American Fisheries Society

Idaho Chapter

Established 1964

Native Peoples Fisheries:

Perspectives on Past, Present, and Future

2011 Annual Meeting

March 2 -4, 2011
Doubletree Riverside Hotel,
Boise, ID

Program and Abstracts

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Committee Room Assignments

Committee	Room
Anadromous Fish	Cinnabar
Fish Culture	Garnet
Mentoring	Delamar
Native Fishes	Liberty
Public Education	Emerald
Riparian	Opal
Fish Habitat	Northstar

Floorplan for Doubletree - Boise

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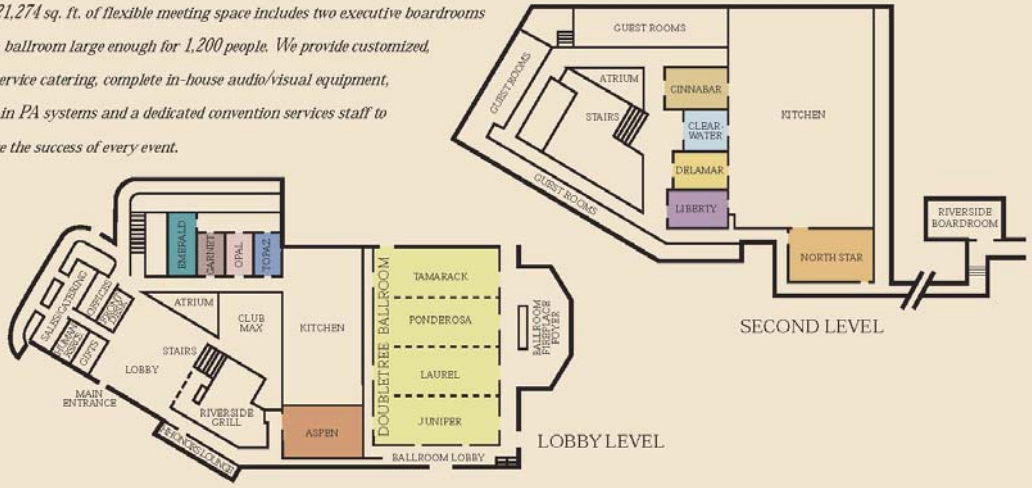


Room	Level	L x W x H	Square Feet	Reception	Rounds	Banquet	Classroom	Theater	Conference	U-Shape	8' x 8' Booths	8' x 10' Booths
Doubletree Ballroom	Lobby	76 x 120 x 14'	9,120	1,200	600	1,000	500	1,000	—	—	88	70
Tamarack	Lobby	76 x 30 x 14'	2,280	300	150	200	125	250	—	—	20	14
Ponderosa	Lobby	76 x 30 x 14'	2,280	300	150	200	125	250	—	—	20	14
Laurel	Lobby	76 x 30 x 14'	2,280	300	150	200	125	250	—	—	20	14
Juniper	Lobby	76 x 30 x 14'	2,280	300	150	200	125	250	—	—	20	14
Ballroom Fireplace Foyer	Lobby	—	1,600	150	—	—	—	—	—	—	13	11
Ballroom Lobby	Lobby	—	2,150	100	—	—	—	—	—	—	11	8
Emerald	Lobby	34 x 15 x 9'	510	75	40	36	28	45	20	16	—	—
Garnet	Lobby	27 x 15 x 9'	405	55	30	32	16	40	20	16	—	—
Opal	Lobby	27 x 15 x 9'	405	55	30	32	16	40	20	16	—	—
Topaz	Lobby	27 x 15 x 9'	405	55	30	32	16	40	20	16	—	—
Aspen	Lobby	16 x 56 x 9'	896	120	100	—	—	—	—	—	—	—
Cinnabar	Second	46 x 26 x 8'	1,196	120	80	72	80	100	40	36	—	—
Clearwater	Second	27 x 24 x 8'	648	30	40	50	36	50	20	20	—	—
Delamar	Second	33 x 24 x 8'	792	95	40	60	40	60	32	32	—	—
Liberty	Second	37 x 24 x 8'	888	100	60	72	60	80	32	32	—	—
North Star	Second	52 x 33 x 8'	1,716	200	130	140	100	175	40	46	—	—
Riverside Boardroom	Second	33 x 24 x 8'	792	—	—	—	—	—	18	—	—	—

Wednesday, March 2

8:00–8:20 AM **Opening Remarks and Presidential Message**
ICAFS President, Ernest Keeley

Plenary Session: Native Peoples Fisheries: Perspectives on Past, Present, and Future

Location: Juniper/Laurel

8:20–8:30 AM **Introduction to Plenary Session**
Jason Vogel, Moderator

8:30—9:10 **Fish in the dirt: archaeological perspectives on native fisheries of the Pacific Northwest**
Sarah Campbell, Western Washington University

9:10—9:35 **Fisheries Management in a Tribal First Foods Context**
Eric Quaempts, Confederated Tribes of the Umatilla Reservation

9:35—10:00 **A Tribal perspective: The importance of Nez Perce Fishing and Treaty Rights to sustainable fisheries in the Snake Basin**
Joe Oatman, Nez Perce Tribe Department of Fisheries Resources Management

10:00—10:30 **BREAK**

10:30—10:55 **Implementing an integrated, ecosystem-based restoration program to recover native fish species in the Kootenai River: a Tribal approach**
Susan Ireland, Kootenai Tribe of Idaho

10:55—11:20 **Shoshone-Bannock Fisheries: Perspective on Past, Present, Future**
Lytle Denny, Shoshone-Bannock Tribes

11:20—11:45 **The limits of indigenous rights and salmon fisheries conservation in the state of Idaho: A common perspective and paradox towards management**
Irene Shaver, Sammy Matsaw Jr., Shoshone-Bannock Tribes

11:45- 11:50 **Concluding remarks**
Jason Vogel, moderator

11:50—1:20PM BOX LUNCH: COMMITTEE BREAKOUTS (room assignments)

Session 1: Related Topics to Plenary and Big Picture Topics

Location: Juniper/Laurel

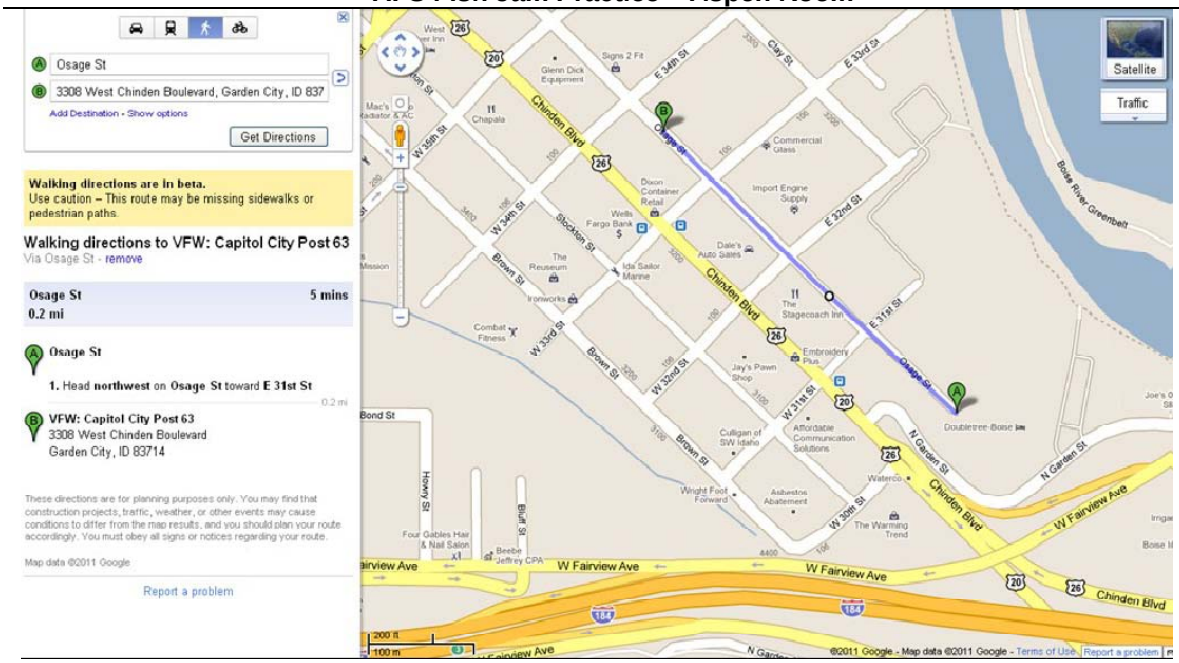
1:20–1:25 PM **Introduction to Session,**
Jason Vogel, Moderator

1:25–1:45 PM **Snake Basin Hatchery and Harvest Management Coordination: Tools For Building Consensus**
Becky Johnson, Nez Perce Tribe, Sam Sharr, Idaho Department of Fish and Game

1:45 –2:05 PM **Adapting model results for wood recruitment to streams for use in restoration and conservation planning for a Tribal fishery**
Angelo Vitale, Coeur d'Alene Tribe

Wednesday, March 2 – Cont.

2:05 –2:25 PM	**Toward conceptualizing the whole: Observing aquatic species in their natural habitat** Mary Edwards, Nez Perce Tribe
2:25 –2:45 PM	**Distribution, behavior, and habitat of spawning adult Pacific lamprey (*Lampetra tridentata*) translocated into tributaries of the Snake and Clearwater Rivers** Brian J. McIlraith, University of Idaho
2:45 –3:05 PM	**Born to be wild: Salmon responses to natural disturbance** Russ F. Thurow, USDA-Forest Service Rocky Mountain Research Station
3:05–3:25 PM	**Broad-scale stray rate of Pacific Rim Chinook salmon migrating beyond Bonneville Dam to the interior Columbia River Basin** Jon E. Hess, Columbia River Inter-Tribal Fish Commission, Hagerman Genetics Lab
3:25–3:50 PM	**BREAK**
3:50–4:10 PM	**Acoustic telemetry of California sea lions in relation to adult salmonids in the Bonneville Dam tailrace** Doug Hatch, Columbia River Inter-Tribal Fish Commission
4:10—4:30 PM	**The spatial scale and ecological determinants of homing in a wild Chinook salmon population** Ellen J. Hamann, University of Idaho
4:30—4:50 PM	**Monitoring and modeling stream temperature patterns associated with climate change across the northwest US** Daniel J. Isaak, USDA-Forest Service Rocky Mountain Research Station
4:50—5:10 PM	**Flow regime, biotic interactions and temperature determine differential responses of four trout species to projected climate change in the western US** S.J. Wenger, Presenter, Trout Unlimited
5:10-5:15	**Concluding comments and wrap-up**
5:30-6:15PM	**MENTORING SOCIAL at Veterans Building!!**
6:30–9:00PM	**STUDENT MIXER at Veterans Building!! See attached map.**
8:30 – 11:00	**AFS Fish Jam Practice – Aspen Room**



Thursday, March 3 (concurrent sessions)

6:00—7:00 AM ***ICAFS Spawning Run –Location: Meet in Ballroom Lobby***

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	Session 2-A: Anadromous Fish ecology and management **Moderator: Jay Hesse** ***Location: Juniper***	***Session 2-B: Native fish ecology and management*** **Moderator: Cathy Gidley** ***Location: Tamarack***
8:00–8:10	Announcements and introduction to Session	Announcements and introduction to Session
8:10–8:30	**Influences of hatchery supplementation, spawner distribution and habitat on genetic structure of Chinook salmon (*Oncorhynchus tshawytscha*) in the South Fork Salmon River, ID** Andrew Matala, Columbia Inter-Tribal Fish Commission	**Phylogenetic relationships of cutthroat trout: does evolutionary history reflect geological history** ? Janet L. Loxterman, Idaho State University
8:30–8:50	**A demographic evaluation of hatchery- and natural-origin Chinook salmon (*Oncorhynchus tshawytscha*) and its impact on the population genetic structure in the South Fork Salmon River, ID.** William Young, Nez Perce Tribe	**Estimating rates of pelican predation on Yellowstone cutthroat trout in the Upper Blackfoot River system** Matt T. Green, Idaho State University
8:50–9:10	**Chinook salmon escapement monitoring using an underwater video counting station** Travis Covel, Nez Perce Tribe	**Age-0 rainbow trout overwintering use of spring-flow tributaries of the Henrys Fork of the Snake River** Jim DeRito, Henry's Fork Foundation
9:10–9:30	**Monitoring adult Chinook salmon (*Oncorhynchus tshawytscha*) escapement in Bear Valley Creek, Idaho using underwater time-lapse video surveillance technology** Lytle Denny, Shoshone-Bannock Tribes	**Development of conservation hatchery techniques for a Bonneville cutthroat trout population** Bryan Grant, Idaho Department of Fish and Game
9:30–9:50	**A bioenergetic evaluation of changes in habitat quality for salmonid fishes: calculating the benefit from stream fertilization in the Salmon River** Steven O. Campbell, Presenter, Idaho State University	**Population-level effects of stocking hatchery rainbow trout in wild trout streams** Brett High, Idaho Department of Fish and Game
9:50–10:15	**BREAK**	
	Session 2-A: Chinook salmon ecology and management **Moderator: Jay Hesse** ***Location: Juniper***	***Session 2-B: Native fish ecology and management*** **Moderator: Cathy Gidley** ***Location: Tamarack***
10:15–10:35	**Predicted climate change effects on streambed scour and risks to Chinook salmon survival in the Middle Fork Salmon River, Idaho** Jaime R. Goode, University of Idaho	**Investigation of smoltification in an impounded, adfluvial redband trout population in the Snake River Drainage, Idaho** Dean E. Holecek, University of Idaho
10:35–10:55	**Effects of experimental salmon carcass and analog additions on resident trout growth rates, abundance, and production** Scott F. Collins, Idaho State University	**Hybridization patterns in redband trout reflect multiple introduction and invasion sources of non-native cutthroat and hatchery rainbow trout in a high-profile river in Idaho** Helen Neville, Trout Unlimited

Thursday, March 3 – Cont.

10:55-11:15	**Smolt-to-adult survivals of Snake River fall Chinook salmon supplemented upstream of Lower Granite Dam** Bill Arnsberg, Nez Perce Tribe	**Age-growth, natural mortality, and models predicting growth of redband trout in high desert streams of Idaho** Daniel J. Schill, Idaho Fish and Game
11:15–11:35	**Factors affecting early life history and growth of naturally-produced fall Chinook salmon in the lower Snake River, Idaho** John M. Plumb, University of Idaho	**Population demographics of Catostomids in Iowa's large rivers: Effects of discharge on recruitment dynamics and growth** Michael C. Quist, University of Idaho
11:35–11:55	**Determining spatially distinct differences in juvenile migration strategies in wild Fall Chinook salmon (Oncorhynchus tshawytscha) in the Snake River, Idaho** Jens Hegg, University of Idaho	**Detecting the disjunctly distributed: the case of the northern leatherside chub in Idaho** Jason R. Blakney, Idaho State University
11:55—2:10	**BUSINESS LUNCHEON** **Location: Laurel/Ponderosa**	

	Session 3A: Steelhead ecology and management **Moderator: Tim Copeland** ***Location: Juniper***	***Session 3B: Management, Education, and Methods Application* Moderator: Tom Curet** ***Location: Tamarack***
2:10—2:15	**Introduction to Session**	**Introduction to Session**
2:15 —2:35	**Salmon and Steelhead Performance Measure Evaluations at the Tributary, Major Population, DPS, and ESU Scales** Jason Vogel, Nez Perce Tribe	**Angler tag reporting evaluations … or "Why should I bother to turn in this Fish tag"?** Steven Elle, Idaho Department of Fish and Game
2:35 —2:55	**Spatial and temporal variation in juvenile steelhead (*Oncorhynchus mykiss*) growth and consumption in a hydrologically altered watershed** Knut Marius Myrvold, University of Idaho	**Closing the Loop on the Trout in the Classroom Program** Joe Chapman, Idaho Department of Fish and Game
2:55—3:15	**An evaluation of spatial and temporal natural steelhead population abundance in the Imnaha River Subbasin** Neal Espinosa, Nez Perce Tribe	**Accuracy of removal electrofishing estimates of trout abundance in Rocky Mountain streams** Kevin A. Meyer, Idaho Department of Fish and Game
3:15 —3:35	**Establishment of a genetic baseline using SNPs to estimate the composition of wild adult steelhead mixtures passing Lower Granite Dam** Michael W. Ackerman, Idaho Department of Fish and Game	**Movements of individual trout in response to electrofishing** Michael K. Young, Rocky Mountain Research Station, Montana
3:35 —4:05	**Testing the power of Single Nucleotide Polymorphism markers (SNPs) for Parentage Based Tagging of Snake River hatchery steelhead** Craig A. Steele, Idaho Department of Fish and Game	**An evaluation of bull trout *Salvelinus confluentus* bycatch from predator reduction netting in Lake Pend Oreille** Nicholas C. Wahl, Idaho Department of Fish and Game
4:05 —4:25	**Physiological characteristics of steelhead kelts in the Snake River, Idaho** Jessica Buelow, University of Idaho	**Circle hooks versus "J" hooks – do they matter when fishing for white sturgeon?** Joe DuPont, Idaho Department of Fish and Game

Thursday March 3 – Cont.

4:45-5:10

Modeling physiological changes in energy stores of sexually mature and post spawning steelhead trout in the Columbia/Snake River
Zachary L. Penney, University of Idaho

Use of wild-caught and transplanted channel catfish to enhance fishing opportunities in small ponds and reservoirs
Joe Kozfkay, Idaho Department of Fish and Game

5:15-6:15

POSTER SESSION (location: Aspen)

Migration timing, growth, and estimated parr-to-smolt survival rates of wild Snake River spring-summer Chinook salmon from the Salmon River basin, Idaho, to the lower Snake River
Stephen Achord, NOAA Fisheries

Evaluating physical marking techniques for juvenile burbot
Neil Ashton, University of Idaho/Kootenai Tribe of Idaho

Mitigating for the loss of marine nutrients from salmon: Ecological effects of salmon carcass and analog additions to headwater aquatic and terrestrial systems in Idaho
Colden V. Baxter, Idaho State University

Resident trout consumption of salmon carcass and analog added to tributaries of the N. Fork Boise River, Idaho
Alex Bell, Idaho State University

Distribution and diet of largemouth bass (Micropterus salmoides) in the lower Boise River,Idaho
Camrin D. Braun, The College of Idaho

Development and assessment of a panel of novel SNP assays for population differentiation of westslope cutthroat trout
Nathan Campbell, Columbia River Inter-Tribal Fish Commission

Genetic diversity and relatedness assessment in captive stock Bonneville Cutthroat
Stacey Dauwalter, Pacific States Marine Fisheries Commission

Use of membrane filtration florescent antibody test (MF-FAT) to identify Renibacterium salmoninarum within eggs of sexually mature female Chinook salmon: An attempt to establish correlative relationships between detection of bacteria in the eggs, ovarian fluid and ELISA levels in the kidney
Mary Edwards, Nez Perce Tribe

Use of a tilted wedge wire coanda screen as an outmigrant fish trap on a dam spillway
Anne Marie Emery, Henry's Fork Foundation

Whitefish passage of the 6X Diversion on the Big Lost River
Selena Gregory, Mackay Jr./ Sr. High School

Scale resorption in migrating and spawning steelhead *(Oncorhynchus mykiss)*
Kala Hamilton, Idaho Department of Fish and Game

Reproductive Success of Reintroduced spring-run Chinook salmon in the Hood River, Oregon
Maureen A. Hess, Columbia River Inter-Tribal Fish Commission

Massive air and stream temperature sensor networks for studying microclimatic variation in mountain landscapes of the northwest U.S.
Daniel J. Isaak, U.S. Forest Service, Rocky Mountain Research Station

Comparison of spring/summer Chinook salmon life histories and resulting scale patterns in jacks, minijacks, and precocial male parr
June Johnson, Idaho Department of Fish and Game

POSTER SESSION CONT. (location: Aspen)

Species composition as an indicator of environmental quality in an impacted stream system
TIMOTHY J. KUZAN, University of Idaho

3rd Annual Western Division Student Colloquium
Amy Long, University of Idaho

Develop a naturalized Chinook salmon (*Oncorhynchus tshawytscha*) population in the Yankee Fork Salmon River using volitional adult spawner and juvenile smolt releases
Carlos Lopez, Shoshone Bannock Tribes

Fishery assessments on the Duck Valley Reservation, Idaho and Nevada, 2007-09
Terry Maret, U.S. Geological Survey, Boise

Sensitivity of off-channel salmon rearing habitats to changing base flows in unconfined low-gradient mountain streams
Jim McKean, U.S. Forest Service, Rocky Mountain Research Station

Genomics of thermal adaptation in redband trout
Shawn R. Narum, Columbia River Inter-Tribal Fish Commission

Reclamation of Historic Wetlands for the Rehabilitation of Salmonid Habitat within North Central Idaho's Nez Perce Reservation
Justin Peterson, Nez Perce Tribe

Modeling The effects of anadromous fish nitrogen on riparian forest carbon balance
Andrea J. Noble Stuen, University of Idaho

Use of natural markers to describe Snake River spring/summer Chinook salmon life history characteristics and environmental correlates.
Jeffrey M. Reader, University of Idaho

Adult abundance & productivity of spring Chinook salmon in Lolo and Newsome creeks- Nez Perce Tribal hatchery monitoring & evaluation results
Sherman Sprague, Nez Perce Tribe

Energy and proximate content of selected tissues from Snake River steelhead trout kelts sampled at Lower Granite Dam
William C. Schrader, University of Idaho

Modeling water and small particle residence times in two rearing units used for intensive culture of steelhead trout in Idaho
Kelly Stockton, University of Idaho

Hooking and landing success and deep hooking rates for stream-dwelling trout fished with baited circle and J-hook.
Christopher L. Sullivan, Idaho Department of Fish and Game

The importance of marine nutrient subsidies in mountainous riparian forests
Tadd A Wheeler, University of Idaho

6:30—?? PM **EVENING SOCIAL AND AUCTION!**

Location: Laurel/Ponderosa

Auction – Bring your money and win/buy some great stuff and support the Chapter!!

Entertainment!!! – AFS Fish Jam – Enjoy Talent from Within the Chapter – All are Welcome to Participate, Bring Your Voices and/or Instruments!!!

Friday, March 4, 2011

Session 4: Contributed Papers

Moderator: Dan Scaife

Location: Juniper/Laurel

8:00–8:10 AM	Announcements and Introduction to Session
8:10–8:30	**An Evaluation of Underwater Epoxies to Permanently Install Temperature Sensors in Mountain Streams** Dona Horan, Presenter, Rocky Mountain Research Station
8:30–8:50	**Evaluating the effects of roads on watershed processes and fisheries in a North Fork Coeur d'Alene River tributary using the GRAIP model: potential uses and implications** Ashley McFarland, Presenter, University of Idaho
8:50–9:10	**West Fork Lake Creek Stream and Wetland Enhancement Project** Stephanie Hallock, Coeur d'Alene Tribe Fisheries Program
9:10–9:30	**Climatic and geomorphic factors affecting temperature sensitivity of streams across the Interior Columbia River basin** Andy Hill, Rocky Mountain Research Station
9:30–9:50	**Is weighted usable area a valid proxy for egg-smolt survival for juvenile Chinook salmon?** James V. Morrow National Marine Fisheries Service
9:50– 10:20	**BREAK**
10:20–10:40	**Use of seismic air guns to reduce survival of salmonid eggs and embryos: a pilot study** Benjamin Cox, University of Idaho
10:40–11:00	**Validation of Diagnostic Assays to Screen Broodstock for *Flavobacterium psychrophilum* Infection** Amy Long, University of Idaho
11:00-11:20	**Evaluation of Virkon Aquatic toxicity and application to disinfect invasive mollusk infested field and hatchery gear** Kelly Stockton, University of Idaho
11:20-11:40	**Species profiling of *Misgurnus anguillicaudatus*: Ecological characteristics of a little known but proliferating invader** Alexander N. Urquhart, Boise State University
11:40-12:00	Best paper awards

Travel Safely!

Presentation Abstracts in Alphabetical Order

Establishment of a genetic baseline using SNPs to estimate the composition of wild adult steelhead mixtures passing Lower Granite Dam

Michael W. Ackerman[1], Jon E. Hess[2], Timothy Copeland[3], [3]William C. Schrader[3], Shawn R. Narum[4], and Matthew R. Campbell[1]:
[1]Idaho Department of Fish and Game, Eagle Fish Genetics Lab
[2] Columbia River Inter-Tribal Fish Commission
[3]Idaho Department of Fish and Game, Nampa Fisheries Research
[4]Columbia River Inter-Tribal Fish Commission
Presenter: Michael W. Ackerman, 208-939-6713, mike.ackerman@idfg.idaho.gov

Genetic stock identification (GSI) using single nucleotide polymorphisms (SNPs) has been conducted successfully in the lower Columbia River and elsewhere throughout the Pacific Rim to estimate the composition of fisheries mixtures. Here, we present a newly established SNP baseline for wild adult steelhead (*Oncorhynchus mykiss*) in the Snake River Basin and use the baseline to estimate the composition of wild steelhead mixtures (spawn year 2010) passing Lower Granite Dam. Our goals in this study were two-fold: 1) document the genetic structure of wild adult steelhead in the Snake River Basin ESU using SNPs, and 2) provide a baseline to estimate the contribution of individual wild adult steelhead stocks passing over Lower Granite Dam. We genotyped a total of 1,912 samples collected at the adult trap at Lower Granite Dam between August 23 – April 21, 2010 at 192 SNPs including a modified Y-specific allelic discrimination assay that differentiates sex in *O. mykiss*. This study is the first to use SNP markers to document the genetic structure of wild Snake River Basin steelhead and to estimate the contribution of individual stocks over Lower Granite Dam. The results presented here indicate that GSI using SNPs should greatly assist managers in assessing the viability of the Snake River Basin steelhead ESU by providing essential information for estimating Viable Salmonid Population parameters (abundance, population productivity, spatial structure, and diversity).

Smolt-to-adult survivals of Snake River fall Chinook salmon supplemented upstream of Lower Granite *Dam*

Bill Arnsberg
Nez Perce Tribe
Presenter: Bill Arnsberg, 208-476-7296 Ext. 3578, billa@nezperce.org

Snake River fall Chinook salmon were listed as “threatened” under the Endangered Species Act (ESA) in 1992. A low of 78 natural adult fall Chinook salmon were counted at Lower Granite Dam in 1990. The Nez Perce Tribe initiated supplementation efforts using Lyons Ferry Hatchery (LFH) yearling fall Chinook salmon smolts at Pittsburg Landing Acclimation Facility on the Snake River in 1996. During 1997, LFH subyearling and yearling fall Chinook were acclimated and released at Big Canyon Creek on the Clearwater River. In 1998, LFH yearling fall Chinook were released at a second acclimation facility on the Snake River at Captain John Rapids. Further efforts to increase fall Chinook natural production continued with the construction of the Nez Perce Tribal Hatchery and the release of subyearlings into the Clearwater River in 2003. The goal of the fall Chinook supplementation programs is to increase natural production of ESA listed Snake River fall Chinook that will lead to recovery, restoration, and eventual harvest. Intensive monitoring and evaluation of juveniles to adult returns has occurred since supplementation began in 1996. Fall Chinook adult return rates have increased from less than 1,000/yr for 20 years prior to supplementation to over 40,000 adults counted at Lower Granite in 2010. Smolt-to-adult survivals (SAR’s) for both subyearling and yearling releases have contributed to the increase in adult abundance of Snake River fall Chinook salmon. SAR’s have ranged from 0.009-1.33% for subyearling releases and 0.008-3.26% for yearling releases back to the Snake River. Although hatchery fall Chinook adult returns have increased significantly during the last 15 years, it

appears that low SAR's of naturally produced fish will not lead to recovery without continued supplementation and/or a substantial increase in juvenile survivals.

Detecting the disjunctly distributed: the case of the northern leatherside chub in Idaho

Jason R. Blakney, Janet L. Loxterman, and Ernest R. Keeley
Idaho State University
Presenter: Jason R. Blakney, 208 282-4458, blakjaso@isu.edu

Detecting a rare species can be difficult because they are often locally scare and may also have a poorly defined distribution, thus a sampling scheme must be constructed in a fashion that aims to maximize contact with the target species. We used historic distribution records of the northern leatherside chub (*Lepidomeda copei*); to detect the range and abundance of this poorly studied cyprinid fish native to a few watersheds in the Intermountain West. We devised a sampling strategy where randomly generated sampling locations were placed on 10% of second and higher order streams within a 20 km radius of stream sites where leatherside chub have been reported. Locations of previous observations and randomly generated sites were sampled using a single pass electrofishing method on 100 m reaches of stream. In addition, we employed a second method in streams where chub were initially detected. This method involved a 'distance shocking' technique, where a 3-5 km of stream was sampled with single-pass electrofishing. By using both methods we evaluated their utility for future monitoring efforts and for achieving the project's objective of identifying the range and distribution of northern leatherside chub. Here we analyze the two methods utilized to collect leatherside chub, which can be used to ascertain the level of rarity and extremely patchy nature of the distribution of a species that often only occupies a few kilometers of stream; while nearby reaches and cosmetically similar streams are devoid of leatherside chub. This approach may serve as a method to be used when collecting baseline information on rare non-game fish species.

Physiological Characteristics of Steelhead Kelts in the Snake River, Idaho

Jessica Buelow[1], Christine Moffitt[2], Zach Penney[1], Kala Hamilton[1], Andy Pape[1], and Bryan Jones[1]
[1]University of Idaho
[2] Geological Survey, Idaho Cooperative Fish and Wildlife Research Unit
Presenter: Jessica Buelow, 208-885-7139, buel0184@vandals.uidaho.edu

Steelhead trout (*Oncorhynchus mykiss*) are iteroparous, but the degree of repeat spawning varies throughout their range. In the Snake River, the proportion repeat spawning is often less than 2%. In a collaborative multi-year study, we are examining several non-lethal methods to determine factors that may be affecting the survival of post spawning steelhead (kelts) in the Snake River system, with a goal of increasing the number of iteroparous fish in the system. To better understand the relationship of physiology, fish condition and migration success, we sampled blood from downstream migrating kelts at Lower Granite Dam, WA, assessed their external condition, and applied a PIT-tag in the pelvic girdle. We collected blood samples from 851 steelhead kelts at the juvenile bypass facility at Lower Granite Dam, WA. We used multivariate and univariate statistical analyses to examine a suite of physiological metrics, and their association with fish external condition (rated as poor, fair and good), sex, hatchery (adipose clipped), unclipped natural origin fish (with or without dorsal fin erosion), and migration timing. We compared selected "smolt" metrics from downstream migrating kelts, such as sodium/potassium ATPase and T4 hormones with those typical for migrating juvenile smolts and found few correlations. Fish condition affected many of the biochemical plasma parameters. Plasma cholesterol and calcium (indicative of nutrition) were significantly higher in good condition fish. Lactic dehydrogenase (LDH; indicative of tissue damage) was higher in poor condition kelts than those in good condition. Among kelts with adipose fins, we compared good condition fish with and without dorsal fin erosion and found several significant differences. The kelts without dorsal fin erosion had higher plasma cholesterol, higher calcium and lower LDH.

Fish in the dirt: archaeological perspectives on native fisheries of the Pacific Northwest

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Abundant fish bones in archaeological sites in the Pacific Northwest provide a long term record of Native American fisheries and their sustainability. To examine trends in harvesting of salmon and other fish, Virginia Butler and I synthesized the ~7500 year long fish bone record from 52 archaeological sites in two areas: the Salish Sea and the upper Columbia River. Over 170,000 specimens from dated contexts, representing 24 families of fish, were tabulated. The importance of salmon is indicated by its ubiquity and relative abundance, although in any given time period, salmon was only a minor or moderate constituent at some locations, where the dominance of flatfish, sculpin, surfperch, herring, ratfish or greenling indicates other important fisheries. Examination of the relative proportion of salmon to all fish showed no temporal trends that would indicate resource depression or an increasingly specialized fishery; the overall record is characterized by stability. Resilience in salmon populations across this lengthy period during which human populations were growing in size may be partially explained by intrinsic aspects of fish biology and reproductive strategy or environmental changes that improved salmon habitat. Given the sophistication of native fishing technologies and the important role of fish as a dietary staple, we reject low exploitation intensity as a sufficient explanation, and suggest instead that traditional cultural practices that regulated the fishery were necessary for sustainable fishing. In spite of differences in the cultural contexts, these traditional practices suggest possible alternatives for future management practices.

A bioenergetic evaluation of changes in habitat quality for salmonid fishes: calculating the benefit from stream fertilization in the Salmon River

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In nutrient deficient streams, low-level nutrient fertilization has often been employed to improve habitat quality for salmonid fishes. In this study, we used a bioenergetic foraging model to evaluate changes in habitat quality from stream fertilization in the Salmon River of central Idaho. We estimated habitat quality for four size classes of salmonid fishes by calculating net energy intake (NEI) rates as a measure of the availability habitat that met growth requirements for a maintenance ration as well as 50% and 80% of a maximum ration. Our study represents one of the first evaluations of changes in habitat quality for stream fertilization efforts. In this presentation we provide an assessment of energetic changes in habitat quality by comparing streams that received salmon carcass analogs to those that did not, over a four month period. Bioenergetic models may offer an approach to evaluate large-scale changes in habitat quality for stream fishes. Such modeling efforts have the benefit of incorporating seasonal changes in habitat quality that account for changes in stream flow, temperature limitations, and food availability. We hope to demonstrate the utility of bioenergetic models for evaluating changes in habitat quality that require an energetic estimate for issues like stream fertilization and climate change.

Closing the Loop

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The Idaho Department of Fish and Game sponsors or co-sponsors Trout in the Classroom (TIC) programs in 109 schools across the state. This program reached 13,625 students last year. In

the Magic Valley Region, about 19 schools and 1,325 students participate. The Hagerman State Fish Hatchery has been responsible for the TIC program at four schools and about 100 students each year for the past ten years. In addition, other TIC programs from the region come to the hatchery for spring tours and fishing. Last year, about 1,280 students toured the hatchery and went fishing. Most of the TIC programs in Idaho involve taking the eggs to the classroom and giving a presentation about stewardship, caring for the eggs, and the life cycle of the fish, followed by a dissection class, then possibly a trip to a hatchery and/or fishing. Many students take their catch home, hoping someone in the family knows what to do with it, but possibly often times the students catch is discarded. Hagerman State Hatchery employees addressed this problem last year. In addition to the three-phase program taught in prior years, students were shown how to clean their catch, prepare and cook it, then given a taste of the finished product, thus educating young anglers about fish preparation and "closing the loop" on the TIC program.

Effects of experimental salmon carcass and analog additions on resident trout growth rates, abundance, and production

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The nutrients delivered via salmon spawning runs is an important subsidy for stream ecosystems of the Pacific Northwest. However, this delivery has declined or been eliminated in basins across the Pacific Northwest. Nutrient mitigation seeks to increase productivity of algae, invertebrates, and fishes through bottom-up propagation of energy and nutrients. With the transfer of energy to higher trophic consumers, resident fishes are a focal species for nutrient mitigation strategies, with responses occurring at individual fish (growth rates), and population (abundance, production) scales. From summer 2008 through 2010 we conducted a large-scale field experiment across nine tributaries of the N. Fork Boise river, consisting of 500-m stream reaches treated with salmon carcasses (n=3) or pelletized salmon (n=3), and un-treated reference reaches (n=3). We hypothesized that additions of salmon carcass and analog pellets would increase growth rates of resident trout, which would translate to increased abundance, biomass, and production of their populations. Multi-pass depletions were conducted annually to quantify fish age, size structure, and population size, and collected fish were PIT tagged and released. Additional single passes 2, 4, and 6 weeks post-application were conducted to recapture fish to estimate growth rates. Nutrient mitigation treatments increased growth rates of resident fishes more than two times over controls by six weeks after treatment additions in 2008-2010. Moreover, increased growth rates translated into more than ~25% more trout production within the study reaches, though increased abundance of trout was not detected. Mitigation strategies should consider the mobility of trout, which can move longer distances than our 500m reach. Emigration of larger fish from the nutrient treatment reaches to mainstem habitats may play a role in population dynamics. The increased short-term responses suggest that direct consumption is important to fish production, as bottom up transfer from could not happen at such a short time scale.

Chinook Salmon Escapement Monitoring Using an Underwater Video Counting Station

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An underwater video counting station was used from 1998 through 2009 to estimate spawner escapement of ESA listed spring/summer Chinook salmon *Oncorhynchus tshawytscha* entering Lake Creek, a tributary of the South Fork Salmon River located in central Idaho. The video counting station was a passive and non-invasive picket weir structure that allowed unimpeded bi-directional fish passage. Videotaped observations of both upstream and downstream passages

allowed for an estimate of spawner escapement, run timing and seasonal migration patterns. The video observations provided an opportunity to estimate length frequency distributions, jack proportions, and hatchery proportions of the Lake Cr. spawning aggregate and were used for comparative evaluations with annual carcass surveys. Over the course of the study the annual maximum escapement of salmon varied by an order of magnitude, from a low of 57 (± 8) in 1998 to a high of 685 (± 59) in 2001. The arrival of the first salmon into Lake Creek varied by more than 5 weeks and ranged from June 9 to July 11. Two distinct and significantly different seasonal migration patterns were observed each year, consisting of an initial period of high daily escapement with few downstream passages followed by a period of high upstream and downstream passage with a low but positive daily escapement rate. Diurnal migration patterns were observed with the least amount of passages occurring between 0700 and 1300 hours. The date of the first salmon arrival was found to be significantly correlated with the mean daily temperature (p-value = 0.016, r^2 = 0.54) and the start of the descending limb of the hydrograph (p-value = 0.0002, r^2 = 0.84) in Lake Cr.

Use of seismic air guns to reduce survival of salmonid eggs and embryos: a pilot study

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Introduced lake trout *Salvelinus namaycush* have become established in numerous lakes throughout the western United States and pose threats to existing fish populations through predation and competition. To mitigate these threats, lake trout suppression programs are increasingly being implemented. These programs primarily rely on gill nets to remove subadult and adult lake trout. Lake trout population growth is highly sensitive to reduced survival in early life stages, but methods to effectively remove lake trout at these early life stages are lacking. Thus, we conducted a pilot study to determine the feasibility of using a small seismic air gun (655.5 cm^3; 40 in^3) to induce mortality in salmonid eggs and embryos. Treatments were conducted at multiple stages of development and consisted of two operation levels (air gun discharge and control), two water depths (5 m and 15 m), and two distances from the air gun (0 m and 3 m). Direct mortality was high during early stages of egg development (5-10 days post-fertilization), but decreased substantially at later stages of development. This only was observed for treatments conducted 0 m from the air gun, with no evidence of mortality for treatments conducted at the 3 m distance. There was no significant difference in mortality between the two water depths. While we saw limited effects from the seismic air gun used in this study, there was evidence that this method can be used to cause mortality in eggs and embryos. It appeared unlikely that the small air gun we tested will be an effective tool for targeting lake trout at early life stages in a natural environment; however, much larger air guns are available and may have more potential for success. We believe seismic air guns should not be dismissed as a viable suppression tool and recommend future research be conducted.

Shoshone-Bannock Fisheries: Perspective on Past, Present, Future

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In historic times, Idaho's Shoshone and Bannock speaking peoples lived at the headwaters of four major river systems in the western Unites States. They most intensively utilized and traveled the river and tributaries of the Salmon and Snake, which in turn feed the Columbia River drainage system, but they also spent time on watercourses leading to the Great Basin as well as the Missouri and Colorado River. The vast majority of their descendants now live on the Fort Hall Indian Reservation in southeast Idaho as enrolled members of the Shoshone-Bannock Tribes.

Present Tribal members continue to hold entitlements to these river systems due to their ancestors' historic patterns of use and because of the treaties and other legally binding agreements these predecessors made with the United States to preserve continued access to these resources. Shoshone and Bannock peoples were fishers who relied, in one degree or another, on the anadromous fish species of the Columbia River drainage and who also depended on a wide variety of other species found in the waterways of their vast territorial range. Walker (1993) estimated a potential annual catch of 4,050,000 pounds or about 250,000 fish harvested in the Weiser – Boise, Hagerman – Shoshone, and Lemhi – Salmon River fisheries. Current estimates suggest less than 1,000 anadromous fish are harvested each year, mainly from the Lemhi – Salmon River fishery. The Tribes are actively pursuing restoration of anadromous fish in all historical fishery areas.

Monitoring adult Chinook salmon (*Oncorhynchus tshawytscha*) escapement in Bear Valley Creek, Idaho using underwater time-lapse video surveillance technology

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Bear Valley Creek, which combines with Marsh Creek to form the Middle Fork Salmon River is an important spawning and rearing stream for Chinook salmon and is an important traditional use area for members of the Shoshone-Bannock Tribes (Tribes). Past redd counts indicate Bear Valley Creek was the primary spawning stream for wild spring Chinook salmon in the Salmon River, if not in the entire Columbia River system (Konopacky et al. 1984). Redd counts for Chinook salmon numbered over 1,000 in the mid-1950's (Schwartzberg and Roger 1986) to three in 1995 (Anderson et al. 2001). On April 22, 1992, Bear Valley Creek Chinook salmon were listed as threatened under the Endangered Species Act (ESA). The Interior Columbia-basin Technical Recovery Team (2007) considers a minimum abundance threshold of 750 spawners for this population to be considered viable. The Tribes implemented escapement monitoring in 2010 to assist with recovery monitoring and harvest management. Activities included enumerating adult escapement using underwater time-lapse video surveillance technology and harvest monitoring. Key biological information was collected on salmon carcasses during harvest monitoring and spawning ground surveys to acquire length, age, gender, origin, as well as percent spawned and tissue samples for future genetic analyses. Time-lapse video technology was successfully used to enumerate adult Chinook salmon escapement in this headwater stream environment. In the first year of operations, the Tribes designed, fabricated, and constructed a "fish counting station," and successfully operated such system in a remote location on Bear Valley Creek. The fish counting station, which includes a temporary picket weir, fish counting chamber, and video surveillance system, was operated from July 6 – September 13, 2010. Preliminary results indicate over 1,000 adult Chinook salmon escaped into Bear Valley Creek in 2010, which is above the ICTRT viable population threshold of 750 spawners.

Age-0 rainbow trout overwintering use of spring-flow tributaries of the Henrys Fork of the Snake River

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Year-class strength of catchable rainbow trout in the Henrys Fork of the Snake River is primarily determined by how many age-0 rainbow trout survive their first winter. Heretofore, most research and restoration of overwintering habitat for age-0 rainbow trout has focused on the mainstem river. We are using a combination of fish traps, seasonal electrofishing, and fish marking/tagging to determine the extent to which age-0 rainbow trout are utilizing four spring-flow tributaries for

overwintering habitat. In the largest tributary (Buffalo River; 5.66 m^3/s base water flow) over 1,000 age-0 rainbow trout have immigrated annually (2006 to 2010) through a fish ladder during autumn. In the smaller tributaries (creeks #1 to #3; 0.03 m^3/s - 0.28 m^3/s base water flows), mean densities of age-0 rainbow trout increased from autumn to spring (prior to snowmelt runoff) and then decreased during the summer. Mean age-0 rainbow trout densities (number of fish/100 m) in creek #1 were: 39 in autumn (2008); 170 in spring (2009); and 30 in summer (2009). Mean densities in creek #2 were: 595 in autumn (2009); 876 in spring (2010); and 45 in summer (2010). Mean densities in creek #3 were: 2 in the summer (2010), 72 in autumn (2010), and a pre-runoff spring estimate will be completed in 2011. To more precisely estimate total emigration, timing, and survival of age-0 rainbow trout in creek #2, we installed a weir and fish traps during November 2010 and will operate that through spring 2011. Our results demonstrate that spring-flow tributaries provide valuable overwintering habitat for age-0 rainbow trout from the Henrys Fork. Fish passage improvement and habitat restoration within these tributaries may increase age-0 rainbow trout overwintering use and survival, resulting in greater year-class strengths and increased angling opportunities in the Henrys Fork.

Circle hooks versus "J" hooks – do they matter when fishing for white sturgeon?

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Increased fishing effort and the presence of hooks found inside dead white sturgeon *Acipenser transmontanus* in the Hells Canyon Reach of the Snake River prompted us to evaluate whether circle hooks would have benefits over the more widely used "J" hooks in reducing catch-and-release related mortality. To evaluate the two hook types, we fished with side by side rod and reel outfits, one rigged with a circle hook and the other a "J" hook. While fishing for sturgeon, we monitored hooking and landing rates, deep hooking rates, and the number of hooks broke off on bottom for both hook types. All fish that we landed were scanned with a metal detector to evaluate whether each sturgeon had ingested or had hooks broken off inside them. A portable x-rayed machine was used to verify the accuracy of the metal detector and determine the actual metal contents inside them. From July 2009 through November 2010 we put in over 1,100 rod hours of effort and landed 218 sturgeon. Through these efforts, we found that catch rates were 16% higher with "J" hooks than circle hooks, 60% more "J" hooks were broke off on the river bottom than circle hooks, and deep hooking rates were about five times higher with "J" hooks than circle hooks. Through use of handheld metal detectors, we determined that 32% of the sturgeon we landed had metal inside them. Metal detectors were accurate 97% of the time in detecting hooks inside sturgeon when verified by x-rays. About 62% of the hooks found inside sturgeon were sturgeon hooks that were likely ingested after being broken off on the bottom. Sturgeon with metal inside them tended to be skinnier than those without metal inside them. Our work suggests circle hooks may have some advantages in protecting sturgeon over "J" hooks including a lower deep hooking rate and less propensity to break off on the bottom. Future evaluations will be used in conjunction with this study to help further evaluate whether circle hook restrictions can result in a long term population level benefit to white sturgeon.

Toward Conceptualizing the Whole: Observing aquatic species in their natural habitat and why images from the fresh water environment are so important

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As fisheries scientists, culturists and managers, we often find ourselves acutely focused on a limited set of data values representing our "species of responsibility" and the relevance of those data points to our objective or mission. We focus the lens of understanding with increasing magnification to unlock genetic codes laid down 20 million years ago to understand life history

characteristics and our potential to impact or change these structures through management decisions. We collect various tissues and examine parts of the whole to acquire information on disease. We produce a staggering number of statistical analyses and models to explore probabilities, or best/worst case scenarios. We are intimate with the parts; we are intimate with the details, yet seldom are we in a position to observe our "species of responsibility" in its natural environment and consider the whole. Photography and video are dynamic tools capable of expanding our perspective; providing documentation and direct observation of diverse environments, cultures and features of the natural world not easily accessible to us. This is especially true for observations in aquatic environments. Marine environments are fairly well known to us, we have devoted considerable resources and technology to reveal the diversity of life that exists there. The same cannot be said regarding documentation of freshwater environments and the cycles of life in these habitats. Often the images of species from freshwater environments are featured outside of their environment, usually held in someone's hands or in a Petri dish. Our view is removed, disconnected from their habitat, their interactions with other species, how they acquire food, reproduce and survive. With the explosion of low cost digital point & shoot cameras with underwater capabilities, the tools are available for us to begin presenting a more complete image of these species in their natural environment. Pressure on freshwater environments is escalating as the demands from agriculture, industry, urban municipalities and the uncertainties of climate change play out across its surface and little awareness is given to what lies beneath. As fisheries professionals we can facilitate greater understanding and synthesis in our own work by considering the whole and by employing images that are representative of our "species of responsibility" in their natural habitat. Truly, a picture is worth a thousand words, as we take the message of our numbers and our bits and pieces of the whole to the public, "we should choose images as carefully as we choose words".

Angler Tag Reporting Evaluations … or "Why Should I Bother to Turn in This Fish Tag"?

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Estimating fish harvest from angler returns of tagged fish requires knowledge of the reporting rate. From 2006 to 2009, we tagged and released 27,180 fish (comprised of 10 species) in 48 water bodies across Idaho to assess angler tag reporting rates and estimate angler exploitation. We used T-bar anchor tags using the high-reward tag method to estimate tag reporting rates, where tags with various dollar values ($0, $10, $50, $100 and $200) were released. To date 5,155 tags have been reported by anglers. Non-reward reporting rate averaged 0.56 across all years and species and varied substantially by species but not across time. Reporting rates were 0.72 for $10, 0.95 for $50 and 1.06 for $100. In general, tag reporting rate was highest for harvest-oriented coowater and warmwater fisheries such as walleye (67%), yellow perch (64%) and crappies (62%). Non-reward tag reporting rate was not substantially higher for households with multiple tags or reward tags to report. Tag loss, estimated by double tagging a proportion of fish, averaged 7.3 and 19.7% in year one and year two, respectively, and varied widely between species. Short-term (7-day) mortality averaged 1.55 for wild fish. For hatchery fish held 22-33 days, mortality averaged 1.1%. We developed 80 estimates of annual expoitation, which were corrected for tag reporting rates, tag loss, and tagging mortality. Estimates averaged 20% and ranged from 0-79%. Expoitation was highest for crappie (30%) and lowest and most variable for hatchery trout (16%, range 0-79%). Our results suggest anglers report about half the Floy tags they encounter, much higher than previously assumed. The reporting rates from this study are now used by managers to estimate harvest for Idaho fisheries. Reporting rates may change over time and should be revisited every 3-5 years to assess changes.

An Evaluation of Spatial and Temporal Natural Steelhead Population Abundance in the Imnaha River Subbasin

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The Imnaha River subbasin is one of five major populations of A-run steelhead (*Oncorhynchus mykiss*) spawning upstream of Lower Granite Dam, although estimates of abundance and distribution within the subbasin is largely unknown. The Nez Perce Tribe evaluated spawner abundance, distribution and spawn timing in four small tributaries in the lower Imnaha River. Weirs were installed in Lightning Creek (2000 – 2007), Cow Creek (2001 – 2007), Horse Creek (2008 – 2010) and a resistivity counter was installed in Camp Creek (2008-2010). Spawner abundance estimates averaged 64.7 (12.4 S.E.) [range 20-104] in Cow, 125.1 (27.2 S.E.) [range 34-248] in Lightning, and 280.5 (95.5 S.E.) [range 145-224] in Horse Creek. Data from one year of resistivity counter data and several years of single pass redd counts in Camp Creek suggest a return of adult steelhead estimated to be greater than 230 adults per year. Hatchery influence was variable; Cow Creek had the highest average influence at 13%, whereas Lightning had 8% and Horse Creek had 3%. Future evaluations will be aided by the installation of seven instream PIT tag arrays and one to two additional weirs throughout the Imnaha subbasin to get spatial and temporal distribution of spawning natural steelhead.

Predicted climate change effects on streambed scour and risks to Chinook salmon survival in the Middle Fork Salmon River, Idaho

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In response to recent climate warming trends in the Pacific Northwest the frequency and magnitude of winter floods is expected to increase in some areas where rain-on-snow events occur. Eggs of fall spawning salmonids are incubating in the streambed at this time of year and may be at risk if streambed scour exceeds typical egg burial depths. Here, we investigate how projected trends in streamflow associated with climate change may alter the scour regime for Chinook salmon (*Oncorhynchus tshawytscha*) in the Middle Fork Salmon River, central Idaho. We predict the depth of scour for current and future bankfull (typical annual flood, Q_2) conditions and compare those values to typical Chinook salmon egg burial depths (15-50 cm). The spatial distribution of critical scour (that which exceeds egg burial depths) is predicted at the basin scale by coupling digital elevation models with empirical predictions of grain size and bankfull shear stress, determined from field surveys of 121 channel reaches. Historic and future values of Q_2 were derived from the Variable Infiltration Capacity (VIC) hydrologic model, down-scaled to 1/8th degree cells. Future predictions of Q_2 were derived from the VIC model forced by output from GCMs under an A1B warming scenario for the 2040s and 2080s. The spatial distribution of critical scour for predicted changes in bankfull flow are compared to active spawning sites (1995-2004 surveys) within the basin to assess location of risk. In the low gradient reaches (S <3%), spawning sites consistently occur where current predictions of bankfull scour depth does not exceed critical scour. Future predictions indicate only a small increase in the length of streams subject to scour in the MFSR, and suggest that this high elevation system could be largely resistant to future such events except under extreme warming scenarios. We plan to extend these analyses across a wider range of elevations and hydroclimates to identify other systems that may be sensitive to scour.

Development of conservation hatchery techniques for a Bonneville cutthroat trout population

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In 2007, the Idaho Department of Fish and Game implemented a conservation 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. Between 2007 and 2009, approximately 493 subadult Bonneville cutthroat trout were collected from the Cottonwood Creek drainage located in the Thatcher management unit. Individuals were sampled for genetic purity and transferred to a spring-fed pond. In May and June 2010, staff from the Grace State Fish Hatchery, Idaho, trapped and spawned wild origin Bonneville cutthroat trout from the pond. Survival from green egg to the swim-up fry stage was 86%. This resulted in the successful production of 17,000 Bonneville cutthroat trout fingerling which will be utilized in supplementation or reestablishment programs within the management unit. The conservation hatchery techniques developed for the Thatcher management unit provide a template for the development of similar techniques in other management units throughout the range of the subspecies in Idaho.

Estimating rates of pelican predation on Yellowstone cutthroat trout in the Upper Blackfoot River system

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Recent increases in piscivorous migratory bird populations and their impacts on fish populations have created conservation concerns for fish populations. These impacts can be especially dramatic in situations where native fish are exposed to increasing bird populations. Such is the case with American white pelicans preying on Yellowstone cutthroat trout in the upper Blackfoot River system of southeast Idaho. In this study we used both radio telemetry and passive integrated transponder (PIT) tagged fish to estimate total pelican predation on Yellowstone cutthroat trout within the Blackfoot River system. In the fall of 2009 and the spring of 2010, 57 cutthroat trout were telemetry tagged via boat electrofishing in the Blackfoot Reservoir. With tracking and tag recoveries we determined that 14 percent (n=8) of the fish were confirmed to have been consumed by pelicans. Another 12 fish mortalities were tracked to areas that also indicated predation by pelicans; providing an upper estimate of pelican predation of 36 percent. We also PIT tagged 1,020 cutthroat trout during the 2010 spring spawning migration. Scanning the nesting islands in the fall of 2010, after the majority of pelicans had migrated out of the area, resulted in the recovery of 81 PIT tags, or an estimated eight percent rate of predation on cutthroat trout. These results indicate between eight and 36 percent of cutthroat trout are consumed by pelican predation. We plan to use these data to model how such rates of predation may influence the population dynamics of cutthroat trout in the upper Blackfoot River.

West Fork Lake Creek Stream and Wetland Enhancement Project

Stephanie Hallock and Angelo Vitale
Coeur d'Alene Tribe Fisheries Program
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The Coeur d'Alene Tribe Fisheries Program is currently working on a large scale project to restore and enhance a degraded section of the West Fork of Lake Creek. The project is 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 is 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 include 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 involves constructing a new stream channel that can access the historic floodplain. Two thousand feet of existing incised West Fork Lake Creek channel will be completely filled and flows will be diverted into a new channel that is 3,025 ft long. A seasonal stream will also be rebuilt and will be connected to the newly built West Fork Lake Creek stream channel. Native plants will be planted in riparian and adjacent upland areas. Large wood material will be used throughout the project to increase lateral roughness and create banks. Nine acres of wetland will be created (0.82 acres will be filled). To date, 2000 ft of new channel has been built with another 500 ft partially completed. The new stream will be activated next year. Funding for the project is through BPA and EPA.

The spatial scale and ecological determinants of homing in a wild Chinook salmon population

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The resilience of organisms to large-scale environmental and climatic change depends, in part, upon the ability to colonize and occupy new habitats. While previous efforts to describe homing, or natal site fidelity, in migratory organisms have been hindered by the confounding effects of fragmented landscapes and management practices, realistic conservation efforts must include considerations of behavioral diversity that drive animal movements and dispersal. Herein, we quantify homing in a wild, threatened salmonid population in a pristine Wilderness basin. Using natural isotopic signatures to reconstruct the migratory behaviors of unhandled individuals, we identify ecological and behavioral factors influencing the propensity to stray. Our results indicate that natal site fidelity is scale-dependent (ranging from 57-87%), and juvenile movement and sex highly influence straying occurrence, findings which lend support for the conservation of behavioral diversity for population persistence.

Acoustic telemetry of California sea lions in relation to adult salmonids in the Bonneville Dam tailrace

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Acoustic pingers (ultrasonic transmitters) were attached to six California sea lions captured at Bonneville Dam to track movements and infer salmonid foraging behavior near Bonneville Dam and the lower Columbia River in 2009. Receivers were located from Bonneville Dam to the Columbia River mouth (approximately 240 river km). Sea lions were tracked for 6 to 44 days. Of the four animals with relatively long datasets, three foraged almost exclusively in the Boat Restricted Zone of the tailrace, while the fourth made daily foraging trips of approximately 8 km downriver from the dam. Detection data showed that approximately 90% of the detections of

these animals occurred during the day and twilight hours. These animals spent approximately 10 of 106 nights away from the favored haul-out site in the tailrace during their stay at Bonneville Dam. All four of these animals made at least one trip to the river mouth and back to Bonneville Dam subsequent to tagging and prior to the end of May. One animal (C697) made two such trips. Three of the instrumented sea lions were opportunistically detected by other researchers using acoustic arrays located near Cascade Head in the Pacific Ocean (~132 km south of the Columbia River).

Determining spatially distinct differences in juvenile migration strategies in wild Fall Chinook salmon (Oncorhynchus tshawytscha) in the Snake River, Idaho

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The development of divergent life history strategies in salmon is the result of variation in individual migratory behavior and the effects of environmental fluctuation. How these divergent life history strategies confer fitness advantages to individuals within the population, and the effect of environmental fluctuation on the spatial distribution of these divergent strategies, is fundamentally important to understanding and managing salmonid populations. Recent research has shown increased variation in the migration strategies of juvenile wild Snake River fall Chinook salmon (Oncorhynchus tshwasytscha). In particular, representation of juvenile migrants at older ages has increased in a population that historically has been dominated by sub-yearling juvenile migrants. Understanding the ecological drivers and spatial distribution of migration strategy has implications for management and hydropower operations of this population. Reconstructing the spatial distribution of juvenile strategies and origins of wild, ESA listed populations can be difficult, however, when tagging large numbers of individuals is not a feasible option. We used otolith microchemistry and geospatial techniques to reconstruct the life history of individual returning adult Fall Chinook from return years 2006-2008. Our goal is to understand the spatial distribution and fitness consequences of alternate life history strategies among juvenile Fall Chinook salmon in the Snake River. Our results show significant spatial differences in the geochemistry of key O. tshawytscha spawning, rearing and overwintering locations which can be recovered from adult otoliths. Using these chemical differences we examined spatial differences in the juvenile stage migration strategy of returning, wild fish. Our investigation indicates distinct differences in the timing of downstream movement and ocean entry between juvenile source locations.

Broad-Scale Stray Rate of Pacific Rim Chinook Salmon Migrating Beyond Bonneville Dam to the Interior Columbia River Basin

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The phenomenon of straying, (i.e. deviations of migrating fish from their natal streams), is a relatively common natural occurrence among populations of salmonid species. There are benefits to natural straying behavior (e.g. colonization and gene-flow), however, human-influences such as hatchery practices have the potential to magnify this behavior and lead to negative consequences (e.g. outbreeding depression). While numerous studies have quantified straying among adjacent or nearby river basins (tens to hundreds of km), relatively few studies have been able to examine this phenomenon on a broad geographic scale (thousands of km). We employed an updated genetic baseline of populations representing the densest coverage of the native distribution of Chinook salmon (*Oncorhynchus tshawytscha*) across the Pacific Rim that has ever been available. Individual assignment to this baseline was used to quantify the frequency and origin of strays from outside the Columbia River Basin that were observed to migrate to the interior of this river system. Genetic data consisted of multi-locus genotypes (13

microsatellites) collected from Chinook salmon that passed Bonneville Dam during four consecutive migrations between 2004-2007 (n=2294, 1810, 2326, and 2785 respectively). Out of 9215 total Chinook salmon sampled, 33 (0.4%) were found to be out-of-basin strays and their estimated origins include river basins of British Columbia, Oregon, and California, as well as Puget Sound, WA. Run-timing of the major Columbia River stocks was also characterized, and examined in context with year class. This rare ability to effectively quantify broad-scale stray rate and to obtain basic stock information via genetic stock identification helps demonstrate the utility of this method in the management of Columbia River fisheries. Further, this approach provided an opportunity to examine natural rates of homing and straying at broad geographic scales.

Population-level effects of stocking hatchery rainbow trout in wild trout streams

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Idaho Department of Fish and Game has proactively dealt with potential adverse genetic effects of introducing hatchery trout on existing populations of wild salmonids by adopting in 2001 a policy whereby only hatchery rainbow trout *Oncorhynchus mykiss* that are treated to induce sterility are stocked in flowing waters; however, concerns remain regarding ecological effects of introducing hatchery trout into streams and rivers supporting wild trout. We stocked fish in the middle three years of a five-year study to assess if stocking sterile hatchery rainbow trout of catchable size (i.e., catchables) reduced wild rainbow trout abundance, survival, growth, or recruitment in streams. Catchables (averaging 249 mm total length; TL) were stocked from 2006-2008 at a density of 3.8 fish/100 m^2 into 12 treatment reaches of stream, which were paired with control reaches in the same stream (3 km apart) where no stocking occurred. Wild rainbow trout abundance (including all fish ≥75 mm TL), recruitment, survival, and growth were determined with population estimates and PIT-tagged recaptures during mark-recapture electrofishing sampling. Abundance averaged 13.2 fish/100m^2, but ranged substantially across all sites in all years, from a low of 0.5 to a high of 131.3 fish/100m^2; similar variability was observed in recruitment to age-1. Total annual survival averaged 0.53 for estimates based on population abundance (which allowed for emigration and immigration) and 0.26 for estimates based on PIT-tagged recaptures (which allowed for emigration but not immigration). Our paired study design demonstrated that wild rainbow trout abundance, survival, growth, and recruitment to age-1 were all unaffected by stocking catchables. The lack of population-level effects from stocking catchables on wild fish was not surprising considering the high short-term mortality and socially and physiologically naive behavior typically exhibited by hatchery catchables stocked in lotic systems.

Factors affecting temperature sensitivity of streams to climate change across the Interior Columbia River basin

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Presenter: Andy Hill

Thermal regimes are fundamental determinants of patterns and processes in aquatic ecosystems because most organisms composing these systems are ectothermic. Increasing empirical evidence from a limited number of long-term monitoring sites suggest that anthropogenic climate change is warming stream and river temperatures globally. Rates of warming vary among streams and understanding factors that cause this variation is key to assessing future risks. In the absence of comprehensive long-term monitoring records, short-term studies wherein temperature changes at many sites are measured contemporaneously and related to local conditions could highlight differences in stream sensitivity to climate forcing. Since 2001, the PIBO stream monitoring program has measured summer stream temperatures at approximately 250 sites each

year across the Interior Columbia River Basin (ICB). Every five years, each of 1,250 sites are resurveyed and almost 800 paired temperature measurements now exist at these sites that are indicative of different climate years. In a preliminary analysis, we examined changes in mean summer stream temperatures between two pairs of years (2003/2008 and 2004/2009) at 371 sites ranging in elevation from 500 – 3,000 m and watershed sizes from 1 – 140 km^2. The average change in summer temperatures for 2003/2008 across 182 sites was -1.62 °C with a standard deviation of -0.76 °C; whereas the average change for 2004/2009 across 189 sites was -0.49 °C with a standard deviation of -0.65 °C. A multiple regression explained 42% of the variation in temperature changes between years and included significant predictor variables for (in decreasing order of importance) average summer stream temperature at a site, inter-annual change in August stream flow, the proportion of forested vegetation in the upstream catchment, site elevation, and inter-annual change in August air temperature. Our results indicate that ICB streams vary considerably in their sensitivity to climate forcing and that higher elevation streams in densely forested catchments may be less responsive to future climate warming. Shifts in thermal habitats for aquatic species could occur at different rates in different streams but maintaining riparian integrity and instream flows could help offset future warming in many streams. The breadth of the PIBO temperature database may also make it possible to develop a regional classification scheme for climate sensitivity of all streams in the ICB. Use of such a classification scheme with regional stream temperature models being developed could yield accurate predictions of species-specific thermal habitat distributions under different climate scenarios to aid in regional conservation efforts.

Investigation of smoltification in an impounded, adfluvial redband trout population in the Snake River Drainage, Idaho

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The goal of this study was to determine if a redband trout population that was once sympatric with steelhead prior to dam construction continues to undergo the smoltification process. Smoltification in an adfluvial population of redband trout *Oncorhynchus mykiss gairdneri* in Mann Creek and Reservoir, Weiser River drainage, southwestern Idaho, was assessed by quantifying the proportion of juvenile outmigrants displaying high skin reflectance, comparing mean gill ATPase activity among outmigrants, and examining outmigration timing compared to neighboring anadromous steelhead populations. A screw trap was operated in the lower reach of Mann Creek, Idaho to collect juvenile outmigrants. Approximately one-quarter of the 1,502 outmigrants examined displayed intermediate or high skin reflectance (non-banded, silvery coloration) typically characteristic of smolts; the other fish maintained a banded coloration more typical of resident fish. We collected 78 gill filament samples over the course of the migration season. The ATPase activity varied considerably among fish (0.95-5.81 µmoles/Pi/hr/mg Protein). Mean ATPase activity was statistically higher for non-banded fish than banded fish at the end of the migration period (May 21 – June 4). Mean ATPase activity in non-banded fish doubled over the course of the outmigration period. Adfluvial redband trout outmigrated from Mann Creek in approximate synchrony with neighboring anadromous steelhead populations. These results suggest the possibility that in areas in the Snake River drainage where steelhead have been extirpated as a result of artificial barriers, remnant populations may retain potential for anadromy if migratory paths were reconnected.

Evaluation of Underwater Epoxies to Permanently Install Temperature Sensors in Mountain Streams

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Stream temperature regimes are fundamentally important to understanding patterns and process in aquatic ecosystems and inexpensive digital sensors enable accurate and repeated measurements of temperature at a site. Most temperature measurements in mountain streams are made only during summer months because of logistical constraints associated with stream access and concerns that large annual floods will destroy sensor installations. We assessed six underwater epoxies to determine whether sensors could be attached to large rocks in streams to provide durable installations, and whether temperature measurements would be biased by heat conduction through the rocks. Only one of the six test epoxies bonded sensors firmly to rock surfaces in laboratory trials. In subsequent field trials, 9 of 11 sensors attached to rocks with this epoxy successfully weathered above-average floods in four Idaho and Nevada streams in 2010. Comparisons of daily maxima, minima, and means between rock-mounted sensors and control sensors at 10 rocks suggested temperature measurements were not biased by attachment to rocks. We also assessed the effect of direct sunlight on sensors by removing solar shields from some sensors and noted rapid and statistically significant increases in daily means (+0.21 °C) and maxima (+0.54 °C), but not minima (-0.01 °C). Subsequent to these trials, we refined the epoxy protocol through installation of an additional 289 tidbits (PIBO and RMRS) across the Columbia River basin as part of a regional sensor network. Sensor installations take approximately 20 minutes and attachments to rock surfaces over a range of stream temperatures (5 to 20 °C) are possible. Use of underwater epoxy for permanent installation of temperature sensors in mountain streams is a viable technique if an appropriate epoxy is chosen, sensors are shielded from direct sunlight, and rocks large enough to withstand floods are used.

Implementing an integrated, ecosystem-based restoration program to recover native fish species in the Kootenai River: a Tribal approach

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More than a century of anthropogenic impacts including diking, conversion of over 50,000 acres of floodplain to agricultural fields, logging, mining, infrastructure development, and construction and operation of Libby Dam, have significantly altered the ecosystem and degraded the capacity of the Kootenai River to support the biological complexity it sustained historically. These impacts are reflected in the threatened, endangered, or petitioned status of numerous fish species that are native to the watershed including the unique landlocked Kootenai River white sturgeon (*Acipenser transmontanus*), which was listed as endangered in 1994. These native species were culturally significant to the Kootenai Tribe of Idaho and were used for spiritual and subsistence purposes. To recover these species, the Kootenai Tribe of Idaho is implementing a multifaceted holistic restoration program that integrates Tribal values and incorporates: conservation aquaculture; nutrient restoration; broad-scale habitat restoration in the main stem river, floodplain, and tributaries, and reconnection of sloughs and side channels; critical uncertainties research; collaborative outreach and coordination; all integrated through a broad adaptive management framework.

Monitoring and modeling stream temperature patterns associated with climate change across the northwest US

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Presenter: Daniel J. Isaak

Abstract: A warming climate may bring unprecedented changes to stream and river ecosystems, with temperature considerations being of utmost importance, given that most aquatic organisms are ectothermic. Previous broad-scale assessments of climate impacts to streams have been limited by inadequate stream temperature data and have often relied on imprecise air temperature-elevation relationships as surrogates. Large regional databases of stream temperature observations are becoming available for the northwest US and can be used to address a host of research and management issues associated with climate change. For example, regional temperature databases are being used with new spatial statistical methodologies to develop models that can accurately predict stream temperatures for all reaches of fish-bearing streams under a variety of climate scenarios. These temperature models will be valuable tools for performing climate vulnerability assessments and for providing spatially explicit maps of thermal habitats for different species. A regional stream temperature monitoring network is evolving that now consists of more than 1,500 sites where full-year data are being collected by numerous resource agencies. Data from these monitoring efforts can be applied to describe long-term trends, to understand short-term sensitivities of streams to climate forcing, to perform historical reconstructions that provide site-specific trend estimates, and to better define thermal criteria associated with species distributions, abundance, and developmental phenologies. In short, the ability to accurately measure and model stream temperature regimes across the region is rapidly improving and significant advancements in our understanding of stream thermal ecology are expected in future years.

Snake Basin Hatchery and Harvest Management Coordination: Tools For Building Consensus

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The 31 extant wild populations of spring and summer Chinook salmon in the Snake River Basin experienced significant declines following construction of dams on the Columbia and Snake rivers and were listed as threatened under the federal Endangered Species Act. To mitigate for lost natural production, state, federal, and tribally operated hatchery programs in the Snake River Basin produce 12 million spring/summer Chinook smolts annually with many thousands of those PIT tagged for research and management purposes. Tribal, state, and federal interjurisdictional management of fisheries for conservation of natural populations, sharing of harvestable returns and ESA take, trapping of hatchery broodstocks, and distribution of fish trapped in excess of brood needs is extremely complex. In an effort to better coordinate hatchery and harvest management, agencies in the basin have implemented a structured pre-season planning, inseason coordination, post season review and evaluation process, and PIT tags play a key role in that process. Weekly inseason coordination teleconferences where run projections, harvest estimates, and hatchery trapping and broodstock collection data are exchanged are particularly important to successful resource management in the basin. This presentation describes the coordination effort that's occurring through weekly information and planning, and internet-

supported teleconferences. These coordination efforts have helped significantly to break down traditional communication barriers between harvest managers and hatchery managers within and among tribal, state, and federal management agencies in the Snake Basin.

Migration timing, run characteristics and selected plasma metrics of steelhead trout kelts from three Clearwater River tributaries, Idaho

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Idaho Department of Fish and Game (IDFG) and the University of Idaho (U of I) have partnered to investigate the fate of natural origin steelhead trout kelts from three Clearwater River tributaries. Fish Creek, a tributary of the Lochsa River, supports a natural population of B-run steelhead. The Potlatch River supports a mix of both A and B-run naturally spawning steelhead trout and some documented repeat spawning fish (iteroparous). Crooked River, a tributary of the South Fork Clearwater supports a population of B-run steelhead trout that were once extirpated by Harpster Dam. After removal of the dam in 1962, hatchery reared B-run and transplanted Selway River steelhead trout were released to restore the population. In 2009 and 2010, biologists from U of I sampled steelhead trout kelts at selected weirs and for each fish determined sex, fork length, external body condition, inserted a PIT-tag into the pelvic girdle, and removed a blood sample from the caudal vessel. Kelt outmigration occurred from March through July. The timing of spawning and subsequent kelt outmigration was related to tributary elevation. Kelts from lower tributaries of the Potlatch River migrated downstream nearly one month earlier than did fish from upper tributaries. These downstream migrations correlate with water temperatures at the weirs. We found a range of sizes of kelts within the Potlatch system, with significant differences between weirs on two adjacent tributaries, the East Fork and West Fork Potlatch. The kelts from both Fish Creek and Crooked River were larger than those from the Potlatch. We found female kelts constituted 74%, 68%, and 15% of all downstream migrants at Fish Creek, the Potlatch River, and Crooked River, respectively. Biochemical attributes of plasma samples were correlated with body condition, and we found the highest nutritional metrics in good condition fish.

Use of transplanted catfish to enhance fisheries opportunities in small urban ponds and reservoirs

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Capturing wild adult channel catfish *Ictalurus punctatus* and transferring them to high-use, urban ponds and reservoirs may be a cost effective alternative to stocking commercially-produced fingerlings for creating fisheries during summer months, if transferred fish survive and are caught readily by anglers. During summer 2009, we captured 1,296 channel catfish via electrofishing and transferred them to eight ponds in southwest Idaho. Carlin-Dangler tags were affixed to 438 of these fish (33%) prior to release. Mean length and weight of transferred fish was 556 mm (±4) and 1,885 g (±37). We estimated harvest rate, release rate, and times to encounter through the voluntary reporting of tags by anglers. Tags were reported through Idaho Department of Fish and Game's tag reporting hotline and web portal, then entered into a database. We queried tags reported before 1/1/2011, and thus estimates reported are for one full year, plus a second partial year. We corrected return rates to account for non-reporting. For 2009 transfers, total corrected harvest rate averaged 27% (±11), whereas total corrected release rate equaled 9% (±6). There was no difference in harvest rate among the three transfer periods (June, July, & September). Mean time to harvest for 2009 transfers was 220 d (± 32) with a maximum of 500 days. There was no difference in time to harvest between transfer periods, despite initial evidence to the

contrary. All catfish were harvested or released from March through October. Capture and transfer of channel catfish has shown to be a useful tool for increasing summer fishing opportunities in many urban ponds. Continued monitoring of tag returns will allow us to fine tune stocking locations, determine persistence of transferred fish, as well as assess inter-annual variation in performance.

Validation of Diagnostic Assays to Screen Broodstock for *Flavobacterium psychrophilum* Infection

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A capture enzyme-linked immunosorbent assay (ELISA) and membrane-filtration fluorescent antibody test (MF-FAT) were developed for *Flavobacterium psychrophilum*, the causative agent of Bacterial Coldwater Disease, using monoclonal antibody FL43 (MAb FL43). There is evidence that *F. psychrophilum* can be transmitted vertically and it has been suggested that culling progeny from heavily infected broodstock may be one way in which losses can be avoided. Before a culling program can be instituted, the specificity and sensitivity of the ELISA and MF-FAT must be evaluated. To do so, tissue and ovarian fluid samples were collected from fish at five hatcheries and screened for *F. psychrophilum* using capture ELISA, MF-FAT, culture, and nested PCR. Agreement between assay results was evaluated using Cohen's kappa coefficient and indirect estimates of the specificity and sensitivity of the capture ELISA, MF-FAT, and nested PCR were calculated. Assay agreement was slight (<0.20) for all assays. Sensitivity estimates ranged from 0.2544 (ELISA) to 0.9043 (nested PCR). Specificity estimates ranged from 0.0208 (MF-FAT) to 0.95544 (ELISA). In addition, prevalence of *F. psychrophilum* at the different hatcheries was evaluated. Significantly higher concentrations of bacteria in tissue samples were observed in fish from hatcheries spawning steelhead, 2.529×10^6 CFU ml^{-1}, versus rainbow trout and Coho salmon. In a separate controlled challenge experiment, the capture ELISA detected *F. psychrophilum* in sub-clinically infected fish. The results of this study demonstrate that the capture ELISA and MF-FAT are appropriate tools to screen broodstock, and the ELISA is the only assay currently available to quantify infection levels.

Phylogenetic relationships of cutthroat trout: does evolutionary history reflect geological history?

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While 14 subspecies of cutthroat trout are generally recognized in the literature, few studies have investigated the evolutionary relationships among these putative subspecies. To investigate these relationships, we used mitochondrial DNA sequence divergence data. We collected samples from 306 populations of cutthroat trout representing nine of the presumed subspecies. Populations were sampled over a broad geographic area in an attempt to represent the genetic diversity within the subspecies complex. The phylogenetic results indicate the primary divisions in cutthroat trout reflect major watershed boundaries, which currently define several cutthroat trout subspecies. However, for some subspecies, clear phylogenetic distinction is not evident. In addition, an understanding of an unidentified cutthroat trout group is emerging that may represent a more recent cutthroat trout lineage. This lineage may be geographically distributed as a result of inter-basin connections that no longer exist, but were responsible for transferring cutthroat trout into areas from which they were previously isolated. Our results illustrate the importance of sampling over a broad geographic area to better understand the evolutionary history of this complex species.

Influences of hatchery supplementation, spawner distribution and habitat on genetic structure of Chinook salmon (*Oncorhynchus tshawytscha*) in the South Fork Salmon River, ID

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We evaluated the genetic structure of putative natural spawning populations of Chinook salmon (*Oncorhynchus tshawytscha*) in the South Fork Salmon River (SFSR), and the associated influences of hatchery supplementation activity. Upper SFSR broodstock was initially collected at Little Goose and Lower Granite dams, and in the upper SFSR from 1978-1980; a segregated program began in 1996 with exclusive use of adipose-clipped broodstock. Genetic samples from natural- and hatchery-origin (HAT) carcasses were collected between 2000 and 2002 at five mainstem sites, located both upstream and downstream of the upper SFSR exclusionary weir. We evaluated allele frequency data across 95 single nucleotide polymorphism (SNP) loci to determine the extent of genetic differentiation among collections. Genetic distance analyses indicated minimal subpopulation distinction in the upper SFSR. The weak overall genetic structure (global F_{ST} = 0.009) likely reflects historic population diversity, or a homogenizing influence from hatchery introgression within the naturally spawning population. Further analyses were conducted to compare the genetic structure among the upper SFSR and two downstream spawning aggregates in adjacent tributaries; Secesh River (void of hatchery stocking), and Johnson Creek in the East Fork South Fork Salmon River, with a discrete, watershed-specific supplementation program. Results indicated spatial patterns of gene flow among watersheds. Observed genetic differentiation was relatively large despite substantial hatchery releases in the upper SFSR, and occurred coincident to the distribution of spawners within a patchwork of suitable spawning habitat. However, our results complement larger Snake River basin-wide evaluations that indicate local similarity of South Fork Salmon River populations (including HAT), having regional distinction as a group; this observation would be unlikely had the genetic influence of exogenous broodstock sources persisted in the upper SFSR. We have confirmed the presence of Chinook salmon subpopulations in the SFSR that likely reflect historic metapopulation structure despite supplementation activity. Hatchery influences appear to be disproportionately distributed among watersheds.

Evaluating the effects of roads on watershed processes and fisheries in a North Fork Coeur d'Alene River tributary using the GRAIP model: potential uses and implications

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The North Fork Coeur d'Alene River and many of its tributaries have been affected by extensive timber harvest, road construction, mining and other development over the last 100 years. As a result, many streams are now identified with water quality impairments related to excessive sedimentation, metals contamination, and warm temperatures. In 2010, the US Forest Service, Department of Environmental Quality, and University of Idaho Extension initiated a collaborative project to further evaluate the extent to which an extensive road network affects watershed processes and sedimentation in the Beaver Creek watershed, a third order tributary to the North Fork Coeur d'Alene River. The Geomorphic Roads Analysis and Inventory Package (GRAIP) was used to estimate the sources and quantity of sediment being generated by roads, the amount of sediment delivered to streams, and the risk of culvert failures or barriers to fisheries and their

habitats. Preliminary results from the model showed that the majority of road-generated sediment in streams came from only a few relatively small areas of the watershed, similar to several other recent road-related studies. The potential for results of the GRAIP model to influence water quality and Total Maximum Daily Load (TMDL) determinations will be explored along with other management implications such as a potential use of the model to explain fisheries composition and habitat quality. A strategy to restore water quality, fisheries, and stream conditions incorporating the model results will also be proposed.

Distribution, behavior, and habitat of spawning adult Pacific lamprey (*Lampetra tridentata*) translocated into tributaries of the Snake and Clearwater Rivers

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Declines in Pacific lamprey (*Lampetra tridentata*) have increased attention on their regional conservation and cultural importance to Native American tribes. Restoration efforts by the Nez Perce Tribe provided an opportunity to obtain life history information for interior lamprey populations. We monitored movement patterns and spawning activity of adult lamprey translocated into tributaries of the Snake and Clearwater Rivers prior to 2007 and 2008 spawning periods. Spawning behaviors of individuals were monitored using radiotelemetry and analyzed in relation to in-river environmental conditions. Spawning habitat use was quantified using individual nest and available habitat data. We sought to qualitatively evaluate translocation protocols, movement patterns and spawning behavior, and subsequent juvenile recruitment as relative measures of translocation success. In 2007 (n = 178) and 2008 (n = 107) adults were released into four spawning tributaries of which 20% and 39% of the translocated population were radio-tagged (30 = 2007; 29 = 2009). Most adults were sedentary after release and then exhibited short distance movements and spawning behavior after mean daily water temperatures remained above 8-10°C. Environmental conditions within release streams exhibited annual variation which appeared to influence timing of movement and spawning behavior. Adult spawning activity was observed in both years, in most streams, and corresponded closely with other regional descriptions. A total of 36 nests were found in primarily run and pool-tail out habitat; within nest substrate was primarily sand and gravel, and median nest areas ranged from 0.13 m^2 (2007) to 0.40 m^2 (2008). In 2009, surveys by the U.S. Fish and Wildlife Service detected larval lamprey in portions of two release streams indicating increased larval recruitment. These results suggest that translocation may be an effective tool in lamprey conservation, as adults remained near release locations and participated in spawning behavior. Increased knowledge of adult spawning behavior and habitat will help guide regional and tribal lamprey conservation efforts.

Accuracy of removal electrofishing estimates of trout abundance in Rocky Mountain streams

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Removal electrofishing is frequently used to estimate fish distribution and abundance in streams because it is simple and requires only one visit to a study site. However, because the removal method often overestimates capture efficiency and therefore underestimates fish abundance, some biologists have questioned its use in favor of less biased methods. In southern Idaho streams in the summers of 2006 and 2007, trout were marked and released in blocknetted reaches with backpack electrofishers using pulsed DC, and four-pass removals were conducted the following day. Removal electrofishing underestimated the abundance of trout ≥ 10 cm by 17,

22, and 25% for four-, three-, and two-pass removals, respectively, whereas for trout < 10 cm, equivalent underestimates were 27, 27, and 37%. Removal estimates were biased in part because capture efficiency progressively decreased for fish ≥ 10 cm, from 58% in pass one to 37, 30, and 18% in passes two, three, and four, respectively; a similar decline was not as evident for fish < 10 cm. Increases in channel complexity, in the form of boulder substrate, water depth, instream wood, and stream shading, resulted in higher bias in removal estimates. Linear regression models incorporating these and other variables explained between 47 and 65% of the variation in this bias. Visiting new sites in the summer of 2009 with a new field crew produced nearly identical amounts of removal estimate bias, but in some cases, predictive models did not accurately predict the bias we measured at individual sites. Our results suggest that multiple pass removal sampling in typical Rocky Mountain streams can produce population estimates that are minimally biased and therefore probably adequate for most basic fish population monitoring, especially if electrofisher settings and crew training balance the need to minimize injury with effective fish sampling.

Is weighted usable area a valid proxy for egg-smolt survival for juvenile Chinook salmon?

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Physical habitat simulation (PHABSIM) modeling is a widely used technique for determining streamflow needed to protect aquatic resources. PHABSIM combines models of water velocity and water depth with a variety of habit measures and life-stage specific habitat use information to produce a habitat metric known as weighted useable area (WUA), expressed as square feet per 1,000 feet of stream. If WUA is a valid measure of habitat condition, then fish survival in habitat limited systems should be positively related to WUA. We compared Chinook salmon egg-smolt survival in the Lemhi River and Marsh Creek to juvenile rearing WUA calculated with a PHABSIM model that included water depth, water velocity, and substrate. We used WUA available in May and August because flow limitations have been demonstrated during those times. In both the Lemhi River and Marsh Creek, WUA increased rapidly as a function of streamflow, reaching maximum at streamflows that were near or below the lowest flows on record, then gradually declined as streamflow continued to increase. Hence, a negative relationship between streamflow and WUA existed across a large range of streamflow. In the Lemhi River, egg-smolt survival was strongly inversely related to WUA in May and very weakly inversely related to WUA in August. In Marsh Creek, egg-smolt survival was weakly inversely related to WUA in both May and August. These negative relations suggest that WUA calculated with water depth, water velocity, and substrate alone is not a valid measure of juvenile Chinook salmon habitat condition in the Lemhi River and Marsh Creek. Relations of egg-smolt survival and streamflow in both the Lemhi River and Marsh Creek are positive, indicating that streamflow is a better indicator of habitat condition than WUA in these two systems.

Spatial and temporal variation in juvenile steelhead (*Oncorhynchus mykiss*) growth and consumption in a hydrologically altered watershed

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Energy requirements for growth in fishes increase with increasing water temperatures. In hot and dry summer climates the scope of growth can be constrained for cool- and coldwater species such as steelhead (*Oncorhynchus mykiss*). We employed a spatially explicit bioenergetic modeling approach calibrated for juvenile steelhead to 1) assess the spatial and temporal distribution of energetically favorable habitat, 2) relate this distribution to achieved growth in individually tagged fish, and 3) assess the deviation from the maximum consumption rates in these individuals across four streams in the Lapwai watershed of north-central Idaho, USA. The

resulting patterns were then related to the altered hydrograph of two of the streams which are caused by water withdrawals for irrigation purposes. Early results showed both spatial and temporal variation in energetically favorable habitats due primarily to the thermal regime of each of the 16 sites. Achieved growth in tagged individuals corresponded chiefly to this variation, but population densities, flow, and physical habitat characteristics influenced the magnitude of the deviations from maximum consumption. We discuss the implications of the altered hydrograph in two of the streams on juvenile steelhead growth and consumption. Because bioenergetic modeling provides a mechanistic linkage between fish and their environment we conclude that it is a suitable approach in describing growth opportunities in fish populations in areas where water temperatures approach and even exceed their tolerance.

Hybridization patterns in redband trout reflect multiple introduction and invasion sources of non-native cutthroat and hatchery rainbow trout in a high-profile river in Idaho

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Hybridization with non-native species is one of the greatest threats to native fishes including trout. Many studies have documented hybridization in native cutthroat trout, but fewer have focused on this issue in native rainbow trout despite wide-spread threats from both non-native cutthroat and hatchery rainbow trout. Here I demonstrate the utility of genetic approaches for rapid assessment of both inter- and intra-specific hybridization in redband trout populations across the upper Boise River, Idaho, a system where native species reside in a mosaic of relatively natural conditions *versus* areas highly impacted by barriers, altered flows and intensive fish stocking. Results suggest that complex patterns of historical introductions of both exogenous trout have left a spatially variable footprint on native redband trout, which currently exist in states ranging from having been completely replaced, to existing as hybrid swarms, to being actively invaded, to maintaining relatively high genetic purity. The maintenance of pure redband trout in some areas is perhaps fortuitous but not likely to be static, given the high propagule pressure from multiple locations in the watershed – including headwater lakes – and known vagility of hybrids. Opportunities to preserve the genetic integrity of this potentially unique eco-type do still exist, but this study emphasizes the complex decisions facing managers today: actively isolating populations is sometimes the only option available to prevent imminent invasion but can greatly increase the extinction risk of salmonid populations in volatile systems like the Boise River. The most effective strategy for conserving native redband trout in this river may be a careful analysis of management options incorporating the specific attributes of each site and population to evaluate the relative risks posed by isolation *versus* maintaining connectivity, and long-term monitoring of the genetic integrity of remaining pure populations in the future.

Modeling physiological changes in energy stores of sexually mature and post spawning steelhead trout in the Columbia/Snake River

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After re-entering freshwater, adult steelhead trout (*Oncorhynchus mykiss*) rely on stored energy to complete migration to their natal spawning streams, gonad maturation, successful reproduction and post spawning migrations. Very little is known about energy use and allocation in adult steelhead trout, especially in how somatic energy stores contribute to successful iteroparity. In 2009 and 2010, we lethally sampled 402 steelhead trout from the Columbia/Snake River at three stages: pre-spawning, sexually mature, and post spawning (kelts) to model changes in stored energy. We determined lipid content and calculated total energy in the liver and white muscle using proximate analysis and bomb calorimetry. In fish with corresponding blood samples we

compared the relationship of triglycerides and cholesterol in the blood plasma to our estimates of lipid content in the tissues. We found that lipid levels of pre and post spawning steelhead varied between the years. The proportion of lipids in livers of mature steelhead trout in 2009 was significantly higher than kelts, but this trend was not observed in 2010. The proportion of lipids in white muscle tissues sampled from steelhead trout showed a significant gradual depletion from highest levels in the early pre-spawning steelhead trout to nearly complete depletion of lipids in migrating kelts. Our results suggest that white muscle may be a more accurate measure of total energy storage over measures of the liver. Using these metrics, we plan to construct a bioenergetic model for adult steelhead trout to help interpret and integrate the physiological profiles as they relate to successful steelhead trout iteroparity.

Factors Affecting Early Life History and Growth of Naturally-Produced Fall Chinook Salmon in the Lower Snake River, Idaho

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Density-dependent mechanisms are a major regulatory force acting on the growth, behavior, and survival of riverine fishes. Density-dependence may be of particular concern in hatchery-managed systems because artificial increases in abundance may exceed the carrying capacity of stocked habitats. We investigated a 17-year time series of information on naturally-reared and individually PIT-tagged subyearling fall Chinook salmon (*n*=5,082*)* in the Lower Snake River. Our objectives were to: (1) quantify temporal changes in individual fish weight and time spent in free-flowing and reservoir habitats, (2) compare empirical fish weights at each recapture to those expected from a bioenergetics model, and (3) use the model to determine per capita consumption with respect to maximum consumption in both free-flowing and reservoir habitats in association with river flows and hatchery-induced changes in fish abundance. In free-flowing reaches, weights at recapture were similar to those expected by the bioenergetics model and maximum consumption (i.e., C_{max}), yet as fish abundances increased in the reservoir, weights at recapture were less than expected by the bioenergetics model and C_{max}. The effect of abundance on weight at recapture was negative and non-linear, supporting the presence of a threshold, whereby large increases in per capita consumption may be expected when < 25,000 subyearlings per day were in the reservoir. Increases in river flow were also associated with an additive increase in per capita consumption and weight at recapture. The measured effect of fish abundance on consumption and growth was likely attenuated, however, by an increased emigration response (i.e., reduced travel time) as abundance increased and river flows decreased in the reservoir. Our findings support the conclusion that recent reductions in weight at recapture and emigration timing were the result of hatchery-induced changes in abundance and river flows in reservoir habitats.

Fisheries Management in a Tribal First Foods Context

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The Confederated Tribes of the Umatilla Indian Reservation's (CTUIR) Department of Natural Resources (DNR) has adopted a mission based on "First Foods" ritualistically served in a tribal meal. The serving ritual identifies spatial and temporal relationships between First Foods and the landscape. We seek to utilize the First Foods to bring attention to ecological processes that may be devalued outside of Tribal culture and to prioritize efforts to re-naturalize those processes that sustain First Foods. Further, we suggest First Foods provide a direct and culturally appropriate

means to monitor and report restoration progress to the Tribal community. First Foods management application examples will include water quality and fisheries habitat restoration.

Population Demographics of Catostomids in Iowa's Large Rivers: Effects of Discharge on Recruitment Dynamics and Growth

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Catostomids are among the most widespread and ecologically important groups of fishes in North America, particularly in large rivers. Despite their importance, little information is available on their population demographics and dynamics. The objectives of this study were to describe annual mortality, recruitment variation, and growth of eight catostomid species, and to evaluate the effects of discharge and temperature on their year-class strength and growth in Iowa rivers. Catostomids were sampled from 3 km reaches in four nonwadeable rivers during June-August 2009. River carpsucker *Carpiodes carpio* and silver redhorse *Moxostoma anisurum* had higher maximum ages (up to age 11), slower growth, lower total annual mortality (20-25%), and higher recruitment variability than the other species. Northern hogsucker *Hypentelium nigricans*, golden redhorse *M. erythrurum*, and shorthead redhorse *M. macrolepidotum* lived 6-8 years, had stable recruitment, and high total annual mortality (i.e., 40-60%). Golden redhorse exhibited the fastest growth; whereas, growth of northern hogsucker and shorthead redhorse was intermediate to the other catostomids. Highfin carpsucker *Carpiodes velifer*, quillback *Carpiodes cyprinus*, and white sucker *Catostomus commersonii* had high growth rates, low mortality (i.e., 25-30%), and stable recruitment. Neither discharge nor temperature was related to recruitment of catostomids. Species that typically consume prey items most common in fine substrates (e.g., chironomids) had higher growth rates in reaches dominated by sand and silt substrate. Species that consume prey associated with large substrates (e.g., plecopterans) had faster growth in reaches with a high proportion of rocky substrates. Temperature was not related to growth; however, high discharge was positively related to growth of nearly all species in the study reaches. This study provides important information on the autecology of catostomids for comparison among species and systems. These data also suggest that connection of rivers with their floodplain is an important feature for catostomids in temperate river systems.

Age-Growth, Natural Mortality, and Models Predicting Growth of Redband Trout in High Desert Streams of Idaho

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Large gaps exist in population dynamics knowledge for redband trout residing in arid environments. Here we estimate natural mortality in nine Idaho streams using rapid assessment methods and quantify longevity and growth in each using sagittal otoliths. We also compare growth between the sexes and investigate relationships between growth, temperature, and other abiotic habitat parameters via multiple regression. The maximum age of redband trout collected in spring from the nine study streams ranged from 2 to 9 years. In general, redband trout in the study streams were small but there were sizeable differences in mean back-calculated length at age, ranging from a mean of 79.7 mm at age 1 in Crab Creek to 129.2 mm in Sinker Creek. Males grew faster, on average, than females and attained greater maximum length in eight of nine streams. Conditional natural mortality approximations using observed data ranged from 0.41 in Little Jacks Creek to 0.88 in Sinker Creek. The best models relating first year growth of redband trout to abiotic variables included mean fall-spring temperature and elevation for both sexes and explained 52% and 59% of the variation in length at age 1 for males and females,

respectively. The reason for the smaller size of females in desert redband trout is unclear but could be the result of a conflict in the timing of somatic and gonadal growth or more complex fitness tradeoffs observed in other salmonid populations. Results of our habitat modeling suggest that the fall-spring period is more important in terms of redband trout growth in desert streams than the summer period (June to August) which is characterized by higher water temperatures, a phenomenon described previously as inverted seasonal growth.

The Limits of Indigenous Rights and Salmon Fisheries Conservation in the State of Idaho: A Common Perspective and Paradox Towards Management

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Salmon are a loved symbol of the Northwest and salmon fishing, among sport fishermen and Native American fishermen, remains a quintessential Northwestern experience and livelihood. Many Native American populations depend on productive salmon runs for cultural continuity and salmon are embedded into their culture and identities. “Fish wars” between sport fishermen, commercial fishermen, fisheries managers, and Native American communities have defined the salmon landscape for the last century. Conflicts between these groups are primarily over harvest rights and harvest allocation. These conflicts persist as Native Americans have asserted their treaty rights to fish and have become co-managers of the resource. Inter-fishermen and interagency conflict has escalated especially as the salmon resource has become more and more scarce.
Data collected from 44 in-depth interviews conducted with Shoshone Bannock fisheries experts and fishermen, sports fishermen, and Euro-American fisheries experts provides the core of this qualitative comparative case study. This study examines the struggle for authority to define this salmon landscape of two disparate groups who share and manage a common geography, Euro-American fisheries experts and Shoshone Bannock fisheries experts who live and work in the headwaters of the Idaho fisheries. Due to the biased geography of salmon fisheries mitigation, historically focused on maintaining only commercial lower river runs (e.g., in Oregon and Washington), and the cumulative lethal effects of the hydropower system, each of the five Idaho salmon stocks have become threatened and disproportionately scarce when compared to lower Columbia populations and historical Idaho abundance. This scarcity leads to the formation of environmental inequalities and crisis fisheries management practices. Results reported here display the social negotiation between different fisheries managers in the headwaters over how to manage and recover salmon. These negotiations are based on their perceptions of inequality and their social constructions and myths, which guide their management goals. This study reveals the shared goals and perceptions of these co-managers as well as suggests explanation for the conflicts and insight as how to reconcile them.

Testing the power of Single Nucleotide Polymorphism markers (SNPs) for Parentage Based Tagging of Snake River hatchery steelhead

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One promising alternative to traditional mechanical tagging methodologies for monitoring and evaluating hatchery Chinook salmon and steelhead in the Columbia River basin is parentage-based genetic tagging (PBT). PBT involves the annual genotyping of all broodstock at each hatchery of interest, creating a parental genotype database. Progeny from any of these parents

(either collected as juveniles or returning adults), if genotyped, could be assigned back to their parents, thus identifying their hatchery of origin and exact brood year they were produced in. A PBT pilot study completed in 2008 on Snake River steelhead demonstrated high parentage assignment accuracy using microsatellite DNA markers (5 hatchery stocks, 1034 adults, 500 offspring) and was successful in permanently "tagging" approximately 2 million smolts. Although microsatellite DNA markers proved accurate, it is believed that Single Nucleotide Polymorphisms markers (SNPs) have significant advantages over microsatellite DNA markers because they are more easily standardized among laboratories and amenable to cost-effective, high-throughput, automated genotyping. Modeling indicates that as few as 60–100 SNPs may allow accurate pedigree reconstruction, however, this number has been met with skepticism and has not been demonstrated empirically. In this study, we screened the same adult/juvenile sample set with 192 SNPs. We demonstrate that fewer than 96 SNPs are needed for high accuracy in parentage assignment, allowing for a single Fluidigm® gene chip to complete genotyping on 96 samples in a single run. We are currently in the process of constructing PBT SNP genetic baselines for all hatchery spring/summer Chinook salmon and steelhead in the Snake River basin (10,000–15,000 adults/year). This is the first large-scale, proof-of-concept study of PBT technology in the Columbia River basin. This technology, along with additional genetic tools for segregating wild runs by origin (genetic stock identification), should provide unprecedented tools for managing wild and hatchery stocks.

Evaluation of Virkon Aquatic toxicity and application to disinfect invasive mollusk infested field and hatchery gear

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In the western U. S., populations of New Zealand mudsnails (NZMS) and *Dreissenid* mussels have become established in fish hatcheries and in many aquatic systems. Resource managers want to limit the potential for transfer of invasive mollusks to new locations. Virkon Aquatic is a broad-spectrum disinfectant used in many hatchery facilities as a disinfectant on footwear, nets, and equipment for protection from bacteria, viruses and one fungus. This chemical has the potential to be used in a broader context in hatchery and fishery field operations, but the appropriate dosage and duration of exposure and safety limits must be determined. We conducted experiments to determine the lethal concentration and duration of exposure for complete killing of NZMS, and quagga mussels. We evaluated bath and spray applications of Virkon Aquatic on felt, neoprene, and rubber soled wading boots infested with NZMS. We found all life stages of NZMS were killed after a 20 minute bath exposure in 2% Virkon Aquatic. All quagga mussel veligers exposed to 0.5% Virkon Aquatic were dead after 10 minutes, and adult quagga mussels were killed after a 10 minutes bath exposure to 2% Virkon Aquatic. We also estimated the toxicity of Virkon Aquatic to steelhead trout fry and fingerlings, and found that quantities carried over in nets or other equipment are very safe. Research by others confirms Virkon Aquatic is also effective on other aquatic invasive species such as didymo. Virkon Aquatic breaks down in the presence of organic material and causes little, if any, damage to neoprene or breatheable nylon waders. Bath applications on wading gear are recommended over spray to assure killing, and Virkon Aquatic powder is easily transported into the field. Virkon Aquatic is recommended for use in field and hatchery disinfection protocols.

Born to be Wild: Salmon Responses to Natural Disturbance

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Dynamic landscapes are shaped by a variety of natural disturbances operating across several spatial and temporal scales. Persistence of species in these dynamic environments is also a matter of scale: how do the species dispersal and reproductive rates merge with the scales of disturbance? Human activities have altered the disturbance regimes of many landscapes and compromised our ability to examine both natural disturbances and species responses. In the Pacific Northwest, salmon populations have evolved with a complex set of natural disturbance patterns and processes. In this study, natural disturbances and wild Chinook salmon populations were evaluated in the Middle Fork Salmon River (MFSR), Idaho. The MFSR is a large wilderness basin where many natural disturbance processes function unimpeded by human activities. During the last 15 years, a series of fires, intense thunderstorms, and debris flows have altered fish habitat within both the mainstem MFSR and several major tributaries. We observed the temporal and spatial responses of spawning Chinook salmon to natural patterns of habitat disturbance and regeneration in the basin. This paper describes those responses, assesses the importance of dispersal and habitat connectivity, and addresses how a changing climate may alter natural landscape dynamics.

Species profiling of *Misgurnus anguillicaudatus*: Ecological characteristics of a little known but proliferating invader

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Successful invasive species share several characteristics which aid their establishment and propagation within introduced habitats. Among these are high fecundity, dietary diversity, and wide tolerance of environmental conditions. Native to Eastern Asia, the Oriental weatherfish (*Misgurnus anguillicaudatus*) is a cryptic, yet internationally invasive species which may pose a threat to native fish populations within its introduced range. Described as a tropical aquarium pet species, *M. anguillicaudatus* has successfully become established in 7 countries across 3 continents, including 10 of the United States. Under commonly cited species account descriptions, the environmental conditions experienced by the fish within its invaded range should serve to decrease its invasive success. However, in the face of apparently expanding population sizes and newly documented occurrences we undertook this study to determine the life history traits which facilitate the fish's survival in these seemingly inhospitable environments. We collected weatherfish from an invasive population in and around the Boise River near Boise, Idaho, throughout 2008-2009. In a series of experiments, weatherfish showed high tolerance and survivorship under freezing temperatures and substrate desiccation similar to local seasonal habitat conditions. Rapid growth, early maturation and high fecundity may also aid survival and expansion of new introductions. Opportunistic omnivorous diet and preference for habitat highly modified through anthropogenic disturbance may facilitate survival through unique habitat use and escape from potential native predators. Together, these traits characterize a successful invasive fish capable of expanding its range far beyond the environmental limitations that previously published accounts would suggest.

Adapting model results for wood recruitment to streams for use in restoration and conservation planning for a Tribal fishery

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The importance of coarse wood to stream channel structure and native fishes is widely recognized, yet there is great need for additional information on the characterization of fine- and large-scale patterns in coarse wood dimensions and loadings with respect to the effects of management and disturbance. The Coeur d'Alene Tribe recently conducted research which examined existing instream wood loads, stream conditions and the wood recruitment capacity of riparian forests associated with more than 74 km of streams. Objectives were to 1) relate instream wood loads and stream conditions to better understand fisheries production potential as it relates to riparian stand condition and recruitment; 2) examine potential management effects on wood recruitment capacity; and 3) draft priorities for restoration/enhancement treatments.
We used the Forest Vegetation Simulator (FVS) model and wood recruitment models, adapted into a GIS framework, to calculate a spatially distributed estimate of wood recruitment rate under three riparian management prescriptions over a 150 year planning horizon. The spatial and temporal differences in recruitment rate translate to differences in wood abundance and wood-formed habitat that is useful in restoration and conservation planning.
From the perspective of habitat quality, management and restoration activities have two primary goals: 1) to develop and maintain well functioning riparian-channel interactions that promote a diverse channel environment with high-quality habitat; and 2) to improve conditions where current habitat quality is low. The appropriate activities to achieve these goals vary with channel and riparian zone attributes and current condition. We identified three primary attributes, each divided into nominal rankings, to aid in determination of appropriate actions and in setting of priority levels for on-the ground projects.

Salmon and Steelhead Performance Measure Evaluations at the Tributary, Major Population, DPS, and ESU Scales

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The Nez Perce Tribe currently has monitoring and evaluation projects monitoring juvenile and adult salmon and steelhead performance measures at the tributary and major population scales. However, until recently estimating these same performance measures at the DPS and ESU scales has been difficult if not impossible. Recently the NPT and the Integrated Status and Effectiveness Monitoring Project (ISEMP) initiated a project in to estimate escapement of adult spring/summer Chinook salmon and steelhead at all these scales using passive integrated transponders (PIT) tags. Remotely operated interrogation sites, utilizing pass-by flat panel antennas are located in strategic locations of the South Fork Salmon River, Imnaha River, Grande Ronde River, Clearwater River, and Lemhi River Basins. Migrating natural unmarked adult salmonids during the 2009-2010 return were systematically captured in the Lower Granite Dam (LGD) fish ladder and tagged with PIT tags. Tissue and scale samples were also collected from tagged adults to enable scale ageing and gender determination in cooperation with the Genetic Stock Identification (GSI) project being conducted by the Idaho Department of Fish and Game. A total of 3,792 steelhead and 1,168 Chinook were tagged, representing 8% and 4 % of the retuning adults over LGD, respectively. Tributary estimates for steelhead were 1,885 ($\pm$ 53, 95% CI) in the SFSR and 578 ($\pm$ 93) in the Lemhi, while estimates for Chinook in 2010 were 7,005 ($\pm$ 350) in the SFSR and 175 ($\pm$ 0) in the Lemhi. However, these estimates do not include

the variance associated with sampling at LGD. These efforts are a result of a long term regional monitoring effort funded by the Bonneville Power Administration. Once all of the ISEMP PIT tag arrays are installed they will total 26 individual remotely operated PIT interrogation sites generating escapement estimates at multiple scales including the tributary, population, and ESU scales. When combined with the GSI project information, escapement estimates by age class and gender will be possible at multiple population scales.

An evaluation of bull trout *Salvelinus confluentus* bycatch from predator reduction netting in Lake Pend Oreille

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Survival rates for kokanee *Oncorhynchus nerka* in Lake Pend Oreille reached record lows following increased predation during the past decade. To increase kokanee survival in Lake Pend Oreille, extensive predator (lake trout *Salvelinus namaycush* and rainbow trout *O. mykiss*) reduction efforts were initiated in 2006 and included contracting a commercial fishing company to remove lake trout. During 2006-2010, about 57,000 lake trout were removed by gill and trap netting. Incidental bycatch of native bull trout *Salvelinus confluentus* was over 4,200 individuals and direct mortality rate was 24%. To minimize bycatch and understand potential effects of netting on the bull trout population, data collected during netting operations were evaluated. Seasonal catch rates by gill net mesh size and panel height were analyzed and used to design nets that maximized the lake trout to bull trout catch ratio. Gill nets with stretch mesh of 5.1-7.0 cm were most effective for targeting juvenile lake trout, while stretch meshes of 11.4 and 12.7 cm were best for targeting mature lake trout. Further, shorter gill net panels reduced bull trout bycatch, especially during the spring. Genetics samples were collected from bull trout and used to assign fish to their stream of origin, which allowed bycatch risk to be assessed for individual tributary stocks. Genetics analyses showed that bull trout from all tributaries distribute throughout the lake and should have been equally vulnerable to capture. However, bull trout assigned to the Lightning Creek drainage were overrepresented in the catch, while bull trout assigned to Trestle Creek (the most abundant stock) were underrepresented. These analyses, combined with lake trout telemetry, have allowed netting operations to most effectively target lake trout while minimizing bull trout bycatch. Additionally, this evaluation showed that lake trout netting has not been detrimental to the Lake Pend Oreille bull trout population.

Flow regime, biotic interactions and temperature determine differential responses of four trout species to projected climate change in the western US

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Climate change is likely to cause changes to trout distributions, but broad-scale studies to date have focused almost exclusively on temperature effects. We analyzed the effects of climate change as mediated by increased temperatures, altered flow regimes and biotic interactions on four species of trout across the historical range of cutthroat trout in the interior West of the United States (~1 million sq. km). We used logistic regression to model distributions based on a database of fish collections at 9890 sites. Flow regime projections were derived from a new database of modeled hydrographs at the stream reach scale. Our forecasts predicted a 50% net

decline in suitable habitat for native cutthroat trout (*Oncorhynchus clarkii*) under the 2040s A1B emissions scenario (82% decline under the 2080s scenario), driven mainly by temperature. We predicted a 57% / 88% (2040s/2080s) decline in suitable habitat for introduced brook trout (*Salvelinus fontinalis*), driven by temperature and altered flow regime. Introduced brown trout (*Salmo trutta*) was predicted to decline by 14% / 45% (2040s/2080s) due mainly to altered flow regime, while rainbow trout (*Oncorhynchus mykiss*, native to part of the region) was predicted to experience only minor declines in total length of suitable stream habitat, though like all the species it was predicted to shift to higher elevations. We found that biotic interactions with the three other species were important determinants of cutthroat trout distributions, constraining it to about a third of the area it would otherwise occupy. Results suggest that trout will persist at high elevations in the interior West through the 21st century, but these are likely to be mainly nonnative species.

Nutrient enhancement in Dworshak Reservoir and its potential for benefitting a kokanee *Oncorhynchus nerka* population

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In 2007, the Idaho Department of Fish Game and the U.S. Army Corps of Engineers began a nutrient supplementation pilot project designed to restore declining nitrogen to phosphorus (N:P) ratios and reduced productivity in Dworshak Reservoir. During the first four years, bottom up trophic responses were observed. Picoplankton density increased during the first year, followed by edible phytoplankton and zooplankton in subsequent years. Nutrient additions did not result in any violations of state mandated water quality standards. Higher trophic levels often take several years to respond to nutrient supplementation; however, we did observe some positive kokanee *Oncorhynchus nerka* population responses. Kokanee initially showed improved growth rate and body condition. By 2010, the population size of age 1 and older kokanee had more than tripled from 2007. Length-at-age decreased at this higher density, but improvements in body condition were sustained. Additional years of nutrient additions and monitoring are necessary to fully understand the long-term benefits of this project, but results to date suggest nutrient supplementation is having beneficial effects.

A demographic evaluation of hatchery- and natural-orign Chinook salmon (*Oncorhynchus tshawytscha*) and its impact on the population genetic structure in the South Fork Salmon River, ID

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We evaluated the demographic structure of the Chinook salmon spawning populations (Oncorhynchus tshawytscha) in the South Fork Salmon River (SFSR) basin to determine the genetic impact of naturally-spawning hatchery fish on natural-origin populations across the basin. Alternative management objectives in the upper SFSR, Johnson Creek and Sesesh River resulted in a wide range of influence from hatchery fish, from very high in areas near the McCall Hatchery Trap (MHT) declining to relatively minor in the Secesh River. From 1996 – 2008 multiple-pass, ground count surveys were completed on 4 sections in the upper SFSR below the MHT to estimate spawner abundance, spawn timing, sex and age composition, natural:hatchery ratio and carcasses distribution in the areas with the highest hatchery influence. The index of spawner abundance of the SFSR below the MHT was highly variable over this time period, averaged 321.9 (S.E. = 51.22) redds with a range of 40 redds in1996 to 715 redds in 2004. Spawner distribution and spawn timing were relatively stable over that time period. We identified

significant differences in female prespawn mortality, age at return, size at return and adult spawner sex ratio for natural-origin compared with hatchery-origin Chinook salmon. Hatchery-origin fish made up approximately 70% of the recovered carcasses in the two sections just downstream and closest to the MHT and approximately 15% in the two sections farther downstream. Genetic differentiation among the hatchery stock and the naturally-spawning groups from each section was not significantly different. Straying hatchery fish, as indicated by the capture or recovery of adipose fin clipped carcasses, into Johnson Creek and Secesh River, made up less than 5% of those populations and suggested limited geneflow. This was confirmed by the genetic analysis demonstrating significant differences between all upper SFSR collections and those from Johnson Creek and Secesh River. These results suggest that the distribution of hatchery spawners, though high in the upper SFSR, has had a minimal impact on Johnson Creek and Secesh River and the overall genetic structure likely represents the historic population in the basin.

Movements of individual trout in response to electrofishing

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Estimating abundance is fundamental to enlightened management and ecological understanding of stream fishes. Commonly used estimators typically assume that fish do not leave sample sections because this would lead to biased measures of abundance. To prevent fish movement, biologists often install block nets at the boundaries of sampling reaches, which is often time-consuming, may be logistically impossible, and detracts from effort that could be invested in sampling additional areas. We individually electrofished 121 trout of three species implanted with radio transmitters in six small, montane streams in western Montana to quantify movement and the influence of habitat. Although about half (49%) of fish moved during the first electrofishing pass (median distance, 5.7 m), most (60%) remained in the habitat unit where first observed and only 10% moved more than 2 habitat units. Forty-two percent were captured on the first electrofishing pass. Capture efficiency was lower and movement rate higher for brown trout in the largest stream sampled, but there were no differences among other streams or species. Habitat variables did not explain fish movement during electrofishing or the probability of capture on the first pass, but the distance that fish moved during the first pass and the length of the initial habitat unit were significantly related to the number of passes necessary to capture a fish. These data help define the level of bias in estimates of fish abundance produced by fish movement and assist biologists with regard to the need for block nets.

Poster Abstracts in Alphabetical Order

Migration timing, growth, and estimated parr-to-smolt survival rates of wild Snake River spring-summer Chinook salmon from the Salmon River basin, Idaho, to the lower Snake River

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Survival, growth, and juvenile migration timing are key life history traits for at-risk salmon populations. To estimate these traits in threatened wild Snake River spring/summer Chinook salmon *Oncorhynchus tshawytscha*, we tagged these fish as parr in 3 to 17 natal streams from 1988 to 2009. We injected passive integrated transponder (PIT) tags into parr collected from streams within the Salmon River basin in Idaho. Each spring, after the previous summer's tagging, fish were detected as smolts in the juvenile fish bypass systems of lower Snake River

dams. Estimated parr-to-smolt survival to Lower Granite Dam (from 1993 to 2010) ranged from 3 to 48% for individual populations and from 8 to 25% (yearly average 16%) for all streams combined. From 1998 to 2004, estimated parr-to-smolt survival declined from 25 to 8%, then from 2005 to 2008 survival increased from 8 to 21%, due, in part, to parr density-dependent effects. Overall annual average growth rates from tagging to detection at Little Goose Dam ranged from 0.13 to 0.16 mm/day (from 35.1 to 46.1 mm) from 2001 to 2010, with significant differences in growth among sites and years. Growth of individuals was positively related to elapsed time between tagging and recapture and negatively related to length at tagging. Annual migration timing distributions for fish populations from the different streams varied highly within and between years. From mid-April to mid-June, timing of the 10th to 90th percentile passing Lower Granite Dam ranged from 22 to 55 days for the combined wild populations (average 38 days). Although the overall 10^{th} and 50^{th} percentile migration timing trends for wild fish at the dam have changed little, the 90^{th} percentile passage trend is 12 days earlier averaged over the most recent 11 years compared to the previous 11 years. Baseline data generated by this project provide a foundation for understanding the bio-complexity of these populations, an understanding critical to effective recovery efforts for these threatened wild fish stocks.

Evaluating physical marking techniques for juvenile burbot

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Assessment of physical tags suitable for juvenile burbot *Lota lota maculosa* is currently absent from the literature. A collaborative program restoring imperiled burbot populations in the Kootenai River seeks cost-effective marking and nonlethal mark recovery techniques. A 26 d experiment on 240 burbot (65–92 mm total length) evaluated 7 tagging treatments in terms of fish survival, growth, and mark retention. A variety of artificial markers including fin clips, freeze brands, visible implant elastomer (VIE) and passive integrated transponder (PIT) tags were studied. Fin clips either removed the anterior dorsal or right pectoral fin. Liquid nitrogen freeze brands were applied dorsally or ventrally. VIE was injected in the dorsal fin base or proximal to the eye. PIT tags were inserted into the peritoneum via small incision. A control treatment consisted of untagged juveniles exposed to anesthesia. Survival was 100% in all treatments. One-way analysis of variance of total length (mm), wet weight (grams), and mark retention revealed no significant differences (P=0.73, 0.88, 0.64 respectively) between tagging or control treatments. Mark retention was 100% with the exception of dorsal fin clips (93%), dorsal VIE (97%), and PIT (97%). A follow-up evaluation by a panel of tag assessors without experience suggested dorsal freeze brands and dorsal fin clips were difficult to identify. Mottled pigmentation, scale presence, and skin regeneration contributed to poor definition in dorsal freeze brands. Regeneration and subtlety of the anterior fin vexed inspections of dorsal fin clips. Study results infer that all tested marks can be safely applied to burbot. These preliminary findings provide a baseline for researching artificial marks retained by burbot throughout juvenile grow-out to adulthood.

Mitigating for the loss of marine nutrients from salmon: Ecological effects of salmon carcass and analog additions to headwater aquatic and terrestrial systems in Idaho

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We are conducting a multi-watershed nutrient supplementation, adaptive management project in the Boise River basin, Idaho to measure differences between two nutrient supplementation strategies (salmon carcasses and salmon carcass analogs) in headwaters where anadromous fishes have been extirpated, to mitigate, at least in part, for the loss of marine nutrients once delivered by large runs of Pacific salmon. Inorganic soil nitrogen levels increased 500-1500 µg g-1 within the immediate vicinity of riparian-deposited salmon carcasses. Soil nitrogen levels increased as deep as 10 cm and remained elevated for almost one year following carcass decay. Two weeks after treatment application, stream algae increased three and six times in the analog and carcass streams, respectively, compared to control streams; total microbial biomass increased two-fold in both the carcass and analog streams. Two weeks after treatment application adult aquatic insects, predominantly chironomid midges, were most abundant along analog-treated streams, and terrestrial Dipterans (Calliphoridae and Muscidae flies) most abundant along carcass-treated riparian habitats. Resident fish growth doubled in both the carcass and the analog treatments within six weeks. Fish diet data suggests this short-term increase in fish growth might be due to direct consumption of analog and carcass material. To date, treatments have not detected increased bat foraging frequencies, activity, and species diversity; we have found no increase in isotopic carbon signatures of bats, suggesting that bats are either not consuming insects that have taken up marine-derived nutrients (13C, 15N), or not consuming them in quantities high enough for marine signals to be detected. Bear data are still undergoing analyses. These data support the hypothesis that nutrient supplementation can help mitigate for the loss of marine-derived nutrients once provided by anadromous fishes in places where runs of those fishes have declined.

Resident trout consumption of salmon carcass and analog added to tributaries of the N. Fork Boise River, Idaho.

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After completing spawning, Pacific salmon die and their carcasses provide an important marine-derived subsidy for freshwater and terrestrial ecosystems. Their reduction or absence from some ecosystems in the Pacific Northwest has prompted the use of nutrient mitigation techniques as a means of offsetting perceived lost productivity in these systems. We conducted an experiment using salmon carcass (n=3), analog pellets (n=3), and control (n=3) treatments in 500-m reaches of nine tributaries on the North Fork Boise River, Idaho. We hypothesized that salmon carcass and analog material would be directly consumed by resident fishes. Rainbow trout (*Oncorhynchus mykiss*) and brook trout (*Salvelinus fontinalis*) were collected by electro-fishing before, and 2, 4, and 6 weeks after treatment additions, and gut contents were obtained via non-lethal gastric-lavage. Diet items were separated into aquatic invertebrate, terrestrial invertebrate, and treatment (i.e., carcass, analog) categories. Both carcass and analog were present in the diets through time and gradually declined. Salmon carcass material comprised 50% of the diets at 2-weeks after treatment and decreased to 10% at 6 weeks. Analog material comprised 30% of the diet at 2 weeks, and decreased to 10% at 6 weeks. Based on this linear decline, we predicted that no treatment would persist in trout diets in carcass streams after 50 days and analog streams after 55 days. Conservative estimates of analog treatment consumption by trout populations ranged from 7 to 18 kg, which was 1.5 to 3.8% total treatment loading. Carcass consumption ranged from 17 to 35 kg, or 1.8 to 2.3% of total loading. Our study shows that salmon carcass and analog treatments provide a food source for resident trout. Further research is being conducted to determine how this alternative diet may affect growth rates and population dynamics.

Distribution and Diet of Largemouth Bass (*Micropterus salmoides)* in the Lower Boise River, Idaho

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Where introduced, largemouth bass *(Micropterus salmoides)* are known to have deleterious effects on aquatic ecosystems. The largemouth bass was first introduced to the Boise River drainage in the late 1800s. We used historical museum records (1942-2006) and contemporary (2009) collection data to assess the distribution of largemouth bass in the lower Boise River. We also analyzed stomach contents of largemouth bass from the 2009 survey to determine diet. Seventy-four largemouth bass were represented in 13 historical collections from five locations throughout the lower Boise River. During autumn 2009, we sampled eight sites in the lower Boise River for largemouth bass and evaluated stomach contents. Sixty-one largemouth bass (range 55-156mm TL; mean=84mm) were captured from five sites downstream of Settler's Diversion Dam. Largemouth bass were absent from all sites upstream of the dam suggesting the barrier is preventing dispersal to upper reaches of the river. This data extends the known distribution of largemouth bass in the river 7.2 river km upstream. The long-term persistence (without recent stocking) of largemouth bass in the lower Boise River indicates the fish may be spawning there and/or entering the system from external sources. Eighty percent of the largemouth bass collected in 2009 were less than 100mm TL. The lack of large individuals in the population suggests that largemouth bass in the lower Boise River may be reproducing at a smaller size than what has been reported for the species. Analysis of largemouth bass stomach contents revealed aquatic insects (40%), crayfish (37%), and small–bodied fishes (11%) comprised much of the diet. Our study confirms the largemouth bass to be a successful invader of the lower Boise River, and the species is piscivorous at small sizes. These findings suggest that largemouth bass could have a negative impact on native fishes of the lower Boise River.

Development and assessment of a panel of novel SNP assays for population differentiation of westslope cutthroat trout

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In this study, DNA sequence data was collected and screened for single nucleotide polymorphisms (SNPs) in order to develop genotyping assays for use in population demographic studies within westslope cutthroat trout (*Oncorhynchus clarki lewisi*). Screening for SNPs was done through PCR amplification and Sanger sequencing of 128 EST fragments in a set of 63 individuals in our ascertainment panel. Individuals chosen for sequencing were collected from various populations across the natural range of westslope cutthroat trout (n=54) and also included two samples each of four other subspecies: Lahontan (*O. c. henshawi*), Bonneville *O. c. utah*, Coastal *O. c. clarki*, and Yellowstone *O. c. bouvieri*. A single double-haploid *O. mykiss* sample was also included in the sequencing panel for detection of duplicated loci and variation between the two species. Eighty-seven SNP detection assays (Taqman assays) were designed based on SNPs discovered in this sequencing effort. Another six *O. mykiss* SNP assays that were variable within westslope cutthroat trout and 12 previously published assays were also included in downstream testing. All assays (N = 105) were tested on a set of six westslope cutthroat trout populations (32 individuals per population). All assays were evaluated for reliability and deviation from Hardy-Weinberg equilibrium. Poorly performing assays were removed from the data set and the remaining assays were used in tests of population differentiation. Descriptive statistics such as heterozygosity and G_{ST} are reported as well as data describing the ability of these markers to differentiate the six test populations.

Genetic Diversity and Relatedness Assessment in Captive Stock Bonneville Cutthroat (*Onchorhynchus clarkii utah*) using Microsatellite Multiplex PCR

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As part of the larger goal to conserve Bonneville cutthroat (*Onchorhynchus clarkii utah*), Idaho Fish and Game established a population of candidate broodstock donors made up of from Thatcher Management Unit (MU) in the Bear River Drainage. It was the aim of this project to 1) develop a multiplex with enough power to determine to compare genetic diversity among wild and captive BCT populations and 2) determine relatedness among the 2010 spawners. This broodstock and the practices developed for re-establishing BCT populations within the Thatcher MU will provide information for re-building BCT populations in other MUs in Idaho. A multiplex of 12 microsatellite loci was developed with which the captive BCT population and wild populations were analyzed for expected and observed heterozygosity, and allelic richness. Two maximum likelihood methods and one relatedness estimator were evaluated using captive broodstock crosses of known relationships to determine the most effective for use with future spawners. Genetic diversity among the 2010 captive spawners was sufficiently higher than that from wild samples in Thatcher MU and all relatedness estimators were successful in identifying related individuals. The 2010 captive spawners were analyzed for relatedness and management recommendations made in consideration of relatedness estimators and inbred crosses.

Use of Membrane Filtration Florescent Antibody Test (MF-FAT) to Identify *Renibacterium salmoninarum* within Eggs of Sexually Mature Female Chinook Salmon: An Attempt to Establish Correlative Relationships between Detection of Bacteria in the Eggs, Ovarian Fluid and ELISA Levels in the Kidney

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The question of whether a female salmon that is positive for *Renibacterium salmoninarum* (Rs, the causative agent of bacterial kidney disease, BKD) by enzyme-linked immunosorbent assay (ELISA) has passed the infection to her offspring through vertical transmission is the 64 million dollar question. This question is further complicated when culling decisions for offspring involve programs where gene conservation and preservation of a threatened stock are the priority, such as the Grande Ronde Basin Spring Chinook Captive Broodstock Program. While ELISA is highly sensitive in detecting the presence of Rs antigen in kidney tissue, it does not document the actual presence of the bacterium or distinguish between actively infected fish versus one that was previously exposed, mounted a successful immune response clearing the infection. We collected samples of 30 eggs and 2 mL of ovarian fluid from 103 mature female Chinook salmon at the time of spawning. We used the Elliot and McKibben membrane filtration fluorescent antibody test (MF-FAT) protocol to count Rs cells in the eggs and ovarian fluid. Kidney samples were also collected and processed by ELISA. Identification of Rs within the eggs and ovarian fluid was successful using this protocol, however bacterial cell concentration for eggs did not correlate well to bacterial cell concentrations in ovarian fluid ($r=0.3265$) or with ELISA ($r=0.2429$). Bacterial cell concentration in ovarian fluid provided a slightly better correlation with ELISA ($r=0.4324$). Detection of high numbers of bacteria in the ovarian fluid by MF-FAT was not predictive of egg cell infection: some females with low ELISA values (<0.2) were identified with high numbers of bacteria in their ovarian fluid and conversely females with high ELISA values (>0.8) had low bacteria counts for their ovarian fluid or egg contents. Detection of Rs bacteria in the eggs and ovarian fluid using MF-FAT was successful, however we do not recommend this process to refine the culling of sensitive populations due to the labor intensive nature of the process.

Use of a tilted wedge wire coanda screen as an outmigrant fish trap on a dam spillway

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We've successfully used a tilted wedge wire Coanda screen as an outmigrant fish trap on the spillway of the Buffalo River Hydroelectric Project Dam for the past two years. The 5.95 m²(64 ft²) screen and supporting framework were designed, constructed, and installed by the Hydroscreens Company at a cost of $11,900. Total water capacity of the trap is about 1.13 m³/s (40 ft³/s). The trap uses 1 mm wire spacing with a wire tilt of 5 degrees. The shearing action of the tilted wires and the coanda effect help pass the majority of the water entering the trap through the screen. Fish and debris, along with remaining water, move down the screen and into a bypass pipe to a holding tank. The trap was operated from June 30 to November 24, 2009 and March 12 to November 19, 2010. A total of over 10,000 fish has been captured in the trap. About 80% of the captured fish were rainbow trout, followed by brook trout, whitefish, dace, and shiners. Capture efficiency of the trap ranged from 12% to 15% of age-0 rainbow trout during the high flow period of spring 2010. Mortality or injury to fishes from the trap has been very low. The trap does not require an electrical power source, has no moving parts, and no repairs or structural maintenance of the screen has been required to date. The screen has required frequent (daily or every other day) cleaning of debris when high aquatic macrophyte loads occur in the summer in the Buffalo River. We recommend the tilted wire Coanda screen for use as a fish trap or as fish exclusion device on spillways and diversions that have similar operating conditions as our installation.

Whitefish passage of the 6X Diversion on the Big Lost River

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The 6X Diversion is located on the Big Lost River in south central Idaho. During the fall of 2008, a submerged orifice ladder and bypass was installed at the 6X Diversion to provide passage for whitefish. During the 2010 irrigation season, I used a cone trap in the ladder to assess whether or not fish used it. The diversion remained passable for fish through most of the irrigation season, but when the flows dropped during August, the 6X Ranch repaired the diversion making it impassable and substantially reducing flows downstream from it. Prior to the repairs, no fish were captured in the trap. In the four days following the repairs, eleven whitefish were captured in the trap. From then until the end of September, when the trapping was discontinued, only trout and sculpin were captured. Based on these observations, whitefish successfully find and use the ladder when the diversion is impassable.

Scale resorption in migrating and spawning steelhead *(Oncorhynchus mykiss)*

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Iteroparity (repeat spawning) is an important aspect of steelhead life history. It has been documented but not well described in steelhead of the Snake River basin. Loss of scale material occurs during migration, spawning, and overwintering, which leads to formation of a spawn check. Variability of resorption leads to differences in the strength of spawn checks, thus complicating the identification of repeat spawners. We quantified resorption seen in scales as

fish transition from a pre- to post- spawn state. We obtained 72 paired scale samples from fish collected at Lower Granite Dam during the upriver migration and as post-spawn kelts moving downriver. In our preliminary work (n=10), we observed a wide range of material loss on the scale margin between individuals. Loss was not uniformly distributed around the scale and region showing the most loss varied among fish. Total area loss ranged from 6-48%, with a mean of 27%. The majority of fish (60%) showed equivalent loss in anterior and posterior fields, while 30% had more loss in the posterior field and 10% in the anterior field. There was a complete loss or an obscured outer annulus in 70% of fish. These results show that there is variation in the amount of material loss among individuals, which leads to differences in strength and characteristics of spawn checks. This level of variation can lead to mis-identification of repeat spawners and assignment of incorrect ages to steelhead in the Snake River basin. We expect further research will aid in the identification of weak spawn checks, providing better estimates of iteroparity.

Reproductive Success of Reintroduced spring-run Chinook salmon in the Hood River, Oregon

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Supplementing declining salmonid populations with hatchery-reared individuals is an important fishery management tool used to increase abundance for conservation and/or harvest objectives. Integrating locally-derived natural origin individuals into supplementation broodstock can help offset negative effects on fitness such as inbreeding and domestication selection. However, when entire populations have been extirpated from historically occupied areas, no indigenous stock remains to initiate a re-introduction program, necessitating use of an out-of-basin stock. We are currently examining how a reintroduced stock in the Hood River, Oregon, may be adapting to its new environment, as reflected by differences in reproductive success between hatchery and natural origin individuals. Spring-run (stream-type) Chinook salmon were deemed extirpated from the Hood River basin following seven consecutive years (1965-1971) of essentially zero escapement to the fish ladder at Powerdale Dam. A re-introduction program was initiated in 1986 with annual releases of juveniles from Carson NFH, then beginning in 1993 with releases from the adjacent Deschutes River stock. To create a localized Hood River stock, an increasing proportion of in-basin adult returns have been incorporated into the hatchery broodstock. Here we report preliminary results from the study, involving genotyping of ~7,700 individuals across 18 years (1992-2009) using 15 microsatellite loci, followed by parentage analysis for hatchery and natural origin individuals spawning above Powerdale Dam (brood years 1992-2004). Our results showed that fish returning to the Hood River during this period were mixtures of the reintroduced stream-type genetic lineage as well as an unexpected proportion of stray fish from the Lower Columbia lineage. The stream-type and Lower Columbia lineages are evolutionarily distinct in the Columbia River Basin, and their sympatry in the Hood River affords a rare opportunity to study their relative reproductive success, in addition to the planned comparisons between the hatchery and natural origin fish derived from the Carson then Deschutes supplementation stocks.

Massive air and stream temperature sensor networks for studying microclimatic variation in mountain landscapes of the northwest U.S.

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Presenter: Daniel J. Isaak

Climate change is motivating extensive research to understand potential responses in terrestrial and aquatic ecosystems. Ongoing efforts to downscale climate models are improving the resolution at which climate data are available, but outputs from even the latest regional climate models are coarse relative to the scales at which ecological processes operate and landscapes and natural resources are managed. Inexpensive digital temperature sensors and remote sensing technology now facilitate collecting large amounts of information for a variety of environmental attributes. Efforts are underway to coordinate and develop massive regional air and stream temperature sensor networks to understand climatic variation more precisely in mountainous landscapes. At present, air temperatures are being monitored at more than 1,000 sites in western Montana and northern Idaho, and full-year stream temperatures are being monitored at more than 1,500 sites in Montana, Idaho, Oregon, and Washington. Numerous agencies are collecting these data and have contributed their site locations and data to the development of this emerging regional network. Planned site installations may add another 500 stream temperature sites to the network in 2011. The collection of full year data at these sites, as well as the density and complementary nature of the sensor networks, enables a range of research questions about fine-scale climate variation to be addressed. This research will provide valuable insights regarding aquatic ecosystem responses to climate change and contribute to a basic understanding of material and energy fluxes through river basins and mountain landscapes.

Comparison of spring/summer Chinook salmon life histories and resulting scale patterns in jacks, minijacks, and precocial male parr

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Male Chinook exhibit a number of life history strategies in addition to anadromy. Males can mature without ever leaving their natal stream (headwater precocials), after a brief residence in the migration corridor or estuary/ocean (minijacks), after one year in the ocean (jack) or after two to four years in the ocean (adults). Our goal was to describe the range of precocious male life histories in Snake River spring/summer Chinook salmon by comparing scale patterns from a range of lengths, from headwater parr to ocean-going jacks. Scales were collected from males producing milt that were less than 46 cm fork length in hatcheries, at screw traps, and on the spawning grounds. We observed scale patterns that indicated differences in the growth of precocials that never left headwater streams, precocials that made partial migrations, minijacks that spent three to four months in the estuary/ocean, and jacks that spent one year in the ocean. The majority of Chinook spend one year in fresh water before migrating or maturing, however precocials scales also showed zero and two years spent in fresh water. There was little overlap in fork lengths of precocials, minijacks, and jacks. The fork length of minijacks was smaller than previously reported in the Columbia River basin. The scale pattern for minijacks migrating below Bonneville was unique due to the large distance between circuli (0.051 mm). Headwater precocials had fewer scale circuli than the other life histories. The continuum of male Chinook life histories that can be seen in scale patterns provide answers to not only their age, but also whether they spent time in productive or unproductive fresh and salt water.

Daly and Sturgill Creek Habitat Improvement / Monitoring Project

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Idaho Power Company (IPC) owns and manages several lands throughout Idaho and Oregon. Riparian habitat improvements on the Daly and Sturgill Creek properties include grazing exclosure fencing, removal of invasive and noxious plants, and planting of native vegetation. These lands are open to the public; however, motorized travel is not allowed in efforts to reduce erosion. IPC initiated a habitat monitoring program in 2007 to assess changes in stream and

riparian habitats in Daly Creek and Sturgill Creek, both of which are tributaries to Brownlee Reservoir. The habitat monitoring program is an adaptation of pre-existing state and federal monitoring programs and includes components of bank stability and coverage, canopy shade, substrate counts, photo points, invertebrate sampling, width:depth, water quality, and stream temperature. In addition, multiple electro-fishing sites have been established within these streams, which may reveal long-term trend relationships between the native redband trout populations and stream habitat conditions.

Species Composition as an Indicator of Environmental Quality in an Impacted Stream System

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Hydrologic alterations are a major threat to fish communities in developed nations. Dams and water withdraws cause large scale changes to lotic environments. The Lapwai basin is mostly within the Nez Perce Reservation of Idaho and contains four major tributaries; two face the implicit in-stream changes associated with water withdraw. The objective of this study is to assess the impact of lower flows and habitat changes on fish communities and provide information on these impacts for people associated with the management of impacted systems. The impacts of stream alterations were analyzed by comparing fish communities across various habitat types and relating the presence and density of species to environmental variables. The relationship of community composition to environmental quality was also integrated as part of a greater study on the growth and survival of juvenile steelhead *Oncorhynchus mykiss* within the system and what impacts fish communities and community changes may have on juvenile steelhead. We found that impacted streams contained more sucker-minnow species while the unimpacted streams contained more scuplin-salmonid species. Through principal component analysis it was determined the major factors of these distributions were temperature, flows, and stream channel morphology and that species such as long nose dace *Rhinichthys cataractae* and bridgelip-sucker *Catostomus columbianus* showed strong associations. It was concluded that water withdraw is a large force behind changing community composition in streams and that community changes may be a good indicator of environmental quality on a case by case basis.

Burbot Extensive Rearing – Exploring Short Term Solutions for Burbot Rehabilitation in the Kootenai River

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Extensively reared burbot *Lota lota* maculosa may be an important short term measure to population rehabilitation in the Kootenai River. Our objective was to determine if extensively reared burbot larvae stocked in predator free pens could achieve a 10% survival rate and grow to a range of 70 to 98 mm total length within six months. On May 24, 2010 we placed 484 burbot larvae into five, 500 µm nitex mesh pens [in a private pond (0.059 ha)] at different stocking densities. Two pens (1.83 m^3) were stocked at low density of 16.4 larvae/m^3, two pens (1.83 m^3) were stocked at moderate density of 32.8 larvae/m^3, and a fifth, larger net pen (3.66 m^3) was stocked at a high density of 83.1 larvae/m^3. We used light traps weekly to determine general abundance and growth of burbot. The zooplankton population in each pen was supplemented weekly with an average density of 16.3 zooplankton/m^3. Burbot were recovered from pens (206) on July 29, 2010, after two months, because of a paucity of food and cannibalism. Burbot from all pens averaged a total length of 37 mm. Growth rates per pen were: low density 0.39 mm/day, moderate density 0.35 mm/day and high was 0.38 mm/day. Survival rates were: low density 86%, moderate density 78%, and high density pen20%. This compares to 2009 daily growth of 0.41 mm/day and overall survival of 21%. Similar growth in the high density pen may have been

due to cannibalism and a density dependent response, the higher mortality reduced competition for food. Rearing of low numbers of burbot in net pens can reduce early mortality but unless plankton (food) densities are maintained at adequate levels mortality due to cannibalism, after about 60 days, can be a limitation. Extensive rearing in pens in the absence of predators can lead to improved survival and more burbot for stocking.

Develop a naturalized Chinook salmon (*Oncorhynchus tshawytscha*) population in the Yankee Fork Salmon River using volitional adult spawner and juvenile smolt releases

Carlos Lopez, Kurt A. Tardy, Alex Graves, and Brock Moss
Shoshone Bannock Tribes
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The Yankee Fork Salmon River (Yankee Fork) is a traditional Chinook salmon fishery area for Shoshone-Bannock Tribal members, reserved under the Fort Bridger Treaty of 1868. Tribal fishermen have witnessed a significant decline in the number of fish being harvested in the Yankee Fork and this decline has been closely linked to the decline in productivity. The Tribes initiated a Chinook salmon (*Oncorhynchus tshawytscha*) supplementation project in Yankee Fork, Idaho to assist in returning 2,000 adults for Tribal conservation (1,500) and harvest (500) management objectives. Yearly, the Tribes install a rotary screw trap to estimate juvenile migrants and two portable picket weirs to enumerate the adult return and collect broodstock. In 2008 – 2010, 294 adult Chinook salmon were trapped, of which 30.3% were natural and 69.7% were hatchery (Tardy and Denny 2010). Approximately 2,955 total hatchery adults were obtained from Sawtooth Fish Hatchery and outplanted in upper Yankee Fork for natural spawning in 2008 and 2009. Intensive spawning ground surveys were completed in all years and 1,101 total redds were observed. In summary, staff estimates a total escapement of 3,640 Chinook salmon in the Yankee Fork; 1,935 in 2008, 1,640 in 2009, and 65 in 2010. Due to insufficient returns to the Yankee Fork from 2008 to 2010, zero broodstock has been collected. Staff anticipates age^{3} returns to the Yankee Fork in 2011 from adult outplants in 2008 and smolt releases in 2010. We also estimate a total of 534,024 (SE 17,348) and 129,733 (SE 5,619) natural x natural, hatchery x hatchery, and/or natural x hatchery juveniles migrated passed the screw trap from program operations in 2009 and 2010, respectively.

Fishery Assessments on the Duck Valley Reservation, Idaho and Nevada, 2007-09

Terry Maret, Dorene MacCoy, and Ross Dickinson Presenter
U.S. Geological Survey, Boise, ID
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Since 2007, the U.S. Geological Survey and the Shoshone-Paiute Tribes of the Duck Valley Reservation have cooperated to assess aquatic biological resources in reservation reservoirs and in the Owyhee River. Decades of mining activity near the reservation in northcentral Nevada and recent mercury advisories on consumption of sportfish from southern Idaho waters prompted these assessments. The objectives were to evaluate mercury concentrations in fish tissue found in reservoir and riverine habitats on the reservation and to evaluate the biological integrity of the fish communities and associated summer water temperatures along the East Fork Owyhee River. In 2007 and 2009, fish tissue filet samples composed of multiple age classes of rainbow trout were collected from Mountain View, Billy Shaw, and Sheep Creek Reservoirs and were analyzed for total mercury. In 2008, fish community data and continuous water temperatures were collected at four East Fork Owyhee River sites and selected sportfish tissue was analyzed for total mercury. Total mercury wet weight concentrations in rainbow trout from the reservoirs were found to be above background concentrations (0.02-0.29 ppm, n=90 versus background of 0.01-0.05 ppm, n=10) but they were below concentrations that would warrant a fish consumption advisory. Fish community data summarized by the Index of Biotic Integrity (IBI) developed to evaluate northwest rivers indicated impairment at lower river sites, with scores ranging from 34 to 57 out of 100. The absence of coldwater native fish species (i.e., trout and sculpins) appears to be the

primary reason for community impairment at the sites as indicated by the IBI scores. Measurements of continuous summer water temperatures may provide the best explanation for this absence of coldwater fish species. Lower river sites regularly had summer water temperatures exceeding coldwater temperature criterion of 22 C.

Sensitivity of Off-Channel Salmon Rearing Habitats to Changing Base Flows in Unconfined Low-Gradient Mountain Streams

Jim McKean, Carolyn Bohn, Dan Isaak, and Russ Thurow
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Critical rearing habitats for juvenile salmon and trout are frequently in off-channel areas of shallow, low-velocity water. Typically, these are remnants of abandoned channel positions that are still hydraulically connected to the contemporary main channel. However, the size and spatial arrangement of this habitat is strongly dependent on water stage in the main channel. In two salmon-bearing streams in the Middle Fork Salmon River, Idaho, we used a high-resolution channel DEM to define the locations, surface areas and volumes of off-channel habitat. We then remapped the functional off-channel areas corresponding to a range of historic and predicted future low flow discharges. Measurements at nearby gages indicate that average late summer and autumn low flows in these streams have declined by about 5% per decade over the prior 60 years, leading to a loss of 15-20% of off-channel habitat. Modern off-channel habitat along the 20km of study streams is not uniformly arranged, even at high flows, and the habitat becomes more fragmented as flows decline. While much prior research has focused on the effects of climate change on the availability and condition of spawning sites and on water temperatures, this study documents likely changes in the amount and condition of rearing habitat. Progeny of summer- and early fall-spawning Chinook salmon rear for up to 2 years in this habitat before migrating to the ocean. Young steelhead use the same areas for up to 3 years. Further investigation is needed to understand whether these fish populations may be at some risk from diminishing rearing habitat during declining base flows caused by external forces, such as a changing climate, dams, or water extractions.

Genomics of thermal adaptation in redband trout

Shawn R. Narum and Nathan R. Campbell
Columbia River Inter-Tribal Fish Commission
Presenter: Shawn R. Narum, nars@critfc.org

Previous work has demonstrated local adaptation in populations of redband (*Oncorhynchus mykiss*) trout occupying desert and montane habitats. To further elucidate the genetic mechanisms of thermal adaptation, gametes were collected from a single representative wild population adapted to each of warm and cool climates. Gametes were fertilized to produce progeny of a pure warm adapted line, pure cool adapted line, and their F1 crosses. Fish from each of these lines were reared in constant conditions at the Hagerman Fish Culture Experiment Station until they reached an average of 5 grams, and then were divided into treatment and control groups. Fish in treatment tanks experienced diel temperature cycles that reached a maximum of 28.5°C in the afternoon and a minimum of 17.0°C at night. Control tanks were held at a constant temperature of 15°C (spring water). Mortality was measured throughout the duration of the experiment (6 weeks) from three replicate tanks for each line. Tissue samples were collected throughout the experiment, with fin clips collected from all survivors and mortalities in the treatment tanks, and liver and gill tissue from both control and treatment tanks at various time periods (24 hours, 72 hours, 7 days, 30 days). DNA was extracted from fin clips of individuals that survived or died in treatment tanks and were screened with numerous SNP markers throughout the genome. Results of this genome scan are being used to identify the gene regions involved in thermal adaptation in this species. Gene expression data is also being collected from liver and gill samples.

Modeling the Effects of Anadromous Fish Nitrogen on Riparian Forest Carbon Balance

Andrea J. Noble Stuen, Kathleen L Kavanagh, and Tadd A. Wheeler
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Wild anadromous fish such as Pacific Chinook salmon (*Oncorynchus* **tshawytscha***)* and steelhead (*Oncorhyncus mykiss*) were once abundant in Idaho, where they deposited their carcasses, rich in marine-derived nutrients (MDN). This study investigates the long-term cumulative effect of presence versus absence of anadromous fish nitrogen on the carbon balance of riparian forests along historically salmon-bearing streams in the North Fork Boise River watershed, Idaho. The ecosystem process model BIOME-BGC is used to develop a representative forest ecosystem and predict the impact of decades of addition and continuing absence of MDN on net ecosystem exchange (NEE) and net primary productivity (NPP). The model is parameterized using local ecophysiology and site data and validated using field measurements of leaf area and soil moisture. Multi-decadal model runs with and without nitrogen deposition at levels consistent with estimates of historical deposition are run to determine the effects of these nutrients on the forest's carbon balance. Results indicate that MDN may increase NPP by approximately 10% relative to no nutrient addition, whereas the continued loss of marine nitrogen may lead to decreasing NPP and NEE relative to historical conditions. Understanding the long-term impacts of MDN to inland watersheds will help inform forest management and nutrient-loss mitigation efforts.

Reclamation of Historic Wetlands for the Rehabilitation of Salmonid Habitat within North Central Idaho's Nez Perce Reservation

Justin Peterson, Bobby Hills, and Emmit Taylor Jr.
Nez Perce Tribe, Watershed
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As is the case throughout much of the Pacific Northwest, diminished water quality and quantity limit salmonid spawning and rearing throughout streams of North Central Idaho's Nez Perce Reservation. One method utilized by the Nez Perce Tribe to rehabilitate hydrological function within the region is reclamation of historic wetland areas. The following illustrates preliminary results of a wetland reclamation project located in "Inptooqsix", a nature preserve which buffers steelhead and coho salmon spawning and rearing habitat in Lapwai Creek, a tributary to the Clearwater River. As depicted, the project utilized ground penetrating radar (GPR), wetland sod installation, drain tile decommissioning techniques, tree and shrub establishment, mechanical and chemical control of noxious weed species, and project photo point monitoring.

Use of Natural Markers to Describe Snake River Spring/Summer Chinook Salmon Life History Characteristics and Environmental Correlates.

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Temporal variation in anadromous salmon abundance has been shown to be strongly correlated to aspects of climate variability. Indeed, Chinook salmon production has been linked to water chemistry, hydrologic, and temperature regimes, all of which are very likely to be altered during the next 50 years because of continued changes in the Earth's physical climate system. However, due to the complex life history of Chinook, which includes a wide range of biological traits and behaviors among and within populations, predicting the ecological response of the species to shifting environmental conditions can be intrinsically difficult. A further complication, it is neither feasible nor practicable to use standard sampling techniques for reconstructing life history and

characteristics of populations that migrate long distances to marine feeding areas thousands of kilometers away, especially those that spawn and rear in remote wilderness stream ecosystems. Utilizing advanced analytical methods, identifying and quantifying natural markers in biological tissues offers great potential as a descriptor of life history diversity, population connectivity, and environmental factors that drive recruitment processes in Snake River Spring/Summer Chinook salmon. A better understanding of the complex interactions between these populations and their environments is essential for accurately estimating juvenile carrying capacity and smolt production, forecasting future spawning run sizes, and designating critical habitat.

Energy and proximate content of selected tissues from Snake River steelhead trout kelts sampled at Lower Granite Dam

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Presenter: William C. Schrader

We sampled summer run steelhead trout from the Snake River as they migrated downstream at Lower Granite Dam on the Snake River. Liver and white muscle tissue were sampled from hatchery and natural origin fish to determine their proximate constituents (water, protein, lipids and ash). Tissues from some fish were also analyzed for total energy content. We provide estimates of the range of these constituents over two years of sampling. We are testing the hypotheses that male steelhead kelts are less likely to have adequate stores energy to complete successful migration to the ocean. These data can be useful in validating bioenergetic models to determine the costs of spawning and migration.

Adult Abundance & Productivity of Spring Chinook Salmon in Lolo and Newsome Creeks Nez Perce Tribal Hatchery Monitoring & Evaluation Results

Sherman Sprague, Thomas Backman, PhD., Justin Bretz, Catherine Bradley, PhD, Carol Reuben, and Jay Oatman
Nez Perce Tribe
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Over 150 years ago, the Nez Perce Tribe signed a treaty with the United States government. In the Treaty of 1855, the Nez Perce retained total fishing rights on all streams and rivers within the boundaries of the original 13.4 million acre reservation that extended outward to “all usual and accustomed places” including the mainstem Columbia River. Since then, salmon and steelhead runs have declined to crisis proportions due largely to hydroelectric power developments, habitat degradation, water quality impacts, and over-harvesting.

The Nez Perce Tribal Hatchery (NPTH) is a supplementation hatchery that uses innovative Natural Rearing System (NATURES) techniques. Our goal is to produce juvenile fish that are physiologically and behaviorally similar to naturally produced fish, resulting in increased post-release survival. Fish are released in under-seeded streams with the goal of returning adults to spawn naturally.
The NPTH program began with the release of parr into Lolo and Newsome creeks (Clearwater drainage) in 2003. Natural smolts have been observed in both creeks. Adult return eight year geometric means for the two streams are 300 (Lolo) and 144 (Newsome). Progeny-per-parent has not approached replacement in the natural populations of Lolo and Newsome creeks for the two brood years analyzed, though the estimated P:P was much higher in BY 2004 than in BY 2003. Natural juvenile abundance has declined in Lolo and Newsome creeks concurrent with a drop in adult escapement.
Adult returns remain volatile but are observing natural production as a result of supplementation. Much of variability is due to variable survival of supplementation fish from release in the fall to smolts the following spring, and then from smolts to adults as they traverse down-river through

the hydrosystem and encounter variable ocean conditions. Additional monitoring and evaluation reports, presentations, and information are available on the Nez Perce Tribe Fishery Department web site (http://www.nezperce.org/~dfrm/index.html

Modeling water and small particle residence times in two rearing units used for intensive culture of steelhead trout in Idaho

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Dworshak National Fish Hatchery rears large quantities of steelhead trout *Oncorhynchus mykiss* that are integral to conservation hatchery supplementation programs in the Snake River system. Concerns about settleable solids in rearing units due to low velocities and hydraulic dead zones led hatchery managers to convert two rectangular circulating Burrows ponds (BP), into experimental mixed-cell raceways (MCR). The MCR uses directed water flow to create discrete units with a circular counter current over centrally placed drains. We measured velocity, hydraulic residence time (HRT) and particle removal efficiency on a BP and a MCR to compare the two rearing systems. We used acoustic Doppler velocimetry to measure water velocities in three dimensions at depths of 1 and 2 meters across the rearing units. We introduced a salt tracer and measured conductivity at discharge to model HRT. Plastic beads were introduced into the BP or MCR to simulate typical particles of feces and waste feed. The removal efficiency was modeled by measuring the mass removed over time. We found the MCR exhibited fewer dead zones, more homogenous velocity distribution, and a higher average velocity than the BP. Vectors revealed well-defined, counter-rotating cells in the MCR. The HRT turnover of the MCR was closer to ideal than was the BP (83.7% compared with 81.1%). Particle removal in the MCR was 99.8% after 50 minutes. We recovered only 6.1% of beads from the BP over the same time frame. The larger, more homogeneous velocities in the MCR are desirable for uniform water quality and optimal fish growth. Although the HRT tests did not reveal dead zones, the efficiency of particle removal validated observations of accumulated solids in production BP that are often associated with bacterial growth and frequency of cleaning. Bead tests confirmed visual observations that the MCR is an efficient system to remove solids.

Hooking and landing success and deep hooking rates for stream-dwelling trout fished with baited circle and J-hooks

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Circle hooks are becoming commonplace in many recreational fisheries (especially marine) because they often reduce deep hooking rates, but there has been little evaluation in trout fisheries. We compared deep hooking rates, hooking success, and landing success among baited inline circle hooks, and inline and offset J-hooks fished actively and passively for stream dwelling trout. Deep hooking rates were highest for actively fished inline J-hooks (29%) and passively fished offset J-hooks (28%) and were lowest for actively fished offset J-hooks (9%) and actively fished inline circle hooks (10%). Hooking success was highest for actively fished inline J-hooks (75%), was lowest for passively fished inline circle hooks (45%), and was always higher for actively fished hooks than passively fished hooks of the same type. Landing success ranged from 76-86% and did not differ significantly between hook type or angling method. The deep hooking rate of passively fished circle hooks was twice as high as actively fished circle hooks, which conflicts with manufacturer's recommendations. Our results suggest actively fishing with

circle hooks has the potential to reduce deep hooking rates compared to passive fishing with other hook types and does not result in significantly less frequent hook-ups or reduced landing success.

The Importance of Marine Nutrient Subsidies in Mountainous Riparian Forests

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Prior to blockage of fish passage in the Columbia River Basin migration of anadromous fish from the Pacific Ocean would have brought with it large stores of marine derived nitrogen (N) and carbon (C) to central Idaho, USA. In a region dominated by nutrient poor soils and complex topography, anadromous fish may have been a primary nutrient input to riparian forests. To examine the importance of this subsidy, anadromous fish carcasses and analog pellets (a carcass substitute) were placed within riparian forests of a watershed void of anadromous fish for nearly a century. Soil samples 0-10cm collected beneath these treatments revealed rapid development of nutrient "hot-spots". Within 10 days of treatment, inorganic N (NH_4^+ + NO_3^-) significantly ($p<0.05$) increased from 2.2 µg/g ± 0.3 SE to 1245 µg/g ± 75 SE and dissolved organic carbon (DOC) significantly ($p<0.05$) increased from 205 µg/g ± 27 SE to 510 µg/g ± 30 SE. DOC and IN concentrations began to decline following snow melt and had returned to near background concentrations by one year post treatment. However, soil respiration measurements two years post treatment found significantly ($p<0.05$) elevated respiration rates suggesting microbial activity remained elevated. Lack of elevated C and N pools in conjunction with elevated respiration and isotopic evidence of rapid vegetative N utilization would suggest that supply and demand had reached a steady state. Foliar isotope analysis of conifer seedlings found significant ($p<0.05$) enrichment in $\delta^{15}N$ from -0.3‰ ± 0.06 SE pre-treatment to 4.7‰ ± 0.03 SE one year post treatment. Foliar %N did not significantly increase suggesting N uptake responsible for the shift in $\delta^{15}N$ was quickly converted to additional biomass. Rapid utilization of N as well as the magnitude of soil C and N responses to these treatments demonstrates the vital nature of this nutrient subsidy to oligotrophic systems.

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