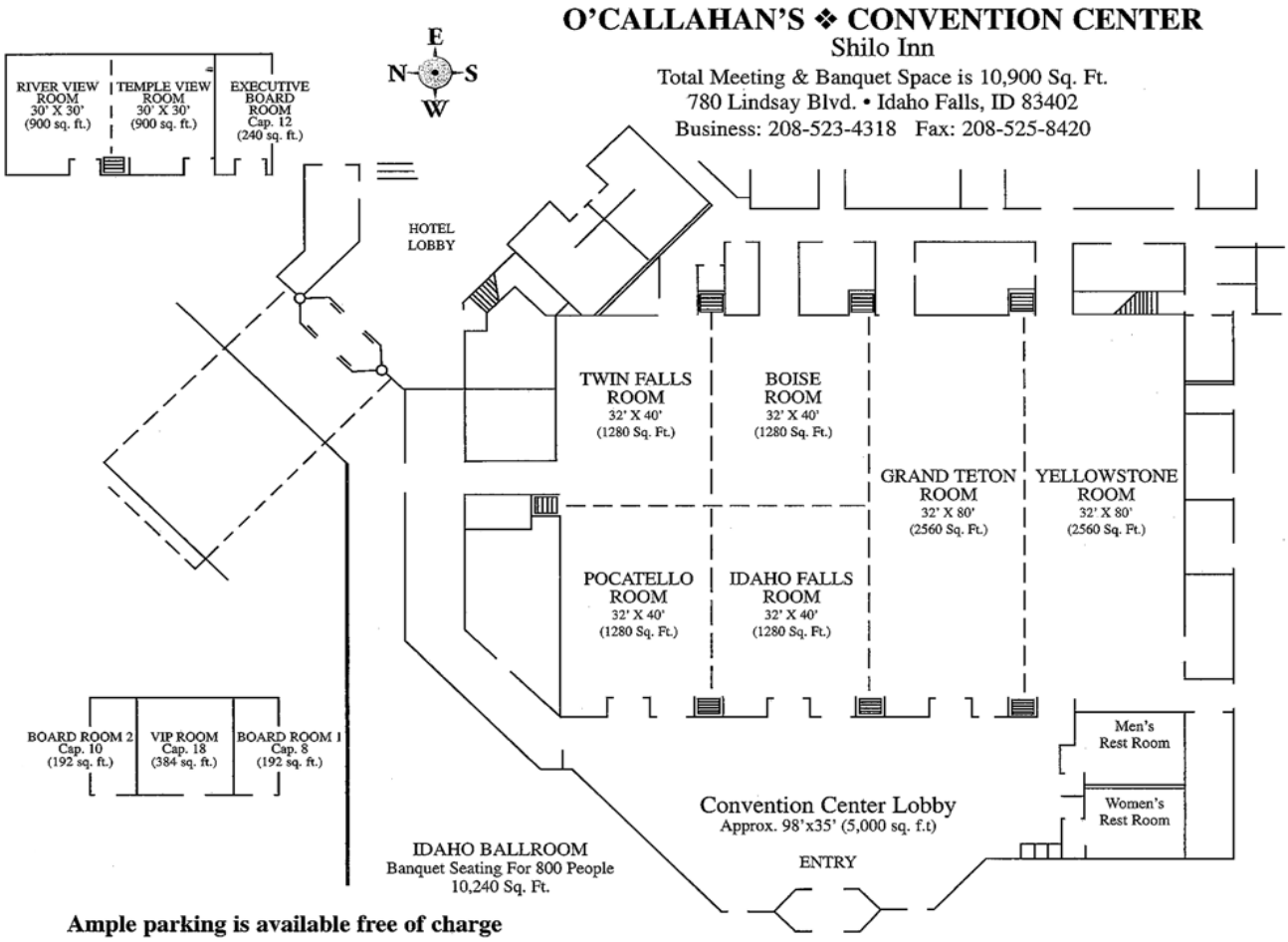
6:00 am - 8:00 am	Complimentary breakfast in hotel restaurant
8:00 am - 12:00 pm	Registration – Convention Center Lobby
8:00 am - 12:00 pm	Concurrent Sessions
12:00 pm - 2:15 pm	Business Lunch
2:15 pm - 4:30 pm	Concurrent Sessions
4:50 pm - 6:00 pm	Poster Session- Temple View Room
6:00 pm - ????	Banquet and Auction

Thursday, Feb. 13

6:00 am - 8:20 am	Complimentary breakfast in hotel restaurant
8:00 am - 11:00 am	Registration – Convention Center Lobby
8:20 am- 11:20 am	General Session
11:20 am - 11:40 am	Best Paper Awards and Meeting Conclusion

Safe Travels Home!

Floor Plan for Shilo Inn Convention Center



Monday, February 10

	2014 ICAFS Annual Meeting: Workshops
6:00 - 8:00	Complimentary breakfast in hotel restaurant
7 am-7:00 pm	Conference and Workshop Registration- Convention Center Lobby
8:00 - 12:00	Workshops 1) Hatchery Innovations 2) PIT-Tag Detection Systems: Options for Remote Monitoring Applications 3) Viewing, Creating and Sharing Geospatial Information in Google Earth
12:00 - 1:30	Lunch on Your Own
1:30 - 5:00	Workshops Continued….
5:00 - 6:30	ExCom Meeting- Temple View Room
7:00 - 8:00	Volunteer Meeting-Convention Center Lobby
6:00 - 9:00	Welcome Social

Committee Room Assignments

(See Map on Prior Page)

Committee	Room
Anadromous Fish	Twin Falls
Fish Culture	Temple View
Mentoring	Yellowstone
Native Fishes	Idaho Falls
Public Education	VIP
Riparian/Fish Habitat	River View

Note: All abstracts and posters are available for viewing on-line at
http://www.idahoafs.org/2014AnnualMeeting/meetingInformation.php

Tuesday, February 11

Session Name	**1A- 2014 ICAFS Annual Meeting: Stream Connectivity in Fisheries Management: Fix it, break it, or leave it?**
Moderator	Kevin Meyer
Room Name	*Grand Teton/Yellowstone*
6:00 - 8:00	Complimentary breakfast in hotel restaurant
8:00-8:10	Opening Remarks and Presidential Message **Joe DuPont - ICAFS President**
8:10-8:20	Introduction to "The Unwritten Laws of Fisheries" **Tom Curet - ICAFS President Elect**
8:20-8:30	Introduction to Plenary Session and Keynote Speakers
8:30-9:00	Watershed Connectivity in the Lemhi River Sub-basin: A Comprehensive Approach to Supporting Recovery of ESA Listed Salmonids. PART 1 **Jeff DiLuccia** **Idaho Department of Fish and Game**
9:00-9:30	Watershed Connectivity in the Lemhi River Sub-basin: Assessing the Effectiveness of Habitat Restoration Actions and Exploring the Risks. PART 2 **Chris Beasley** **Qualitative Consulting, Inc.**
9:30-10:00	Utilizing Fish Barriers to Protect Westslope Cutthroat Trout Populations: Balancing Opportunity, Long Term Success, and Recreation **Dave Moser** **Montana Fish, Wildlife, and Parks**
10:00-10:30	**BREAK- Sponsored by U.S. Fish and Wildlife Service- Lower Snake River Comp**
10:30-11:00	Informing "Make it or Break It" Decisions with Accurate Geospatial Data and High Resolution Stream Climate Scenarios **Dan Isaak, U. S. Forest Service** **U. S. Forest Service**
11:00-11:30	Connectivity Management: Complex Genetic Considerations in a Rapidly Changing World **Helen Neville** **Trout Unlimited**
11:30-11:55	Panel Discussion
11:55-12:00	Concluding Remarks **Kevin Meyer**

12:00-1:35	Box Lunch: Committee Breakout- Room Assignments on Monday Schedule
Session Name	**1B- Stream Connectivity in Fisheries- Contributed Papers**
Moderator	Daniel Bertram
Room Name	*Grand Teton/Yellowstone*
1:40-1:45	Introduction to Session
1:45-2:05	Little Lost River Drainage Results of Fix It, Break It, or Leave It **Jim Gregory** **Lost River Fish Ecology**
2:05-2:25	Effects of Anthropogenic Barriers on Movement, Gene Flow Potential, and Life-History Expression of *Oncorhynchus mykiss* in Lapwai Creek, Idaho **Jeffrey Caisman** **University of Idaho, Department of Fish and Wildlife Sciences**
2:25-2:55	BREAK
Moderator	Matt Green
2:55-3:15	Reconnecting Streams for Cutthroat Trout in the Bear River Watershed **Jim DeRito** **Trout Unlimited**
3:15-3:35	Malad River Fish Passage - Restoration of a Fluvial Life History for Rainbow Trout **Steve Brink** **Idaho Power Company**
3:35-3:55	Patch Size But Not Short-Term Isolation Influences Occurrence of Westslope Cutthroat Trout Above Human-Made Barriers **Michael Young** **U. S. Fish and Wildlife Service, Abernathy Fish Technology**
3:55-4:00	Concluding Remarks and Wrap Up **Tom Curet**
4:30 - 5:30	ICAFS Spawning Run - Location: Meet in Conference Center Lobby Prizes and Fun! **Sponsored by Biomark**
6:30 - ????	Student/Professional Mixer - Convention Center – Pizza and Beverages!

Wednesday, February 12 (Concurrent Sessions)

Session Name	**2A-Fish Management in Relation to Flows and Temperature**		**3A- Fisheries Techniques, Genetics, and Culture**
Moderator	**Christopher Tretter**		**Brett Bowersox**
Room Name	*Twin Falls/Pocatello*		*Yellowstone*
6:00 - 8:00	Complimentary breakfast in hotel restaurant		
8:00-8:10	Introduction to Session		Introduction to Session
8:10-8:30	Effects of Fisheries and Flow Management on Long-Term Viability of Native Cutthroat Trout in the South Fork Snake River		Comparison of Sampling Techniques for Fish Assemblages in Western Rivers
	Rob Van Kirk		**Michael Quist**
	Henry's Fork Foundation and Humboldt State University		**University of Idaho, Department of Fish and Wildlife Sciences**
8:30-8:50	Managed Aquifer Recharge and Potential Fishery Impacts: Building a House Without All the Tools		Estimation of Gear Selectivity for Lake Trout in Priest Lake, Idaho
	Tom Bassista		**Elizabeth Ng**
	Idaho Department of Fish and Game		**University of Idaho, Department of Fish and Wildlife Sciences**
8:50-9:10	Win Win for Farmers and Fish: Restoring Connectivity by Restoring Flow in the Teton River Watershed, Idaho		Using Occupancy Modeling to Compare Sampling Methods for Burbot *Lota lota*
	Sarah Lien		**Zachary Klein**
	Friends of the Teton River		**University of Idaho**
9:10-9:30	Effects of Water Level Regulation and Habitat Characteristics on Shore-Spawning Kokanee *Oncorhynchus nerka* Incubation Success and Habitat Selection		Otoliths and the Confusion Surrounding Zonation; A Comparison of Redband Trout *Oncorhynchus mykiss gairdneri* and Bluegill *Lepomis macrochirus*
	Steven Whitlock		**Dennis Daw**
	University of Idaho		**Idaho Department of Fish and Game and Boise State University**
9:30-9:50	Movement Patterns and Habitat Use of Westslope Cutthroat Trout in the South Fork Clearwater River Basin		PIT Tag Systems on a Budget: The Half Duplex System
	Marika Dobos		**Mike Lien**
	University of Idaho		**Friends of the Teton River**
9:50-10:20	BREAK		
Moderator	**Andy Dux**		**Bill Young**

10:20-10:40	Utilization of Cold-Water Thermal Refugia by Salmonids in Middle Fork Salmon River		Evaluating the Accuracy and Precision of Multiple Abundance Estimators Using State-Space Models: A Case Study for a Threatened Population of Chinook Salmon *Oncorhynchus tshawytscha* in Johnson Creek, Idaho
	Jon Flinders		**Ryan Kinzer**
	Idaho Department of Fish and Game		**Nez Perce Tribe**
10:40-11:00	Population Dynamics of Largescale Suckers in the Kootenai River, Idaho: Effects of Nutrient Enhancement and Discharge on Growth and Recruitment		Relative Contributions of Neutral and Non-Neutral Genetic Differentiation to Inform Conservation of Steelhead Trout Across Highly Variable Landscapes
	Carson Watkins		**Andrew Matala**
	University of Idaho, Department of Fish and Wildlife Sciences		**Columbia River Inter-Tribal Fish Commission**
11:00-11:20	Mechanisms of Thermal Adaptation: Transcriptional Response to Heat Stress Among Desert and Montane Populations		Monitoring the Effects of Historic Fish Stocking on Amphibian Populations in High Mountain Lakes of the Clearwater Region, Idaho
	Shawn Narum		**Timothy Lambert**
	Columbia River Inter-Tribal Fish Commission		**Idaho Department of Fish and Game**
11:20-11:40	Applications of Spatial Statistical Network Models to Stream Data		Bear River Bonneville Cutthroat Trout Conservation Aquaculture in Idaho
	Dan Isaak		**Eric Pankau**
	U. S. Forest Service		**Idaho Department of Fish and Game**
11:40-12:00	Idaho Applications of the NorWeST Stream Temperature Database, Model, and Climate Scenarios		Evaluating Captive Reared Snake River Sockeye Salmon Adult Releases Within Redfish Lake, Idaho to Identify Their Contribution to the ESA Population
	Dan Isaak		**Mike Peterson**
	U. S. Forest Service		**Idaho Department of Fish and Game**
12:00-2:15	Business Luncheon - Boise, Idaho Falls and Grand Teton rooms		
Session Name	**2B-Habitat Use and Selection**		**3B-Native Fish**
Moderator	**Ryan Beatty**		**Trisha Giambra**
Room Name	*Twin Falls/Pocatello*		*Yellowstone*
2:15-2:20	Introduction to Session		Introduction to Session
2:20-2:40	Determining the Habitat Bottleneck: Is It Rearing or Spawning Limited?		Tragedy of the Commons
	Steven Cramer		**Jay Hesse**
	Cramer Fish Sciences		**Nez Perce Tribe**
2:40-3:00	Fish Assemblage and Population Relationships with Habitat in the Kootenai River, Idaho		Cedar Sculpin *Cottus schitsuumsh,* A New Species of Sculpin in Idaho: The First of Several?
	Michael Quist		**Michael Young**
	University of Idaho, Department of Fish and Wildlife Sciences		**Rocky Mountain Research Station**

3:00-3:20	Modeling Fish Assemblage Structure and Habitat Use to Guide Rehabilitation Activities in the Kootenai River, Idaho		Westslope Cutthroat Trout *Oncorhynchus clarkii lewisi* Abundance Trends in Idaho
	Michael Quist		**Pat Kennedy**
	University of Idaho, Department of Fish and Wildlife Sciences		**Idaho Department of Fish and Game**
3:20-3:50	**BREAK**		
Moderator	**Christine Stewart**		**Jody Brostrum**
	East Fork Owyhee River Retains the Capacity to Support Salmon and Steelhead Populations		Bull Trout Trends in Abundance and Probabilities of Persistence in Idaho
	Ian Courter		**Kevin Meyer**
	Cramer Fish Sciences		**Idaho Department of Fish and Game**
4:10-4:30	Movements of Fluvial Redband Trout in a Severely Altered Ecosystem		Oh Where, Oh Where, Have All the Redds Gone?
	Thomas Biladeau		**Phil Groves**
	Coeur d'Alene Tribe		**Idaho Power Company**
4:30-4:50	**BREAK**		
4:50-6:00	**POSTER SESSION- See list on page next page**		
	Temple View and River View Rooms REFRESHMENTS SERVED!		
6:00-9:00	**Evening Social and Auction**		
	Convention Center		

Events Include :

Buffet Dinner

Live and Silent Auctions

Come Prepared to Spend!

Win/Purchase Items!

All proceeds will go to support the chapter and scholarships!

List of Contributed Posters

Run Salmon Run into the River of No Return Wilderness Sun -
Scott Cazier- Shoshone Bannock Tribes

Seasonal Use of a Spring-fed Tributary by Wild Rainbow Trout in an Isolated Reach of the Henry's Fork Snake River, Idaho-
Anne Marie Emery- Henry's Fork Foundation

Allometry of Prey Size Selection and Morphological Constraints in Adult Chinook Salmon and Coho Salmon
Cody Feldman- Idaho State University

Carcass Recovery Efficiency and Deterioration Rates in Red River (Clearwater Drainage, North Idaho)
Tyler Gross- Pacific States Marine Fisheries Commission/ Idaho Department of Fish and Game

West Fork Lake Creek Stream and Wetland Enhancement Project
Stephanie Hallock- Coeur d'Alene Tribe

Responses of Chinook Salmon (Oncorhynchus tshawytscha) Spawning Behaviors to Disturbance and Climate Impacts in the Salmon River Basin
Jessica Helsley- University of Idaho

Expansion of Parentage-Based Tagging Technology Throughout the Columbia River Basin
Maureen Hess-Columbia River Inter-Tribal Fish Commission

A Thermal Map For All Streams in the State of Idaho
Dan Isaak- United States Forest Service

Heath Trays vs.Upwellers: A Survival Comparison of Deadwood Kokanee Salmon at Mackay Fish Hatchery
Jason Jones- Idaho Department of Fish and Game

The "Following Fishes" Lesson Plan
Leslie Reinhardt- Idaho Department of Fish and Game / Pacific States Marine Fisheries Commission

An Update on the Effects of Initial Feed Timing on Triploid Rainbow Trout
Chad Smith-Idaho Department of Fish and Game , Grace Fish Hatchery

Evaluation of Removal and Sectioning Locations of Dorsal Spines for Estimating Age of Common Carp
Carson Watkins- University of Idaho , Department of Fish and Wildlife Sciences

Thursday, February 13

Session Name	**4A-Contributed Papers**
Moderator	**Stuart Rosenberger**
Room Name	*Grand Teton/Yellowstone*
6:00 - 8:20	Complimentary breakfast in hotel restaurant
8:20-8:30	Announcements and Introduction to the Session
8:30-8:50	Patterns of Beaver Establishment and Effects on Salmonid Habitat Condition in the Interior Columbia River Basin **Christy Meredith** **U. S. Forest Service**
8:50-9:10	Complexity Drives Habitat Use and Selection by Stream Fishes in a Snake River Basin Tributary **Dan Dauwalter** **Trout Unlimited**
9:10-9:30	Population Characteristics of Wild Adult Chinook Salmon in the East Fork Salmon River, Idaho **Eric Stark** **Idaho Department of Fish and Game**
9:30-9:50	Trophic Ecology of Northern Pike and Their Effect on Conservation of Westslope Cutthroat Trout **John Walrath** **University of Idaho**
9:50-10:20	BREAK
Moderator	**Art Butts**
10:20-10:40	Phosphorus Enrichment as a Management Strategy for *Didymosphenia geminate* Nuisance Mats in the Kootenai River, Libby, Montana **Mary Coyle** **University of Idaho**
10:40 -11:00	Dispersal of Adult Steelhead (*Oncorhynchus mykiss*) in the South Fork Clearwater River, Idaho **McLain Johnson** **Nez Perce Tribe**
11:00-11:20	Direct and Indirect Responses of Stream and Riparian Organisms to Artificial Additions of Salmon Carcasses and Salmon Analog Pellets are Mediated by Subsidy Form and Duration **Scott Collins** **Idaho State University**

11:20-11:40 Best Paper Awards and Adjournment

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Presentation Abstracts in Alphabetical Class

Managed Aquifer Recharge and Potential Fishery Impacts: Building a House Without all the Tools

Tom Bassista and Walt Poole
Idaho Department of Fish and Game
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Aquifer recharge has the potential to diminish natural river flow and alter fishery resources and aquatic habitat. Now is the time for fisheries professionals to start examining and recommending minimum and maximum biological flows for our river systems or water managers and politicians will do it for us. Managed aquifer recharge, or simply recharge, is a tool used by water managers and irrigation districts to replenish depleted underground aquifers and help mitigate water shortages. Currently, only the Idaho Water Resource Board administers recharge allocations. However, there are several irrigation districts and private consultants who have applied for recharge water rights and there is proposed legislation aimed at recharge credits and expanding administrative procedures for managed recharge. The basic principle behind recharge is to deliver natural river flow to a recharge location after all senior water rights are satisfied and reservoirs are filled, typically during spring runoff. River systems and aquatic habitats are dependent on high spring flows to promote riparian vegetation, clean and sort spawning gravels and assist downstream migration. Continually diverting high water flows for the purpose of recharge will flatten already altered hydrographs and may have grave consequences to our fishery resources and aquatic habitats. Another strategy is to deliver natural flow or stored water from reservoirs outside the irrigation season, typically during fall and winter. Reducing fall and winter flow, the most critical time period for many species of fish, could decrease winter survival and ultimately reduce fish populations. On top of all this, increased water diversion at unscreened diversions will also increase fish entrainment. It is absolutely imperative that fisheries managers and researchers have a seat at the table and understand when, where and how much additional water will be diverted from our river systems. One of the most influential tools for environmental negotiations over recharge will be well sounded, scientifically based minimum and maximum biological river flow recommendations. Unfortunately, those data are currently lacking from our tool box on most river systems.

Watershed Connectivity in the Lemhi River Sub-basin: Assessing the Effectiveness of Habitat Restoration Actions and Exploring the Risks. PART 2

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The Lemhi River serves as an example of extreme anthropogenic modification, first to support agriculture and development, and recently to reestablish natural processes in support of imperiled anadromous salmonids. At the coarsest scale, habitat restoration actions in the Lemhi River will improve in-stream flow, habitat complexity, and most importantly, support access to tributary habitat that has been largely unavailable to anadromous salmonids for nearly 100 years. From the perspective of habitat action effectiveness, it is relevant to ask a very simple question – if you reconnect it, will they come? I will report on the results and observations from the first four years of a nine year monitoring and evaluation program developed specifically to quantitatively address that simple question. I will describe how habitat restoration actions have changed the quantity of available habitat, whether anadromous salmonids have capitalized on those changes, and how those pieces of information can be used to plan and evaluate future restoration actions in the Lemhi River and elsewhere. I will share documented examples of anadromous production from previously isolated resident populations, escapement of anadromous adults to newly available habitat, and definitive evidence that tributary reconnections have reestablished migratory pathways for fluvial species. These self-same improvements in connectivity have also enabled non-native species to access previously isolated habitat occupied by native resident subpopulations. In short, the Lemhi River provides the opportunity to assess questions of fundamental biological significance against the backdrop of a rapidly changing landscape. For species like *Oncorhynchus mykiss* that exhibit both anadromous and resident life-history forms, how is equilibrium achieved, and what actions can tip the balance? Are “invasive” actions required to reestablish anadromy in watersheds that are conducive to resident species? Perhaps most importantly, as tributary reconnections proceed, are the benefits to reestablishment of indigenous fish populations outweighing the risks of spreading non-native species?

Movements of Fluvial Redband Trout in a Severely Altered Ecosystem

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The distribution of redband trout in Hangman Creek, a tributary of the Spokane River, has been substantially altered over the last century. The population is highly fragmented throughout the upper watershed, creating isolated subpopulations with less resiliency. Much of the fragmentation is directly related to agricultural and forest management practices, resulting in unfavorable stream temperatures, extreme fluctuations in discharge, and periods of dewatering in many tributaries. Redband trout are primarily confined to the upper reaches of tributaries in forested areas of the watershed. Fluvial individuals however continue to utilize mainstem habitat, albeit in severely restricted reaches with cold-water refuge. VIE tagging of redband trout at migration traps suggests that individuals using mainstem habitat have a very low exchange rate between adjacent tributaries. This data prompted the Coeur d'Alene Tribe to further investigate how fluvial individuals were using mainstem habitat. PIT-tag interrogation sites have been established to determine mainstem use through a five-kilometer reach of Hangman Creek. Current data shows fluvial redband trout originating from adjacent tributaries are utilizing this area at a low rate. Only 21% of emigrants from Indian Creek, the tributary directly upstream, utilized this reach for summer rearing. In Nehchen Creek, the tributary directly downstream, 41% of migrants which entered this reach passed directly through and into mainstem habitat upstream with colder temperatures. Continuous stream habitat monitoring shows water temperatures in this reach approaching sub-lethal levels throughout summer rearing periods. The Coeur d'Alene Tribe Fish and Wildlife Program is initiating an ambitious project to restore and reconnect this large and vital reach of mainstem Hangman in hopes of providing rearing habitat and an improved migration corridor for fluvial redband trout. Upon completion of this restoration project, monitoring efforts will continue to determine changes in rearing and dispersal habits by redband trout.

Malad River Fish Passage - Restoration of a Fluvial Life History for Resident Rainbow Trout

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The Malad River supports one of the few self-sustaining, tributary populations of fluvial rainbow trout with connectivity to the middle Snake River, Idaho. Construction of two diversion dams divided the river into three reaches each approximately 1.6 km in length and created upstream migration barriers. It is believed that the Malad River likely provided spawning and juvenile rearing habitat for fluvial redband trout that would migrate from the Snake River to the Malad River seasonally to spawn. Recent research by Idaho Power Company (IPC) revealed that large (>35 cm total length [TL]) non-native rainbow trout introduced to the Snake River through past hatchery plantings used the lower reach of the Malad River for spawning and displayed a fluvial life history. Rainbow trout above the first diversion were smaller in size with few trout >25 cm TL. Restoring a fluvial life history strategy to areas above the diversion dams was the management goal of the Idaho Department of Fish and Game. As mitigation for a new federal license by the FERC for the Malad River Hydroelectric Project, IPC proposed to construct fishways at both diversion dams on the Malad River to restore connectivity of the lower 4.8 km of the Malad River to the Snake River. Since becoming operational in March 2008, the lower diversion fishway (vertical-slot weir ladder) has passed more than 32,000 wild rainbow trout either upstream or downstream. More than 22,000 of these trout have used the fishway to migrate downstream towards the Snake River. Upstream passage through the fishway has totaled more than 10,000 since 2008 and during the last three years has averaged over 2,600 rainbow trout annually. On average about 200 of these trout are spawning-sized adults (> 30 cm TL) including an average of 119 that are larger, fluvial-sized trout (> 35 cm TL). Overall, most downstream migrating rainbow trout are juvenile-sized at 15-22 cm TL.

The larger sized rainbow trout (>35 cm) migrate upstream through the fishway each year during time periods consistent with observed spawning in the reaches above and below the fishway, suggesting a spawning migration. These movements, coupled with the high numbers of juvenile-sized fish migrating downstream through the fishway, indicate an increasing fluvial population of rainbow trout in the Malad/Snake rivers since the fishway became operational in 2008.

Effects of Anthropogenic Barriers on Movement, Gene Flow Potential, and Life-History Expression of Oncorynchus mykiss in Lapwai Creek, Idaho

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Large-scale habitat modification and population isolation are processes that define the evolutionary history of salmon and their relatives. In the Anthropocene, salmonid populations in the Columbia River basin have experienced unnatural levels of habitat fragmentation due to impassable dams and barriers throughout much of their range, with many of these populations maintaining isolated populations above these barriers to upstream movement. Even though the area above impassable barriers to upstream movement may represent a small fraction of a system's total available fish habitat, previous research has shown that occasional gene flow from these above-barrier populations to the central population is critical in maintaining genetic diversity, a trait which is vital to long-term population persistence. Our objectives were to understand how putative barriers to movement have influenced life-history expression, movement patterns, and potential for gene flow between fragmented populations of Oncorhynchus mykiss in the Lapwai Creek basin, Idaho. In summer 2013, we captured juvenile O. mykiss by electrofishing and took fin clips for genetic analysis. Genetic material from 98 individuals from below-barrier populations and 55 individuals from above-barrier populations were analyzed at 187 SNPs. Preliminary results indicate significant genetic differentiation between above- and below-barrier populations, but also indicate the presence of individuals of above-barrier origin in below-barrier populations. One-way "leakage" of individuals moving downstream over these diversion dams was confirmed through analysis of movement patterns. In one tributary, 3 out of 27 (11.1%) PIT-tagged above-barrier individuals moved downstream and passed over the diversion dam and emigrated out of the basin, indicating possible anadromous intention. Our results show these above-barrier populations have retained the ability to become anadromous, even after 100+ years of selection against an ocean return and therefore acting against this life-history pathway. Although we did not directly examine exchange of genetic material between above- and below-barrier populations, our results indicate this occurrence likely happens at low to moderate levels. Throughout the Pacific Northwest where small dams fragment habitat, these isolated populations likely serve as sources of genetic diversity for salmonid ESU's and are important for the long-term viability of these threatened populations.

Direct and Indirect Responses of Stream and Riparian Organisms to Artificial Additions of Salmon Carcasses and Salmon Analog Pellets are Mediated by Subsidy Form and Duration

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Understanding the effect of subsidies of salmon in food webs may require consideration of the role of its physical form, including the potential for subsidies and their effects to propagate and feedback among aquatic and terrestrial habitats. Over four years we experimentally tested how the physical form of subsidies, either complex (carcasses of Pacific salmon) or simple (pelletized salmon tissue, referred to as "analog"), influenced direct and indirect responses by organisms across multiple time scales (weeks to years) within two linked, recipient habitats (streams and riparian zones). Salmon carcasses were frequently removed (typically by black bears) from streams to the wetted margins and riparian zones, whereas salmon analog was not. Salmon carcasses had both a greater array and magnitude of short-term ecological effects in comparison to analog. Carcasses increased predation by stream fishes on benthic stream insects. Over the duration of the experiment, fish consumption of benthic insects increased by 110-140% and 44-66% in carcass and analog treatments, respectively. Consequently, fishes efficiently cropped benthic insects, resulting in reduced average biomass of adult aquatic insects in the riparian zone, which indirectly reduced abundance of Tetragnathidae spiders and feeding activity of *Myotis californicus* and *yumanensis* bats in riparian habitats. Translocation of salmon carcasses to riparian zones increased terrestrial Diptera through behavioral attraction and greater emergence from riparian soils subsidized by carcasses. The activity of M. *thysanodes* and *evotis* bats increased at sites with more terrestrial Diptera, and, in a manner consistent with amplified apparent competition, there were corresponding declines in Araneidae spiders on which these bats also prey. Our experiment demonstrated that the form of a subsidy determines the initial conditions in space (i.e., likelihood of dispersal among multiple recipient habitats) and through time (i.e., persistence of subsidy), and that, in turn, these constrain the type and magnitude of ecological responses to the subsidy.

East Fork Owyhee River Retains the Capacity to Support Salmon and Steelhead Populations

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The East Fork Owyhee River has historically supported anadromous runs of Chinook salmon and steelhead trout, but dams and water diversion structures along the Columbia, Snake, and Owyhee Rivers have restricted access to spawning and rearing areas for more than 80 years. The Shoshone-Paiute Tribe has proposed to reintroduce salmon and steelhead by transporting fish from dams on the lower Snake River. Prior to implementing the reintroduction effort, literature reviews, extensive habitat surveys, carrying capacity modeling, and hydraulic modeling were utilized to determine if the basin still retained the capacity to support production of anadromous salmonids. Habitat-based carrying capacity estimates were calculated using the Unit Characteristic Method. Dependent on flow and temperature conditions, which vary dramatically with meteorological conditions, we predicted the watershed was capable of producing 3,600 to 41,000 juvenile Chinook salmon and 3,300 to 43,000 juvenile steelhead trout when fully seeded. Spawning capacity estimates were also calculated based on the availability of appropriate substrate and flow conditions for each species. Lower elevations were found to have more potential for supporting spawning adults compared with high gradient canyon reaches in the upper basin. Key limiting factors for anadromous fish production in the East Fork Owyhee River were high summer temperatures, low summer flows, and large amounts of fine sediment substrates. Future restoration activities should focus on addressing these three limiting factors. In spite of decades of habitat degradation and water infrastructure development, the East Fork Owyhee River basin still appears to retain the capacity to support self-sustaining populations of anadromous fish when paired with a truck-and-haul program.

Phosphorus Enrichment as a Management Strategy for Didymosphenia geminata Nuisance Mats in the Kootenai River Libby, MT

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Didymosphenia geminata (Didymo) has rapidly gained notoriety among aquatic ecologists and water recreationists. Covering river bottoms with thick mats resembling sewage or wet toilet paper, Didymo thrives in oligotrophic conditions in cold, fast flowing streams and rivers. This diatom smothers the river bed displacing benthic invertebrates such as Ephemeroptera, Plecoptera, and Trichoptera, threatening not only the aesthetic value of rivers and streams but also overall ecosystem health and productivity. The processes which allow for these masses of stalk material to form in nutrient limited water is an active area of research as the presence of nuisance blooms has only become a notable global issue within the last 10-15 years. Research into basic components of Didymo ecology is still maturing and control methods for nuisance mats are rare. Management strategies for D. geminata are currently restricted to biocides, chemical compounds and mechanical removal, all of which are unsuitable for the Kootenai River system due to its size and the presence of highly desirable fish species, or fish species listed under the US Endangered Species Act of 1973. The objective of this study was to experimentally examine potential management strategies to reduce D. geminata nuisance mat infestation of the Kootenai River in Libby, Montana. An experimental flume system was designed and used to test applications of dissolved phosphorus. The addition of phosphorus resulted in a statistically significant decrease in the stalk length of Didymosphenia geminata relative to control flumes which only received additions of river water. Once phosphorus additions stopped, the density of Didymo cells declined to pre-treatment levels, removing the concern that short-term phosphorus enrichment would increase mat severity via increased Didymo cell density. Frequency of dividing cells (FDC) showed a short term increase (12 May to 9 June 2013) which reflects the findings of previous studies. Lower levels of dissolved phosphorus should be tested to investigate the most efficient concentration for Didymo stalk reduction. As the Kootenai is culturally oligotrophic, other algal blooms from phosphorus enrichment will need to be minimized to reduce further ecosystem complications.

Determining the Habitat Bottleneck: is it Rearing or Spawning Limited?

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Biologists confronted with prescribing minimum flows or choosing which habitat restoration projects get funding have wrestled with the challenge of identifying which habitat factors are the real bottleneck to fish production. We identified relationships between measurable habitat features and fish preferences for rearing and spawning, based on published studies. Rearing capacity is influenced by channel unit type, depth, cover, area, fine sediment, and temperature, while spawning capacity is influenced by depth and area of suitable gravels. We developed methods to measure all of these features on a single survey during base flow, and then predict how the features would differ at the different flows expected in different seasons. We field tested these methods to estimate production potential of spring Chinook, steelhead, and resident rainbow trout in Battle Creek, a high gradient boulder-dominated stream. The factor that was most limiting was strongly affected by the season in which spawning occurs for each species and the size of the spawners. Spring Chinook spawn during summer base-flow, while steelhead and rainbow trout spawn during winter-spring high flows. Rearing capacity for the juveniles of both species is constrained by summer low flows. The number of suitable patches for steelhead spawning was substantially greater than for Chinook, because steelhead require half of depth required by Chinook (15 cm vs. 30 cm), and the area defended per spawning pair is only 4 m^2 for steelhead, one fifth of the 20.7 m^2 required per pair of Chinook. These methods clearly distinguished that spawning capacity was most limiting for spring Chinook, while rearing capacity was most limiting for steelhead and rainbow trout. Potential benefits of flow management and specific types of habitat restoration can readily be estimated with the model.

Complexity Drives Habitat Use and Selection by Stream Fishes in a Snake River Basin Tributary

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Impacts from grazing, agriculture, and other anthropogenic land uses can decrease stream habitat complexity that is important to stream biota and often is the basis of habitat restoration. We evaluated how habitat complexity structured a fish assemblage and influenced habitat selection by the northern leatherside chub (Lepidomeda copei), a recent candidate for listing under the Endangered Species Act, in Trapper Creek, a tributary to the Snake River. Fishes were sampled using pre-positioned areal electrofishing (~1 m^2), and microhabitat conditions were measured within a 1-m diameter circle. Constrained correspondence analysis showed complexity in water depths and velocity to structure the fish assemblage and partition habitat use by northern leatherside chub, rainbow trout (Oncorhynchus mykiss), and redside shiner (Richardsonius balteatus). Habitat selection models showed that the northern leatherside chub used areas of heterogenous depths and flows in addition to the low velocity, deep habitats often considered to be the species habitat. Additionally, chubs were almost certain to occur in deep-water habitats when overhead cover, often from mature riparian shrubs, was present. The complex depths and flows structuring the fish assemblage, and selected by the northern leatherside chub, were often directly tied to other stream features such as boulders, mature riparian vegetation, and beaver dams; stream features that have direct ties to active and passive habitat restoration techniques. Our study suggests that habitat complexity should be routinely incorporated in studies evaluating fish habitat use, occupancy, and abundance. Doing so will result in models that are more informative to practitioners conducting stream restoration on the basis of improving habitat complexity.

Otoliths and the Confusion Surrounding Zonation: A Comparison of Redband Trout (Oncorhynchus mykiss gairdneri) and Bluegill (Lepomis macrochirus)

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There is a considerable amount of confusion surrounding the timing and interpretation of otolith zones, specifically, which zone represents fast growth and which represents slow growth. In an attempt to determine if this confusion is a species difference, we compared growth periods and otoliths zonation for a cold water (Redband trout: Oncorhynchus mykiss gairdneri) and a warm water (Bluegill: Lepomis macrochirus) species. This was accomplished by sampling five bodies of water, two streams and three ponds, in Southwestern Idaho. Monthly incremental analysis and edge analysis were performed on otoliths. Growth was calculated and compared to the edge condition each month to determine which zone was forming during the period of fast growth. Both species had a sharp decrease in increment width in May, which suggests the formation of one annulus per year. Rainbow Trout (RBT) showed their fastest growth during the month of June, with a continuation of growth through September. The opaque zone started to form in March with 37.5% of RBT having an opaque edge. By June, 100% of all RBT had formed a complete opaque zone on the outer edge of the otolith. Bluegill showed their fastest growth during the month of May with growth continuing until July. As with RBT, the fastest growth rates for BG were during late spring and early summer. This fast growth coincides with the formation of the translucent zone, which was formed in 95% of BG by the month of May. Similar to RBT, 100% of BG had formed their fast growth zone by June: RBT having an opaque edge and BG having a translucent edge. We found that the confusion may come from the fact that everybody is correct, and it depends on the species of fish being examined.

Reconnecting Streams for Cutthroat Trout in the Bear River Watershed

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The Bear River watershed (UT, ID, WY) has been intensively developed to provide hydropower and agriculture needs. Dams, diversions, and irrigation canals have prevented or limited migratory cutthroat trout from accessing habitat needed to complete their life cycles. Over the past ten years, work undertaken by a variety of partners has resulted in the completion of over fifty projects in the Bear River watershed to reconnect several hundred stream miles. We present two case studies in Idaho where significant investments have been made to reconnect migratory cutthroat trout and recent fisheries sampling may provide evidence of the benefits. On the Cub River, a fish ladder has been constructed and fish screens installed in three irrigation canals. A total of more than 900 cutthroat trout have been passed upstream through the fish ladder during spring-time spawning periods since 2007. In 2013, the highest densities of cutthroat trout in the Bear River watershed in Idaho were found between the two lower irrigation canals on the Cub River. On Bear Lake, three tributaries have been reconnected with the installation of ten fish screens, the replacement of culverts, and the construction of two fish ladders. A notable increase in the proportion of wild or naturally-spawned cutthroat trout versus hatchery-reared cutthroat trout was found during netting surveys of Bear Lake during 2012. Further work is needed for both of these cases to more directly quantify the recruitment benefits of these projects and to optimally use limited water supplies to maximize the fish passage benefits.

Watershed Connectivity in the Lemhi River Sub-basin: A Comprehensive Approach to Supporting Recovery of ESA Listed Salmonids. PART 1

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Recovery of ESA listed Snake River spring/summer Chinook salmon and steelhead in the Columbia River basin is a common goal of federal regulatory and state agencies, and public organizations. Once numbering in the millions, these species have been reduced to a fraction of their historic levels. Declines in abundance and geographic distribution are the result of multiple factors, including juvenile and adult mortality from the Federal Columbia River Power System, and widespread degradation of freshwater habitats. Among natal tributary streams, high quality spawning and rearing habitats that are well distributed and interconnected are critical to the persistence of anadromous salmonid populations. In Idaho, tributaries located in areas with limited human disturbance contain the highest quality habitat and connectivity and represent strongholds for salmonids. However, in the Lemhi River sub-basin, Idaho, multiple anthropogenic disturbances has led to widespread habitat fragmentation and the loss of functional connectivity between nearly all tributaries and the mainstem. Road culverts and irrigation dams create barriers to upstream migrating fish, and irrigation water withdrawals often result in dewatered tributary segments that are impassable to all life stages of fish. In 2005, Idaho collaboratively developed a habitat action plan to address limiting factors in the Lemhi and support the recovery of salmon and steelhead. This plan included measures to establish functional connectivity between prioritized tributaries and the Lemhi River in an effort to provide access to currently unavailable high quality habitat. The plan followed a biologically based viability approach to providing natural conditions for maintaining self-sustaining populations. Since 2006, aggressive project implementation has resulted in the functional reconnection of three tributaries and additional projects are in progress to connect three additional tributaries with the Lemhi River. Simultaneously, a rigorous effectiveness monitoring program in the Lemhi is determining anadromous fish response to the restorative actions while guiding adaptive management strategies.

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

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Although abundant in northern Idaho, the overall distribution of westslope cutthroat trout (WCT) (Oncorhynchus clarki lewisi) has been greatly reduced. The primary factors attributed to the reduced distribution of WCT are habitat alteration, introduction of nonnative species, and overharvest. High summer stream temperatures and other habitat characteristics (e.g., availability of deep pools) are thought to limit WCT populations in the South Fork Clearwater River (SFCR) system of northern Idaho. We evaluated the influence of stream temperature and habitat on movement and distribution of WCT using radio telemetry. Home range was described as the distance between the upper and lower terminus of stream reaches used by radio tagged WCT during each season (determined by abrupt changes in water temperature). Habitat use was evaluated by modeling the effects of fish size, stream temperature, and other environmental characteristics (e.g., channel unit type, depth, substrate) on total seasonal displacement (total distance traveled in a season) and minimum displacement per week. Akaike's Information Criteria adjusted for small samples was used to select the best model that explained the most variation in seasonal and weekly displacement. Results will provide a better understanding of seasonal movement patterns and habitat use of WCT in the SFCR, and will also indicate important areas for habitat conservation.

Utilization of Cold-Water Thermal Refugia by Salmonids in the Middle Fork Salmon River

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In the Upper Salmon River subbasin the confluences of colder tributaries with rivers create cold-water thermal plumes during summer conditions. The presence of cold water thermal plumes may be important for salmonid persistence and survival, particularly during periods of low discharge during summer that results in high water temperatures in mainstem rivers. Salmonids may behaviorally thermoregulate by moving to localized patches of cooler water in the plumes when temperatures approach sub-lethal or lethal levels. However, many tributaries in the Upper Salmon are dewatered by irrigation water withdrawals, and these cold water inputs are unavailable to mainstem rivers. We investigated the importance of thermal refugia by evaluating an intact wilderness river system, the Middle Fork Salmon River (MFSR), to determine if salmonid densities differed significantly above (i.e. mainstem) and below tributary confluences (i.e. plume). Bioenergetics model simulations were also run to evaluate reduced plume water temperatures on specific growth rate (g/d/d) of rainbow trout and westslope cutthroat trout. A total of 35 and 37 thermal plume habitats were surveyed via snorkeling in 2012 and 2013, respectively. Of the sites surveyed, 74% (n=26) in 2012 and 73% (n=27) in 2013 contained higher salmonid densities in plume habitats compared to the mainstem. Plume habitats were on average 1.4 °C (SE$\pm$0.2) and 1.7 °C (SE$\pm$0.3) colder than the mainstem MFSR in 2012 and 2013, respectively. In 2012 total fish densities differed significantly in the lower and middle sections suggesting a longitudinal increase in salmonids utilizing plume habitats downriver as water temperatures increase. A similar longitudinal pattern was not as pronounced downriver in 2013. Identifying and understanding the importance of thermal plumes as potential refugia for salmonids exposed to higher summer water temperatures in the Upper Salmon may help direct future habitat restoration efforts aimed at stream connectivity.

Little Lost River Drainage Results of Fix It, Break It, or Leave It

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Lost River Fish Ecology[1], US Forest Service[2]
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The Little Lost River, one of the sinks drainages in Idaho, has population of bull trout that were listed as threatened under the Endangered Species Act in the late 1990's. Within the Little Lost drainage, several streams are disconnected for various reasons, both natural and anthropogenic, which has resulted in several isolated bull trout populations. Furthermore, brook trout and rainbow trout have been introduced in the basin and in some places are sympatric with some bull trout populations.
In an effort to extend access for migratory bull trout, managers have reconnected some streams. Conversely, concern over brook trout invasion into bull trout headwaters streams led managers to attempt installation of a selectively passable barrier that would allow bull trout to pass while blocking passage of brook trout. The effect of these actions has been tracked with regular population sampling and passage studies at the selective barrier. Results of these actions and studies will be discussed.

Oh Where, Oh Where, Have All the Redds Gone?

Phil Groves
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Management and recovery goals for fish populations often rely on estimating the number of fish that can be supported by finite habitats. Intensive, long-term, cooperative redd surveys of fall Chinook salmon (Oncorhynchus tschawytscha) in the Snake River have allowed managers to evaluate the carrying capacity of that river, with respect to spawning. Adult escapement generally increased during the years 1991 to 2013; consequently site use and total redd counts also increased, until recently. With an apparent abundance of habitat and continuing increases in returning adults, we expected to observe an increasing number of redds; however, we are seeing a leveling-off of the total counts. Together, the annual use of spawning sites, and the redd counts (as functions of adult escapement), provide evidence for density dependent changes in the availability and capacity of spawning habitat. In this presentation we will explore one aspect of density of adults on resultant redd numbers: superimposition. What does it mean for future surveys, and ultimately what might it mean with respect to production?

Tragedy of the Commons·

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The conflict between individual interests and the common good (tragedy of the commons) is a principle most natural resource professionals learned about early in our educations, and it remains at the heart of many of our contemporary fisheries management issues (hydropower generation, timber and mineral extraction, and harvest allocations). There are two additional aspects of commonality that we need to be better at accounting for in our day to day actions as fisheries professionals 1) common species and 2) and common interests. This presentation will highlight opportunities to improve data collection and management consideration of fish species (i.e. suckers, dace, bass) commonly encountered during anadromous fish research and how we examine their role in ecosystem function. The second common, frequently overlooked, is similarity across natural resource entities. Let's face it, human nature tends to focus on areas of conflict and us science types are actually trained to detect differences, being able to reject a hypothesis of similarity is what we seek. Natural resource professionals can do better a job of acknowledging the 99% we have in common. If we don't, the natural resources we seek to care for will be put at risk.

Idaho Applications of the NorWeST Stream Temperature Database, Model, and Climate Scenarios

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The diverse topography of Idaho, where elevations range from 600-13,600 feet, creates an equally diverse stream thermalscape for aquatic organisms. It is now possible to accurately describe that thermalscape for all of Idaho's >100,000 stream kilometers using a consistent set of digital temperature maps developed by the NorWeST (Northwest Stream Temperature) project. NorWeST was initiated in 2011 to develop a comprehensive, interagency stream temperature database, accurate temperature model (R^2 ~ 90%; RMSE < 1.0 C^o), and high-resolution (1 kilometer) climate scenarios across the Northwest U.S. (~400,000 stream kilometers in Washington, Oregon, Idaho, Montana, and Wyoming). Those products, which include temperature measurements from >6,000 unique sites and >17,000 summers of monitoring effort, are completed for Idaho and available for download through the project website as ArcGIS geospatial layers (http://www.fs.fed.us/rm/boise/AWAE/projects/NorWeST.shtml). This presentation will review some aspects of temperature characteristics across Idaho and describe how the information is being used to facilitate various research, management, and monitoring projects. The analytical infrastructure used to develop the stream temperature model and maps consists of a new type of spatial statistical network model (SSNM) that can also be used with water chemistry data, biological surveys, or habitat measurements. In addition to predictive performance that is better than traditional statistical models, SSNMs enable a suite of powerful new analyses for data on stream networks that are discussed in a related paper.

Applications of Spatial Statistical Network Models to Stream Data

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Streams and rivers host a significant portion of Earth's biodiversity and provide important ecosystem services for human populations. Accurate information regarding the status and trends of stream resources is vital for their effective conservation and management. Most statistical techniques applied to data measured on stream networks were developed for terrestrial applications and are not optimized for streams. A new class of spatial statistical network model (SSNM), based on valid covariance structures for stream networks, can be used with many common types of stream survey data (e.g., water chemistries, habitat conditions, biological attributes) to develop accurate information at river network scales. The SSNMs account for spatial autocorrelation (i.e., non-independence) among measurements, which allows their application to databases with non-random measurement locations. Large amounts of stream survey data exist in many areas where spatial statistical analyses could be used to develop novel insights, improve predictions at unsampled sites, and aid in the design of efficient monitoring strategies at relatively low cost. SSNMs require larger sample sizes than non-spatial models (n > 50 or 100 observations) and are computationally demanding (both for data preprocessing and estimation) but provide significant advantages for many stream applications. Here, we demonstrate the use of SSNMs with datasets relevant to common water quality research and management questions. Free software for implementing the spatial models has been developed that enables custom applications with many stream databases. More information and example datasets are available at the SSN/STARS website (http://www.fs.fed.us/rm/boise/AWAE/projects/SpatialStreamNetworks.shtml) and the Spatial Stream Networks (SSN) package for R is also available from the CRAN website (http://cran.r-project.org/web/packages/SSN/index.html).

Dispersal of Adult Steelhead (Oncorhynchus mykiss) in the South Fork Clearwater River, Idaho

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Hatchery-origin adult steelhead (Oncorhynchus mykiss) support harvest opportunities and conservation efforts throughout the Snake River basin. While most steelhead propagation is intended to support fisheries, there are a few efforts to supplement natural populations. To assess the efficacy of supplementation management strategies, information on characteristics (e.g. comparative behavior of hatchery and natural-origin adults) of steelhead is necessary at the population level. In the South Fork Clearwater River (SFCR) population, evaluation of supplementation strategies is underway. In collaboration with a localized broodstock collection program, radio transmitters were inserted into sixty-one adult natural and hatchery-origin steelhead during winter of 2013 to determine movement and distribution throughout the watershed. Tagged steelhead were released near the mouth of the SFCR and followed throughout the winter and spring with a combination of fixed-site and mobile tracking telemetry methods. Throughout March and April, tagged steelhead moved upstream incrementally, with movements associated with precipitation events and increasing water temperature, to presumable spawning locations. Generally, adipose clipped and adipose intact hatchery-origin fish remained in lower reaches of the watershed throughout the spawning season. Natural-origin fish preferred areas in the upper mainstem and tributaries. Males typically displayed greater movement throughout the watershed than females. During the upstream migration, only a small number of tagged fish surpassed a high gradient area near Golden, ID, suggesting a velocity barrier during periods of high discharge. By the end of May, the majority of tagged fish had died while some left the system entirely (suggesting kelting behavior). Final known locations of tagged steelhead suggested that spawning locations of hatchery-origin fish (lower river) are segregated from their natural counterparts (upper river and tributaries). Ongoing telemetry research in the SFCR will continue to investigate the fidelity of hatchery-origin adults to juvenile release locations and further examine the potential velocity barrier. The inaugural year of this evaluation program has provided insight into supplementation efforts in the SFCR.

Westslope Cutthroat Trout (Oncorhynchus clarkii lewisi) Abundance Trends in Idaho

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We estimated intrinsic rates of population change for westslope cutthroat trout (WCT) (Oncorhynchus clarkii lewisi) using linear regressions of snorkel survey data in ten different areas across Idaho (averaging 19 years of record). We also compare trends in total catch from hook-and-line sampling (averaging 45 years of sampling) and screw traps (averaging 13 years of sampling) in several of the same areas. There were 17 total data sets where population change was estimated. Clearwater River sub-basin WCT populations were estimated to be stable or growing with average (SE) rates of population change 0.1 (0.04). Salmon River mainstem and Upper Salmon River were stable or declining with average rates of change of -0.08 (0.07). Populations in the Middle Fork of the Salmon River sub-basin were estimated to be increasing at 0.08 (0.01). Estimates of population change using total catch data aligned well with snorkel estimates in some areas while in other areas it did not.

Evaluating the Accuracy and Precision of Multiple Abundance Estimators Using State-Space Models: a Case Study for a Threatened Population of Chinook Salmon (Oncorhynchus tshawytscha) in Johnson Creek, Idaho

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The recovery goals for an ESA listed species are often predicated on the ability to quantify population abundance. The Johnson Creek population of spring/summer Chinook salmon is one of 55 populations in the Interior Columbia Basin that was listed as threatened in 1992 under the ESA. Since 1998 Johnson Creek Chinook salmon spawner abundance has been measured using direct observations from a mark-recapture (MR) survey, and indirectly based on three different redd count surveys (RCS) which vary temporally and spatially on the spawning grounds. We use a state-space model to determine the accuracy and precision of a mark recapture, and three different redd count survey, abundance estimates relative to the unseen true population abundance. From our analysis we found the mark-recapture survey and the multiple-pass extended redd count survey (MPE RCS) which provides a census redds on the spawning grounds to be the most accurate, accounting for 100% of the total abundance on the spawning grounds. For the index redd count surveys which are a temporal subset of the complete redd count, we found the multiple-pass (MPI RCS) and single-pass (SPI RCS) surveys to account for only 87\% and 81\% of the total abundance, respectively. The CV between the true abundance and the survey abundance - an inverse measure of precision - was 0.13 for the mark-recapture, 0.06 for multiple-pass extended and multiple-pass index redd count surveys, and 0.39 single-pass index redd count surveys. Using the estimates of accuracy and precision for the four different survey methods we conducted a risk analysis and determined that for a delisting goal of 1000 spawners the measured abundances for SPI RCS, MR, and MPE/MPI RCS would have to be 1204, 1075, and 1052, respectively, to ensure there is a less than a 0.10 risk of falsely delisting the Johnson Creek Chinook Salmon. Naturally, lowering the risk of making an incorrect management decision is always desired, but lowering the risk comes with real costs. The cost of reducing that risk to the species and managers can now be answered quantitatively with this type of model.

Using Occupancy Modeling to Compare Sampling Methods for Burbot *(Lota lota).*

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Burbot (Lota lota) populations are declining throughout much of their native distribution; however, they have received very little research interest. One important gap in our knowledge is the lack of standardized sampling methods for Burbot in lotic and lentic systems. Past research has focused on passive gears in lentic systems, but declining populations in many lotic systems suggests that research into effective sampling methods for Burbot is warranted. Nighttime electrofishing, 6.4-mm bar measure mesh hoop nets, and 19-mm bar measure mesh hoop nets were compared at 41 sites in the Green River drainage of Wyoming. Occupancy models were used to estimate the probability of detection (p) and occupancy (Ψ), within the context of various habitat characteristics (i.e., velocity, dominant substrate, depth, in-stream cover, bank type, temperature, conductivity). Nighttime electrofishing was the most effective sampling method (p = .35) closely followed by 6.4-mm bar measure mesh hoop nets (p = 0.25). For all top models, alluvium bank was positively correlated with detection probability. Nighttime electrofishing was most influenced by Secchi depth, whereas both hoop net types (i.e. 6.4-mm and 19-mm) were negatively correlated with mean velocity. Occupancy modeling provided insight on the most effective gear and the effect of habitat, and was particularly useful for comparing sampling methods with differing units of effort (i.e., passive and active gears).

Monitoring the Effects of Historic Fish Stocking on Amphibian Populations in High Mountain Lakes of the Clearwater Region, Idaho

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In historically fishless headwater lakes of the Rocky Mountains, widespread salmonid introductions have altered the distribution and abundance of native amphibians. Within lakes, predation by fish can reduce amphibian abundance. At larger geographic scales, some amphibian species may be at greater risk of local extinction in basins where fish occur (e.g., Pilliod et al. 2010). These basin-wide effects may persist for decades after fish are first introduced. With the goal of detecting amphibian population trends, Idaho Department of Fish and Game (IDFG) and the United States Forest Service (USFS) initiated long-term monitoring of Columbia spotted frogs (Rana luteiventris) and long-toed salamanders (Ambystoma macrodactylum) in 74 high mountain lakes of the Clearwater Region, Idaho. The study lakes are contained in nine HUC5 watersheds, which were randomly selected after stratification by fish occupancy. Each lake will be surveyed for amphibians, fish, and zooplankton approximately five times between 2006 and 2025. Through 2013, most lakes have been surveyed at least twice. Results from the first seven years of monitoring, supplemented by data from historic surveys, show that R. luteiventris was more likely to occupy lakes containing >50% silt and organic matter ($p = 0.002$). Controlling for these habitat effects, R. luteiventris occupancy was not significantly affected by fish ($p = 0.45$), although adult abundance was marginally lower in fish-containing lakes ($p = 0.06$). In contrast, fish significantly affected A. macrodactylum in both occupancy ($p < 0.001$) and abundance ($p = 0.03$ for adults; $p < 0.001$ for larvae). Repeat surveys of sites suggest that occupancy and/or detection probabilities can be influenced by seasonality, habitat, survey effort, and other factors. These covariates must be controlled for in order to accurately estimate rates of colonization and local extinction. An appropriate statistical framework must also allow for detection probabilities that are <1 (MacKenzie et al. 2003). Preliminary analyses within such a framework suggest how continued amphibian monitoring in the Clearwater Region might be structured to most accurately quantify long-term trends in amphibian populations. Such information will assist managers in prioritizing lakes for amphibian conservation and restoration.

Win Win for Farmers and Fish: Restoring Connectivity by Restoring Flow in the Teton River Watershed, Idaho

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Historically, tributaries to the Teton River of Idaho contained important spawning and rearing habitat for both fluvial and resident Yellowstone cutthroat trout. However, under current conditions, the middle sections of virtually all tributaries to the Teton River are dewatered 8 months of the year due to agricultural diversion, resulting in significant loss of fluvial Yellowstone cutthroat populations. Friends of the Teton River (FTR) worked with the Idaho Department of Fish and Game, Wyoming Game and Fish, and the US Forest Service to research and prioritize streams where flow restoration can benefit fluvial fish without threatening genetically pure resident Yellowstone cutthroat trout populations; and, in 2013, FTR worked with the Idaho Water Resource Board and willing water right holders to implement the first stream flow transactions in Idaho for the benefit of a non-ESA listed species. While significant legal and institutional barriers to flow restoration exist in Idaho, FTR believes that strategies piloted in the Teton Watershed can be applied throughout Idaho for the benefit of both landowners and native trout. In this presentation, we will report on research strategies used to identify streams where flow restoration is and is not appropriate; discuss mechanisms for restoring flow in Idaho streams, as well as barriers to success; discuss economic and ecological benefits of flow restoration; and present plans for future work, including monitoring for effectiveness, and future collaboration with other NGO's and agencies to expand the flow restoration program piloted in the Teton throughout southeast Idaho.

PIT Tag Systems on a Budget: The Half Duplex System

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PIT tagging can be a useful tool to learn how fish utilize a watershed, determine the efficacy of watershed restoration work, and inform decisions about fixing, breaking, or leaving stream connectivity. However, the antennas can be expensive and time consuming to build and maintain. Friends of the Teton River (FTR) has developed 8 remote sites on flashy mountain streams in the Teton River Watershed at cost of approximately $7,000 to $9,000 a site. With the help of agency partners from Idaho Department of Fish and Game, Wyoming Game and Fish, and the US Forest Service, there are now over 3,000 trout pit tagged in the Teton River Watershed. FTR is a small non-profit with limited funding opportunities, so the systems had to be constructed on a budget. In 2010, after careful prioritization, FTR constructed 6 Half Duplex antennas on 4 streams ranging from small spring streams to streams with flood discharges of up to 1,000 cfs. By 2013, FTR added 3 more antennas and solar systems to each site. FTR received assistance from agency and funding partners to cover the costs of installing the sites. The largest and most remote antenna site is located in the lower canyon section of Bitch Creek which has discharges ranging from 250 cfs to 1,500 cfs, a gradient of 1% and a width of 80 feet. The construction of this antenna was FTR's largest undertaking to date and there were numerous issues that had to be overcome including buffering noise from the solar system. Thus far, the Teton Watershed PIT tagging program has been used to determine baseline information on trout movement in the watershed including timing of spawning runs, barrier issues, and location of spawning reaches; and to track the movement of non-natives in conservation stronghold streams such as Bitch Creek. The antennas will also play a critical role in monitoring the response of fluvial Yellowstone cutthroat trout to flow restoration in key tributaries that are currently dewatered for irrigation purposes during periods critical to Yellowstone cutthroat life cycles.

Relative Contributions of Neutral and Non-neutral Genetic Differentiation to Inform Conservation of Steelhead Trout across Highly Variable Landscapes

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Mounting evidence of climatic effects on riverine environments, and adaptive responses of fishes has elicited growing conservation concerns. Measures to rectify population declines include assessment of local extinction risk, population ecology, viability, and genetic differentiation. While conservation planning has been largely informed by neutral genetic structure, there has been a dearth of critical information regarding the role of non-neutral variation (e.g., adaptation). We evaluated genetic variation among steelhead trout of the Columbia River Basin, which supports diverse populations distributed among dynamic landscapes. We categorized 188 SNP loci as either putatively neutral or candidates for divergent selection (non-neutral) using a multi-test association approach. Neutral variation distinguished lineages and defined broad-scale population structure consistent with previous studies, but fine-scale resolution was also detected at levels not previously observed. Within distinct coastal and inland lineages, we identified 11 and 22 candidate loci (respectively) commonly associated with precipitation or temperature variables, and putatively under divergent selection. Observed patterns of non-neutral variation suggest overall climate is likely to shape local adaptation (e.g., potential rapid evolution) of steelhead trout in the Columbia River region. Broad geographic patterns of neutral and non-neutral variation demonstrated here can be used to accommodate priorities for regional management and inform long-term conservation of this species.

Patterns of Beaver Establishment and Effects on Salmonid Habitat Condition in the Interior Columbia River Basin

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We examined patterns of beaver colonization in the Interior Columbia River Basin and potential effects on aquatic habitat. Over a ten-year period, we documented that beaver colonized at least 8% of sites which had not been previously occupied. Of the sites that beaver colonized, approximately 40% of sites exhibited notable changes in stream characteristics based on qualitative criteria. Field measurements indicated that most measures of habitat condition did not change predictably in a given direction after beaver establishment. Exceptions were significant increases in the depth and extent of pools and decreases in substrate size. The variability in habitat conditions was also greater at sites occupied by beaver compared to unoccupied sites. We found that beaver colonization depended on the availability of deciduous vegetation and stream gradient. Beaver colonization was less likely in areas of low grazing pressure and was more likely in areas in close proximity to other sites with beaver. Some areas colonized by beaver were also in close proximity to exotic brook trout, which may have negative consequences for native bull trout populations. Across landscapes, our results indicate that average measures of habitat condition used by managers are likely to remain the same or improve after beaver establishment. Although salmonids may benefit from increases in habitat heterogeneity, both natural and anthropogenic factors limit the potential for beaver colonization. Ultimately, effects on salmonid population dynamics and interactions with native species are complex and will require further investigation as beaver continue to expand in the region.

Bull Trout Trends in Abundance and Probabilities of Persistence in Idaho

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We estimated bull trout population growth rates and used population growth models to evaluate observation error and estimate bull trout persistence probabilities using 25 data sets (averaging 19 years of record) that indexed abundance across Idaho. These data sets were derived from a variety of fish sampling techniques including weirs, screw traps, redd counts, daytime snorkeling, electrofishing, and angler creel. Bull trout populations in Idaho were relatively stable prior to 1994, but since 1994, substantially more population growth rates trended statistically upward (n = 13) than downward (n = 3). Average (SE) intrinsic rates of population change were 0.01 (0.03) prior to 1994 and 0.07 (0.02) since 1994; across all years of data, rate of change averaged 0.07 (0.02). Forty-five percent of the data sets had zero to minimal estimated observation error according to Gompertz state space model estimates; observation error was least common in data from screw traps and redd counts, and most common in snorkel data. Gompertz-type density-dependent models were most often the best fit for bull trout population growth. Moreover, few of the most reliable model results (i.e., those from data sets estimated to have zero to minimal observation error) contained a period effect or time (i.e., year) effect, suggesting that carrying capacity generally did not differ between the time periods before or after 1994, and generally was not trending positively or negatively through time. Parametric bootstraps predicted that mean (median) probability of falling below quasi-extinction levels of 20 adults in the next 30 years was 9.8% (4.7%) for data sets estimated to have zero to minimal observation error. The weight of evidence from our modeling results suggests that for most bull trout populations in Idaho for which trend information is available, abundance is stable or increasing and risk of extirpation is low in the foreseeable future.

Utilizing Fish Barriers to Protect Westslope Cutthroat Trout Populations: Balancing Opportunity, Long Term Success, and Recreation

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In the Upper Missouri Drainage, non-hybridized westslope cutthroat trout (WCT) populations currently occupy less than 4% of historically occupied habitat. Two status assessments completed in 2003 and 2008 were used to qualitatively assess populations and catalog threats to persistence of WCT throughout Montana. This data is summarized as miles of stream with protected populations and those at risk for hybridization and competition. The primary tool for protecting WCT from hybridization and/competition is the construction of fish barriers. Construction of fish barriers where feasible generally requires balancing extinction risks due to isolation (e.g. demographic, genetic, environmental catastrophe) with those due to connectivity (disease, hybridization, competition). Driving forces in barrier project selection is finding a site adequate to block non-native fishes during extreme flow events while minimizing the risk of intentional or unintentional sabotage. Without a good location these projects will likely eventually fail given enough time and public access. This requirement necessarily has forced managers to build the bulk of barriers which protect non-hybridized WCT in sections of stream less than 8 miles in length. These short segments provide limited recreational value for most of the public. Ideally, a continuum of projects should be implemented with small and moderate sized drainages used to protect populations from genetic introgression and larger projects (> 25 miles) which provide connected populations of fishable and harvestable WCT with multiple life histories. As managers, we will probably have to accept low levels of genetic introgression in these larger populations.

Mechanisms of Thermal Adaptation: Transcriptional Response to Heat Stress Among Desert and Montane Populations of Redband Trout

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As ectothermic organisms have evolved to differing aquatic climates, the molecular basis of thermal adaptation is a key area of research. In this study, we tested for intraspecific transcriptional response of natural populations of redband trout (Oncorhynchus mykiss gairdneri) that have evolved to warm and cool climates. Fish were reared in a common garden environment and exposed over four weeks to diel water temperatures that were similar to those experienced in desert climates within the species range. Tissues were collected from gill arches of three strains of fish (desert, montane, F1 crosses) at the peak of heat stress and tested for mRNA expression differences across the transcriptome with RNA-seq methods. Strong differences in transcriptional response to heat stress were observed across strains confirming that fish from desert environments have evolved diverse mechanisms to cope with stressful environments. Each strain had both shared and unique contigs that were differentially expressed, but the desert population had more than double the number of unique differentially expressed genes than the montane population (4339 versus 2112 genes respectively) or F1 strain intermediate (2490 unique differently expressed genes). Key stress response genes such as molecular chaperones (i.e., heat shock proteins) had adaptive patterns of gene expression among strains, but also a much higher number of metabolic and cellular process genes were differentially expressed in the desert strain demonstrating these biological pathways are critical for thermal adaptation to warm aquatic climates. The results of this study further elucidate the molecular basis for thermal adaptation in aquatic ecosystems and extend the potential for identifying regions in the transcriptome and genome that may be critical for adaptation to changing climates.

Connectivity Management: Complex Genetic Considerations in a Rapidly Changing World

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Intentional isolation is often necessary to preserve the genetic integrity of native fishes threatened by hybridization, yet ironically it also presents genetic problems that may jeopardize the long-term persistence of populations. Balancing the pros and cons of isolation is complicated and there are generally no clear-cut answers, but I will explore the complex genetic nature of this management question. From a theoretical perspective, isolation inherently disrupts gene flow and creates smaller populations, which experience increased rates of genetic drift. Drift decreases genetic variability and typically increases differentiation, while reducing a population's ability to respond to selection. Empirical studies of isolation using neutral (non-selected) genetic markers confirm expected losses of genetic variability in various fish species across different isolation scenarios, and raise general concern for the future viability of small isolated populations. Reassuringly, recent efforts to reconnect populations, either through natural dispersal after connectivity is physically restored or via human-mediated transfers of individuals into isolated habitats, have demonstrated rapid re-establishment of dispersal (in the former case) and are suggesting positive responses to demographic and/or genetic 'rescue' (in both cases). However, where hybridization remains a threat, it is difficult to predict its trajectory, particularly in a changing climate. Finally, our understanding of the genetic nature of many important traits (e.g., temperature tolerance, spawning phenology, and migration) is still evolving, and thus it is unclear how isolation and the potential loss of important, possibly irreplaceable, genetic variants over time may impact the future adaptive potential of native species, even where populations can be reconnected. In light of this complex and uncertain management landscape, further genomic-level research resolving the genetic architecture of both adaptation and hybridization will be particularly informative, especially when paired with landscape-scale environmental and biological correlates in natural populations.

Estimation of Gear Selectivity for Lake Trout in Priest Lake, Idaho

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Accurate estimates of catch rates and population size structure are important for many monitoring and assessment techniques. However, the gears used to sample fish populations are generally highly size selective. Fishing multiple gear types can ameliorate size bias, but it is often useful to correct naive size distributions for gear selectivity. In Priest Lake, Idaho, the first fishery-independent survey of the Lake Trout (Salvelinus namaycush) population was conducted from March to May 2013. Large trap nets and monofilament gill nets were used to sample 4,201 Lake Trout. Four trap-net configurations and eight gill-net mesh sizes were used. Selectivity was estimated indirectly for each gear type or mesh size by fitting a response surface to catch rate data using generalized linear models. The naive length distribution was then divided by the estimated selectivity for each length class to produce a corrected length distribution. The results of this research provide corrected estimates of size structure, which will be used in further analyses and as a baseline for future monitoring efforts. Gear selectivity can also be used to design sampling programs to effectively target population segments with the gears deployed.

Bear River Bonneville Cutthroat Trout Conservation Aquaculture in Idaho

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In 2007, the Idaho Department of Fish and Game implemented a conservation aquaculture strategy to help restore 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, 960 sub-adult Bonneville cutthroat trout have been collected from tributaries of the Bear River located within the Thatcher management unit. Individuals collected have been sampled for genetic purity and transferred to a spring-fed holding pond. Beginning in May 2010, staff from the Idaho Department of Fish and Game's Grace Fish Hatchery have trapped and spawned wild origin Bonneville cutthroat trout from the pond. Between May 2010 and June 2013, 147 females and 197 males have been spawned. As of October 2013, 45,449 hatchery reared Bonneville cutthroat trout have been stocked within the Thatcher management unit, with an additional 28,000 juvenile Bonneville cutthroat trout currently being reared at the Grace Fish Hatchery. The conservation aquaculture techniques developed for Bonneville cutthroat trout in the Thatcher management unit provide a template for the development of similar techniques in other management units throughout the range of this subspecies in Idaho.

Evaluating Captive Reared Snake River Sockeye Salmon Adult Releases within Redfish Lake, Idaho to Identify their Contribution to the ESA population.

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Precipitous declines of Pacific salmon (Oncorhynchus spp.) have led to population levels that require prompt reactions to avoid extinction of many stocks. Started in 1991, the Snake River sockeye salmon captive broodstock program was initiated to prevent the extinction and to preserve the genetic diversity for this evolutionary significant unit protected by the Endangered Species Act. The monitoring and evaluation component of the program has been evaluating several life-stage release strategies, one of which is the use of full term captive adults released into Redfish Lake, ID for volitional spawning. Four brood years were utilized to evaluate captive reared adult releases to increase natural smolt production and contribute to the overall anadromous adult returns of Snake River sockeye salmon by answering three primary questions: 1) do captive reared adults successfully produce redds and spawn; 2) how many smolts are produced and what is their survival during downstream migration; and 3) do progeny successfully return as adults to Redfish Lake, ID. We demonstrated that the release of captive reared adults produce redds, offspring that migrated to the ocean, and anadromous adult returns. Observed productivity (such as egg deposition, smolts produced, egg-to-smolt survival and smolt-to-adult survival) resulting from captive adult releases from broodyears 2004-2007 fell within the range reported from 1954-1965 (Bjornn et al 1968). This suggests that productivity resulting from captive reared adults was similar to the naturally reproducing population within the lake from 1954-1965. Releases of captive reared adults for volitional spawning appear to provide an additional tool for fishery managers to aid recovery of severely at-risk salmonid populations, particularly Snake River sockeye salmon.

Fish Assemblage and Population Relationships with Habitat in the Kootenai River, Idaho

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Understanding relationships among fish assemblages and populations with habitat is critical for conservation and management of river systems. Transitions in habitat and fish assemblage structure were investigated in the Idaho portion of the Kootenai River. Forty-three river reaches (500 m) were repeatedly sampled in the summers of 2012 and 2013 with multiple gears (hoop nets, boat-mounted electrofishing, benthic trawls) to investigate relationships among fish assemblages and populations with habitat. Assemblage structure was investigated with ordinations of presence-absence and relative abundance data. Hurdle regressions were used to investigate population-level relationships with habitat. Gradients of habitat and fish assemblage structure were apparent among geomorphic sections in the Kootenai River. Upper river sections were characterized by high flow velocities and large substrates with fish assemblages dominated by native salmonids and cyprinids (e.g., Mountain Whitefish Prosopium williamsoni, Redside Shiner Richardsonius balteatus). Conversely, the lower river section had low water velocities, fine substrates, and high maximum depths. Fish assemblages in the lower section were composed of native cyprinids (e.g., Peamouth Mylocheilus caurinus, Northern Pikeminnow Ptychocheilus oregonensis) and non-native species (Pumpkinseed Lepomis gibbosus, Yellow Perch Perca flavescens). A general pattern of species addition was discovered from upstream to downstream sections and was related to increased occurrence of non-native fishes and habitat complexity in lower sections. Species-specific hurdle regressions further emphasized differences in habitat and fish assemblage structure along the longitudinal gradient of the Kootenai River. Sampling habitat and fish assemblages in large rivers can be difficult; however, understanding such relationships is critical for the management of river systems.

Comparison of Sampling Techniques for Fish Assemblages in Western Rivers

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Large river systems have high habitat complexity and diverse fish assemblages. Consequently, multiple-gear protocols are generally used to sample fish assemblages in rivers. Research comparing multiple sampling techniques in coldwater rivers of western North America would improve gear selection and sampling efficiency for future monitoring efforts. Detection probabilities (probability of sampling a species given their presence at a site) were used to compare the effectiveness of three gears (hoop nets, boat-mounted electrofishing, benthic trawls) for 30 species in the Kootenai River, Idaho and the Green River, Wyoming. Relationships among detectability and habitat characteristics were also investigated. A total of 223 sampling events was conducted among 73, 500-m sample reaches in the summer (2012, 2013) and fall (2012). Species-specific detectability varied by habitat characteristic, life history stage, and system, but were most influenced by gear. In general, detection probabilities were highest with electrofishing for most species, but hoop nets had greater detectability for several species (e.g., adult Burbot Lota lota, juvenile Northern Pikeminnow Ptychocheilus oregonensis). Benthic trawls had low detection probabilities for most fishes. Our research illustrates differences in detectability among gears and fishes, and highlights the importance of understanding species-specific detection probabilities.

Contribution of Captive-Reared Chinook Salmon (Oncorhynchus tshawytscha) to Natural Production in the East Fork Salmon River.

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The captive rearing program for Salmon River spring Chinook salmon was initiated to prevent localized extinctions and ensure a continuum of spawners in three Idaho study streams. Chinook salmon were sourced as eyed-eggs from natural-origin redds. Eggs were brought into freshwater culture where they were incubated, hatched, and reared to smolt-stage. Smolts were transferred to saltwater rearing, and upon maturation, adults were released into their natal streams to spawn volitionally. The ability of captive adults to produce progeny that return as anadromous adults was determined through parentage genetic analyses in the East Fork Salmon River (EFSR) for spawn years 2004-2008. Tissue samples were collected from all returning adults (parents) captured at the EFSR trap since 2004 and from all mature captive fish released (parents) to spawn in the EFSR. A total of 1,467 adults (progeny) were successfully genotyped from 2007-2013 EFSR adult returns. CERVUS 3.0 software was used to assign offspring (returning adults) to their parents (wild spawners or captive spawners). Wild fish contributed greater to adult returns, yet a total of 84 adult returns were documented to be progeny of captive parents. Although captive adults released to spawn were smaller than their wild counterparts of the same age, adult returns from captive fish were no different than wild-origin fish in mean length at age. Captive production from spawn years 2004-2008 equates to an average of 0.24 progeny per female, which while low relative to wild females (2.39) still provided a population benefit. When considering the total number of eggs collected over 5 years to rear as captive fish to maturity (n=1,500), and their progeny that returned as adults; captive rearing could have provided a 32-fold survival advantage during spawn years 2004-2008 over an equivalent number of wild eggs left in the redd. In previous studies captive Chinook salmon have exhibited the same courtship behaviors; redd site selection, and digging behaviors as wild fish. They have also been documented to spawn successfully. Now, parentage results suggest captive rearing can be used successfully to prevent cohort collapse and not only ensure a continuum of spawning but also produce anadromous adult returns.

Effects of Fisheries and Flow Management on Long-Term Viability of Native Cutthroat Trout in the South Fork Snake River

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The South Fork Snake River supports one of the last remaining large-river populations of Yellowstone cutthroat trout. Although rainbow trout were first introduced to the upper Snake River in the 1880s, they did not establish a viable population in the South Fork until the 1990s. By 2003, rainbow and cutthroat-rainbow hybrid trout were more abundant than cutthroat trout. In 2004, Idaho Department of Fish and Game and its partners implemented a three-prong management strategy aimed at limiting further displacement of cutthroat trout: 1) reproductive isolation of cutthroat trout in the four primary South Fork spawning tributaries, 2) delivery of a spring-time freshet from Palisades Dam to reduce rainbow trout egg and fry survival, and 3) voluntary angler harvest of rainbow and hybrid trout. Analysis of population, harvest, and flow data show that reproductive segregation and angler harvest have prevented further displacement of cutthroat trout but that the freshet has had little detectable effect. Since implementation of the program, rainbow/hybrid trout and cutthroat trout have co-existed in roughly equal numbers, currently around 1025 fish/km for each species. Angler exploitation on rainbow/hybrid trout increased from 4% in the 1990s to around 25% in 2006 but has since declined. In 2012, exploitation was 17% over the whole rainbow/hybrid population, but because anglers preferentially harvested larger fish, exploitation on the older age classes exceeded 50%. A simulation model predicts that if this level of exploitation is continued for 25 years, the cutthroat trout population will nearly double, and the population of rainbow/hybrid trout will decrease to fewer than 200 fish/km. On the other hand, without any harvest, rainbow/hybrid trout will increase to around 1200 fish/km, and cutthroat trout will decrease to fewer than 500 fish/km, even with continued reproductive segregation in the tributaries. Freshet peaks have averaged 19,000 cfs, whereas modeling suggests that the freshet has a population-level effect only at peaks exceeding 25,000 cfs. Because water-supply and flood-control constraints prevent managed flows of this magnitude, angler harvest provides the most effective management tool for long-term conservation of native cutthroat trout in the South Fork.

Trophic Ecology of Northern Pike and Their Effect on Conservation of Westslope Cutthroat Trout

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Westslope Cutthroat Trout (Oncorhynchus clarkii lewisi) in Coeur d'Alene Lake, Idaho have declined in recent years and predation by Northern Pike (Esox Lucius), is thought to be a causative mechanism. The goal of this study was to describe the seasonal food habits of Northern Pike and determine their influence on Westslope Cutthroat Trout. Fishes were sampled monthly from March 2012 to May 2013 in four bays using pulsed-DC electrofishing and experimental gill nets. Electrofishing catch rates for Northern Pike were generally low, but increased slightly each season and were highest in the southern portion of the lake. Northern Pike catch rates using gill nets were approximately 50% higher during the two spring sampling periods compared to the summer and fall. Seasonal growth and food habits were analyzed from 695 Northern Pike varying from 162 to 1,080 mm in total length and 24 to 9,628 g in weight. The diet of Northern Pike primarily consisted of Kokanee (Oncorhynchus nerka), Westslope Cutthroat Trout, and Yellow Perch (Perca flavescens). Results of a bioenergetics model estimated that Westslope Cutthroat Trout represented approximately 2-30% of the biomass consumed by age 1-4 Northern Pike. The highest occurrence of Westslope Cutthroat Trout in Northern Pike diets occurred during spring. Thus, reducing predation of Westslope Cutthroat Trout by Northern Pike might be a useful tool for conserving Westslope Cutthroat Trout.

Modeling Fish Assemblage Structure and Habitat Use to Guide Rehabilitation Activities in the Kootenai River, Idaho

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Since disconnection of the Kootenai River from its historic floodplain, off-channel habitats have been of high importance to the fish assemblage. In particular, side channels in the braided reach of the Kootenai River, Idaho are thought to provide important habitat diversity for many fishes. While the importance of side channels in the Kootenai River to the fish assemblage has not been assessed, the functional diversity they offer likely makes them an important component of the lower Kootenai River ecosystem. The Kootenai Tribe of Idaho has been actively rehabilitating main- and side-channel habitat throughout the Kootenai River to restore ecosystem function and benefit native species. We used boat-mounted electrofishing to sample fishes in 118 sites during 17 sampling events from July 2012 to January 2013 in side- and main-channel habitats. We used multivariate techniques to describe differences in fish assemblage structure among main- and side-channel habitats. We used hurdle regression to explain the influence of habitat variables on occurrence and relative abundance of ecologically-important species in the Kootenai River. The results of this research will provide insight on the relative importance of off-channel habitats for fishes in the braided reach of the Kootenai River.

Population Dynamics of Largescale Suckers in the Kootenai River, Idaho: Effects of Nutrient Enhancement and Discharge on Growth and Recruitment

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The largescale sucker (Catostomus macrocheilus) is a widespread species in Idaho and an ecologically-important species in many large river systems throughout the Pacific Northwest. Largescale suckers are ubiquitous in the Kootenai River and make up the majority of the vertebrate biomass in the Idaho portion of the river. Additionally, largescale suckers have been thought to positively respond to an ongoing nutrient addition project in the lower river. However, there is little information on the population dynamics of largescale suckers and the factors potentially influencing growth and recruitment, particularly in the Kootenai River. As such, we evaluated the population characteristics (i.e., age structure, growth, recruitment, mortality) and described the influence of nutrient addition, discharge, and temperature on growth rates and recruitment dynamics of largescale suckers of the Kootenai River, Idaho. We used a repeated-measures mixed-effects model to evaluate the influence of the factors effecting growth rates and recruitment variability where we treated age as a fixed effect and year as a random effect. We used an information theoretic approach to select the best multiple-regression model that explained the most variation in growth and recruitment. This research will help to inform management by evaluating the influence of an ongoing nutrient addition project and seasonal discharge on an important species in the Kootenai River.

Effects of Water Level Regulation and Habitat Characteristics on Shore-Spawning Kokanee (Oncorhynchus nerka) Incubation Success and Habitat Selection

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The effect of habitat characteristics and altered hydrologic regimes on shore-spawning kokanee (Oncorhynchus nerka) incubation success was evaluated using a comprehensive in situ egg box study in Lake Pend Oreille, Idaho. A probabilistic sampling design was used to randomly allocate 60 incubation sites among current and historic spawning reaches, and unused shoreline reaches. Kokanee survival was modeled in relation to a suite of habitat variables, including substrate composition, dissolved oxygen, wave disturbance, and groundwater influence. The model was also used to test whether survival was enhanced by additional shoreline habitat provided by a 1.3 m increase in water level. Survival was not related to substrate size composition or depth, indicating that shore-spawning kokanee do not currently receive a substrate-mediated survival benefit from higher water levels. This study also revealed that shoreline spawning habitat is not as limited as previously thought and that downwelling areas contribute substantially to shore-spawning kokanee recruitment.

Cedar Sculpin (Cottus schitsuumsh), a New Species of Sculpin in Idaho: the First of Several?

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Fishes of the genus Cottus have long been a taxonomic challenge because of morphological similarities among species and their tendency to hybridize, hence the number and distribution of species in the western U.S. remains uncertain. We coupled spatially comprehensive stream surveys with genetic and morphological assessment to describe a new species, cedar sculpin (Cottus schitsuumsh), from the St. Joe and Coeur d'Alene River basins in Idaho and the middle Clark Fork River basin in Montana. This name was chosen after consultation with the Coeur d'Alene tribe, whose traditional homeland largely overlaps the range of this species. Although historically described as part of the shorthead sculpin (C. confuses) complex, the cedar sculpin is a distant relative. The two species can be morphologically differentiated based on lateral-line pores on the caudal peduncle and preopercular spines, and an array of additional characters distinguish cedar sculpins from all other sculpins in Idaho. Its disjunct distribution in Montana may have resulted from human-assisted translocation. Phylogenetic methods did not reveal the closest relatives of the cedar sculpin, but did imply the presence of more undescribed species of sculpins in Idaho and the interior western U.S.

Patch Size but Not Short-Term Isolation Influences Occurrence of Westslope Cutthroat Trout Above Human-Made Barriers

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Habitat fragmentation in aquatic systems has led to widespread isolation of stream fishes. Island biogeography predicts that population persistence is directly related to patch size, patch quality, and time since isolation, but empirical data describing this relationship for stream fishes are rare. We assembled 246 observations of occurrence of westslope cutthroat trout (WCT), a taxon of concern in the western U.S. and Canada, in stream networks isolated for up to 100 years (median 40 years) above human-made barriers at road crossings within National Forests in Montana and Idaho. We used logistic regression to analyze how WCT occurrence varied with patch size, isolation time, and stream-level covariates. Occurrence was positively related to stream length and habitat quality within the isolated stream network and negatively related to elevation and channel gradient. Unexpectedly, the probability of occurrence was not related to how long a habitat patch had been isolated. At the median elevation (1354 m) and channel gradient (14%), and where habitat quality was poor, WCT were likely to occur (probability >0.5) if an isolated stream network was at least 1.7 km. If habitat quality was high, about 0.2 km of habitat produced the same probability of occupancy. Although there are important limitations, this analysis provides the first empirical estimate for how patch size and patch-level characteristics influence persistence of WCT in isolated stream networks.

Poster Abstracts in Alphabetical Class

Run Salmon Run into the River of No Return Wilderness Sun

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Bear Valley Creek is an important spawning and rearing stream for Chinook salmon and is also an important traditional use area for members of the Shoshone-Bannock Tribes of the Fort Hall Indian Reservation. Past counts of Chinook salmon redds indicate Bear Valley Creek was the primary spawning stream in the Salmon River, if not in the entire Columbia River basin. Understanding the limiting factors that are either preventing or facilitating salmon recovery is necessary to make educated resource management decisions. As such, the Tribes developed the Bear Valley Creek Chinook Salmon Abundance Monitoring Project (BRCAMP) to provide critical biological information from one of the last relatively vigorous wild populations in the Columbia River basin. Research program operations include utilizing a rotary screw trap to collect age, size, and timing data for emigrating juvenile Chinook salmon, operating an adult video weir to measure adult escapement, conducting harvest monitoring under the Shoshone-Bannock Tribes Salmon River Tribal Resources Management Plan, and performing spawning ground surveys to collect pertinent information on the number of redds in the watershed and biological data from carcasses. An average of 1,280 Chinook salmon escaped into Bear Valley Creek between the years 2010-2013. A rotary screw trap was installed to enumerate juvenile production for three years, 2011-2013. Estimates indicate an average of 746,872 juvenile Chinook salmon emigrated from the system annually. Tribal harvest within the Bear Valley Creek fishery management area during program operations yielded 319 adult Chinook salmon and 23 jacks. Multi-pass, intensive spawning ground surveys in all years resulted in the average of 443 redds in Bear Valley and Elk creeks combined. The results indicate this Middle Fork Chinook salmon population is performing well above the viability threshold recommended for ESA recovery and provides hope that salmon recovery is feasible in Idaho. BRCAMP information is expected to assist co-managers evaluate the status of the Chinook salmon population and provide long-term information to develop trending analyses.

Seasonal Use of a Spring-Fed Tributary by Wild Rainbow Trout in an Isolated Reach of the Henry's Fork Snake River, Idaho

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The Henry's Fork supports a world-renowned and economically important wild rainbow trout fishery in the Caldera reach, 45 river km between Island Park Dam and Mesa Falls, but the population has fluctuated substantially over the past 35 years. The dam blocks upstream fish migration out of the reach, and the falls block upstream migration into the reach. The largest tributary in the reach is the spring-fed Buffalo River; a dam near its mouth has limited fish passage since 1938. We have monitored fish use of the Buffalo River since 2006, following restoration of fish passage at the Buffalo River Dam. Young-of-year fish migrate into the Buffalo River during the fall, presumably to access more abundant cover there during winter, when flow in the main river is lower. The rainbow trout population in the Caldera reach has increased over the past decade, in response to improved winter flow management and Buffalo River fish passage.

Allometry of Prey Size Selection and Morphological Constraints in Adult Chinook Salmon and Coho Salmon

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Prey size is often cited as one of the primary factors influencing prey selection in fishes and is thought to be limited by morphological constraints such as mouth size and gill raker spacing. In this study we investigated whether prey size is related to body size in two Pacific salmon species and how morphological features may limit prey selection. Adult Chinook salmon and coho salmon were collected by angling in the ocean in waters surrounding Prince of Wales Island, southeast Alaska. Fish were measured for mass and length, and the head and stomach were preserved for measurement in the laboratory. All intact stomach contents from salmon were identified to general taxonomic level and measured for maximum length and width. Morphological measurements of mouth size and gill raker spacing were also compiled from salmon heads. Chinook and coho salmon captured from the ocean fed almost exclusively on other species of fish. The size of prey consumed by Pacific salmon was positively correlated with the size of the fish. The largest prey items consumed were always smaller than mouth width based on maximum width of prey. In contrast, prey length exceeded mouth size and did not appear to be the prey dimension that limited prey size selection. Gill raker spacing was much smaller than prey size dimensions and did not appear to limit the minimum prey size of items in the diet of salmon. While mouth size appears to limit the maximum size of prey available in the ocean, gill raker spacing did not appear to limit minimum prey size. Minimum prey size may be limited by gill raker spacing when fish feed on relatively small prey items when in freshwater habitats. Our study provides some of the first quantitative estimates of prey size selection for adult Pacific salmon and can help estimate the range of prey items that are preferred by salmon in while in the ocean.

Carcass Recovery Efficiency and Deterioration Rates in Red River (Clearwater Drainage, North Idaho).

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We planted 100 Chinook salmon (Oncorhynchus tshawytscha) carcasses in Red River (Clearwater River drainage, North Idaho) over a 3 week period to determine efficiency in carcass recovery and carcass deterioration rates. Fish were planted during two events within the same transect on Red River between Little Moose Creek and Red River weir. The first replicate event occurred on August 30th, 2013 and the second on September 13th, 2013. Carcasses ranged from 430-1010 mm in fork length. Carcasses were fitted with jaw tags on either the right or left jaw to represent males (M) and females (F), respectively. For the purpose of this study only biological male carcasses were used because biological female carcasses were unusable due to the spawning process. Each of the two planting events consisted of 25 M and 25 F resulting in 100 total fish. Males were placed in deep pools, along the stream banks, and in a variety of complex habitats, and Females were placed in riffles and runs at or below a potential redd location. Replicate one and two recoveries occurred on the September 4th, 2013, and September 17th, 2013 respectively. Replicate one recovery resulted in 10 of 25 (40%) of F, 19 of 25 (76%) of M, and 29 of 50 (58%) overall. Replicate two recovery resulted in 14 of 25 (56%) of F, 16 of 25 (64%) of M, and 30 of 50 (60%) overall. All carcasses were left to be re-recovered and over the course of the study (25 days) 66% of the carcasses were located. Due to season-long tracking and the use of photos taken at all plantings and recoveries, we recorded individual carcass condition decline. Recovered carcasses were assigned a condition of 0-5 with 0 being total carcass decay and 5 being excellent carcass condition. Mean condition numbers for replicates one and two were 1.7 and 1.9, respectively. Average carcass condition over 5, 18, and 25 days of exposure was 1.8, .9, and .5, respectively.

West Fork Lake Creek Stream and Wetland Enhancement Project

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A major stream and wetland restoration project was recently completed on the West Fork Lake Creek between 2009- 2012 by the Coeur d' Alene Tribe Fisheries Program. The project was located within the Lake Creek Watershed, a tributary to Coeur d' Alene Lake. This watershed contains both resident and adfluvial forms of Westslope Cutthroat Trout (Oncorhynchus clarki), a species of special concern to the Coeur d' Alene Tribe. There was limited production potential within the project reach due to poor habitat, lack of cover, and lack of large woody debris. Historic photos show the channel having been straightened before 1937. Project goals included 1) create wetland habitats and hydraulic connections with the valley bottom; 2) reduce bank erosion 3) provide a long-term source of large woody debris for natural recruitment; and 4) provide measurable increase in abundance and distribution of Westslope cutthroat trout. Project planning began in 2008 with a design finalized in June 2009. The final design approach involved constructing a new stream channel that can access the historic floodplain. Two thousand feet of existing incised West Fork Lake Creek channel was completely filled and flows were diverted into a new channel that is 3,025 ft long. A seasonal stream was also rebuilt and reconnected to the newly built West Fork Lake Creek stream channel. A new culvert was installed as well as a grade control structure that linked the new stream with the old stream channel downstream. The portions of old channel that were filled were converted back to farmland. Native plants were planted in riparian and adjacent upland areas. Large wood material was used throughout the project to increase lateral roughness and create banks. Nine acres of wetland were created (0.82 acres was filled). The new stream channel was activated in 2011. The new stream channel has access to the historic floodplain, increased amount of large woody debris, increased channel length, and increased riparian area. Funding for the project is through BPA and EPA.

Responses of Chinook Salmon (Oncorhynchus tshawytscha) Spawning Behaviors to Disturbance and Climate Impacts in the Salmon River Basin

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The spawning behaviors of Chinook salmon (Oncorhynchus tshawytscha) have evolved in habitats that are uniquely characterized by a suite of biophysical stream variables (e.g. stream flow, velocity and substrate composition) within discrete parts of a stream network. The adequate representation of suitable spawning habitat, as occurs in Idaho's wilderness rivers, can contribute to successful reproduction and confers benefits to the growth and survival of juvenile salmon. Earlier work from our lab looked at homing of adult salmon and asked how individual factors (e.g. sex, age) and environmental factors (e.g. hydrology) affected the propensity of adult salmon to stray from natal sites, a potentially important factor determining resilience in disturbed sites. We also used remote sensing techniques to examine how physical habitat variables influenced spawning habitat choice. To examine the potential that disturbance may impact spawning habitat choice in addition to physical habitat variables, spawning adults were filmed in the upper basin of one central Idaho (USA) wilderness stream to allow for behavioral analysis. When combined with our previous findings, this video data provided background information for the development of population models used to assess the potential population level impacts to a wild Chinook population under varying biological, social, and hydrologic scenarios.

Expansion of Parentage-Based Tagging Technology Throughout the Columbia River Basin

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Parentage-based tagging (PBT) is a large-scale tagging technology for monitoring and evaluating salmonid hatchery stocks. Implementation of PBT involves annual sampling of hatchery broodstock to create a parental genotype baseline. Offspring produced by these parents can be non-lethally sampled either as juveniles or adults, and then genotyped to be assigned back to their parents thus identifying their age and hatchery of origin. This tagging technology is used for Chinook salmon and steelhead hatchery stocks in the Snake River basin, Idaho (2008-present). Information gleaned from the current parent baseline has been used to evaluate stock contribution to various fisheries, determine origin of hatchery strays, evaluate run time and stock abundance at Bonneville and Lower Granite dams, and refine estimates of natural origin stock abundance. Adopting PBT more broadly in the Columbia River basin would allow the ability to mark millions of smolts and the opportunity to address a variety of parentage-based research and management questions.

A Thermal Map for All Streams in the State of Idaho

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USFS[1], TU[2], CSIRO[3], NOAA[4]
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The aquatics community within the state of Idaho amassed significant amounts of stream temperature data through their collective monitoring efforts in past decades. As part of a larger regional effort, the NorWeST project funded by the Northern Pacific and Great Northern LCCs has developed a comprehensive, interagency stream temperature database for Idaho that consists of data from >6,000 unique sites and >17,000 summers of monitoring effort. Those data were used with spatial statistical network models to develop an accurate, high-resolution (1 kilometer) stream temperature model (R^2 ~ 90%; RMSE < 1 C^0), which was then used to develop consistent sets of historical and future climate scenarios for all of Idaho's streams in the USGS 1:100,000-scale NHDPlus hydrography layer. This poster depicts a historical composite scenario that represents the average August temperature from 1993-2011. The data for stream climate scenarios are available as ArcGIS shapefiles for download from the NorWeST website (www.fs.fed.us/rm/boise/AWAE/projects/NorWeST.html). Daily summaries (min/max/mean) of the temperature data used to develop the temperature model for Idaho are also available through the website if permission was given for their distribution. All data distributed through the website are attributed to the original source agency and contributing biologists/hydrologists in metadata files. More details regarding the NorWeST project are described here http://greatnorthernlcc.org/features/streamtemp-database.

Heath Trays vs. Upwellers: A Survival Comparison of Deadwood Kokanee Salmon at Mackay Fish Hatchery

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The Mackay State Fish Hatchery has historically used Heath trays for the incubation of Deadwood Reservoir kokanee salmon (Oncorhynchus nerka), but has also historically experienced less than optimal survival. Because of this, staff members decided to experiment with upwellers to find out if the survival from eyed eggs to swim-up fry would be improved. Unlike the other species raised at the Mackay State Fish Hatchery (rainbow trout (O. mykiss) and Yellowstone cutthroat trout (O. clarkii)), kokanee do not all hatch within a 24-hour period. The main issue impacting swim-up fry survival is that Heath trays prohibit the newly hatched kokanee fry from escaping the un-hatched eggs and fungus that accumulates in the trays, and also creates burdensome manual egg picking routines. With the upwellers, the hypothesis is that once kokanee are hatched, the fry will be able to swim freely and avoid the un-hatched eggs and fungus, ultimately resulting in better survival

The "Following Fishes" Lesson Plan

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The “Following Fishes” Lesson Plan is a joint project between the Idaho Chapter of the American Fisheries Society Anadromous Committee and the Idaho Department of Fish and Game. There is a need to educate the populace about anadromous fisheries issues and recruit able young scientists to our field. There are 330 public secondary schools in Idaho, all of which must teach biology as per the Idaho State Content Standards, and about 116,000 high school science students in Idaho, all of whom must pass through those biology classes. This allows a unique opportunity to make an impact on those who will guide policy and join the work force in the future. I created a complete lesson plan that was sent to 50 high school science teachers in Idaho as a pilot project. I show an overview of the lesson plan and an example of how a student can track a steelhead trout through its life cycle. Teachers who agreed to teach the lesson and provide feedback were sent packets including electronic and hard copies of a formal lesson plan and supporting materials. In addition to biology teachers, environmental science teachers, oceanography teachers, and college professors have also shown an interest in using the lesson plan. Feedback thus far has been both constructive and positive, with some teachers choosing to use the lesson as-is and others extending the lesson using the list of accessory resources provided.

An Update on The Effects of Initial Feed Timing on Triploid Rainbow Trout

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The timing of initial feeding for trout fry varies greatly among hatchery professionals. Literature pertaining to initial feeding time of trout fry also varies with a wide range of recommendations provided. Fish culturists at Grace Fish Hatchery sought to reduce the variability of initial feed timing for triploid rainbow trout (Oncorhynchus mykiss) fry. The purpose of this study was to determine if there is a number of days post hatch to begin feeding triploid rainbow trout fry where they will experience the least mortality and most favorable growth factors. Treatment groups of triploid rainbow trout fry were fed for 30 days with initial feeding times of 13, 15, 17, 19, 21 and 25 days post hatch on 12.2 C^0 water. This study was conducted in December 2011 and repeated in March 2013. Variations in mortality, condition factor, size and feed conversions were evaluated. Grace Fish Hatchery has used these results to implement an initial feed timing protocol for rainbow trout of 25 days post hatch. Fish health and performance data has remained positive using the selected method. This data not only provides fish culturists at Grace Fish Hatchery with an optimal initial feeding time for rainbow trout, it also eliminates the variability that is common among hatchery professionals in regards to initial feed timing.

Evaluation of Removal and Sectioning Locations of Dorsal Spines for Estimating Age of Common Carp

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Understanding age distributions and dynamic rate functions are critical components of effective management of fish populations. As such, the accuracy and precision of rate function estimates depends on reliable estimates of fish age. Pectoral fin rays of common carp (cyprinus carpio) have been previously compared to otolith (i.e., asteriscus) age, a validated structure. Age estimates are commonly derived from both fin rays and dorsal spines of common carp, but dorsal spines have not been compared to otoliths. In October 2012, common carp were sampled using electrofishing and experimental gill nets from Crane Creek Reservoir (n = 121) and Lake Lowell (n = 88) in southwestern Idaho. We compared dorsal spines, pectoral fin rays, scales, and otoliths to determine the efficacy of different structures for estimating age. Additionally, we evaluated the precision of age estimates from different sectioning locations of dorsal spines. We compared the precision and readability of age estimates from locations where spines might be removed from a live fish (i.e., base, immediately distal to base, 25, 50, and 75% of the total structure length). This research provides insight on the use of dorsal spines as non-lethal alternatives for obtaining age information from common carp.