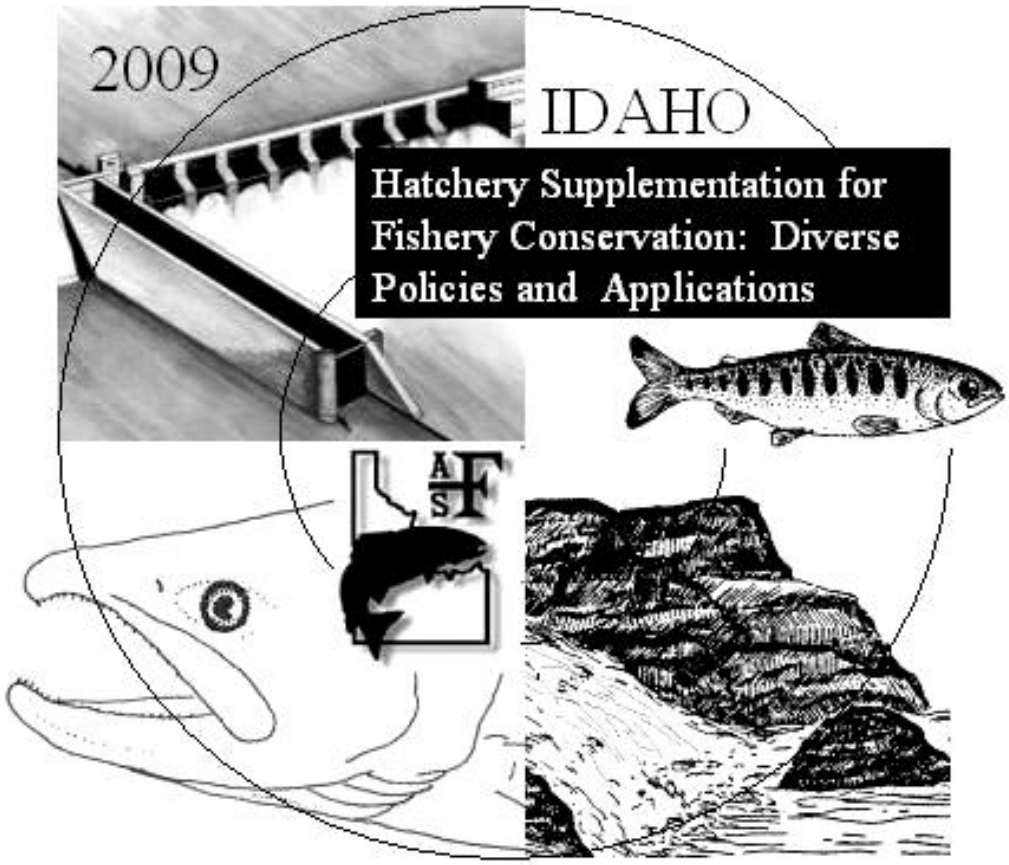
AMERICAN FISHERIES SOCIETY

Idaho Chapter

Established 1964

2009 Annual Meeting



March 4-6
Doubletree Riverside Hotel
Boise, Idaho

Program and Abstracts

Thanks to our Meeting Sponsors!

$1,000 -- Sturgeon Level

USFWS, Lower Snake River Comp
Kootenai Tribe of Idaho
U.S. Forest Service, Northern Region

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Idaho Chapter Leadership

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President	Jim Fredericks	208-525-7290	jfredericks@idfg.idaho.gov
President elect	vacant		
Vice President	Ernest Keeley	208-282-3145	keelerne@isu.edu
Past President	Bart Gamett	208-588-2224	bgamett@fs.fed.us
Secretary	Chris Kozfkay	208-939-6713	ckozfkay@idfg.idaho.gov
Treasurer	Matt Davis	208-769-3049	madavis01@fs.fed.us
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Palouse Unit President	Brian McIlraith	253-219-1166	bmcilraith@vandals.uidaho.edu
Portneuf Unit President	Joe Benjamin	208-282-2139	benjjose@isu.edu

Committee Chairs

Anadromous Fish	Tim Copeland	208-465-8404, ext. 232	tcopeland@idfg.idaho.gov
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	John Cassinelli	208-465-8404, ext. 239	johncassinelli@hotmail.com
	Jason Vogel	208-843-7145	jasonv@nezperce.org
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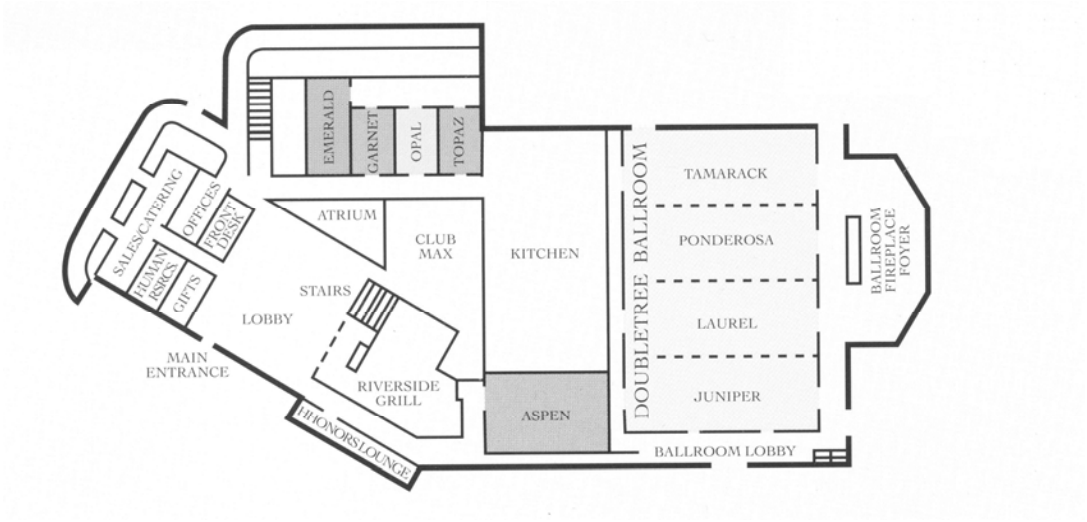
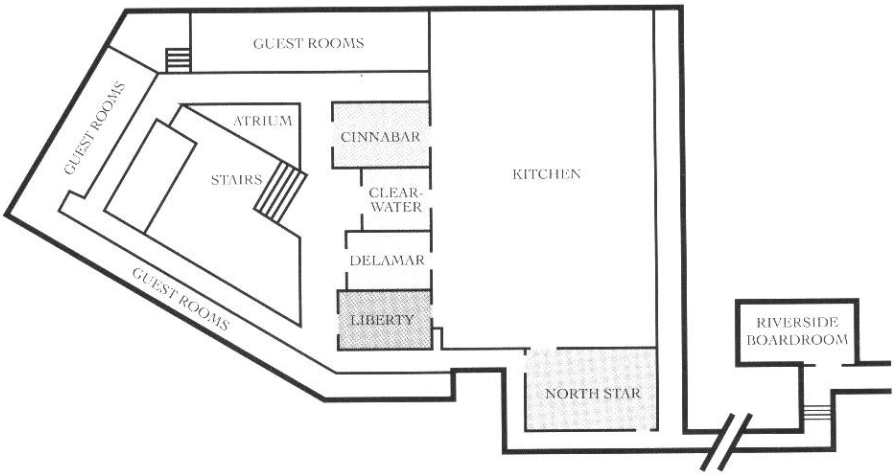
Riparian	Corey Lyman	208-557-5838	clyman@fs.fed.us
Water Quality/ Stream Hydrology	Stephanie Hallock	208-686-0701	shallock@cdatribe-nsn.gov

Conference Center Map

LOBBY LEVEL



UPPER LEVEL



Committee Room Assignments

COMMITTEE	ROOM	CHAIR
Anadromous Fish	Garnet	Tim Copeland
Aquaculture	Liberty	Bryan Grant
Mentoring	Opal	Kevin Meyer
Native Fishes	Delamar	Dan Garren
Public Education	Riverside	Lauri Monnot
Riparian	Topaz	Corey Lyman
Water Quality/Stream Hydrology	Cinnabar	Stephanie Hallock

Wednesday, March 4

8:00ï 8:20 AM **Opening Remarks and Presidential Message**
ICAFS President, Jim Fredericks

Plenary Session:

8:20ï 8:30 AM **Introduction to Plenary Session**
Jeff Heindel, Moderator

8:30ð 8:55 **Supplementation—an IDFG Perspective**
Ed Schriever, Chief of Fisheries, Idaho Department of Fish and Game

8:55ð 9:20 ***Nez Perce Tribe Perspective: Development and Use of Hatchery Supplementation as a Tool to Rebuild Salmon Runs and Support Sustainable Fisheries in the Snake Basin***
Joseph Oatman, Deputy Program Manager, Nez Perce Tribe Department of Fisheries Resources Management

9:20ð 9:45 **Using Conservation Aquaculture as Part of an Integrated Approach to Native Fish Restoration in the Lower Kootenai River: A Tribal Perspective**
Susan Ireland, Fish and Wildlife Program Director
Kootenai Tribe of Idaho

9:45ð 10:15 **BREAK**
(Sponsored by USFWS Lower Snake River Comp)

10:15ð 10:40 **Supplementation: A Viable Management Tool or Only Wishful Thinking?**
Rich Carmichael, Program Director, Fisheries Research and Development, Oregon Department of Fish and Wildlife

10:40ð 11:05 **The Salmonid Enhancement Program in BC: Policies, Processes and Progress**
Don MacKinlay, Program Support Biologist, Department of Fisheries & Oceans Canada

11:05ï 11:45 **Panel Discussion**
All Speakers

11:45-12:00 **Concluding Remarks**
Jeff Heindel, moderator

12:00ï 1:40 PM BOX LUNCH: COMMITTEE BREAKOUTS (see previous page for room assignments)

Session 1: Supplementation Case Studies (contributed papers)

1:40ï 1:45 PM **Introduction to Session,**
Jeff Heindel, Moderator

1:45ï 2:05 PM ***Pedigree analysis reveals relative survival and abundance of juvenile hatchery steelhead (Oncorhynchus mykiss) outplanted as eyed eggs in the Yankee Fork Salmon River, Idaho***
Lytle Denny, Shoshone-Bannock Tribes

2:05ï 2:25 PM ***How do we go from Notalota lota to Alota Lota lota***
Vaughn L. Paragamian, Idaho Department of Fish and Game

2:25ï 2:45 PM ***Working together to assist Snake River sockeye salmon: Utilizing partnerships between hatcheries and research to gain ground towards recovery***
Mike Peterson, Idaho Department of Fish and Game

2:45ï 3:05 PM ***Bigger is not always better – evaluating parr releases of endangered Snake River sockeye salmon Oncorhynchus nerka in three Sawtooth Valley lakes, Idaho***
Robert G. Griswold, Biolines Environmental Consulting

3:05ï 3:25 PM **BREAK**
(Sponsored by Kootenai Tribe of Idaho)

3:25ï 3:45 PM ***The Effects of Supplementation on Abundance, Productivity, and Survival of Johnson Creek Summer Chinook: A Ten Year Review***
Craig Rabe, Nez Perce Tribe

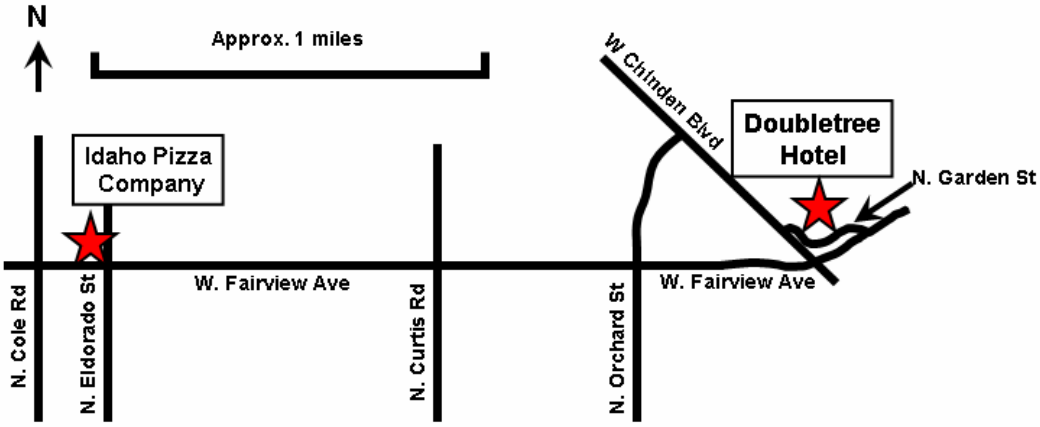
3:45ï 4:05 PM ***Abundance and productivity of spring Chinook from the Nez Perce Tribal Hatchery: A "NATURES" designed supplementation hatchery***
Sherman Sprague, Nez Perce Tribe

4:05ð 4:25 PM ***Captive rearing program for Salmon River Chinook salmon***
Eric Stark, Idaho Department of Fish and Game

4:25ð 4:45 PM ***Snake River Fall Chinook Salmon Management Actions: Use of the Hatchery Tool to Preserve a Population and Enhance Abundance***
Scott Everett, Nez Perce Tribe

4:45ð 5:00 PM **Concluding Comments and Wrap-up**
Moderator: Jeff Heindel

6:00ï PM **STUDENT MIXER!! (Idaho Pizza Company)**



Thursday, March 5 (concurrent sessions)

6:00ð 7:00 AM ***ICAFS Spawning Run***

	Session 2-A: Tagging and Techniques **Moderator: Jens Hegg**	***Session 2-B: Habitat Restoration and Assessment*** **Moderator: Cory Lyman**
8:00ï 8:10	Announcements and introduction to Session	Announcements and introduction to Session
8:10ï 8:30	***Resolving natal origins and life history of wild fall Chinook salmon using otolith microchemistry*** Brian P. Kennedy, University of Idaho	***Monitoring streams and riparian vegetation to detect effects of grazing management on fish habitat using multiple indicators*** Tim Burton, Bureau of Land Management
8:30ï 8:50	***Use of dual frequency identification sonar to estimate adult salmon escapement in the Secesh River, Idaho: the rest of the story*** Paul Kucera, Nez Perce Tribe	***Implementing a forest road and fish passage assessment for portions of four watersheds on the Coeur d'Alene Reservation*** Stephanie Hallock, Coeur dÂlene Tribe Fisheries Program
8:50ï 9:10	***Assessing the feasibility of Parentage Based Tagging for estimating harvest of individual hatchery stocks in Idaho*** Matthew R. Campbell, Idaho Department of Fish and Game	***Full moon demonstration project: restoration after remediation*** Wade Jerome, USDA Forest Service
9:10ï 9:30	***Preliminary results of an in-stream pass over PIT tag array in the South Fork Salmon River and future applications*** Rick Orme, Nez Perce Tribe	***Assessing the effects of alternative setback channel constraint scenarios employing a river meander migration model*** Alex Fremier, University of Idaho
9:30ï 9:50	***Marking of Snake River Basin anadromous fish: What is being done and can it be better integrated?*** Jay A. Hesse, Nez Perce Tribe	***Use of remote sensing, satellite imagery, and on-the-ground field measures to classify salmon habitat and ecosystem structure in Big Creek, Idaho*** Ellen J. Hamann, University of Idaho
9:50ï 10:15	**BREAK** **(Sponsored by USFS N. Region)**	
	Session 3-A: Anadromous Life History and Ecology **Moderator: Danielle Dorsch**	***Session 3-B: Culture and Management*** **Moderator: Atilla Folnagy**
10:15ï 10:20	**Introduction to Session**	**Introduction to Session**
10:20ï 10:40	***Comparison of the Lemhi River and Marsh Creek Chinook salmon populations, Volume 3, the Wet Years*** James Morrow, National Marine Fisheries Service	***Evaluation of white sturgeon fishing effort in the CJ Strike Reach of the Snake River using a roving-access creel survey*** Joseph R. Kozfkay, Idaho Dept. of Fish and Game

10:40ï 11:00	***Sequence divergence of heat shock proteins within and among three Oncorhynchids*** Shawn Narum, Columbia River Inter-Tribal Fish Commission	***Angler values, satisfaction, and management opinions for the Henry's Fork in Harriman State Park*** Jim De Rito, Henryôs Fork Foundation
11:00ï 11:20	***Effects of an altered hydrologic regime on juvenile Oncorhynchus mykiss growth, survival and emigration*** Richard Hartson, University of Idaho	***An assessment of the potential use of mollusks to improve water quality in aquaculture systems*** Rebecca Fritz / Lubia Cajas, University of Idaho
11:20ï 11:40	***Production, productivity, and life history characteristics of steelhead, Oncorhynchus mykiss, in the Potlatch River drainage, Idaho*** Brett J. Bowersox, Idaho Department of Fish and Game	***Evaluation of mixed cell raceways at Dworshak National Fish Hatchery*** Katherine M. Teater, University of Idaho
11:40ï 12:00	***Migration and distribution of radio-tagged adult Pacific lamprey in the Snake River, ID*** Brian McIlraith, University of Idaho	***Variation in the individual performance of juvenile Oncorhynchus mykiss: a comparison of multiple metrics of growth and condition*** Chau Tran, University of Idaho
12:00ð 2:15	**BUSINESS LUNCHEON** **Location: Ponderosa and Tamarack Rooms**	
	Session 4-A: Resident Natives **Moderator: Brian McIlraith**	***Session 4-B: Supplementation: Fish, Carcasses, and Nutrients*** **Moderator: Brent Snider**
2:15ð 2:20	**Introduction to Session**	**Introduction to Session**
2:20ð 2:40	***A tale of two fishes and their future climatic fates: a case history of the Boise River Basin with relevance for Idaho*** Daniel J. Isaak, USDA Forest Service	***Evaluation of the Johnson Creek summer Chinook supplementation program using genetic parentage analysis; Do hatchery fish reproduce in the wild?*** Jason L. Vogel, Nez Perce Tribe
2:40ð 3:00	***A prey-driven model of habitat quality for stream-dwelling salmonid fishes*** Ernest Keeley, Idaho State University	***Demographic and genetic impacts of hatchery-origin Chinook salmon to the South Fork Salmon River population*** William P. Young, Nez Perce Tribe
3:00ð 3:20	***Temperature selection of Bonneville cutthroat trout based on summer river temperatures in the Bear River of Idaho and Wyoming*** Ryan W. Hillyard, Idaho State University	***Abundance, survival, and productivity of spring Chinook salmon in the Lostine River, Oregon, after eleven years of supplementation*** Peter J. Cleary, Nez Perce Tribe
3:20ð 3:40	***Assessment of cutthroat trout habitat access & availability in three creeks of Caribou County, Idaho*** Jamie C. M. Young, SWCA Environmental Consultants	***There's no fish like dead fish: How do salmon additions influence resident-fish growth?*** Scott Collins, Idaho State University
3:40ð 4:00	***Irrigation diversion impacts on the mountain whitefish (Prosopium***	***Short-term periphyton and nutrient responses to experimental salmon***

williamsoni) population in the Big Lost River
Patrick Kennedy, Utah State University

additions in headwater streams
Amy M. Marcarelli, Idaho State University

4:00ð 4:20 ***Detecting change with the Conservation Success Index: Mountain whitefish in the Big Lost River basin***
Daniel C. Dauwalter, Trout Unlimited

Testing assumptions behind alternative recovery strategies for anadromous salmonids: An analysis of food limitation in the upper Salmon basin, Idaho
J. Ryan Bellmore, Idaho State University

4:30ð 5:00 ***Juniper Room -- Poster Session Speed Presentations!***

4:30ð 6:00 PM ***POSTER SESSION (Tamarack Room)***

4:30ð 5:00 PM **Speed Presentations (3 minutes each)**
Moderator: Steve Elle

Determination of available late summer rearing habitat for wild juvenile steelhead in the Potlatch River, Idaho
Ryan Banks, Idaho Department of Fish and Game

South Fork Salmon River adult Chinook salmon monitoring and evaluations, 1996-2008
Michael L. Blenden, Nez Perce Tribe

The use of genetic methods to maintain genetic diversity within an endangered captive broodstock program
Amanda J. Boone, Idaho Department of Fish and Game

Speed Presentation ***Managing population specific Chinook salmon (Oncorhynchus tshawytscha) harvest while promoting recovery of a listed species***
Scott Brandt, Shoshone-Bannock Tribes

Speed Presentation ***Life history evaluation of hatchery supplementation fish and natural origin fish in Lolo and Newsome creeks in the Clearwater Basin, Idaho***
Justin Bretz, Nez Perce Tribe

Using Passive Integrated Transponder (PIT) tag technology to quantify unknown loss in acclimated PIT-tagged populations
Justin Bretz, Nez Perce Tribe

Development of aquaculture methods for burbot (Lota lota)
Kenneth D Cain, University of Idaho

Speed Presentation ***Parr production from adult hatchery steelhead planted in two tributaries to the headwaters of the Salmon River, Idaho***
Tim Copeland, Idaho Department of Fish & Game

Management of anthropogenically derived hybrid populations: explicit recognition of assumptions
Matthew P. Corsi, University of Montana

Speed Presentation ***Relationship of wild steelhead, Oncorhynchus mykiss, migration patterns with flow events in Big Bear Creek, Potlatch River, ID***
Ethan Crawford, Idaho Department of Fish and Game

Relationships Between Benthic and Drift Production and the Trophic Transfer of Energy to Juvenile Chinook Salmon
Kara J. Cromwell, University of Idaho

Pedigree analysis reveals relative survival and abundance of juvenile hatchery steelhead (Oncorhynchus mykiss) outplanted as eyed eggs in the Yankee Fork Salmon River, Idaho
Lytle Denny, Shoshone-Bannock Tribes

Emergence survival of progeny from captive-reared Chinook salmon released to spawn naturally in the East Fork Salmon River
Josh Gable, Idaho Department of Fish and Game

An overview of salmon supplementation studies in Idaho rivers
Jade Helmich, Nez Perce Tribe

Speed Presentation ***History and the mystery***
Robert M. Hoover Idaho Department of Fish and Game

Speed Presentation ***A map of thermally suitable bull trout natal habitats across the interior Columbia River basin: current and future distributions projected under climate change***
Daniel J. Isaak, USDA Forest Service

The prevalence of wild juvenile Chinook salmon from Lake Creek, Idaho that rear a second year in freshwater
Ryan Kinzer, Nez Perce Tribe

Speed Presentation ***Burbot extensive rearing – exploring short term solutions for burbot rehabilitation in the Kootenai River***
Corie Laude, Idaho Department of Fish and Game

Fish On" –Line: A Web-based Aquatic Biological Database
Dorene E. MacCoy, U.S. Geological Survey

Life history comparisons of natural and supplemented Chinook salmon in Johnson Creek, Idaho
Doug Nelson, Nez Perce Tribe

Working together to assist Snake River sockeye salmon: Utilizing partnerships between hatcheries and research to gain ground towards recovery
Mike Peterson, Idaho Department of Fish and Game

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

Speed Presentation ***Idaho supplementation studies: Determining the long-term effects of supplementation on naturally spawning Chinook salmon populations***
David A. Venditti, Idaho Department of Fish and Game

Effects of 8.5mm PIT Tags on Juvenile Chinook Salmon Survival and Growth
Scott Storms, Nez Perce Tribe

Salmonid Gamete Preservation in the Snake River Basin: Chinook salmon and steelhead gamete collections from 1992-2008
William P. Young, Nez Perce Tribe

6:00ð ?? PM ***EVENING SOCIAL AND AUCTION!***

Friday, March 6, 2009

Session 5: Managing Invasives

Moderator: Ryan Hardy

8:00ï 8:10 AM	Announcements and Introduction to Session
8:10ï 8:30	***Using GIS to estimate the risks and benefits of barrier removal to native fish populations in Idaho*** Paul Reyes, University of Idaho
8:30ï 8:50	***Are population genetic studies of cutthroat trout congruent with our knowledge of cutthroat trout ecology and life history?*** Matthew P. Corsi, University of Montana
8:50ï 9:10	***Identification of bull trout, brook trout, and their hybrids based on phenotype*** Bart L. Gamett, USDA Forest Service
9:10ï 9:30	***An experimental comparison of food web effects by native and nonnative trout*** Joseph R. Benjamin, Idaho State University
9:30ï 9:50	***Comparison of trophic basis of production for native and non-native fishes in the Colorado River, Grand Canyon*** Kevin Donner, Idaho State University
9:50ï 10:10	***Colorado's zebra/quagga mussel monitoring program*** Kelly Stockton, University of Idaho and Colorado Division of Wildlife
10:10ï 10:30	**BREAK**
10:30ï 10:50	***Effects of abiotic and biotic factors on the abundance of larval freshwater drum (Aplodinotus grunniens)*** Chris Sullivan, University of Nebraska
10:50ï 11:10	***Predator removal in Lake Pend Oreille: an update on recent efforts*** Andy Dux, Idaho Department of Fish and Game
11:10ï 11:30	***Competition as a factor in displacement of native cutthroat trout by nonnative rainbow and hybrid trout*** Laurie Battle, Montana Tech
11:30ï 11:50	***Effectiveness of flow management and rainbow trout harvest on long-term viability of native Yellowstone cutthroat trout in the South Fork Snake River*** Rob Van Kirk, Humboldt State University
11:50ï 12:10	***Age, sex distribution and fecundity of the invasive Oriental Weatherfish (Misgurnus anguillicaudatus) in Idaho*** Alex Urquhart, Boise State University
12:15ï 12:25	Best Paper Awards

Travel Safely!

Abstracts

(in order of presentation)

Pedigree Analysis Reveals Relative Survival and Abundance of Juvenile Hatchery Steelhead (Oncorhynchus Mykiss) Outplanted as Eyed Eggs in the Yankee Fork Salmon River, Idaho

Lytle Denny and Kurt Tardy
Shoshone-Bannock Tribes
Presenter: Lytle Denny, (208) 239-4560, ldenny@shoshonebannocktribes.com

The Shoshone-Bannock Tribes (Tribes) developed supplementation activities designed to improve viability of natural populations of steelhead to support harvest and increase abundance, productivity, spatial structure, and genetic diversity. The Tribes operate and maintain a steelhead streamside supplementation program in the Yankee Fork Salmon River (Yankee Fork). In 2007, the Tribes supplemented Yankee Fork with 360,000 broodyear (BY) 07 eyed eggs and released approximately 330,000 fry (93% hatch rate). Currently, the number of natural spawning adult steelhead is considered unknown. In this study, we use DNA parentage analysis to determine the survival and distribution of BY 06 - 07 age0+ and age1+ hatchery-origin O. mykiss produced from the supplementation program. From 2006 through 2008, the Tribes conducted three-pass removal electrofishing and estimated overall O. mykiss densities at 0.027, 0.061, and 0.070 fish/m2, respectively.

How do we go from Notalota lota to Alota Lota lota

Vaughn L. Paragamian[1] and Michael J. Hansen[2]
[1]Idaho Department of Fish and Game
[2]University of Wisconsin
Presenter: Vaughn L. Paragamian, (208) 769-1414, vparagamian@idfg.idaho.gov

Burbot *Lota lota* maculosa in Idaho are endemic only to the Kootenai River where they once may have provided one of the most robust fisheries in north America. Soon after operation of Libby Dam in Montana and habitat changes the population collapsed to only about 19 fish in 2008, it would decline to extinction by 2018 if recruitment failure continued.. We developed rehabilitation goals for burbot to include in an updated International Burbot Conservation Strategy. First, we developed a catchability model for burbot in the Kootenai River and then used capture rates in two Alaskan rivers to develop surrogate rehabilitation targets for burbot. Next, we used demographic statistics for burbot in the Kootenai River in a stochastic density-dependent population model to estimate recruitment rates for rehabilitation. The population reached the interim target abundance of 5,500 individuals (45 fish/km; 3.0 fish/ha) within 25 years when each adult produced 0.85 recruits per year and the ultimate target abundance of 17,500 individuals (143 fish/km; 9.6 fish/ha) at 1.1 recruit per year. We recommend the following rehabilitation goals for burbot: (1) an interim goal of 5,500 burbot and ultimate goal of 17,500 burbot; (2) population rehabilitation within 25 years; and (3) annual recruitment rate of 0.85ï 1.1 recruits per adult. Although our rehabilitation goals appear logical it is not likely the population will improve unless there are critical habitat changes to river flow and temperature through Libby operational changes. These changes will not occur because dam operations will not be changed until sufficient juveniles are present to deem it reasonable. We further investigated the prospects of burbot rehabilitation through supplementation with extensively reared fingerling burbot. The modelling will provide a threshold number to begin operational changes and the role of population supplementation and rehabilitation with the wild population. At this time supplementation appears to be the only short term measure for burbot rehabilitation.

Working together to Assist Snake River Sockeye Salmon: Utilizing Partnerships Between Hatcheries and Research to Gain Ground Towards Recovery

M. P. Peterson, J. Heindel , D. Baker, and T. Brown
Idaho Department of Fish and Game
Presenter: Mike Peterson, (208) 465-8404), mpeterson@idfg.idaho.gov.

Snake River sockeye salmon Oncorhynchus nerka were listed as endangered in 1991. Prior to listing, a captive broodstock program was initiated to prevent species extinction and to begin rebuilding the population. Between 1991 and 2008, the captive broodstock program produced approximately 4,201,400 eyed-eggs to meet broodstock as well as reintroduction needs. Progeny from the captive broodstock program are reintroduced using four strategies: 1) eyed-eggs are planted in Pettit and Alturas Lakes in November and December; 2) age-0 presmolts are released to Alturas, Pettit, and Redfish lakes in October; 3) age-1 smolts are released into Redfish Lake Creek and the upper Salmon River in May; and 4) hatchery-produced adult sockeye salmon are released to Redfish Lake for volitional spawning in September. Joint hatchery and research monitoring and evaluation efforts have focused on maximizing the use of limited hatchery rearing space and identifying and prioritizing the most successful reintroduction strategies. The programs near term goals of preserving genetic diversity and ultimately preventing extinction have been successful. Current and future plans focus on transitioning from a genetic conservation program to a species recovery program. To enable this transition, the current broodstock station at Eagle, Idaho was expanded to double production and the development of a new smolt rearing facility is under investigation. The program is a cooperative effort among IDFG, NOAA Fisheries, Shoshone-Bannock Tribes, ODFW, and University of Idaho with funding primarily provided by the Bonneville Power Administration.

Bigger is not Always Better – Evaluating Parr Releases of Endangered Snake River Sockeye Salmon *Oncorhynchus nerka* in Three Sawtooth Valley Lakes, Idaho

Robert G. Griswold[1], Andre E. Kohler[2], and Doug Taki[2]
[1]Biolines Environmental Consulting
[2] Shoshone-Bannock Tribes
Presenter: Robert Griswold, (208) 481-1900, robertggriswold@gmail.com

In November 1991, Snake River sockeye salmon Oncorhynchus nerka were listed as endangered. As a result of the listing, the Redfish Lake sockeye salmon project was initiated to conserve and rebuild Snake River sockeye salmon populations in Sawtooth Valley lakes designated as critical habitat. In this paper we evaluate the growth and survival of Snake River sockeye salmon parr stocked from 1998 to 2007. We used hydroacoustic surveys and limnological data to estimate O. nerka densities and zooplankton biomass. We determined sockeye salmon growth rates using length and weight data collected prior to release as parr and at capture during smolt migration. We estimated cumulative survival to Lower Granite Dam using passive integrated transponder tag data and the SURPH survival model. Densities in nursery lakes were negatively correlated ($p = 0.0450$) with zooplankton biomass. Growth of yearling sockeye salmon was variable and positively correlated ($p = 0.0005$) with total zooplankton biomass. The percent of hatchery parr that emigrated was inversely related ($p = 0.0002$) to growth, evidence that sockeye salmon residualized when growth rates were high. Of particular interest are the relationships between size at release, growth, and survival of sockeye salmon parr. We found a negative relationship between size at release and corresponding growth rates of Snake River sockeye salmon parr; smaller individuals grew faster than larger individuals within the same release groups. In addition, mean size of parr at release was negatively correlated ($p < 0.0001$) with downstream survival in all three lakes; smaller parr survived better. However, survival from smolt traps to Lower Granite Dam did not correlate with growth in Redfish ($p = 0.7079$) and Pettit lakes ($p = 0.6378$), but was significantly correlated in Alturas Lake ($p =$

0.0195), where fish experienced low growth rates and frequently lost weight during the winter. These data suggest that a threshold growth rate is required for survival to lower Granite Dam on the Snake River.

The Effects of Supplementation on Abundance, Productivity, and Survival of Johnson Creek Summer Chinook: A Ten Year Review

Craig D. Rabe, Douglas D. Nelson, and Jason Vogel
Nez Perce Tribe Department of Fisheries Resources Management
Presenter: Craig Rabe, (208) 634-5290, craigr@nezperce.org

In the Johnson Creek drainage of Idaho, the Nez Perce Tribe has established a supplementation program to reduce the demographic risk of extirpation and to conserve genetic and life history traits of a threatened summer Chinook Salmon, Oncorhynchus tshawytscha, subpopulation. Hatchery and natural escapement have been at levels typically below viability, harvest, and ecological escapement thresholds. This program exclusively utilizes natural origin fish for broodstock to ensure that supplementation fish only experience the hatchery environment for one generation. Comparisons of abundance, survival, and productivity are made for natural and hatchery-origin summer Chinook salmon (Oncorhynchus tshawytcsha) at the juvenile and adult life history stages. Our management methods, such as those executed at the weir, have been effectively implemented to provide estimates of hatchery fraction (34%), weir efficiency (81% on average), and estimate proportions of strays in the spawning population (2% annual average). Survival estimates of juvenile migrants from tributary to Lower Granite Dam were significantly higher for natural-origin smolt than for hatchery smolt. Redd count productivity comparisons did not differ significantly over time with an unsupplemented reference population. Comparisons of juvenile production within the Johnson Creek population indicate most migrants leave the system at the parr life history stage. Recruit per spawner estimates were significantly higher for hatchery-origin fish than for natural origin Chinook, however natural origin Chinook maintained significantly higher smolt-to-adult return ratios (Lower Granite to Johnson Creek). Progeny per parent ratios for hatchery-origin adults were higher than natural origin adults (adult:adult, female:female, and adult:adult ï excluding three year-olds) over the course of four brood years evaluated.

Abundance and Productivity of Spring Chinook from the Nez Perce Tribal Hatchery: A "NATURES" Designed Supplementation Hatchery

Sherman Sprague, Thomas Backman, Catherine Bradley, Ryan Johnson, and Justin Bretz
Nez Perce Tribe
Presenter: Sherman Sprague, (208) 621-3585, shermans@nezperce.org

In the Clearwater River drainage a Dam was in place on the Clearwater River from 1927-1973, functionally extirpating anadromous fish in that system. The Nez Perce Tribe has implemented a supplementation program to re-establish and ultimately conserve genetic and life history traits of spring Chinook salmon. Since reintroduction, hatchery and natural escapements have been at levels typically below viability, harvest, and ecological escapement thresholds. This program utilizes natural and hatchery origin fish for broodstock, releases fish at multiple lifestages, and utilizes a ñNATURESò approach. This program has completed a 7 year review (2002-2008) in order to examine the effects of supplementation in Lolo and Newsome creeks within the Clearwater River subbasin. Comparisons of the contribution of supplementation at the juvenile and adult lifestages were completed using a set of performance measures. Specifically, we discuss the abundance (e.g., adult escapement, hatchery fraction, estimated smolts surviving to the mainstem) and productivity (e.g., smolt-to-adult return rate, recruits per spawner) of hatchery and natural origin fish over the last seven years in Lolo and Newsome creeks. Natural origin

juvenile survival rates to Lower Granite Dam are significantly greater than their hatchery counterparts, however, Smolt to Adult Return rates do not differ significantly. Hatchery fraction on the spawning grounds fluctuates across years, in part due to broodstock selection. Hatchery fraction was correlated with juvenile survival success in Newsome Creek, while in Lolo Creek, no relationship was observed. Capture efficiency rates on returning adults varies from 13% up to 98% and is directly correlated with weir installation and flow. Redd count trends in reference to natural production have been declining over the past 7 years. Monitoring and evaluation activities have utilized adaptive management and improved the implementation and effectiveness research on the NPTH program.

Captive Rearing Program for Salmon River Chinook Salmon

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In 1995, Idaho Fish and Game (IDFG), in cooperation with NOAA Fisheries, the University of Idaho, and the Shoshone-Bannock Tribes, initiated an experiment to determine the efficacy of captive rearing techniques to prevent localized extinctions of spring Chinook salmon in the Lemhi River, East Fork and West Fork Yankee Fork Salmon River in Idaho. Program objectives included: 1) developing culture techniques to rear adults through maturation in the hatchery 2) reintroducing maturing adults with appropriate morphological, physiological, and behavioral attributes 3) and monitoring and evaluating post-release behavior and spawning success. Hydraulic redd pumping methods were used to remove a small number of eyed-eggs from natural redds to source annual rearing groups. Fish culture technology was successfully developed to rear Chinook salmon through smoltification in fresh water (IDFG's Eagle Fish Hatchery) and from smolt to sexual maturity in seawater (NOAA Manchester Experiment Station). Average survival from collection as eyed-eggs to transfer to saltwater as smolts was 95%, and in saltwater through maturation was 60%. Fish health risk was reduced by shifting from juvenile collections (1995-1998) to eyed-egg collections (1999-2005) and by following strict culture protocols. To date, the program has released over 2300 fish to the habitat for natural spawning. Post-release monitoring efforts indicate that captive reared adults display similar courtship and mating behavior as wild Chinook salmon. The program continues to address producing fish of comparable size, females with comparable fecundity levels, and fish with more similar spawn synchrony with natural fish. Despite some divergence from wild fish, captive reared fish are able to spawn, fertilize eggs, and progeny survive well to fry stage. Parentage genetic analyses will help determine how well progeny from captive-reared Chinook contribute to natural production and return to study streams as adults.

Snake River Fall Chinook Salmon Management Actions: Use of the Hatchery Tool to Preserve a Population and Enhance Abundance

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Snake River fall Chinook salmon abundance and productivity have been and continue to be influenced by construction and operation of hydroelectric dams, among other natural and management factors. Historical abundance of fall Chinook salmon in the Snake River Basin was 500,000 fish annually. However, from the mid 70's to late 90's return levels have averaged less than 1,000 and were as low as 100 natural-origin fish. Much of this decline was directly attributable to blocked access or inundation of spawning habitat. Hatchery programs were

developed in the past 20 years to mitigate for some of this lost productivity. Hatchery programs were modified and expanded in the mid 90's to incorporate supplementation objectives (release of hatchery juveniles in natural production areas) as a result of litigation by the Columbia River treaty tribes. Recent returns, including hatchery origin fish, have been 10,000 to 15,000 (~2,500 natural origin adults). Distribution of spawners within the accessible habitat has started to re-colonize areas in the Salmon River, Imnaha River, Grande Ronde subbasin, and South Fork Clearwater River, but much of the historic habitat remains block or unutilized. Several critical uncertainties still exists relative to the short-term and long-term productivity of Snake River fall Chinook salmon, including: relative reproductive success of supplementation and natural origin adults; long-term persistence of an ESU with a single extant population spatial structure and diversity; estimates of juvenile abundance/production; factors influencing and magnitude of carrying capacity.

Resolving Natal Origins and Life History of Wild Fall Chinook Salmon (Oncorhynchus Tshawytscha) using Otolith Microchemistry

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The emergence and maintenance of life history strategies in salmon populations is the combined result of variation in individual migratory behaviors and fluctuating environmental conditions. It is therefore of fundamental interest to understand how different migratory strategies confer fitness advantages to individuals within a population and how this is influenced by changing environmental conditions over large geographic scales. Recent studies have documented increased variation in the migration strategies of juvenile wild Snake River fall Chinook salmon (Oncorhynchus tshawytscha), wherein there is increased representation of juvenile migrants at older ages in a population that was historically represented by underyearling juvenile migrants. Reconstructing the juvenile strategies and habitat origins of successfully returning adult fish can be difficult when tagging all individuals is not an feasible option. We are employing otolith microchemistry, with a goal toward understanding the spatial representation and fitness consequences of alternate life history strategies of juvenile fall Chinook salmon in the Snake River. Our results show significant spatial differences in the geochemistry of key O. tshawytscha spawning locations. These chemical signatures are recoverable in the otoliths of returning wild fish and inform us of site-specific migratory strategies. We are currently analyzing returning adults from 2006 ï 2008 in order to develop a spatially explicit understanding of juvenile migration strategy that could inform regional management practices and hydropower decisions.

Use of Dual Frequency Identification Sonar to Estimate Adult Salmon Escapement in the Secesh River, Idaho: The Rest of the Story

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Dual frequency identification sonar (DIDSON) was used in the Secesh River from 2004 to 2008 to determine natural origin (wild) adult salmon escapement relative to population viability (delisting) thresholds. The Secesh River is the only stream in the Snake River basin where natural origin salmon escapement is directly monitored absent a supplementation program. DIDSON technology provides a passive method that avoids incidental trapping and handling mortality and impedance related concerns on this threatened population. High frequency DIDSON sonar files that sampled the entire water column were continuously collected during the salmon migration

period. Estimated salmon escapement at the DIDSON monitoring site, with 95% confidence intervals in parenthesis, ranged from 209 salmon (± 24) in 2006 to 914 fish (± 194) in 2004. To obtain accurate and precise escapement information it was crucial to adjust the raw daily salmon passage data for directional file reader error and convoluted samples over threshold (CSOT) file processing error. Uncertainty around the DIDSON escapement estimates was 5.6% to 10.8% (C.V.ís) for all years. Validation monitoring with underwater optical cameras has not been able to directly measure the magnitude of bias of potentially counting large bull trout, that overlap in size with jack salmon, as salmon. However, it is believed that the potential magnitude of this bias may be low given the small numbers of larger bull trout observed at the Lake Creek underwater video fish count station, located upstream of the DIDSON monitoring site, from 2004 to 2008. Natural origin spawner abundance ranged from 191 salmon in 2006 to 890 salmon in 2004. The 10 year geometric mean spawner abundance was 432 salmon. The Secesh River Chinook population is not viable as defined by the Interior Columbia Basin Technical Recovery Team (2006) based on the spawner abundance criteria.

Assessing the feasibility of Parentage Based Tagging for Estimating Harvest of Individual Hatchery Stocks in Idaho

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For twenty years coded-wire tag (CWT) recoveries have been the primary tool used by fish managers to estimate harvest of individual hatchery stocks in Idaho. However, the process of physically tagging tens of thousands of juveniles from different hatchery stocks is logistically difficult, labor intensive, cost prohibitive, and potentially increases physiological stress to the juveniles. All of these restrictions ultimately limit the total number of juveniles tagged each year, which in turn limits the number of CWT recoveries and the precision of stock contribution harvest estimates. Annually, IDFG personnel handle approximately 6000 adults to recover only 500-800 CWTs in Statewide fisheries. An alternative to CWT management, that would potentially eliminate a variety of the problems described previously, is parentage-based genetic tagging (PBT). PBT would involve the annual genotyping of all broodstock at each hatchery, 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 the hatchery they originated from and exact brood year they were produced in. To assess the feasibility of this technology we sampled and genotyped (17 microsatellite loci) all of the parents that produced progeny reared at the Magic Valley hatchery in 2008 (5 stocks, 1034 samples). We also representatively sampled and genotyped ~100 offspring of these parents from each stock. Parentage analyses indicated 100% accuracy in assigning these juveniles back to their stock of origin. By genotyping 1034 hatchery adults, we permanently ñtaggedò approximately 2 million smolts. We believe that PBT technology could be used to estimate harvest of individual hatchery stocks in Idaho with better precision than the current CWT program, with only minor changes to the existing creel program and for very similar costs.

Preliminary Results of an In-stream Pass Over PIT Tag Array in the South Fork Salmon River and Future Applications

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The Nez Perce Tribe operated a passive flat panel PIT tag array in the upper South Fork Salmon River (SFSR). The array, installed in February 2008, consists of five 3x20 foot panels flush with

the bottom substrate spanning the entire river at base flows. PIT tag detections at this array enables quantification of reach specific survival estimates, seasonal migration patterns, site specific temporal and spatial migration patterns, and adult escapement estimates. From installation through October of 2008, the array logged 269,538 detections of which 25,874 were unique PIT tags that encompassed both juvenile and adult Chinook salmon and steelhead. During the week of March 17, 2008, over one million hatchery Chinook salmon smolts were released 54 km above the PIT tag array of which over 55,000 were PIT tagged. PIT tags from this release group were detected from March 19 through September 5, 2008 with 50% of all detections occurring by March 27 and 90% by April 14. Reach specific survival from the release site to the array was estimated at 92% (+ 1%) and 85% (+ 9%) for hatchery and wild Chinook salmon smolts, respectively. Survival from the array to Lower Granite Dam (LGD) was estimated at 60% (+ 1%) and 64% (+ 7%) for hatchery and wild Chinook salmon smolts, respectively. PIT tagged adult salmon were detected from June 23 through August 15 with an estimated conversion rate of 88% from LGD to the array and 42% from the array to the SFSR adult weir. Both juvenile and adults migrated past the array predominantly at night with the majority of detections occurring in the center of the river. This PIT tag array is one of a total of six arrays that will be installed and operated in the SFSR Basin as part of a broader research and monitoring program.

Marking of Snake River Basin Anadromous Fish: What is being done and can it be Better Integrated?

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Marking fish supports multiple aspects of fisheries management: stock/origin identification, harvest management, monitoring and evaluation, and policy/permitting. No one single mark or level of marking will fulfill all program needs. The primary purposes for marking hatchery-origin Snake River Basin salmon and steelhead include; broodstock composition management, quantification of escapement (abundance)/run reconstruction, harvest management, run prediction, and monitoring specific program/release effectiveness. However, marking fish does not come without cost; financially, philosophically, and for Tribal fisheries managers, culturally. The Nez Perce Tribe Department of Fisheries Resources Management has a guiding principle which states: ñMinimizing intrusive marking and handling of fish supports cultural and spiritual beliefs, respect for the fish, and maximum survival.ò Many hatchery-origin fish are given multiple types of marks prior to release and may receive additional marks after release. For example, approximately 75% of Snake River basin hatchery-origin fall Chinook salmon are marked, with 50% of the released fish being adipose fin clipped, 60% coded-wire tagged (CWT), and 12% (671,000 fish) passive integrated transponder (PIT) tagged. Understanding fish marking at a basin-wide scale is not common and has lead to research inefficiencies, management conflict, and unnecessary fish marking. The information presented will highlight the need for assessing the impacts of fish marking associated with Snake River Basin anadromous fish and opportunities to better coordinate marking efforts.

Monitoring Streams and Riparian Vegetation to Detect Effects of Grazing Management on Fish Habitat Using Multiple Indicators

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Numerous studies during the last 30 years have demonstrated the affects of livestock grazing on riparian and aquatic habitats and fish. The general consensus among investigators has been that improper livestock grazing can degrade these habitats resulting in decreased fish productivity. Most have concentrated on grazing effects to streambanks which, when degraded affect stream temperature, channel erosion, sediment input, and hiding cover and suitable living space for fish. More recently research in Wyoming demonstrated that improper grazing resulted in half the riparian vegetation, half the terrestrial invertebrates recruited to streams and trout diets, and also half the trout abundance compared to properly grazed riparian areas. The complexity and diversity of grazing effects calls for a robust monitoring protocol. To be effective, the protocol must include techniques with enough precision and accuracy to detect changes through time, yet feasible and cost-efficient. Because riparian grazing should achieve, or make measurable progress towards achieving the desired conditions for fish, monitoring multiple indicators to evaluate both implementation success and management effectiveness is necessary. To implement such monitoring, the Idaho State Office of BLM and Region 4, Forest Service jointly developed and published the Multiple Indicator Monitoring (MIM) protocol - an Interagency Technical Bulletin, available on the WEB at: http://www.blm.gov/id/st/en/info/publications/technical_bulletins/tb_07-01.html. This protocol evaluates multiple indicators, based on existing, commonly used techniques. Because multiple techniques are brought together in one protocol, and all the observations are made at the same time and place, the approach improves efficiency, reduces costs and time to sample, and allows statistical comparisons between short- and long-term variables.

Implementing a Forest Road and Fish Passage Assessment for Portions of Four Watersheds on the Coeur d'Alene Reservation

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The Coeur dôAlene Tribe Fisheries Program is currently completing an inventory and assessment of forest roads and stream crossings in portions of four watersheds on the Reservation, including Alder, Benewah, Evans and Lake Creeks. These roads are managed by Tribal, state, county, and private landowners. The objectives of this study are to: 1) Evaluate sediment contributions from road segments within the target watershed that are within proximity to critical areas for spawning and rearing habitat, 2) Identify any complete or partial barriers that may affect the ability of westslope cutthroat trout to access key spawning and rearing habitats, and 3) draft a planning document to identify priorities for restoration/enhancement treatments based on the study results. Field surveys were conducted along identified road segments between August-November 2008. These surveys consisted of field crews collecting road characteristics such as road width, length, cut and fill slope information, ditch characteristics, cross-drain location and condition, location of stream crossings, proximity to the stream, and locations of mass failures. In addition, at each stream crossing, physical stream data and culvert characteristics were measured. Over 320 miles of road were surveyed. Results from a preliminary draft report will be discussed. A final planning document describing study results will be completed by May 2009. The Tribe will use the study as the basis for developing cooperative projects with landowners interested in meeting the identified habitat needs.

Full Moon Demonstration Project: Restoration after Remediation

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From 1998 through 2000, the USDA Forest Service performed a $1.9 million CERCLA (Comprehensive Environmental Response, Compensation and Liability Act) removal action at the abandoned twenty-acre Silver Crescent Mine and Mill Complex in the East Fork of Moon Creek. Heavy metal concentrations at the site exceeded human health and chronic aquatic life criteria. The entire width of the riparian area was excavated for 1,000 meters in order to remove tailings, waste rock, and contaminated soils. The excavation produced over 100,000 cubic meters of material contaminated with lead, arsenic, copper and mercury to be placed into an on-site repository. Five years later, monitoring of groundwater and surface water indicate metal concentrations below human health and chronic aquatic life criteria, with the exception of dissolved zinc concentrations. The East Fork of Moon Creek is one of a few tributaries to the South Fork of the Coeur dôAlene River that provides adequate fish passage and valuable spawning and rearing habitat for Westslope Cutthroat trout. With human health concerns addressed, the increase in water, soil, and sediment quality gave the site much potential for fisheries, wildlife and terrestrial restoration. Restoration work began in the summer of 2007 and was completed in the spring of 2008. Improvement activities consisted of: treating noxious weeds, constructing ponds, wetlands, and sections of stream channel, installing pool forming, gradient control, and bank protection structures, placing logs for stream channel cover, wildlife habitat, and planting sites, applying top soil, installing cuttings, and planting emergents, shrubs, and trees. Information will be presented illustrating restoration efforts in fish and wildlife habitat, vegetative recovery, and hydrologic changes in channel dimension, pattern and profile. A five year monitoring plan was established to evaluate the project and share lessons learned.

Assessing the Effects of Alternative Setback Channel Constraint Scenarios Employing a River Meander Migration Model

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River channel migration and cutoff events within large river riparian corridors create heterogeneous and biologically diverse landscapes. However, channel stabilization (riprap and levees) impede the formation and maintenance of riparian areas. These impacts can be mitigated by setting channel constraints away from the channel. Using a meander migration model to measure land affected, we examined the relationship between setback distance and riparian and off-channel aquatic habitat formation on a 28-km reach of the Sacramento River, California, USA. We simulated 100 years of channel migration and cutoff events using 11 setback scenarios: 1 with existing riprap and 10 assuming setback constraints from about 0.5 to 4 bankfull channel widths (bankfull width: 235 m) from the channel. The percentage of land reworked by the river in 100 years relative to current (riprap) conditions ranged from 172% for the 100-m constraint setback scenario to 790% for the 800-m scenario. Three basic patterns occur as the setback distance increases due to different migration and cutoff dynamics: complete restriction of cutoffs, partial restriction of cutoffs, and no restriction of cutoffs. Complete cutoff restriction occurred at distances less than about one bankfull channel width (235 m), and no cutoff restriction occurred at distances greater than about three bankfull widths (>700 m). Managing for point bars alone allows the setbacks to be narrower than managing for cutoffs and aquatic habitat. Results suggest that site-specific ñestriction of cutoffõthresholds can be identified to optimize habitat benefits versus cost of acquired land along rivers affected by migration processes.

Use of Remote Sensing, Satellite Imagery, and On-The-Ground Field Measures to Classify Salmon Habitat and Ecosystem Structure in Big Creek, Idaho

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Variation in salmon life history can be attributed to the complex hydrological, physical, and climatic processes that influence the geomorphology, productivity and ecological relationships of river systems. Over short time scales, salmon productivity, diversity and life history variation has been linked to the type, amount, and quality of habitat that is available. Over much longer time scales, the Shifting Habitat Mosaic (SHM) hypothesis (Stanford et al. 2005) predicts that complex, dynamic and non-linear biophysical processes control the productivity of river habitats. Attempts to reconcile how processes operating over different time scales control the productivity and biodiversity of river systems require new approaches at quantifying habitat over large spatial scales metrics. Traditional methods of classifying aquatic habitat types and ecosystem structure have involved walking stream segments and describing flow, depth, and geomorphic characteristics. These methods are limited, however, by the subjective nature of the measurements as well as the spatial extent to which it is possible to sample. These limitations can be overcome through the application of remote sensing technologies. In cooperation with Flathead Lake Biological Station's Salmonid Rivers Observatory Network, stream classification of Big Creek, Idaho began in the summer of 2008. Located in the Frank Church/River of No Return Wilderness Area of central Idaho, the Big Creek Watershed represents one of the eastern-most destinations for anadromous salmonids in their Pacific distribution. Quickbird Multispectral Satellite Imagery coupled with Acoustic Dopler Profiling technology were used in combination with ground measures, including habitat use and production, to ultimately look at juvenile salmon growth, recruitment, and survival in the SHM context.

Comparison of the Lemhi River and Marsh Creek Chinook Salmon Populations, Volume 3, The Wet Years

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The 2008 returns of Snake River spring/summer Chinook salmon were the fifth highest since counts at Lower Granite Dam began in 1975. However, not all populations reacted the same way to the climatic conditions responsible for the relatively good returns. The Marsh Creek and Lemhi River spring/summer Chinook salmon populations are prime examples of populations that benefited from climatic conditions, in the case of Marsh Creek, and that declined in spite of apparently favorable climatic conditions, in the case of Lemhi River. The Marsh Creek 2004 year class had relatively good egg-to-smolt survival, downstream migration survival, and smolt to adult return rates and had an overall recruit to stock ratio of 3.7 to 1. The Lemhi River 2004 year class also experienced good downstream migration survival and smolt to adult return rates, but egg-to-smolt survival was poor and overall recruit to stock ratio was only 0.8 to 1. In the Lemhi River, year class strength is set by environmental conditions during the early rearing phase of the life cycle which tends to damp effects of favorable conditions during migration. In Marsh Creek, environmental conditions during rearing have less effect on year class strength which allows the population to benefit more from favorable migration conditions. Climatic conditions experienced by the 2004 year class were generally good throughout the Salmon River drainage, which benefited Marsh Creek Chinook salmon. However, Lemhi River Chinook salmon experienced relatively poor rearing conditions in spite of favorable climatic conditions, apparently due to water withdrawals. Climatic conditions and river management experienced by the 2005 year class were

similar to those experienced by the 2004 year class. Likewise, egg-to-smolt and migration survival of the 2005 year class suggests that 2009 returns will be relatively good for Marsh Creek and poor for the Lemhi River.

Sequence Divergence of Heat Shock Proteins within and Among Three Oncorhynchids

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Heat shock proteins (HSPs) are induced in response to high temperatures and other stressors, and sequence variation is important for regulation of expression of these genes. In this study, we investigated sequence variation in the three major classes of heat shock proteins (HSP90, HSP70, and low molecular weight HSPs) within and among three cold water fish species (O. clarki, O. mykiss, and O. tshawytscha) with variable life history and thermal tolerance characteristics. Sequences collectively totaled 4,556 bp across nine gene fragments and 198 SNPs and 43 indel sites were observed among species. Within species, sequence variation was much lower for O. clarki than the other two species, and genetic distance among species pairs was highest between O. mykiss and O. tshawytscha (0.043), intermediate with O. clarki and O. tshawytscha (0.037), and lowest among O. mykiss and O. clarki (0.023) overall sequence data. We found that sequences involved in transcription of HSPs were highly polymorphic within and among species. Previous studies have shown that induction of HSPs corresponds with levels of thermal stress experienced in nature, and these genes are likely to have important roles in thermal adaptation. These results indicate that HSP genes may be locally adapted in O. clarki, while higher HSP polymorphism is necessary for O. mykiss and O. tshawytscha and variation at the sequence level may have important evolutionary consequences for these species.

Effects of an Altered Hydrologic Regime on Juvenile Oncorhynchus Mykiss Growth, Survival, and Emigration

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Salmon are confronted by habitat change and degradation throughout all stages of their lives. As such, if habitat quality is ignored at one life cycle stage, management actions targeted at other stages may have limited impact. We are in the preliminary stages of research to address the system-wide impacts of water withdrawal on ESA threatened populations of juvenile Oncorhynchus mykiss in Lapwai Creek, a fifth order tributary of the Clearwater River, approximately 20 km upstream from the town of Lewiston, Idaho. Lewiston Orchards Irrigation District currently withdraws surface flow to support seasonal agricultural and domestic water needs in Lewiston, which in turn reduces instream flows in approximately half of the watershed. Our overarching goal is to understand how decreased summer flows influence juvenile salmonid growth, movements and survival through both direct and indirect pathways (e.g. temperature, productivity and trophic interactions). In summer 2008 we established multiple study reaches with both experimental (with hydrologic alteration) and control (no hydrologic alteration) sites within the Lapwai basin. We have tagged a portion of the population using PIT tags in order to monitor growth and survival of individual fish; and we have installed PIT antennas to quantify outmigration of tagged individuals. Our preliminary results suggest that densities in the impacted sites are significantly lower; however, survival, condition factor, and growth in these sites tends to be higher. We hypothesize that high variation in emigration and/or survival of juveniles in hydrologically impacted sites can lead to years of low recruitment, which in turn has density-dependent effects on survival and growth. Future work will continue to develop a spatially explicit

understanding of flow-mediated growth, survival and emigration in the Lapwai basin in order to contribute to our general understanding of hydrologic impacts on the energetics and demographics of salmonid populations.

Production, Productivity, and Life History Characteristics of Steelhead, Oncorhynchus Mykiss, in the Potlatch River Drainage, Idaho

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The Potlatch River Steelhead Monitoring and Evaluation Program (PRSME) is providing effectiveness monitoring for numerous habitat restoration projects currently occurring within the drainage. The PRSME framework is establishing baseline levels of steelhead production and productivity within the drainage. Prior to this project limited data was available regarding steelhead population dynamics and life history within the lower Clearwater River Distinct Population Segment. The monitoring effort began in the lower Potlatch drainage in 2005 and in the upper Potlatch drainage in 2008. Adult steelhead escapement estimates into Big Bear Creek, tributary to the lower Potlatch River, has ranged from 68 ï 384 adults in 2005 ï 2008. During the first year of trapping, the adult escapement estimate into the East Fork Potlatch River, a tributary to the upper Potlatch River, was 197 adults. Juvenile outmigration estimates have ranged from 4,817 - 14,164 fish on Big Bear Creek from 2005 -2008 and was estimated at 6,976 fish on the East Fork Potlatch River during the first year of trapping in 2008. Adult female spawners and subsequent years of juvenile outmigration data have been used to estimate recruits per spawner productivity estimate of 27.9 recruits/female in Big Bear Creek for BY 05. A variety of different life history strategies have been observed within the upper and lower Potlatch steelhead populations. Data associated with this project has challenged the A-run designation for the Potlatch River steelhead population as well as provide additional direction for habitat restoration within the drainage.

Migration and Distribution of Radio-Tagged Adult Pacific Lamprey *Lampetra tridentata* in the Snake River, ID

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Many aspects of Pacific lamprey (Lampetra tridentata) migration and distribution within the lower Snake River Basin, ID are not well understood. The goal of this study is to characterize the behavior and timing of adult Pacific lamprey upstream spawning migration. Unimpeded portions of the Snake River above Lower Granite Dam, WA coupled with an extensive system of fixed-site radio telemetry receivers provide an opportunity to study this component of lamprey life history within the state of Idaho. From 2006-2008, 46-50 adult Pacific lamprey were collected at lower Snake River dams, radio-tagged on site, and released above Lower Granite Dam from July to October. In each year fixed site telemetry receivers placed at major tributaries within the Snake and Clearwater basins and terrestrial mobile tracking allowed us to determine locations within the basin, determine migration rates and timing between fixed-site receivers, and gather information on lamprey overwintering locations. Preliminary results indicate that lamprey halted upstream migration by November, resumed migration in March, and traveled almost exclusively at night. Distribution of radio-tagged lamprey between the Snake and Clearwater basins has been generally equal across all three years. Here we report on the spawning locations, migration rates and timing from fixed sites, overwintering habitat preferences, as well as overall lamprey distribution within the Snake and Clearwater basins. Our results will contribute to our limited

understanding of lamprey migratory behavior and demographics within the Snake River with a goal towards optimizing management practices that address the entire fish community.

Evaluation of White Sturgeon Fishing Effort in the CJ Strike Reach of the Snake River Using a Roving-Access Creel Survey

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The population of white sturgeon Acipenser transmontanus in the Snake River downstream of CJ Strike Dam supports a year-round, intense, and popular catch and release fishery. Anecdotal observations indicate that this fishery has increased in popularity. We sought to quantify effort, catch rate, and total annual catch as well as loss rate and the total number of fish lost in this reach from May 1, 2007 to April 30, 2008. Collecting reliable creel data from sturgeon anglers is difficult due to long trip duration and often nocturnal fishing habits. To circumvent these difficulties, we used a modified roving-access creel survey design that was supplemented with post cards. We contacted over 400 anglers and handed out 1,282 post cards. Through voluntary return and follow up phone calls, we acquired useable trip information for over 90% of the post cards (i.e. individual white sturgeon fishing days). We determined that a total of 36,630 hours of sturgeon fishing effort was expended between CJ Strike Dam and Grandview bridge during one year. Most effort, approximately 85%, was expended by bank anglers immediately below the dam. By expanding effort, catch rates, and loss rates, we determined that 1,822 catches and an additional 2,356 losses of white sturgeon occurred. Comparing these numbers to recent population estimates, we determined that an average sturgeon was hooked 7.4 times in a year, including being landed 3.2 times and lost an additional 4.2 times. Catch rate varied from one fish landed every 10 hours in June to one fish landed every 30+ hours for August and December-March. About 43% of the sturgeon hooked by anglers were landed. These results should be used to monitor fisheries intensity, educate anglers, or to structure management changes if deemed appropriate.

Angler Values, Satisfaction, and Management Opinions for the Henry's Fork in Harriman State Park

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The Henry's Fork of the Snake River within Harriman State Park is one of the most well known angling locations in the world. Only fly fishing is allowed within the park boundaries, and the waters within and adjacent to the park have been managed as a wild rainbow trout fishery since 1978; catch-and-release regulations have been in place since 1987. In spite of these restrictive regulations, anglers have recently expressed concern over a perceived decline in their angling experience, citing fewer fish, diminished insect hatches, and a lack of rising fish. Some anglers have even suggested that trout stocking is the answer. These concerns warranted a survey of anglers, but standard creel measures are unlikely to fully describe this technical dry fly angling experience. Therefore, we developed an angler attitude survey to measure angler values and satisfaction, along with opinions on wild trout management versus hatchery trout management. A total of 614 anglers were surveyed at river access points for the park from June 15 (the season opener) through October, 2008 when angling use dropped off substantially. Anglers valued the quality of insect hatches, opportunities to fish to rising fish, and condition of fish habitat, but

angler satisfaction with these factors was generally low. Anglers were about equally split between those who rated the quality of fishing in Harriman State Park today either as ñexcellentò or ñgoodò versus those who rated it as ñfairò or ñpoorò. Eighty-eight percent of anglers approved and 6% disapproved of managing the fishery for wild trout, whereas 16% approved and 76% disapproved of managing the fishery with stocked trout. The Henryôs Fork within and adjacent to Harriman State Park will continue to be managed for wild trout, but future work will focus on habitat assessments and potential restoration options that may improve the angling experience.

An Assessment of the Potential Use of Mollusks to Improve Water Quality in Aquaculture Systems

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Aquaculture systems can become more efficient and likely more sustainable by rearing integrated sets of species that compliment one another in their environmental requirements. We seek to assess the possibility of integrating native bivalve mollusks in a salmonid aquaculture setting to reduce water pollution and increase the quality of ecosystem services. We are using data from the scientific literature to define the range of freshwater bivalve mollusk filtration rates and production capacity in environments similar to those found in Idaho. We obtained filtration rates for various bivalves in the scientific literature. Anodonta anatine was reported to filter 2.6 to 2.9 L per hour in temperatures ranging from 18 to 20°C. Anodanta is a genus represented in the Pacific northwest. We illustrate the potential benefits and risks of integrating mollusks into culture systems, and simulate filtration rates and phosphorous reduction using data from a regional salmonid hatchery.

Evaluation of Mixed Cell Raceways at Dworshak National Fish Hatchery

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Mixed cell raceways (MCR) utilize multiple water flow outlets situated around a central drain to create hydraulically separated cells, with adjacent cells utilizing a different direction of flow. We are testing the MCR an alternative to the Burrows Ponds as an improvement of water quality at Dworshak National Fish Hatchery. Two ponds were converted by removing the center wall, installing 4 drains in each pond. The water delivery using drop legs into the system causes each cell to act hydraulically like an individual circular tank, and can improve solids removal and water quality. This MCR system was conceived and tested in several cases on the East Coast and Europe. At Dworshak, we are evaluating the flows, waste removal, fouling, and have begun fish production studies. It was hypothesized the mixed cell raceway would increase oxygen levels, improve fish health, and enhance water efficiency over conditions in a typical Burrows pond.

Variation in the Individual Performance of Juvenile Oncorhynchus Mykiss: A Comparison of Multiple Metrics of Growth and Condition

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Ecological studies and management strategies often focus on metrics at the population scale (e.g. abundance, biomass). However, considerable variation can exist at the individual level that ultimately provides insight into population level processes. We are quantifying the variation in performance of individual rainbow trout (Oncorhynchus mykiss) and how this relates to the spatial variation in food and habitat availability in a river system that has undergone a dramatic shift to a simple fish community dominated by resident O. mykiss. Our goal is to quantify baseline conditions in system productivity and individual growth and condition of O. mykiss prior to restoration activities that could return anadromy to this system. Condition factor, lipid analysis and individual consumption rates are separate and independent approaches to understanding the growth potential or predicting the survival of individual fish. Using natural signatures of geologically-derived cesium (133Cs) as a metabolic tracer, we estimated individual consumption rates of juvenile O. mykiss from the Icicle Creek basin, Washington. Here we combine the 133Cs approach with other traditional approaches to quantify the individual variation in performance of juvenile fish. Additionally, we combine our performance metrics with otolith microstructure to compare their relative ability at explaining past growth experience by individual fish. Our work serves both to quantify variation in the performance of fish within a population and to develop novel approaches for accomplishing this.

A Tale of Two Fishes and Their Future Climatic Fates: A Case History of the Boise River Basin with Relevance for Idaho

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Idahoôs streams provide important recreational fisheries and some of the best remaining habitat for several federally listed salmonid species of regional importance. A warming climate will bring unprecedented changes to these streams, with thermal considerations being of utmost importance given that most aquatic organisms are ectothermic and salmonids, in particular, require cold water temperatures. Previous assessments of climate-related thermal impacts to streams have relied on surrogate air temperature-elevation relationships and have not modeled stream temperatures directly because of limited data availability and difficulties associated with downscaling in mountainous terrain. We compiled a large stream temperature database (n = 780) from 1993 ï 2006 for the 6,900 km2 Boise River Basin to assess potential trends in summer stream temperatures and thermally suitable habitat for rainbow trout and bull trout. The data were used to parameterize multiple regressions based on new spatial statistical models that account for network topography (i.e., flow direction and volume). Models with four predictorsð radiation, elevation, air temperature, and stream flowð accounted for 93% and 86% of the variation in mean and weekly maximum stream temperatures, respectively, during the 14 year study period. During this time, we estimate that basin averaged annual maximum stream temperatures increased by 0.48°C (0.34°C/decade) and means by 0.38°C (0.27°C/decade), primarily due to gradual, but long-term (30 ï 50 year) trends in air temperatures and stream flows. Wildfires were the least important factor affecting temperatures at the basin scale, despite burning 25% of the basin since

1993 and often having strong local effects. Thermally suitable habitat for rainbow trout encompassed much of the stream network at the outset of the study and was minimally affected by these temperature increases. Potential bull trout habitats initially encompassed approximately half the stream network, and suitable stream lengths based on mean temperature are estimated to have decreased by 0.8% - 1.3% per year, with faster loss rates occurring in the coldest, highest quality habitats at upper elevations. If past trends in air temperature and stream flow continue, we project that 39% - 63% of currently thermally suitable stream lengths will be unsuitable for bull trout by the year 2056. Moreover, these estimates of future stream temperature increases and bull trout habitat losses could prove conservative because the distribution of future fires is unknown and climatic extremes are increasing at rates faster than the average trends we modeled. Our results suggest trends associated with a warming climate have begun to affect stream temperatures and thermal habitat distributions in the Boise River Basin. Similar trends are likely in many of Idaho's streams, given statewide trends toward warmer air temperatures, recent wildfire increases, and hydrologic alterations. As in the Boise River, however, impacts are likely to be both species and context specific. Accurate predictions of current and future conditions will be necessary to inform proactive management.

A Prey-Driven Model of Habitat Quality for Stream-Dwelling Salmonid Fishes

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We used a bioenergetics model to estimate habitat quality for juvenile Yellowstone cutthroat trout (Oncorhynchus clarkii bouvieri) and to determine if the abundance of fish in the stream was related to net energy intake rates (NEI) and the proportion of suitable habitat. We conducted monthly sampling of cutthroat trout, invertebrate drift, and physical habitat features in pool and riffle habitats. Fish observed during this study selected foraging positions that enabled them to maximize NEI and most fish were capable of sustaining high growth rates from July to September. Across the study sites, the availability of suitable habitat and NEI declined from July to October, primarily due to a decline in temperature over the four months. Mean NEI rates and the proportion of suitable habitat at sites were greater in pools relative to riffle habitats. Cutthroat trout biomass was significantly related to NEI and the proportion of suitable habitat at a site. Our assessment of habitat quality, based on NEI, provides an energetic explanation for commonly observed spatial and temporal differences in the abundance of stream-dwelling salmonids. Bioenergetic models may provide a means to predict changes in habitat quality in the face of changing environmental conditions.

Temperature Selection of Bonneville Cutthroat Trout Based on Summer River Temperatures in the Bear River of Idaho and Wyoming

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Alterations to an ecosystem's thermal regime can significantly affect growth and survival of organisms. Human alterations of the Bear River watershed in Idaho and Wyoming have changed the river's thermal characteristics. These impacts have potentially influenced the use of thermal resources by native Bonneville cutthroat trout (Oncorhynchus clarkii utah) population. In the summers of 2005 and 2006, we collected temperature data from the Bear River that indicated periodic temperatures exceeding lethal limits for cutthroat trout. We compared habitat selection of cutthroat trout in the Bear River by comparing temperature used by cutthroat trout versus

temperature available in the river. We hypothesized that cutthroat trout would select habitats with lower temperatures more frequently than habitats with temperatures that often exceeded lethal limits. We measured habitat selection by surgically implanting radio-telemetry tags equipped with temperature sensors into 84 cutthroat trout. We also measured habitat quality, based on temperature, using three methods: (1) floating temperature surveys, (2) temperature data loggers and (3) airborne thermal imagery. The results from our study identify relatively rare, cool-water locations that cutthroat trout use more frequently than average water temperature in the Bear River. These data indicate that maximum summer water temperatures can influence habitat quality for Bonneville cutthroat trout.

Assessment of Cutthroat Trout Habitat Access and Availability in Three Creeks of Caribou County, Idaho

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SWCA Environmental Consultants (SWCA) was commissioned by HWS Consulting Group (HWS) to conduct trout habitat surveys in East Mill, Kendall, and Mosquito creeks in the vicinity of Nu-West Industries Inc.ôs decommissioned North Maybe Mine in Caribou County, Idaho. The objective of these surveys was to determine whether habitat is present for resident or spawning populations of cutthroat trout and to evaluate access to this habitat via road-stream crossings. No fisheries surveys were conducted during this study; however the Idaho Department of Fish and Game (2007) and May et al. (2007) listed East Mill, Mosquito, and Kendall creeks as being currently occupied by Yellowstone cutthroat trout (Oncorhynchus clarkii bouvieri). SWCA and HWS conducted surveys of physical habitat using a modification of the Forest Serviceôs R1/R4 Fish Habitat Inventory Procedures (Overton et al. 1997) and passage assessments using Clark in et al.ôs road-stream crossing barrier identification protocol (2005) in the summer and fall of 2007. Cutthroat habitat suitability indices (Hickman and Raleigh 1982) indicate that moderate-quality cutthroat trout habitat exists in the lower reaches of East Mill and Kendall creeks, but minimal habitat exists in Mosquito Creek. Habitat quality and quantity in East Mill and Kendall creeks is limited by the presence of natural and manmade barriers to fish movement, lack of spawning habitat, and lack of overwinter habitat. Impassable culverts prevent fluvial cutthroat trout from accessing all but 0.87 km of lower East Mill Creek and all of Kendall Creek upstream of the Diamond Creek Road. These tributaries represent the fringes of cutthroat habitat and historically would not have supported robust resident populations. However, if connectivity downstream and within were restored, the physical habitat suggests that they may support low-density resident populations of cutthroat trout or provide a small amount of spawning habitat to the fluvial population.

Irrigation Diversion Impacts on the Mountain Whitefish Population in the Big Lost River

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Management agencies have documented a decline in the mountain whitefish Prosopium williamsoni population on the Big Lost River and unscreened diversions are recognized as a potential factor for this decline. Research suggests the Big Lost River mountain whitefish population is genetically divergent from its parent population in the Upper Snake River. In 2007, entrainment was evaluated in twelve canals to gain an understanding of relative entrainment and to prioritize our efforts in 2008. Entrainment was evaluated in six canals in 2008 using multiple

pass electrofishing depletions. We found that entrainment rates varied widely between diversions, however several canals entrained substantial numbers of mountain whitefish. Variations are attributed to seasonal patterns and the physical characteristics of the diversion. We believe that the substantial numbers of fish entrained in some canals may be having a population effect. Modeling comparisons between the host population and canal catches suggests that the screening of some diversions may provide substantial benefits to the population, while screening other diversions may not be warranted when resources are limited.

Detecting change with the Conservation Success Index: Mountain whitefish in the Big Lost River basin

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The Conservation Success Index (CSI) was developed by Trout Unlimited to describe the status of native salmonids at the subwatershed scale and help inform management and restoration efforts. We evaluated how the CSI reflected changes in mountain whitefish Prosopium williamsoni populations and habitat in the Big Lost River basin from 2004 to 2009. Since 2004, mountain whitefish fish have been found in two additional subwatersheds within their historic range, abundance has increased, and fish passage was provided on six water diversion structures. Rangewide Condition indicators reflected the two newly occupied subwatersheds in the basin, and mountain whitefish now occupy 11 of 26 (42%) historically occupied subwatersheds and 61 of 214 miles of historical habitat. Population Integrity indicators reflected increases in population density and extent of connected habitat. For extant populations, the extent of connected habitat within subwatersheds increased from an average of 10.4 miles (range: 0.3 to 40.9 miles) to 16.2 miles (range: 0.3 to 54.8 miles). Connectivity in three subwatersheds on the mainstem increased from 1.4 to 10.8 miles (12 to 89%) from fish passage projects. The CSI consists of 20 different indicators and the changes in mountain whitefish populations over time and habitat restoration projects resulted in an average increase of 4 points in overall CSI scores across subwatersheds and up to 8 points within a single subwatershed. Because the CSI is an aggregate index that is made spatially explicit, the overall scores can be disassociated to determine exactly why and where changes have occurred. Though not its primary application, the CSI can reflect the successes of conservation investments over time and effectively present those changes graphically and numerically across coarse scales.

Evaluation of the Johnson Creek Summer Chinook Supplementation Program Using Genetic Parentage Analysis; Do Hatchery Fish Reproduce in the Wild?

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The Nez Perce Tribe Johnson Creek Supplementation Project completed a ten year review (1998-2008) in order to examine the effects of supplementation in Johnson Creek, Idaho. The Johnson Creek program incorporates a unique supplementation strategy that utilizes only natural origin fish for broodstock in order to minimize the effects of hatchery origin fish. Genetic samples were taken from both hatchery and natural origin adults at the weir and from carcasses on the spawning grounds. Microsatellites were genotyped and used to perform parentage analysis. Relative reproductive success of natural fish removed for broodstock and spawned, and the success of their returning offspring during natural spawning was then tested using principle

component analysis. Variables included; rearing type, sex, age, size, run timing, and year of return.

Demographic and Genetic Impacts of Hatchery-Origin Chinook Salmon to the South Fork Salmon River Population

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Demographic and genetic analysis results were used to evaluate the impact of hatchery-origin (HOR) Chinook salmon on the genetic stock structure of natural-origin (NOR) Chinook salmon in the upper South Fork Salmon River (SFSR). A broodstock collection weir separates the SFSR into two management areas with differing ratios of hatchery-origin spawners. Four spawning reaches downstream of the weir were surveyed. Weir returns, redd counts, and carcass recoveries from five sections in the upper SFSR were used to estimate the number of spawners and the HOR:NOR fraction. Redd counts varied significantly from 1996 through 2008 for all sections. Significant numbers of HOR carcasses were collected in all sections, ranging from an average of 16% (HOR) at section 5 (Poverty Flat) to 71% (HOR) in the section 2 directly below the weir. Genetic analysis utilizing microsatellites and SNP loci detected variable effects of the hatchery stock (HAT ï a locally-derived stock) on the NOR populations. Although some specific temporal and spatial differences were detected between sections, the analysis indicated a weak overall genetic structure (global FST = 0.005) and lack of clear distinction between natural and hatchery population segments.

Abundance, Survival, and Productivity of Spring Chinook Salmon in the Lostine River, Oregon, After Eleven Years of Supplementation

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Efforts to rebuild Lostine River Chinook salmon Oncorhynchus tshawytscha in Oregonôs Grande Ronde Basin using supplementation began in 1997 with the collection of adult broodstock and production of hatchery smolts. These smolts were acclimated and volitionally released during the spring. Hatchery Chinook salmon were monitored as smolts and returning adults using coded-wire tags, PIT tags, redd counts, and mark-recapture escapement estimates. We found that mortality after release in an 18 km reach immediately below the release site ranged from 0% to 15.3%. Survival estimates for hatchery Chinook salmon smolts 18 km downstream of release to Lower Granite Dam ranged from 43.2% to 70.2%. Survival estimates for natural Chinook salmon smolts from 1999 to 2007 were higher than for hatchery Chinook salmon smolts in all years except 2002. Survival estimates were significantly higher for natural than for hatchery Chinook salmon smolts in 1999, 2001, 2005, and 2006. The first female adults from the supplementation program returned in 2001 and the redd count trend in the Lostine River mirrored redd count trends in un-supplemented streams in the Grande Ronde Basin from 2001 to 2007. Total escapement of natural and hatchery Chinook salmon initially increased from a low of 100 adult returns in 1999 to more than 2,000 adult returns in 2008. However, both natural and hatchery progeny-to-parent ratios declined from brood year 1999 to brood year 2003.

There's No Fish like Dead Fish: How do Salmon Additions Influence Resident-Fish Growth?

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Salmon carcass and analog (i.e. pelletized salmon) additions are utilized as nutrient mitigation tools in streams of the Pacific Northwest. These additions subsidize nutrients lost from natural salmon returns. Carcasses provide a food source to aquatic and terrestrial consumers, including resident-fishes, via direct (e.g. consuming salmon) and indirect (e.g. dissolved nutrients) pathways. We conducted an experiment consisting of two salmon-addition treatments (carcass and analog) and a non-treated control, over nine streams in the upper Boise basin, Idaho. We hypothesized that resident fish in treatment streams would have higher growth rates due to increased food availability. Growth rates of resident rainbow trout (Oncorhynchus mykiss) and brook trout (Salvelinus fontinalis) were estimated by marking (using PIT tags) and recapturing (electrofishing) individuals before and at 2 and 6 wks after treatments. Fish were also collected during these sampling periods for analysis of their diets. Both carcass and analog treatments caused a doubling of growth rates by resident fishes in comparison to the control. No differences were observed between rainbow and brook trout or among size classes. Analysis of stomach contents showed that rainbow and brook trout fed directly on fragments of salmon carcass and analog material, as well as aquatic invertebrates. Our initial findings show that salmon and analog additions increase resident-fish growth rates in the short-term following such treatments. Future work, including annual applications of these experimental treatments and on-going monitoring, will allow us to evaluate whether increased growth translates to population-level responses in abundance, biomass, and production of resident fishes.

Short-Term Periphyton and Nutrient Responses to Experimental Salmon Additions in Headwater Streams

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Returns of anadromous salmon have declined dramatically in the past century throughout Idaho, reducing delivery of marine-derived nutrients to streams and rivers. Because of the nutrient-poor nature of streams draining the Idaho Batholith, the loss of salmon could have had profound effects on stream nutrient processing and primary production. Now, additions of salmon carcasses and salmon analog have been proposed to mitigate for the loss of marine-derived nutrients, and ultimately boost stream-riparian productivity, in headwater streams of the Snake River. Our objective was to determine short-term responses of primary producers (biomass, metabolism) and nutrient cycling (periphyton nutrient limitation, whole-stream nutrient uptake) to marine-derived nutrients from salmon. We conducted an experiment in the North Fork Boise River, with three streams receiving additions of salmon carcasses, three streams receiving salmon analog, and three control streams with no additions. Two weeks after treatment application, periphyton chlorophyll was three times greater in the analog and six times greater in the carcass streams compared to the control streams, and remained two and three times greater by six weeks after treatment. Periphyton nutrient limitation, determined with nutrient-diffusing substrates, changed from N-limited in the control streams to P-limited in the analog streams and not nutrient limited in the carcass streams. Together, these results suggest that salmon nutrients increased periphyton biomass by supplying adequate nutrients to eliminate N limitation, although the carcasses supplied adequate N and P, while the analog induced P limitation. Further data will

demonstrate whether salmon nutrients also changed nutrient uptake and primary production in our stream streams. In conclusion, our study suggests that salmon carcasses and analog may increase the nutrients available to primary producers and alter nutrient cycling in headwater streams. However, their utility as a mitigation tool at the landscape scale and their effects on higher consumers remains to be determined.

Testing Assumptions behind Alternative Recovery Strategies for Anadromous Salmonids: An Analysis of Food Limitation in the Upper Salmon Basin, Idaho

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Habitat restoration, along with nutrient and salmon carcass additions, are currently the main mitigation and recovery strategies for salmon and steelhead in the Snake River basin. The rationale for applying these recovery strategies is based on the assumption that habitat and/or food limit populations of anadromous salmonids. In contrast, use of hatchery and egg-box supplementation is based on the assumption that ample resources exist to sustain supplemented fish. Predicting and prioritizing successful recovery strategies for salmon and steelhead in the Snake River basin will require evaluating these contradictory assumptions through an analysis of limiting factors. In this study we quantitatively assessed food limitation of anadromous salmonids in the Yankee Fork Salmon River, via a comparison of fish production and energetic demand to aquatic invertebrate production. The Yankee Fork is an excellent setting for such a comparison because it is the location of a proposed floodplain restoration project and also receives hatchery and egg-box supplementation. Our results show that local invertebrate production greatly exceeds fish demand, indicating that food availability is not likely to be the limiting factor for this stage in the life-cycle of anadromous salmonids in this area. On the contrary, this result suggests that excess invertebrate production may support further hatchery and egg-box supplementation, though the extent to which supplementation translates to increased adult returns is largely unknown. Our finding calls into question the potential response of anadromous fish to floodplain restoration in the Yankee Fork, and also the effectiveness of nutrient and salmon carcass additions. Moreover, our observations support the idea that downstream factors (hydropower, harvest, and ocean conditions) are likely limiting populations of anadromous salmonids in this area, and that recovery efforts that focus on headwaters are probably inadequate.

Using GIS to Estimate the Risks and Benefits of Barrier Removal to Native Fish Populations in Idaho

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Removing fish passage barriers can provide risks or benefits to native fish populations. Some of the benefits include improved access to upstream spawning areas, and enhancing the viability of metapopulations. Conversely, eliminating barriers can potentially open access for invasive species and pathogens to areas where native species currently exist. These interactions can adversely affect the health of indigenous fish populations. In this study, we develop a methodology using GIS tools, to assess the risks and benefits of barrier removal through delineating habitat characteristics of selected target invasive species and assessing stream network connectivity. Our first goal is to characterize habitat that would likely favor populations of

each selected invasive species. Our assessment identifies three levels of risk based on specific geomorphologic characteristics of the watershed (i.e., stream gradient, drainage size and land use). We pose risk factors with models using several hierarchical spatial extents. With areas of risk delineated, our second goal is to simulate the effects of removing improperly designed culverts and irrigation diversion structures that constraint fish passage based on the spatial distribution of these structures within the watershed. Factors that we consider include: length of opened stream connectivity in areas where (1) the risk of infection is lowest and (2) there is no presence of invasive species. The initial phase of our study focuses on assessing risks from infection of whirling disease parasite in the Boise National Forest, and plan to provide a similar approach for assessing other National Forests and federal lands with native fish species at risk. The results and approach used in this study might help managers to efficiently prioritize the removal of barriers minimizing the associated risks for native fish.

Are Population Genetic Studies of Cutthroat Trout Congruent with our Knowledge of Cutthroat Trout Ecology and Life History?

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To make conclusions regarding hybridization and population structure, researchers have often sampled cutthroat trout populations where they have had the greatest confidence of sampling a population in genetic equilibrium. This has lead to sampling at relatively high elevations in populations of predominately resident individuals. The advantages of such a strategy are that researchers can utilize population genetic models to make inferences about populations, such as levels of hybridization and patterns of genetic migration and population structure. This approach has led to important advancements in our understanding of migration and hybridization in high elevation populations. Our study examined the appropriateness of that approach for understanding population structure in populations with mixed migration life histories using an evaluation of published studies and local case studies. For example in the Jocko River, MT, similar to other studies of cutthroat trout, we detected high levels of population differentiation over short geographic distances in small, high elevation streams. As elevation decreased and stream size increased, we observed much lower levels of genetic differentiation. We hypothesize that because populations in low elevation systems should have a greater degree of likely migratory individuals, there is more straying between populations and thus low levels of genetic differentiation. If our hypotheses are true, researchers may need to reconsider what traditional population genetic sampling approaches teach us about cutthroat trout life history and ecology.

Identification of Bull Trout, Brook Trout, and their Hybrids Based on Phenotype

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Correctly identifying bull trout, brook trout, and their hybrids can be a critical component of successfully managing bull trout populations. While genetic analysis can be used to distinguish these fish, cost and time constraints limit the usefulness of this identification method for many management activities. Subsequently, a technique for identifying these fish based on phenotype would be useful. We developed and tested a guide for rapidly identifying bull trout, brook trout, and their hybrids using phenotype. We evaluated the effectiveness of the guide on fish from

central Idaho by comparing identifications made using the guide with identifications made using genetic analysis. The evaluation found that the lead investigator identified 99% of the fish correctly, observers that used the guide following a training session identified 99% of the fish correctly, and observers that used the guide without training identified 97% of the fish correctly. Overall, 98% of the fish were correctly identified. This suggests that the identification guide is a reliable method of identifying bull trout, brook trout, and their hybrids.

An Experimental Comparison of Food Web Effects by Native and Nonnative Trout

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Nonnative species have unknown effects on communities they invade; and impacts may propagate across habitat boundaries. In streams, invading fish may deplete benthic insects, potentially increasing periphyton biomass and reducing the flux of adult insect emergence and the abundance of riparian consumers such as spiders (Tetragnathidae). We tested these effects by manipulating the presence and density of nonnative brook trout and native cutthroat trout in a large-scale field experiment. Enclosed reaches were treated with either no fish (NF), brook trout at natural densities (0.4 fish/m2; BKNat), cutthroat trout at natural densities (0.15 fish/m2; CT), or brook trout at densities similar to CT (BKRed). We expected BKNat to increase periphyton biomass and reduce the flux of emerging insects and abundance of tetragnathid spiders, NF to exhibit the opposite response, and CT and BKRed to have intermediate values. Contrary to our hypotheses, periphyton biomass and riparian spider abundance were similar across treatments. Brook trout reduced insect emergence flux by 52% compared to control reaches, but this was only significant for the BKRed treatment. Therefore, the replacement of native cutthroat trout by nonnative brook trout may alter the flux of emergent adult aquatic insects to riparian zones. However, the findings are counterintuitive in that it was the lower density brook trout treatment that caused decreased emergence, and there were no accompanying responses in either periphyton or spiders. Our results contrast those from other manipulative experiments (e.g. Japan and New Zealand) where nonnative salmonids had significant effects on multiple trophic levels, and suggest that not all ecosystems invaded by nonnative salmonids experience strong indirect effects on food webs.

Comparison of Trophic Basis of Production for Native and Non-native Fishes in the Colorado River, Grand Canyon

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Native fishes of the Colorado River are imperiled due, in part, to interactions with invasive, non-native fishes. As in most large rivers of the West, competition for resources between native and non-native fishes is likely a key mechanism driving reductions in native species. Dietary overlap, in particular, may lead to interspecific competition if food resources are limiting. To evaluate the potential for such exploitative competition between native and non-native fishes, we quantified diets and dietary overlap for the entire assemblage of fishes in a segment of the Colorado River in Grand Canyon. During summer 2008, we collected diet samples from native humpback chub

(Gila cypha), flannelmouth sucker (Catostomus latipinnis), bluehead sucker (Catostomus discobolus), and speckled dace (Rhinichthys osculus), as well as non-native rainbow trout (Oncorynchus mykiss), carp (Cyprinus carpio), fathead minnow (Pimephales promelas), and yellow bullhead (Ictalurus natalis). To estimate diet composition for each fish species, we identified diet items (invertebrates to family and other resources to coarse categories, e.g., algae, terrestrial plant material) and weighed each prey type. For each fish species, we combined diet proportions with assimilation efficiencies to estimate the trophic basis of their production (TBP). Comparisons of TBP indicated substantial overlap between native and non-native fishes. For instance, carp and flannelmouth suckers had greater overlap than did the native suckers. Strength of overlap varied with life history stage. For example, native suckers and non-native fathead minnows had large overlap during juvenile stages, but little overlap during adult stages. Strong overlap between native and non-native fishes may be partially driven by the low diversity of food resources available. Future analyses will evaluate resource overlap at multiple sites and across seasons to determine the strength of interactions between fish species, an effort whose results may apply to other large, regulated rivers throughout the West.

Colorado's Zebra/Quagga Mussel Monitoring Program

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Invasive Zebra or Quagga mussels pose a serious problem when they are introduced into water systems because they are extremely prolific filter feeders that encrust hard surfaces causing environmental and economic damage while presenting a health risk. Zebra mussels were likely introduced into the Great Lakes in 1988, and spread to locations within the Mississippi, Missouri, and Platte River systems. Mussels have been found on boats being hauled to waters in many more states. Quagga mussels have infested United States water, especially in the West. Colorado was at risk for Zebra or Quagga mussels because waters in nearby Kansas, Nebraska, Utah, Nevada, and California are infested. Colorado Division of Wildlife found Zebra mussels in Pueblo Reservoir, south of Denver, in January 2008. State and federal agencies had been monitoring for aquatic nuisance species throughout the state prior to this infestation, but monitoring protocols were revised, more technicians were hired, more water bodies monitored, and agencies started working together when Pueblo Reservoir tested positive. A monitoring priority was established, based on how much the lake was used, by whom, and for what purpose. Starting June 2008, artificial substrates were placed at boat entry points and by outlet structures at every high and very high priority water bodies. Technicians conducted shoreline surveys at least monthly at every medium, high, and very high priority water bodies. When the water temperature reached about 60^{o}F, plankton tows were conducted. As monitoring progressed three reservoirs in the headwaters of the Colorado and Platte River drainages and two in the Platte River drainage were found positive for Zebra or Quagga mussels. These lakes have a range of water qualities and were not predicted to become infested. Future plans include continued monitoring for Quagga and Zebra mussels and other target invasive species.

Effects of Abiotic and Biotic Factors on the Abundance of Larval Freshwater Drum *Aplodinotus Grunniens*

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The presence of non-game fish in aquatic systems can have profound effects on aquatic communities, such as reducing the survival of game fish through competition for food resources. Determining the factors which affect the abundance of these fish is important for fisheries managers trying to balance game and non-game fish within these systems. The freshwater drum, *Aplodinotus grunniens*, is an example of a non-game fish found in several rivers and reservoirs throughout the U.S.; however the abiotic and biotic processes which influence their annual abundance are not well understood. We collected larval freshwater drum in Harlan County Reservoir, Nebraska, using push nets during the summers from 2002-2007. Abundance data from these years was compared with abiotic and biotic data collected from the reservoir and analyzed using PCA in an effort to determine factors promoting strong and weak larval drum assemblages. We found differential abundance between years, suggesting that there are annual differences in the early survival of freshwater drum. By determining the factors which lead to these occurrences, fisheries managers will be able to better assess the overall health of these systems.

Predator Removal in Lake Pend Oreille: An Update on Recent Efforts

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Lake trout *Salvelinus namaycush* were introduced into Lake Pend Oreille, Idaho in 1925. This population remained at low density for many years, but grew exponentially during 1999-2005. The increased abundance of lake trout, combined with already established populations of rainbow trout *Oncorhynchus mykiss* and bull trout *Salvelinus confluentus*, resulted in high levels of predation on kokanee *Oncorhynchus nerka*. This forced the closure of the kokanee fishery in 2000. Lake trout establishment also posed a substantial risk to the native bull trout population. In response, a predator removal program was developed to reduce rainbow trout abundance over the short-term and target long-term suppression or collapse of the lake trout population. These efforts began in 2006, using both anglers and a commercial fishing operation. The Angler Incentive Program encouraged anglers to harvest both rainbow trout and lake trout by offering a $15 per fish reward. Since 2006, anglers have removed 18,784 rainbow trout and 41,726 lake trout. Commercial netting that targets lake trout has removed 21,871 fish since 2006, including 11,761 fish in 2008. Efficiency of netting efforts was improved in 2008 by targeting lake trout spawning sites identified by telemetry research. Lake trout aggregated at two sites in the lake, which allowed an estimated 65% of mature fish to be removed by netting in the fall of 2008. The kokanee population has remained at a perilously low level, but some improvement was documented in 2008. Kokanee survival from age-1 to age-2 increased from a record low of 10% in 2007 to 28% in 2008. Similarly, abundance of mature kokanee (age-3 and age-4) increased for the first time since predator removal efforts began. Monitoring of the kokanee and lake trout populations in upcoming years will be conducted to evaluate the effectiveness of removal efforts.

Competition as a Factor in Displacement of Native Cutthroat Trout by Nonnative Rainbow and Hybrid Trout

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Native salmonid fishes have been displaced worldwide by nonnatives through hybridization, competition, and predation, but the dynamics of these factors are poorly understood. We apply stochastic Lotka-Volterra models to displacement of cutthroat trout by rainbow/hybrid trout in the Snake River, Idaho, USA. Cutthroat trout are susceptible to hybridization in the river but are reproductively isolated in tributaries via removal of migratory rainbow/hybrid spawners at weirs. Based on information-theoretic analysis, population data provide evidence that hybridization was the primary mechanism for cutthroat trout displacement in the first 17 years of the invasion. However, under some parameter values, the data provide evidence for a model in which interaction occurs among fish from both river and tributary subpopulations. This situation is likely to occur when tributary-spawned cutthroat trout out-migrate to the river as fry. Resulting competition with rainbow/hybrid trout can result in extinction of cutthroat trout even when reproductive segregation is maintained.

Effectiveness of Flow Management and Rainbow Trout Harvest on Long-Term Viability of Native Yellowstone Cutthroat Trout in the South Fork Snake River

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The South Fork Snake River supports one of the last remaining large-river populations of Yellowstone cutthroat trout (YCT). Rainbow and rainbow x cutthroat hybrid trout (collectively, RHT) established a self-sustaining population in the upper South Fork in the mid-1980s. In 2003, density of each species was 1,400 fish per mile. In 2004, U.S. Bureau of Reclamation began delivering a spring ñfreshetò from Palisades Dam, and Idaho Department of Fish and Game removed harvest limits on RHT. We evaluated current and future effectiveness of these management actions with a stochastic simulation model parameterized with observed data. Total RHT + YCT recruitment is positively correlated with winter flow, and RHT recruitment is negatively correlated with maximum freshet flow. There is little temporal overlap in spawning, and hybridization alone does not explain the observed RHT invasion rate. Nonetheless, continued removal of RHT from spawning tributaries is necessary to prevent long-term loss of YCT. A model of juvenile competition between the two species based on experimental results of Seiler and Keeley explains observed invasion rates. Current densities of 1,700 YCT per mile and 925 RHT per mile indicate reversal in population trends since 2004, and our analysis suggests that this is due primarily to harvest of RHT, which increased from 7% in 2003 to 20% in 2005. About 15% exploitation on RHT is required to prevent YCT extinction. We considered a likely future scenario to include mean winter flow of 1,600 cfs (72% of 1987-2007 mean but necessary to enable the freshet operation), maximum freshet flow averaging 20,000 cfs, and RHT harvest at 20%. Assuming environmental variance as observed since 1987, the 25-year population projection is about 1,100 fish per mile of each species. Increased percentage of YCT requires higher RHT harvest and/or higher maximum flows, and increased abundance requires higher winter flows.

Age, Sex Distribution and Fecundity of the Invasive Oriental Weatherfish (Misgurnus Anguillicaudatus) in Idaho

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The Oriental Weatherfish was first found in 1951 in a canal near Eagle Island State Park, Idaho. Since then, individuals have been collected in the Payette and Boise River drainages. In Idaho, little is known about this invasive speciesô population structure, life history or environmental tolerances. Here we present some preliminary data on age, sex distribution and fecundity of weatherfish in the Treasure Valley area. We could reliably differentiate sex by pectoral fin morphology. Based on length frequency and otolith section analysis, males appear to have 3 separate age classes, while females appear to have 5 age groupings. Gonadosomatic index (GSI) shows that for both sexes onset of sexual maturity begins at ~ 10 cm total length (TL) and is directly correlated with length. Ovarian dry weight indicates high fecundity with the potential for rapid population increase. Weatherfish appear to have multiple reproductive events per season and spawn from April through late October.

POSTERS

(Abstracts in Alphabetical Order by **Presenting Author's** Last Name)

Determination of Available Late Summer Rearing Habitat for Wild Juvenile Steelhead, Oncorhynchus mykiss, in the Potlatch River, Idaho

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The Potlatch River Low Water Habitat Availability Protocol (LWHAP) was created in 2007 to quantify and evaluate late summer juvenile steelhead habitat within the lower Potlatch River drainage. Over summer rearing habitat has been found to be a limiting factor within the lower drainage and is currently the focus of habitat restoration projects within the lower Potlatch River. Six lower Potlatch River tributaries were stratified into upland and canyon reaches and two 500m transect were randomly chosen within these strata resulting in four transects per tributary. The length of wetted habitat, pool density, and pool characteristics were recorded within each transect. The estimated percent wetted habitat within lower Potlatch River tributaries increased from 54% in 2007, to 73% in 2008. Pool density within lower Potlatch River tributaries increased from 1.02 per 100m in 2007, to 1.6 per 100m in 2008. Environmental variables such as snowpack, early spring rainfall, and temperature affect late summer rearing habitat for juvenile steelhead. The relationship between streamflow and environmental variables will be important for assigning a level of success to habitat restoration projects in the drainage.

The Use of Genetic Methods to Maintain Genetic Diversity within an Endangered Captive Broodstock Program

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Snake River sockeye salmon were protected under the ESA in November of 1991. Genetic methods have been used since the initiation of the Snake River Sockeye Salmon Captive

Broodstock Program. The goal of these methods is to sustain genetic diversity and fitness levels, and reduce inbreeding within a small, captive population. The IDFG Genetics Laboratory has utilized several genetic techniques to determine genetic diversity and relatedness within the broodstock. This year, we had the largest return of anadromous fish to the Stanley Basin since the inception of the program. Since there are hatchery restrictions, not every fish can be incorporated into the broodstock during large return years. Techniques had to be implemented to determine which fish to release as adults to spawn naturally and which to keep and contribute to the broodstock. A total of 13 microsatellite loci were utilized to determine genetic importance by ranking each fish. Top ranked individuals (ones most unique from others) are then put into an inbreeding avoidance matrix used to choose spawning pairs and avoid crosses among close relatives. During the fall of 2008, these methods were used to select 39 females and 34 males of the 650 anadromous adults that returned to the Stanley Basin. The selected anadromous adults, in addition to the 146 male and 77 female captive adults will collectively contribute to the captive brood year 2008 stock which will spawn during the fall of 2011. Anadromous fish were incorporated into the captive broodstock program to avoid potential hatchery domestication and to ensure that natural selective processes are brought into the program. Overall, we feel that these methods ensured that genetic diversity and fitness was maximized. It will be important to utilize these genetic resources as the program expands from a genetic conservation program into a recovery program and potentially be used as an aid in recovery efforts for other programs.

Managing Population Specific Chinook Salmon (Oncorhynchus Tshawytscha) Harvest While Promoting Recovery of a Listed Species

Scott Brandt and Kurt Tardy
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Snake River spring/summer Chinook salmon are cultural and social symbols for the Shoshone-Bannock Tribes (Tribes) and historically provide an annual subsistence fishery in the Columbia River basin. Despite the significance of these fish to the Tribes, there has been widespread and dramatic decline in abundance, distribution, genetic diversity, and productivity of Chinook salmon in the Salmon River sub-basin, resulting in this species being listed as threatened under the Endangered Species Act (ESA) in 1992. The Tribes developed a Tribal Resource Management Plan (TRMP) to provide population specific harvest management of Chinook salmon in a manner that promotes recovery of the listed species. The Tribes report salmon harvested, overall escapement, and total impact rates as factors for population specific management.

Life History Evaluation of Hatchery Supplementation Fish and Natural Origin Fish in Lolo and Newsome creeks in the Clearwater Basin, Idaho

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The Nez Perce Tribal Hatchery (NPTH) Monitoring and Evaluation Program has completed a 7 year review (2002-2008) in order to examine the effects of supplementation in Lolo and Newsome creeks within the Clearwater River subbasin. The Monitoring and Evaluation program is designed to determine the effectiveness of the ñNATURESò designed supplementation program. Comparisons of the life history characteristics of supplementation fish and natural fish were completed in study streams using a set of performance measures based on Viable Salmonid Population (VSP) criteria. Life history characteristics of juveniles (e.g., length at emigration and arrival timing at Lower Granite Dam) and adults (e.g., adult migration timing, sex ratios, age at return, fecundity, spatial distribution of redds) are compared over the past 7 years in Lolo and

Newsome creeks. The similarity of hatchery/natural juvenile arrival timing at Lower Granite dam is directly related to the hatchery life stage at release. Earlier hatchery releases tend to mimic the natural fish rather than later life stage releases. Natural and hatchery adult run timing has not significantly changed since the implementation of the NPTH program. Adult sex ratios are not significantly different between hatchery and natural returning adults (50:50 sex ratio). The evaluation of the supplementation program indicates that natural occurring life history characteristics have not been altered as a result of supplementation efforts.

Parr Production from Adult Hatchery Steelhead Planted in Two Tributaries to the Headwaters of the Salmon River, Idaho

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Supplementation is a widespread response to the declining runs of anadromous salmonids in the Pacific Northwest. A common type of supplementation is the intentional release of adult hatchery fish to spawn naturally (outplanting). Our objective was to quantify the juvenile steelhead (Oncorhynchus mykiss) production from the adult outplants during a 12 year period in two streams. We used a simulation model to estimate likely level of adult returns, given the observed juvenile production. Densities of juvenile steelhead were highly variable. Outplanting status explained a significant proportion of the variance for the age-0 and age-1 densities but not for the age-2+ densities. The relationship to number of females outplanted was linear for age-0 densities and dome-shaped for age-1 densities. In the model simulations, as juvenile survival over winter decreased from the most moderate levels, the smolt-to-adult return (SAR) rate necessary to produce a pair of adult recruits increased above the range of recent values. Given the SAR rates measured in recent years, we concluded the observed juvenile production likely would produce very few adults and would not result in a self-sustaining population. This conclusion was corroborated by adult return data.

Development of Aquaculture Methods for Burbot *Lota Lota*

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Burbot Lota lota are freshwater cod native to Idaho, USA and near demographic extinction from Idahoøs Kootenai River and British Columbiaøs Kootenay River/Lake. Idaho burbot were denied federal listing in 2000 and remain a species of concern. The Kootenai Tribe of Idaho, the University of Idaho and the British Columbia Ministry of Environment collaborated ca. 2003 and brought wild adult burbot into captivity to develop suitable rearing systems and fundamental hatchery methods as an option should hatchery burbot be needed to replenish the Kootenai(y) stocks. Early work focused on the use of hormone analog (sGnRha) for adult spawning and determining optimum egg incubator design. Larval weaning from live diets to commercial larval diets was evaluated from 2004-2006, and improvements are made annually. The current burbot culture systems in use consist of full or partial recirculation water systems designed to conserve water and maintain critical water temperatures for spawning (2-5ºC), egg incubation (3-5ºC), larval feeding and juvenile grow-out (8-20ºC). Additionally, six 8000L fiberglass tanks are kept outdoors for semi-intensive pond style rearing. Results have that volitional (in tank) spawning is common requiring collection of eggs from tanks followed by incubation in 1L conical bottom upwelling incubators suspended overtop a screened (0.5mm) 1m circular tank where larvae are

collected, develop and begin feeding on live prey. Live prey feeding begins with brackish (10ppt NaCl) rotifers Brachionus plicatilis mass produced in closed recirculation systems followed by Artemia hatched in 19L water containers (5ppt NaCl). When rotifer feeding ends, commercial larval weaning diet (200-600 micron) feeding begins. Due to this bottleneck, semi-intensive and extensive rearing methods are being developed. All burbot culture system designs and method development results will be used to produce a burbot hatchery manual for design of a conservation hatchery aimed at revitalizing burbot populations in Idahoôs Kootenai River and British Columbiaôs Kootenay River/Lake.

Management of Anthropogenically Derived Hybrid Populations: Explicit Recognition of Assumptions

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Hybridization and introgression between native and introduced species is one of the most challenging issues currently facing fisheries managers. While recognizing we are simplifying arguments, we suggest two hybrid management paradigms have emerged. The first posits that as long as introgression is at moderate to low level, and the resulting hybrids are morphologically and ecologically similar to the native taxon, they should be considered a member of the parental species. The alternative view suggests that conservation efforts should be focused on pure native genomes that have evolved in response to localized selective pressures and hybridized populations are a conservation threat. We suggest that both management approaches are based on a few key assumptions about the nature and ultimate outcome of hybrid fitness and ecology. Although these assumptions are implicit in the arguments presented by both sides of the debate, neither the assumptions nor the management implications of violations of those assumptions are consistently clarified and discussed. In our poster, we present a framework that addresses various assumptions surrounding hybridization in cutthroat trout Oncorhnchus clarkii populations by introduced rainbow trout O. mykiss and the ecological outcomes each assumption would predict. We further suggest hybridization management actions should have clearly defined goals and be explicit about their assumptions. Finally, we provide an example of our framework applied to a common management action used to manage hybrid invasions: the use of barriers.

Relationship of Wild Steelhead, *Oncorhynchus mykiss*, Migration Patterns with Flow Events in Big Bear Creek, Potlatch River, ID

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This study was part of the Potlatch River Steelhead Monitoring and Evaluation Program, and focused on the migration patterns of juvenile steelhead in Big Bear Creek, a tributary to the Potlatch River. The objective of this study was to examine environmental influences on juvenile steelhead migration timing. The data for this study was collected from December 2007 through February of 2009 using PIT tag detections at an instream PIT tag interrogation site located on Big Bear Creek, Potlatch River. We used detections from other interrogation sites within the drainage to determine if fish were actively migrating out of the Potlatch River or simply changing locations within the basin. Analyses showed a positive correlation between flow and migration patterns. Additional factors that affect migration patterns, such as water temperature, moon phase, and photoperiod were also investigated. The findings of the study have management implications,

such as timing the installation of rotary screw traps and installation of adult weirs, not only within in the Potlatch River Basin, but to other basins that experience similar flow regimes and share similar habitat types. The findings of this study also help determine the factors that drive juvenile steelhead migration within and out of the Potlatch River basin, and potentially direct habitat enhancement projects to increase over winter habitat.

Relationships Between Benthic and Drift Production and the Trophic Transfer of Energy to Juvenile Chinook Salmon (Oncorhynchus Tshawytscha)

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Quantifying the links between juvenile salmon and their energy sources provides insight into limits on individual growth and survival. Stream-dwelling salmonids forage on macroinvertebrate organisms suspended and transported in the water column.The composition of drifting macroinvertebrates is highly variable in space and time,responding to changes in physical, chemical, and behavioral factors that drive energy supply from aquatic and terrestrial sources. Therefore, sampling that realistically quantifies potential energy of juvenile salmon can be difficult and many studies rely primarily on benthic measures to assess energy available to upper trophic levels. However, the correlation between benthic and drift measures is poorly understood, and measures of the benthic community do not account for the variation in terrestrial contributions to drift. With the objective of evaluating the sources, quantity, and composition of prey items available to juvenile Chinook salmon (Oncorhynchus tshawytscha) rearing throughout Big Creek, Idaho, we collected samples of benthic and drifting macroinvertebrates in two main stem and two tributary sites at multiple time points in summer 2006. Additionally, stomach contents and stable isotopes were analyzed to inform relationships between energy supply and diet selection. We found that the numeric contribution of terrestrials to the drift was variable, but terrestrial biomass remained spatially homogeneous and was higher than biomass of any of the six focus aquatic families. Overall, quantity and composition of the benthos were only weakly correlated with the same measures in the drift. Although each site had a different pattern of benthos-drift linkage, measures of biomass were more strongly related between benthos and drift more than were those of density. Due to this variability, the benthic macroinvertebrate community may provide an insufficient proxy measure of fish prey availability. Further research into the relationship of productivity measures is necessary to describe the realized energy resources for juvenile salmon.

Pedigree Analysis Reveals Relative Survival and Abundance of Juvenile Hatchery Steelhead (Oncorhynchus Mykiss) Outplanted as Eyed Eggs in the Yankee Fork Salmon River, Idaho

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Shoshone-Bannock Tribes
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The Shoshone-Bannock Tribes (Tribes) developed supplementation activities designed to improve viability of natural populations of steelhead to support harvest and increase abundance, productivity, spatial structure, and genetic diversity. The Tribes operate and maintain a steelhead streamside supplementation program in the Yankee Fork Salmon River (Yankee Fork). In 2007, the Tribes supplemented Yankee Fork with 360,000 broodyear (BY) 07 eyed eggs and released approximately 330,000 fry (93% hatch rate). Currently, the number of natural spawning adult steelhead is considered unknown. In this study, we use DNA parentage analysis to determine the survival and distribution of BY 06 - 07 age0+ and age1+ hatchery-origin O. mykiss produced from the supplementation program. From 2006 through 2008, the Tribes conducted three-pass

removal electrofishing and estimated overall O. mykiss densities at 0.027, 0.061, and 0.070 fish/m2, respectively.

Emergence Survival of Progeny from Captive-Reared Chinook Salmon Released to Spawn Naturally in the East Fork Salmon River

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This study was designed to test for differences in survival from the eyed egg stage to fry emergence for progeny from captive-reared versus natural origin Chinook salmon spawned naturally in the East Fork Salmon River (EFSR). Field investigations for this study began during the fall of 2007 with the collection of 2,750 eyed eggs from 15 redds formed by captive-reared females and 11 redds formed by natural returning females. Using modified hydraulic sampling methods, eyed eggs were either inserted back into their natal redd after being enumerated and carefully placed into an egg capsule, or taken to the Eagle Fish Hatchery (EFH) and raised to buttoned-up fry stage for use in parentage genetic analyses. Embryo development was monitored through water temperatures and emergence timing was estimated based on existing data. When emergence was predicted, capsules were extracted from the gravel and hatched fish were enumerated. Captive-reared fish and natural fish were each treated as study groups and each redd was treated as a sample unit. Eyed-egg to emergence survival were averaged from all redds created by captive-reared fish and natural fish, respectively. Emergence survival of eyed eggs from captive-reared naturally spawning adults averaged 83.3% (+/- 0.08, n=15). Natural origin emergence survival averaged 89.5% (+/- 0.06, n=11). Natural origin progeny demonstrated slightly better survival to emergence than captive-reared progeny from brood year 2007 studies. However, captive-reared survival was similar, and the difference in survival was not statistically significant as evidenced by overlapping confidence intervals.

History and the Mystery

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Significant historical preservation of agency records, photographs, and equipment at Idaho Fish and Game began on a small scale at the Mackay State Fish Hatchery ten years ago. Potential artifacts were sought at other installations and the urgency of preservation became apparent. Combined with enlarged historical photographs of agency activities, obsolete items were first put on exhibit in 2000, eliciting positive public interest and feedback. The exhibitions continued through 2002 at state and county fairs and sportsmenôs shows, illustrating state fish hatchery history. A 1957 hatchery truck was restored by a high school vocational program as a community project. Since 2006, the expanded collection was invited to the three largest museums in the state, culminating in 2007 with the ñA Century of State Fish Hatcheriesò exhibit still currently on display. These museum exhibits lead to the creation of a department policy to assure the preservation of its history for its employees and a public archive. Agency presence is expected at fairs and sportsmenôs shows by the public, however the exhibit topic is not. The reaction is one of curiosity, generating specific questions to better understand past activities. The historical photographs drew in the public that would not have otherwise entered fair booths. Furthermore, the public did not expect agency presence in the museums. In seven months with over 20,000 visitors to one museum, there were no negative comments and an unexplained increase in fishing license sales was observed in that area when license sales are normally decreasing. An agencyôs historical exhibit lends credibility to its actions and gives ownership to the public viewer

on a personal level. History used as an outreach program can engage public interest through partnerships, and can create a dimension of support previously unseen for fisheries management as well as other agency programs.

A Map of Thermally Suitable Bull Trout Natal Habitats across the Interior Columbia River Basin: Current and Future Distributions Projected Under Climate Change

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A warming climate could profoundly affect the distribution and abundance of many fishes. Bull trout (Salvelinus confluentus) may be especially vulnerable to this warming given that spawning and early rearing are strongly constrained by cold water temperatures and contemporary distributions at the southern extent of the species range are already heavily fragmented. In 2007, scientists at the US Forest Service Aquatic Sciences Lab published research that documented a strong association between the lower elevation limit of juvenile bull trout distributions and mean annual air temperatures across the interior Columbia River Basin. This relationship was used to map and explore potential impacts of climate warming on bull trout for a range of air temperature increases that may occur in the next 50+ years. The map we provide gives a detailed visualization of these results so that fisheries professionals can understand how populations in their areas may be impacted. The map displays suitable natal habitat distribution under current conditions, habitats associated with a 250 m increase in the lower elevation limit of juvenile bull trout (~1.6°C increase in mean annual air temperatures), and habitats associated with an 800 m increase (~5°C increase). The 250 m increase represents a ñbest caseò scenario that is at the low end of projections by the year 2050 based on global climate models downscaled to the Pacific Northwest. The 800 m increase represents a ñworst-caseò scenario associated with uncontrolled warming that is at the upper end of projections by 2100. Areas intermediate to these extremes, therefore, approximate suitable habitat distributions under anthropogenically warmed, but stabilized future climatic conditions. The map is most useful for highlighting broad patterns across the Columbia Basin and should be complimented by more detailed, local assessments to plan local management activities. Exact future distributional boundaries will ultimately depend on the level at which the global climate stabilizes, local biophysical conditions, and the effectiveness of management actions to restore and maintain resilient habitats and populations.

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

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Extensively reared burbot Lota lota may be an important short term measure to population rehabilitation in the Kootenai River. Our objective was to determine if extensively reared burbot larvae could achieve a 10% survival rate and grow to a range of 70 to 98 mm total length within six months of release. On May 9, 2008 the Idaho Department of Fish and Game in cooperation with the University of Idaho Aquaculture Research Institute , Kootenai Tribe of Idaho, BC Ministry of Environment, released 60,000 - 37 day-old burbot larvae into a private (0.15 ha) pond. Of the total, 60 were placed into 50µm nitex net pens as a predation free survival control. We used light traps in the net pens and pond to determine general abundance and growth. A total of 84 burbot captures occurred in the net pens and one in the pond during the sampling period. On August

27, 2008 both net pens were removed and burbot were measured and tagged with Visible Implant Elastomer to distinguish between net pen and pond reared burbot. A total of 47 burbot were recovered from the net pens with an average length of 41mm. Once tagged, 44 (3 mortalities) burbot were released into the pond. After discovering yellow perch in the pond, we deployed two ¼ògill nets, removing over 700 yellow perch. But on December 9, 2008 we pumped the pond to remove the remaining yellow perch and the pond allowed to freeze. A total of nine burbot larvae (four tagged) were recovered from the pond with one surviving with an average length of 89 mm and weight of 4 g. Future efforts will include additional net pens and pond stocking. Extensive rearing without predators can lead to improved survival for burbot rehabilitation

Life History Comparisons of Natural and Supplemented Chinook Salmon in Johnson Creek, Idaho

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The Nez Perce Tribe Johnson Creek Supplementation Project completed a ten year review (1998-2007) in order to examine the effects of supplementation in Johnson Creek, Idaho. Comparisons of the life history characteristics of supplementation fish and natural fish were completed using juvenile and adult life history strategies relating to migration timing, fish size, fish age, adult sex ratios and spawning distribution. A supplementation strategy that utilizes only natural origin fish for broodstock was chosen to maximize the success of maintaining these life history characteristics.

Working together to Assist Snake River Sockeye Salmon: Utilizing Partnerships Between Hatcheries and Research to Gain Ground Towards Recovery

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Snake River sockeye salmon Oncorhynchus nerka were listed as endangered in 1991. Prior to listing, a captive broodstock program was initiated to prevent species extinction and to begin rebuilding the population. Between 1991 and 2008, the captive broodstock program produced approximately 4,201,400 eyed-eggs to meet broodstock as well as reintroduction needs. Progeny from the captive broodstock program are reintroduced using four strategies: 1) eyed-eggs are planted in Pettit and Alturas Lakes in November and December; 2) age-0 presmolts are released to Alturas, Pettit, and Redfish lakes in October; 3) age-1 smolts are released into Redfish Lake Creek and the upper Salmon River in May; and 4) hatchery-produced adult sockeye salmon are released to Redfish Lake for volitional spawning in September. Joint hatchery and research monitoring and evaluation efforts have focused on maximizing the use of limited hatchery rearing space and identifying and prioritizing the most successful reintroduction strategies. The programs near term goals of preserving genetic diversity and ultimately preventing extinction have been successful. Current and future plans focus on transitioning from a genetic conservation program to a species recovery program. To enable this transition, the current broodstock station at Eagle, Idaho was expanded to double production and the development of a new smolt rearing facility is under investigation. The program is a cooperative effort among IDFG, NOAA Fisheries, Shoshone-Bannock Tribes, ODFW, and University of Idaho with funding primarily provided by the Bonneville Power Administration.

Develop a Naturalized Chinook Salmon (Oncorhynchus Tshawytscha) Population in the Yankee Fork Salmon River Using Volitional Adult Spawner and Juvenile Smolt Releases

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The Shoshone-Bannock Tribes (Tribes) initiated the Yankee Fork Chinook Salmon Supplementation Program (YFCSS) to develop a locally adapted spring Chinook salmon run in the Yankee Fork Salmon River using Upper Salmon River stock. The YFCSS Program will provide adult Chinook salmon for natural production, artificial propagation, and harvest opportunities in the Yankee Fork. In 2006, approximately 136,000 broodyear 2004 Upper Salmon River hatchery-origin smolts were released in Yankee Fork. From this release, 185 hatchery-origin and 43 additional natural-origin adults were trapped at the lower Yankee Fork weir. All hatchery-origin Chinook salmon were transported above a secondary picket weir in the upper Yankee Fork for natural spawning and all natural-origin Chinook were immediately passed upstream for natural spawning and distribution. An additional 1,490 Upper Salmon River hatchery-origin Chinook trapped at Sawtooth Fish Hatchery were transported to the upper Yankee Fork for natural spawning, for a total outplant of 1,675 adults in 2008.

Idaho Supplementation Studies: Determining the Long-term Effects of Supplementation on Naturally Spawning Chinook Salmon Populations

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Supplementation is a common response to declining salmon populations, but its long-term effects are unknown. The Idaho Supplementation Studies (ISS) is a large scale experiment designed to assess the long-term fitness effects of supplementation on naturally spawning populations from the short-term use of hatchery Chinook salmon to increase the number of fish spawning in the Salmon and Clearwater rivers. Four cooperating agencies including the Idaho Department of Fish and Game, Nez Perce Tribe, Shoshone-Bannock Tribes, and the U.S. Fish and Wildlife Service are involved with this experiment. The study includes 15 supplemented streams and 14 untreated reference streams. Depending on the long-term effects of supplementation, we hypothesize that after supplementation is stopped, production could remain higher in treated streams than in reference streams (best case), return to levels observed in reference streams (no long-term effect), or drop below those observed in reference streams (long-term deleterious effects). Production and productivity will be measured during pre-supplementation, supplementation (treatment), and post-supplementation (evaluation) phases using redd counts and juvenile production estimates. Two analytical techniques have been developed for the final analyses, and should serve as complimentary approaches (ANOVA and regression). Two things set the ISS program apart from all other supplementation programs; the number of reference streams included in the design and the fact that our final evaluation will measure the fitness response of natural spawning populations after supplementation ceases. Currently, a regional assessment of supplementation is being proposed that is very similar to the ISS design. In addition to advancing our understanding of supplementation, the ISS program demonstrates that multiple agencies (with different management philosophies) can successfully undertake long-term programs providing a collaborative model for others to follow.

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