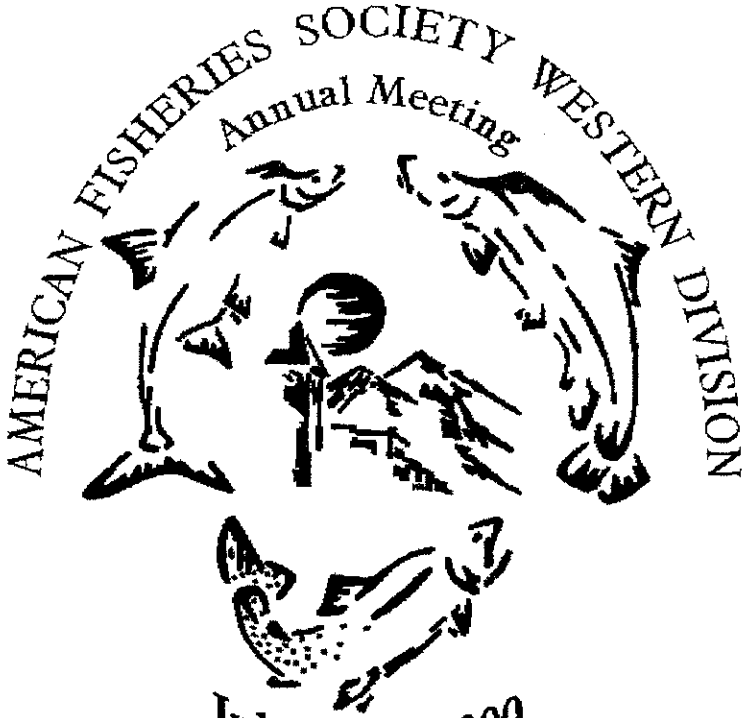
Western Division of the American Fisheries Society
Annual Meeting - 2000
Telluride, Colorado



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Wild Wings - Lake City, Minnesota 55041-0451

Program Overview

~ Sunday, July 16th ~

9:00 - 11:00	Coordination Meeting	Klammer Board Room
11:15 - 12:00	Meet With Telluride Staff	Klammer Board Room
1:00 - 6:00	Registration	Registration Office
1:00 - 6:00	Trade Show Setup	Reception Area
1:00 - 6:00	Poster Setup	Lobby

~ Monday, July 17th ~

7:00 - 5:00	Registration	Registration Office
8:00 - 1:00	Trade Show Setup	Reception Area
8:00 - 7:00	Poster Setup	Lobby
8:00 - 5:00	Riparian Workshop	West Ballroom
8:00 - 5:00	Modeling Workshop	Center Ballroom
1:00 - 5:00	Statistics Workshop	East Ballroom
10:00 - 12:00	WDAFS EXCOM Meeting	Klammer Board Room
12:00 - 2:00	Lunch	On Your Own
2:00 - 4:00	AFS Leadership Training	Klammer Board Room
5:00 - 6:30	Student Caucus	Klammer Board Room

~Tuesday, July 18th ~

7:00 - 5:00	Registration	Registration Office
8:00 - 12:00	Statistics Workshop (cont.)	Klammer Board Room
8:30 - 12:00	Plenary Session	Mountain Village Ballroom
12:00 - 2:00	WDAFS Business Luncheon	West Ballroom
PM Concurrent Sessions		
2:00 - 5:00	Fish Barrier Removal and Fish Passage: Issues and Opportunities	West Ballroom
2:00 - 5:00	Endangered Species Recovery: Theory, Application, and the Law	Center Ballroom
2:00 - 5:00	Contributed Papers	East Ballroom
5:00 - 6:30	Fish. Mgmt. Section Meeting	Klammer Boardroom
8:00 - 5:00	Trade Show Display	Reception Area
8:00 - 5:00	Poster Display	Lobby
6:00 - 9:00	Social	Telluride Elks Lodge

~Wednesday, July 19th~

8:00 - 12:00	Registration	Registration Office
AM Concurrent Sessions		
8:00 - 12:00	Salmonid Habitat and Populations: Critical Components	West Ballroom
8:00 – 12:00	Native Fish Conservation and Management in the West: An Epitaph or a New Hope?	Center Ballroom
8:00 – 12:00	Species Conservation Without the ESA: How Much is Enough?	East Ballroom
12:00 – 2:00	CO/WY Business Luncheon (or on your own)	Mountain Village Ballroom
PM Concurrent Sessions		
2:00 – 5:00	Salmonid Restoration via Natural Colonization: Lessons from Nature and Experiments	West Ballroom
2:00 – 5:00	Native Fish Conservation and Management in the West: An Epitaph or a New Hope?	Center Ballroom
2:00 – 5:00	Contributed Papers	East Ballroom
8:00 – 5:00	Trade Show	Registration Area
8:00 – 5:00	Poster Display	Lobby
5:00 - 6:30	Bull Trout Committee Meeting	Klammer Boardroom
6:30 – 7:30	No Host Bar, Trade Show Raffle	Reception and Lobby Areas
7:30 – 9:30	Banquet, Awards, Raffle	West Ballroom

~Thursday, July 20th~

AM Concurrent Sessions

9:00 – 11:00	Invasive Species Issues and Management	East Ballroom
9:00 – 11:00	Contributed Papers	Center Ballroom
11:00 – 12:00	Best Paper Awards, Adjourn	Mountain Village Ballroom

TITLES AND PRESENTERS

~ Tuesday, July 18th ~ Morning
Plenary Session

Mountain Village Ballroom

Effectiveness in the New Millennium
Ken Hashagen, WDAFS President - Moderator

8:30 – 8:45	Welcome and Announcements; Ken Hashagen, WDAFS President
8:45 – 9:15	Chris Moffitt; AFS President
9:15 – 9:45	Gus Rassam; AFS Executive Director
9:45 – 10:15	**Break**
10:15 – 10:45	Paul Brouha; Associate Deputy Chief, USFS
10:45 – 11:30	Spencer Amend; Dynamic Solutions Group: Achieving Organizational And Personal Effectiveness In The New Millennium
11:30 – 12:00	Question and Answer Period, Announcements
12:00 - 2:00	**WDAFS Business Luncheon - East Ballroom**

~ Tuesday, July 18th ~ Afternoon

West Ballroom

Fish Barrier Removal and Fish Passage: Issues and Opportunities
Elise Holland and Mike Meinz - California/Nevada Chapter; Darryl Hayes - CH2M Hill

2:00 - 2:20	Fish Passage on the Lower Truckee River; *Brent Mefford*
2:20 - 2:40	Adult and Juvenile Fish Passage in the Yakima River; *Dave Fast*
2:40 - 3:00	Facilitating Fish Passage at Ultra-low Head Dams: An Alternative to Removal; *Mufeed Odeh*
3:00 - 3:20	To Idaho Headwaters and Back—What's the Dam Difference? *Patrick Marcuson*
3:20 - 3:40	**Break**
3:40 - 4:00	Rivers Reborn: Restoring Rivers and Removing Dams in California; *Steve Evans*
4:00 - 4:20	Dam Removal and Restoration Opportunities at The Nature Conservancy's Juniper Hills Preserve, Oregon; *Berta Youtie*
4:20 - 4:40	FishXing: Fish Passage Software for Culvert Design and Assessment; *Susan Firor*
4:40 - 5:10	Restoring Rivers through Dam Removal and Non-traditional Passage Alternatives; *Laura Wildman*

Center Ballroom

Endangered Species Recovery: Theory, Application, and the Law
Chris Keleher – Central Utah Water Conservancy District; Yvette Converse – US Fish and Wildlife Service

2:00 - 2:05	Introduction; *Chris Keleher and Yvette Converse*
2:05 - 2:20	The Endangered Species Act: Recovery and the Law; *Steve Spangle*
2:20 - 2:40	Genetic Factors and Recovery; *Paul Evans*
2:40 - 3:00	When is a Population Recovered? Some Insights Using Population Viability Analysis; *Phil Miller*
3:00 - 3:20	From Populations to Landscapes: Toward a View of Recovery Criteria for Threatened Salmonid Fishes in the Pacific Northwest; *Jason Dunham*
3:20 - 3:40	**Break**
3:40 - 4:00	Recovery Criteria for Four Endangered Fish of the Colorado River Basin; *R.A. Valdez, R.J. Ryel, T.E. Czapla, R.T. Muth, H.R. Maddux, and S.W. Carothers*
4:00 - 4:20	Endangered Species Recovery: Theory, Application, and the Law: Pacific Salmon; *Norma Sands*
4:20 - 4:40	Translating Science and Policy Into Action: The Middle Rio Grande Silvery Minnow Recovery Plan Implementation; *Jeff Whitney*
4:40 - 5:00	Questions and discussion from audience

East Ballroom

Contributed Papers
Pete Bisson - USDA Forest Service

2:00 - 2:20	Effects of Starvation, Water Temperature and Secondary Stressors on the Health and Survival of Juvenile Rainbow Trout; *Darin Simpkins, Dr. Wayne Hubert and Dr. Carlos Martinez del Rio*
2:20 - 2:40	Differences in Embryonic Temperature Tolerance Affect the Distributions of Rainbow Trout and Brown Trout in the Firehole River, Yellowstone National Park; *Jack Goldstein, Wayne Hubert, Daniel Woodward, Aida Farag and Joseph Meyer*
2:40 - 3:00	Winter Habitat Utilization and Movement by Snake River Cutthroat Trout in the Snake River near Jackson, Wyoming; *David Harper and Daniel Woodward*
3:00 - 3:20	Movement of Bonneville Cutthroat Trout in Relation to Spawning and Water Quality; *A.J. Schrank and F.J. Rahel*
3:20 - 3:40	**Break**
3:40 - 4:00	A Survey of Bull Trout in the Bull River Drainage, Montana; *Paul Winkle, James Chadwick, Don Conklin Jr., and J. DosSantos*
4:00 - 4:20	The Distribution of Introgression in Westslope Cutthroat Trout Populations in the Clearwater Basin, Idaho; *D.E. Weigel, J.T. Peterson and P. Spruell*
4:20 - 4:40	Cryopreservation of Salmonid Gametes in the Snake River Basin; *R.D. Armstrong and P.A. Kucera*
4:40 - 5:00	Novel Species-Specific Molecular Genetic Markers Identify Hybrids Between Steelhead/Rainbow Trout (*Oncorhynchus mykiss*) and Coastal Cutthroat Trout (*O. clarki clarki*); *Carl Ostberg and Rusty Rodriguez*

~ Wednesday, July 19th ~ Morning

West Ballroom

Salmonid Habitat and Populations: Critical Components
George Pess – National Marine Fisheries Service; Steve Cramer – S. P. Cramer & Associates, Inc.

8:00 - 8:20	Development of Protocols for Determining Bull Trout Presence and Habitat Suitability; *Philip Howell, James Peterson, Jason Dunham, Scott Bonar and Russ Thurow*
8:20 - 8:40	Factors Influencing Success of Cutthroat Trout Translocations; *Amy Harig and Kurt Fausch*
8:40 - 9:00	The Ecosystem Diagnosis and Treatment Method (EDT) in the Yakima Basin; *J.D. Hubble and B.D. Watson*
9:00 - 9:20	A Coarse-Scale, Spatially Explicit Model for Predicting Pacific Salmon (*Oncorhynchus* spp.) Abundance as a Function of Land Cover and Land Use in the Pacific Northwest, United States; *Blake Feist, E. Ashley Steel, George Pess and Robert Bilby*
9:20 - 9:40	Contemporary and Historic Chinook Salmon and Coho Salmon Smolt Production Capacity Within the Lower Snohomish River Basin, WA; *Andrew Haas and Brian Collins*
9:40 - 10:00	**Break**
10:00 - 10:20	Functioning of Montane Landscapes to Produce Stream Habitats: Hypothesis Tests Based on Spatially Explicit Path Analyses; *Daniel Isaak and Wayne Hubert*
10:20 - 10:40	Temperature Tolerances and Habitat Conditions for Bonneville Cutthroat Trout in the Thomas Fork of the Bear River, Wyoming; *H.C. Johnstone and F.J. Rahel*
10:40 - 11:00	Influence of Basin Geomorphology on Presence/Absence of Brook and Brown Trout in Southeastern Wyoming: Modeling Across Spatial Scales; *N.P. Nibbelink and F.J. Rahel*
11:00 - 11:20	The Reynolds Number as a Descriptor of Juvenile Salmonid Habitat and Estimator of Stream Reach Carrying Capacity; *David Smith, Ernie Brannon and Mark Allen*
11:20 - 11:40	Linking Spatially-Explicit Steelhead (*Oncorhynchus mykiss*) Abundance Records to Habitat Characteristics in the Willamette River Basin Using a Hierarchical Statistical Model; *E. Ashley Steel, Blake Feist, George Pess and Robert Bilby*
11:40 - 12:00	Relating Landscape and Land Use Variables to Coho Salmon (*Oncorhynchus kisutch*) Abundance in the Snohomish River, Washington State, USA; *George Pess, David Montgomery, Robert Bilby, Harvey Greenberg, Blake Feist and Ashley Steel*
12:00 - 2:00	**Colorado/Wyoming Chapter Business Lunch or lunch on your own**

Center Ballroom

Native Fish Conservation and Management in the West: An Epitaph or a New Hope?

Kathryn Staley - NRCS Wildlife Habitat Management Institute; Tim Patton - Southeastern Oklahoma State University

8:00 - 8:20	Introduction; *Kathryn Staley*
8:20 - 8:40	CARA and Conserving Native Species Habitat; *Jim Gutherie*
8:40 - 9:00	California's Natural Diversity Database; *Darlene McGriff*
9:00 - 9:20	Native Fish Management in Utah; *Matthew Anderson*
9:20 - 9:40	CARA and Wyoming's Native Aquatic Species; *Dirk Miller*
9:40 - 10:00	**Break**
10:00 - 10:20	The Bureau of Land Management and Native Fish, a Strategy for Conservation; *Jill Silvey*
10:20 - 10:40	Status Review of Native Fishes in Wyoming; *Tim Patton*
10:40 - 11:00	Current Status of Large River Species of Concern in the Missouri River and Its Major Tributaries in Montana; *Lee Bergstedt*
11:00 - 11:20	Community Compositions of Fishes in the Colorado River and Tributaries of Grand Canyon, Arizona; *D.R. Van Haverbeke*
11:20 - 11:40	Providing a Context for Aquatic Species Conservation and Watershed Management on National Forest Systems Lands; *Lynn Decker*
11:40 - 12:00	Discussion
12:00 - 2:00	**Colorado/Wyoming Chapter Business Lunch or lunch on your own**

East Ballroom

Species Conservation Without the ESA: How Much is Enough?

Ron Remmick - Wyoming Game and Fish Department

8:00 - 8:20	Recovering Native Fishes, How Much is Enough? *Robert Wiley*
8:20 - 8:40	Cutthroat Trout Conservation in Montana: Agreements, Actions, and Observations; *Ken McDonald*
8:40 - 9:00	How Much is Enough; Thoughts on Conserving Native Trout: An Idaho Perspective; *Steve Yundt*
9:00 - 9:20	Space, Numbers and Movements: Exploring Persistence of Stream-Resident Cutthroat Trout Populations; *Robert Hilderbrand*
9:20 - 9:40	How Much is Enough? A Reasonable and Practical Approach to Colorado River Cutthroat Trout Restoration in the LaBarge Watershed, Wyoming; *H.M. Sexauer*
9:40 - 10:00	**Break**
10:00 - 10:30	Public Attitudes Towards Conservation of Native Fish: Westslope Cutthroat in the Elkhorn Mountains of Montana; *Brad Shepard*
10:30 - 11:00	How Much is Enough? The ESA Assessment for Westslope Cutthroat Trout; *Lynn Kaeding*
11:00 - 12:00	Panel Question/Answer/Discussion, Summary
12:00 - 2:00	**Colorado/Wyoming Chapter Business Lunch or lunch on your own**

~ Wednesday, July 19th ~ Afternoon

West Ballroom

Salmonid Restoration via Natural Colonization: Lessons from Nature and Experiments

Eric Knudsen - U.S.Geological Survey, Alaska Biological Science Center

2:00 - 2:20	Colonization and Development of Stream Communities Across a 200-Year Gradient Following Glacial Recession in Glacier Bay National Park, Alaska; *Alexander M. Milner, E. Eric Knudsen, Chad Soiseth, Anne, L. Robertson, Don Schell, Ian T. Phillips and Katrina Magnusson*
2:20 - 2:40	Relations Among Populations of Salmonids: Potentials for Recolonization; *Gordon Reeves, Christian Zimmerman and Kitty Griswold*
2:40 - 3:00	Homing Fidelity and Natural Colonization of Steelhead in the Cedar River, WA: Using DNA to Test the Limits; *Paul McElhany and Mary Ruckelshaus*
3:00 - 3:20	Natural Production of Anadromous Salmonids in Three Western Washington Watersheds Formerly Inaccessible to Migratory Fish; *Dave Seiler*
3:20 - 3:40	**Break**
3:40 - 4:00	Salmon Colonization of Two Watersheds in Southeast Alaska After Fish Pass

	Construction; *Brenda Wright and Mason Bryant*
4:00 - 4:20	Elwha River Salmon Restoration: Hatchery Versus Natural Re-Colonization; *Bob Wunderlich and Brian Winter*
4:20 - 5:00	Summary and Discussion

Center Ballroom

Native Fish Conservation and Management in the West: An Epitaph or a New Hope?
Kathryn Staley - NRCS Wildlife Habitat Management Institute; Tim Patton - Southeastern Oklahoma State University

2:00 - 2:20	Isolated Populations of Longnose Suckers in the Black Hills, South Dakota and Wyoming; *Mark Barnes*
2:20 - 2:40	Parasites and Diseases Influence the Distribution of Native and Non-Native Fishes: Examples from Western North America; *Pete Bisson*
2:40 - 3:00	Use Of Geometric Morphometrics To Differentiate Gila (Cyprinidae) Within The Upper Colorado River Basin; *Michael Douglas*
3:00 - 3:20	Fish Community Structure in a Large Desert River Relative to Anthropogenic Influences: Verde River, Arizona, USA; *John Rinne*
3:20 - 3:40	**Break**
3:40 - 3:45	Facilitating Conservation on Private Lands; *Kathryn Staley*
3:45 - 4:00	AFS' Role in Native Fish Conservation Issues; *Christine Moffit*
4:00 - 4:15	Critical Research Needs; *Kevin Bestgen*
4:15 - 4:30	The Nature Conservancy's Freshwater Initiative; *Nicole Silk*
4:30 - 5:00	Commentary and Panel Discussion; Symposium Participants

East Ballroom

Contributed Papers
Pete Bisson - USDA Forest Service

2:00 - 2:20	Density and Size of Juvenile Salmonids in Response to the Placement of Large Woody Debris in Western Oregon and Washington Streams; *Philip Roni and Thomas Quinn*
2:20 - 2:40	And After the River Ran Through It, What Then? *N. Allen Binns*
2:40 - 3:00	Consequences of Variable Discharge for Habitat Availability and Habitat Use by Two Species of Trout in a Wyoming Tailwater During Winter; *Matthew Dare, Wayne Hubert and Thomas Wesche*
3:00 - 3:20	Use of Slow Fill and Strobe Lights to Reduce the Entrainment of Salmon Smolts at a Navigation Lock in Seattle, Washington; *Frederick Goetz, Dave Seiler and Peter Johnson*
3:20 - 3:40	**Break**
3:40 - 4:00	Adaptation of an Analysis for Temporally-Stratified Mark-Recapture Data to Estimate Smolt Abundance in Small Coastal Watersheds; *E.P. Bjorkstedt*
4:00 - 4:20	Underwater Video Monitoring of Adult Chinook Salmon Escapement in the Secesh River and Lake Creek, Idaho; *Dave Faurot, Paul Kucera and Jay Hesse*
4:20 - 4:40	California Heritage Trout: A New Program Supporting Restoration Efforts, Providing Angling Opportunities, and Emphasizing Education for Native Trout; *David Lentz*
4:40 - 5:10	River and Inmate Restoration; *Rod Van Velson and Tom Bowen*

~ Thursday, July 20th ~ Morning

East Ballroom

Invasive Species - The Good, The Bad, The Ugly
Ken Hashagen – WDAFS President

9:00 – 9:20	Initial Evaluation and Management Assessment of an Illegally Introduced Northern Pike *Esox lucius* Population in Parker Canyon Lake; *D. C. Mitchell and K. L. Young*
9:20 – 9:40	Range Expansion, Movement, Food Availability, and Stomach Content of an Illegally Introduced Northern Pike Population in a Major Salmon Producing System; *David Rutz*
9:40 – 10:00	Report on the Discovery, Distribution, and Agency Reaction to the Noxious Aquatic Weed Giant Salvinia (*Salvinia molesta); C. O. Minckley*
10:00 – 10:20	**Break**
10:20 – 10:40	*Myxobolus cerebralis*: Impacts of an Exotic Parasite on Wild Trout; *R.. Barry Nehring*

10:40 – 11:00 The 100th Meridian Initiative: Preventing the Spread of Aquatic Nuisance Species; *Robert Pitman*
11:00 – 11:30 Break for Best Paper Judging
11:30 – 12:00 Reconvene for Best Paper Awards – Mountain Village Ballroom; Adjourn

Center Ballroom

Contributed Papers
Steve Wolff - Wyoming Game and Fish Department

9:00 – 9:20 Modeling the Distribution, Growth, and Abundance of Juvenile Coho and Steelhead Using 3D Video Analysis; *Jack J. Piccolo*
9:20 – 9:40 The Yakima/Klickitat Fisheries Project: Monitoring and Evaluating Supplementation of Salmonid Populations in the Columbia River Basin; *David E. Fast*
9:40 – 10:00 Quantifying the Energetic Cost of Handling Associated With Catch-and-Release Fishing: Putting Largemouth Bass Through Stressful Paces; *Daniel W. Beyers*
10:00 – 10:20 **Break**
10:20 – 10:40 Application of a Conservation Approach for Use of Artificial Propagation in Salmon Recovery; *J.L. Vogel, J.A. Hesse and C. Beasley*
10:40 – 11:00 Risk Assessment and Recovery Exploitation Rates for Pacific Salmon; *Norma Sands*
11:00 – 11:30 Break for Best Paper Judging
11:30 – 12:00 Reconvene for Best Paper Awards – Mountain Village Ballroom; Adjourn

ABSTRACTS

Tuesday, July 18th
Afternoon Session- West Ballroom

Fish Barrier Removal and Fish Passage: Issues and Opportunities

Fish Passage on the Lower Truckee River

Brent Mefford, Hydraulic Research Engineer, US Bureau of Reclamation, Denver Technical Center, Denver, CO; (303) 445-2149, bmefford@do.usbr.gov

During its history, the Bureau of Reclamation has designed and constructed many small irrigation diversion dams throughout the western United States. Most of these diversion dams are on rivers that are home to mainly non-game fish species. Thus, little attention has been focused on the fishery impacts imposed by these barriers. Many of these diversion dams are approaching 100 years of age and only now are we realizing the detrimental impact small dams have on many resident fish species. Reclamation is now involved in research, construction, and evaluation of fish passage structures designed for native fish species of the western United States. The lower Truckee River downstream of Reno, Nevada is a case study that spans nearly 100 years of fish passage trials. The river is unusual in that it ends at Pyramid Lake which is a large natural sink with no outflow. The lake is home to several unique fish species including the Lahonton Cutthroat Trout and the Cui-ui lake sucker. These fish species evolved by migrating in large numbers up the Truckee River to spawn. The first diversion dam was constructed on the lower Truckee River in 1908. Since then, construction of other dams have followed. The three downstream most dams on the river included fish passage structures. Each structure has provided a lesson on designing fish passages for native species. This presentation discusses recent fish passage designs that have been implemented on the lower Truckee River. A fish lock, a fishway with a dual vertical slotted baffle design, and a roughened channel fishway have been constructed to replace existing fishway structures.

Adult & Juvenile Fish Passage in the Yakima River

David E. Fast, Research Manager, Yakama Nation Fisheries Program, 771 Pence Road, Yakima, WA 98902, (509) 945-1206; Fax (509) 966-7406; fast@yakama.com

The Yakima River Subbasin contains numerous irrigation diversion facilities that have caused fish passage delays and/or barriers to adult and juvenile anadromous salmonids. These facilities range in size from mainstem diversion dams that supply large irrigation districts to small tributary facilities. Passage improvements have been made by updating adult ladders and installing new juvenile passage screening facilities. Projects have addressed large mainstem facilities first, with smaller tributary projects still ongoing. Fish passage has improved, but many diversions in smaller streams still block adult spawning migrations, and have no screens to prevent outmigrating fish from being swept into irrigation canals. These passage improvement projects are ongoing.

Facilitating Fish Passage at Ultra-Low Head Dams: An Alternative to Dam Removal

Mufeed Odeh, Ph.D., P.E., USGS-BRD Conte Anadromous Fish Research Center, 1 Migratory Way, Turner Falls, MA 01376, (413) 863-8994 x43, odehm@external.umass.edu

Ecosystem sustainability and returning the biological integrity to rivers continue to change the landscape of fish passage technology. Installing a conventional fishway, such as a pool/weir, vertical slot, or Denil type, usually accommodates fish passage at low head dams and river obstructions, with a limited degree of success. Recently, the option of total removal of dams has been gaining momentum among resource managers, conservationists, and even engineers. Certain dams, however, cannot be removed, and conventional fishways are either too expensive to build or the real estate is simply not available; yet freedom of passage must be attained. At the 427 m (1,400 ft) long, 3.8 m (12.4 ft) high Little Falls Dam on the Potomac River a notch in the crest of the dam was installed to accommodate passage of anadromous fish such as American shad (Alosa sapidissima). The notch is 7.3 m (24 ft) wide and 1.2 m (4 ft) deep, and has three labyrinth weirs (each 0.6 m (2 ft) high) are placed in series within and downstream of the notch to dissipate water energy. Water velocities are maintained at less than about 4 m/s (13 ft/s) anywhere within the passage structure during migratory season river flows. Shad can overcome this velocity for a long enough time to pass through the passage structure and over the dam; a distance of no more than 6 m (about

20 ft). Construction of this novel design was recently completed and future biological evaluations are planned.

To Idaho Headwaters and Back – What's the Dam Difference?

Pat Marcuson, IDFG, P.O. Box 1336, Salmon, ID, 83467, 208-756-6022 (w), 208-756-6274 (f)

Anadromous fish migration from the Pacific Ocean to central Idaho and back require negotiating four hydroelectric dams on the Columbia River, four dams on the lower Snake River and numerous irrigation dams in every tributary. Since construction of Hells Canyon on the Snake River, anadromous fish only have unobstructed access to the Salmon and Clearwater rivers. Irrigation diversion dams usually allow passage of fish in either direction. Those irrigation dams constituting a problem on small tributaries are the gravel-pushup barriers to fish. Idaho's fish screen program has eliminated forty-two surface diversions and four pumps in agricultural tributaries. Another nine irrigation dams have been modified to allow upstream and down stream fish passage. Idaho has over 600 surface irrigation diversions and 250 irrigation pumps in the upper Salmon and Clearwater rivers. One hundred sixty-five diversions have fish screens meeting National Marine Fisheries Service criteria. Ninety-five pumps have intake screens that meet criteria. Idaho State Fish & Game's Fish Screen Program concentrates on saving endangered fish by habitat improvement, which to date included elimination of 39 irrigation diversions, removal of in-stream barriers used to divert water to agricultural lands (42), and reconnected tributaries (3). We strive to keep fish out of the diversion ditch in the first place by modifying the configuration of the water diversion dams (8) and installed 57 lockable/controllable head gates (57). One hundred percent of Idaho's restoration efforts for anadromous fish are funded by awards for the mitigation of diminished runs of salmon and steelhead resulting from the construction of dams. Idaho State Fish & Game is working diligently on habitat issues but still has miles of streams unchanged from the days of bountiful salmon. All efforts to restore wild Snake River Chinook and Sockeye runs has not brought the population levels up to a level to avoid eventual extinction. Should the fish return, passage issues in Idaho will have been addressed and enhanced and resident fish have benefited from habitat restoration. The issue of saving endangered salmon and steelhead trout in Idaho has to be focused on breaching the four lower Snake River dams. We see no biological basis to conclude other options can provide recovery.

Rivers Reborn: Removing Dams and Restoring Rivers in California

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There are more than 1,400 dams in California. Many of these dams block habitat historically used by the state's threatened and endangered salmon and steelhead populations. Some of these dams have been abandoned, no longer provide a useful function, or fail to deliver significant benefits. Some of these dams are in a state of disrepair and pose public safety hazards to the general public. It is clear that some of these dams should be modified, breached, or removed to restore fisheries and habitat, enhance river ecosystems, and protect public safety. Dam removal in California is not a new phenomenon. More than 25 dams have been removed in the state since the turn of the century to restore fisheries and remove safety hazards. Friends of the River has identified more than 30 existing dams, large and small, throughout the state that could be removed to restore rivers. Government programs such as the CALFED Bay Delta Program have also identified potential dam removal projects in the Central Valley, but little comprehensive data is available for other regions of the state. Extensive studies are needed before dams can be removed. Alternative ways to provide benefits originally delivered by the dam, disposal of sediment, removal cost, and who pays are just a few of the questions that must be answered before a dam is removed.

Dam Removal and Restoration Opportunities at The Nature Conservancy's Juniper Hills Preserve, Oregon

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The Juniper Hills Natural Area, an 18,000-acre tract in Eastern Oregon purchased by The Nature Conservancy in 1998, has two target conservation goals: restoration of Lost Creek, and protection and enhancement of the juniper savanna. TNC owns all of the watershed except for a portion of the headwaters area, for which TNC holds the USFS grazing allotment permit. A large reservoir on the stream, contained by Dick Dam, was built for irrigation prior to 1946. Red band trout are found in all stream reaches, but those below the dam cannot move past the dam. The safety and stability of the earthen dam are also in question.

Upstream of the dam is a wet meadow, which probably extended under the current reservoir footprint, and is valuable for potential re-establishment of native grasses, water quality, and waterfowl breeding habitat. Presently, Lost Creek is functioning at risk, and dam breaching will assist to restore the stream to proper functioning condition. CH2M HILL prepared a review of dam modification and removal options to return Lost Creek to natural flow regimes and to improve fish passage. A field site reconnaissance was conducted to verify background information and photography of the 30-foot high dam and stream. Based on this information, prior experience in Oregon, and discussions with The Nature Conservancy and state regulatory agency representatives, the project team developed three dam removal alternatives and described the restoration benefits, risks, permitting requirements, and cost associated with each alternative. Following review and further discussion with The Nature Conservancy, an alternative was selected, which will improve fish passage, increase the area of wet meadow, and remove safety questions, while minimizing potential for sediment mobilization and downstream scouring. A proposal will be submitted for grant funding for lowering the dam and the channel restoration.

FishXing: Fish Passage Software for Culvert Design and Assessment

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Thousands of culverts are currently installed in fish-bearing streams, many of which are partial or total barriers to upstream fish migration. It is imperative to inventory and prioritize existing culverts and properly design new stream crossings to ensure they will function as desired. The design and assessment of culverts for fish passage is complex requiring knowledge of hydraulics, fisheries biology, and hydrology. FishXing is an interactive software package that integrates a culvert design and assessment model for fish passage nested in a multimedia educational setting. FishXing models hydraulic conditions throughout the culvert over a wide range of flows. Additionally, the model incorporates fisheries inputs including fish species, size, and swimming abilities. The software uses the swimming abilities to determine whether the culvert installation will accommodate fish passage at desired flows and to identify specific locations within the culvert that impede passage. Software output includes water surface profiles and hydraulic variables such as water depths and velocities displayed in both tabular and graphical formats. The FishXing CD is available in a Windows 95/2000/NT format and can be downloaded at http://www.stream.fs.fed.us/fishxing/.

Restoring Rivers through Dam Removal and Non-Traditional Passage Alternatives

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This presentation will focus on a "natural" approach to fish passage, utilizing alternatives to the more traditional fish ladder designs. Specifically, alternatives such as dam removal, by-pass channels, and rock riffle fishways (roughened ramps) will be emphasized. These multi-functional passage alternatives provide aquatic habitat, fish passage, and often recreational boat passage. The benefits of utilizing these designs to restore a river system's many functions will be discussed along with several case studies presently on-going in New England. The specific issues of dam removal will be identified, as well as the regulatory coordination required to successfully remove small non-hydroelectric dams in New England. A brief summary of the fish passage alternatives analysis and ranking procedure utilized on the case study dams is presented. Alternatives considered include: No Action; Repair or Replace Dam; Full Dam Removal; Partial Dam Removal; Rock Riffle Fishway (or Roughened Ramp); Bypass Channel; Fish Ladder; Combination of Methods.

Tuesday, July 18th
Afternoon Session- Center Ballroom

Endangered Species Recovery: Theory, Application, and the Law

The Endangered Species Act: Recovery and the Law

Steve Spangle, U.S. Fish and Wildlife Service, Albuquerque, NM

The Endangered Species Act specifically provides for programs to recover threatened and endangered species. The Act authorizes formation of Recovery Teams, who serve at the pleasure of Service Regional Directors to develop recovery plans for listed species and, often, monitor and advise on their implementation. Recovery Teams are exempt from the Federal Advisory Committee Act, but the breadth of that exemption

has become a matter of debate. In the past Recovery Teams were usually composed solely of scientific experts and representatives of State and Federal resource and land-management agencies. Policy now requires stakeholder involvement in recovery planning; the degree of such involvement and, therefore, the influence stakeholders have in recovery implementation can vary substantially. Recovery plans are advisory in nature, although acceptance of recovery plans through signature by a Regional Director generally formalize their adoption by the Service. While other Federal agencies are not legally required to implement recovery plans, proposed Federal actions reviewed under section 7 consultation are generally evaluated with respect to recovery goals, delisting criteria, and management recommendations contained in a species recovery plan. Once recovery is attained, species may be considered for removal from the list of threatened and endangered species. While recovery goals and delisting criteria are considered in delisting deliberations, they are not necessarily the absolute determinant of whether a species should be delisted; delisting may occur in absence of meeting stated recovery goals, and species may remain listed after recovery goals are met.

Genetic Factors and Recovery

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Genetic factors are important in the maintenance of a species evolutionary potential. In the determination of extinction risks, cases for increasing or moderating the relative magnitude of genetic factors in comparison to demographic stochasticity, environmental stochasticity, and catastrophic insults are presented. Generally, populations of reduced size have an increased risk of extinction due to environmental, demographic, and genetic events. The effects of these events are not independent. Genetic deterioration (inbreeding depression, outbreeding depression, loss of heterozygosity and/or fixation of deleterious alleles) impacts recovery efforts at population sizes larger than previously recognized. Stochastic fluctuations in population size increase the uncertainty in predictions of population susceptibility to inbreeding depression or loss of heterozygosity. Birth and death rates and sex-ratio is affected by inbreeding depression. Rates of inter- and intraspecific gene flow are altered in disrupted environments. The genetical aspects of recovery should concentrate on the maintenance of genetic diversity as an indicator of evolutionary potential. This presentation will suggest approaches for the incorporation of morphological, allozyme, and DNA based markers in the estimation of genetic diversity and the prioritization of recovery efforts.

When is a Population Recovered? Some Insights Using Population Viability Analysis

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An abundant literature exists on the perils faced by declining stocks of salmonid fishes in the Pacific Northwest. Effective management of the fundamental unit of biodiversity conservation B the species or population B is very often hampered by three difficult issues: 1) the quantitative definition of recovery is species- and population-specific, making the successful application of ecological rules of thumb marginal at best; 2) conservation managers are traditionally trained to think more deterministically at the expense of an appreciation of the significant impact that stochastic processes (operating at both spatial and temporal scales) can have on long-term population persistence; and 3) a broad lack of detailed ecological and demographic data on the species of concern makes targeted conservation actions difficult to specify. Population Viability Analysis (PVA) has emerged as an important tool for assembling and exploring biological information on endangered populations in the context of assessing the risk of decline associated with a specified set of demographic, genetic and environmental conditions. Moreover, the tool can be uniquely suited to provide a framework for defining quantitative population-level recovery goals using the probability of persistence as a consistent metric across applications. Simulation models explicitly incorporating stochastic processes are most appropriate for this purpose, and have recently been shown to provide accurate projections of population persistence when detailed long-term demographic datasets are available. In the absence of detailed data, PVA tools can employ sensitivity analysis to pinpoint specific parameters that most directly influence population growth dynamics, thereby helping to prioritize both research and management alternatives. The dogmatic view of PVA as a black box techno fix must be retired in favor of a flexible instrument that can greatly assist the conservation planning decision-making process.

From Populations to Landscapes: Toward a View of Recovery Criteria for Threatened Salmonid fishes in the Pacific Northwest

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For many species of imperiled fishes, such as salmonid fishes in the Pacific Northwest, managers must deal with recovery of widely distributed local populations. Accordingly, recovery criteria based on the "small population paradigm" (SPP) are unlikely to be broadly applicable. However, concepts developed from the SPP may be important for developing ranking schemes or "rules of thumb" for recovery criteria. I review three examples of such "rules of thumb" developed for salmonids. Because most salmonids are widespread and exhibit a large degree of variation in population characteristics, there is a lot of potential "signal" or information in the landscape that may be useful for 1) identifying important patterns of ecological or genetic variation for identifying conservation units; 2) identifying important risk factors to local populations; and 3) prioritizing management actions. Lack of information on larger-scale ecological patterns is a major gap in our knowledge of these relatively well-studied fishes. If salmonids can be viewed as a model of recovery for other less well-known species, we should strive for more equal representation of studies focused on genetic and ecological variation at large scales, and more importantly, strive to develop more coherent research programs to integrate genetic and ecological information.

Recovery Criteria For Four Endangered Fishes Of The Colorado River Basin

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We present recovery criteria for four endangered fishes of the Colorado River, including the Colorado pikeminnow (*Ptychocheilus lucius*), humpback chub (*Gila cypha*), razorback sucker (*Xyrauchen texanus*), and bonytail (*Gila elegans*). Recovery criteria include site-specific management actions; objective, measurable recovery criteria; and estimated time to recovery, consistent with provisions specified under Section 4(b), Basis For Determinations, and Section 4(f)(1), Recovery Plans, of the Endangered Species Act of 1973, as amended (ESA; 16 U.S.C. 1531 et. seq.). Two recovery units are recognized, lower Colorado River basin and upper Colorado River basin. Recovery is defined as the process by which the decline of an endangered or threatened species is arrested or reversed, and threats to its survival are neutralized, so that its long-term survival in nature can be ensured. The goal of this process is the maintenance of secure, self-sustaining wild populations of the species with the minimum necessary investment of resources, such that protection of the ESA is no longer necessary. Four conditions are considered for recovery; genetics, demographics, population redundancy, and threats. Criteria for downlisting and delisting each species include numbers of populations, numbers of adults and demographic structure, and management actions to minimize or remove threats.

Endangered Species Recovery: Theory, Application, and the Law: Pacific Salmon

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Twenty six Pacific Salmon Evolutionarily Significant Units (ESU) have been listed as endangered or threatened species under the Endangered Species Act (ESA) and include populations of coho, chinook, chum, and sockeye salmon and steelhead and coastal cutthroat trout. Listings of Pacific salmon started with Snake River sockeye in November 1991 and Snake River fall and spring/summer run chinook in April 1992. Eleven of the 26 ESUs were listed just last year in 1999 (6 chinook, 2 chum, 1 sockeye, and 2 steelhead). To address the recent large number of salmonid ESU listing, recovery planning efforts will be organized by discrete geographic areas that will cover all listed ESUs and will be developed under two phases. The first phase is largely technical and will involve Technical Recovery Teams (one per geographic area) determining ESU delisting criteria, characterizing habitat/fish productivity relationships, identifying factors causing the declines, developing early actions for recovery, and identify research, monitoring, and evaluations needs. In phase two, this information will be given to planners and policy makers who will be in charge of developing the actual Recovery Plan. During this phase the Technical Recovery Teams will act as advisors on the feasibility and effectiveness of proposed recovery plans. The Technical Recovery Team (TRTs) are appointed by NMFS from a list of submitted candidates that have been reviewed by an independent review team. The first TRT that was created was for Puget Sound and has already started meeting, with a team of eight people from various agencies in the area. The team will be addressing three listed ESU from Puget Sound, one on chinook, one on Hood Canal chum, and one on Ozette sockeye salmon. Some nine more TRTs are expected to be formed in the near future.

Translating Science and Policy Into Action: The Middle Rio Grande Silvery Minnow Recovery Plan Implementation

Jeffery C. Whitney, Rio Grande Coordinator, U.S. Fish and Wildlife Service, Region 2

Often there is disagreement between scientific investigators, policy makers, and resource managers when addressing ecological restoration of natural systems. The Rio Grande silvery minnow (*Hybognathus amarus*) is a small fish which remains in less than 5% of its historic range. The natural variability of the Rio Grande hydrograph has been dramatically altered as the result of numerous direct and indirect anthropogenic factors. These include flood control, sediment retention in reservoirs, diversions for agriculture, interstate water deliveries under the Rio Grande Compact, and effluent discharge. These ongoing activities and the resulting changes in flow volumes and timing, floodplain extent, river channel dimension, pattern, and profile have led to concern over the viability of this important North American river system in supporting native aquatic and terrestrial fauna and flora. The Rio Grande Silvery Minnow Recovery Team, a first for stakeholder involvement in the development of a recovery plan, recognized the need to take a systems approach to recovery and is an example of a broad scale pro-active ecological restoration program. Consideration of the complexity of the socio-economic, political, institutional, and ecological considerations are vital for true recovery to occur. Aspects of the planning effort and the current and future implementation of the recovery will be presented.

Tuesday, July 18th
Afternoon Session- East Ballroom

Contributed Papers

Effects Of Starvation, Water Temperature, And Secondary Stressors On The Health And Survival Of Juvenile Rainbow Trout

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Overwintering trout frequently endure long periods of limited food resources that can lead to depletion of body reserves and condition. However, secondary stressors, such as exhaustive movements during changing environmental conditions, have been thought to cause mortality of young fish during these periods. We monitored relative weight (Wr), proximate body composition, swimming performance, and survival of both inactive and active unfed juvenile rainbow trout (*Oncorhynchus mykiss*) over 140 d at 4.5, 7.5, and 15 C to assess the effects of starvation, water temperature, and secondary stressors on physiological health. Active (forced to reside in current velocity of 15 cm/s) and inactive (no current) fish did not differ significantly in Wr among temperature treatments. However, activity and warmer water temperatures caused fish to lose substantially more lipid reserves than fish in other treatments. After 91 d, mortalities of 15 C and 7.5 C fish were observed, but not among fish in 4 C treatments. Swimming performance was significantly different among treatments, and subsequent mortalities of fish occurred when lipid reserves had diminished. Our results suggest that starvation alone may not cause overwinter mortality. Mortality may occur in relatively warm streams when starved fish experience secondary stressors, such as exhaustive levels of activity.

Differences in Embryonic Temperature Tolerance Affect the Distributions of Rainbow Tout and Brown Trout in the Firehole River, Yellowstone National Park

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The geothermal features of the Firehole River basin, Yellowstone National Park, Wyoming, USA, elevate temperature and mineral content of the river and its tributaries. We studied the effects of elevated temperatures on the distribution of rainbow trout Oncorhynchus mykiss and brown trout Salmo trutta in the Firehole River and its tributaries from June 1997 to June 1998. Temperatures in geothermally influenced waters ranged up to 30°C and were consistently 5-10°C higher than upstream sites unaffected by geothermal effluents. Assessments of spatial patterns of species, densities, and spawning indicated that brown trout distributions were limited by the elevated temperatures but rainbow trout were tolerant of these conditions. Brown trout and rainbow trout have similar upper lethal temperature limits (22-26°C); however, brown trout embryos have a lower temperature tolerance range (1-11°C) than rainbow trout embryos (5-15°C). The low densities and limited spawning of brown trout in geothermally influenced areas were likely due to water temperatures exceeding the tolerance limit of brown trout embryos. Embryonic temperature tolerances may be the most limiting thermal factor in determining salmonid species distributions.

Winter Habitat Utilization and Movement by Snake River Cutthroat Trout in the Snake River Near Jackson, Wyoming

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The availability of winter habitat can be the limiting factor in determining salmonids populations in high elevation streams. Habitat use and movement by Snake River cutthroat trout (*Oncorhynchus clarki* spp.) was monitored by radio telemetry from November – March 1998/99 and 1999/2000, in the Snake River near Jackson, Wyoming. Microhabitat measurements were recorded at over 400 fish locations and included data from 48 different fish. Deep runs, backwater areas with groundwater discharge, stream margin areas with shelf ice, and lateral scour pools with woody cover were important overwintering habitat. Backwater pool areas with groundwater influence were uncommon in the study area, but were used frequently by radiotagged Snake River cutthroat and appear to be important overwintering habitat. Depth, shelf ice, and boulders were the most frequently selected cover. Winter movement was generally in a downstream direction, however there was variability in the distance and direction of individual fish movement. The average movement was 6 km downstream. Several fish displayed a strong fidelity to specific locations and frequently returned to the same habitat structures. Long downstream migration (>30 km) was not observed.

Movement of Bonneville Cutthroat Trout in Relation to Spawning and Water Quality

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Conservation of Bonneville cutthroat trout (BRC) has become a priority as the historical range of this subspecies has become severely reduced and fragmented. Objectives of our research are 1) to determine the importance of migratory spawners to BRC populations and identify critical fall/winter habitat for these adult fish in the Thomas Fork drainage of Wyoming, and 2) to monitor summer water quality in streams to determine how BRC respond to stressful conditions. We used VI tags, radio telemetry, weirs and abundance estimates to investigate fish movement throughout the drainage during and after spawning. Fish movement and water quality were monitored to determine if fish avoided certain tributaries in response to high temperatures and/or poor water quality. It appears that migratory spawners are important contributors to the BRC population, though winter habitat still needs examination. Two fish tagged in tributary streams moved more than 20 km downstream to spend the summer in mainstem habitats. BRC did not move out of tributaries despite high summer temperatures.

A Survey of Bull Trout in the Bull River Drainage, Montana

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A fish population survey was conducted in the Bull River drainage in 1999 using snorkeling and electrofishing methods to provide baseline information for the FERC relicensing process on Avista Corporation's Noxon Rapids and Cabinet Gorge dams. Historic and anecdotal data suggests that the Bull River supports the largest number of spawning bull trout of any tributary to Cabinet Gorge Reservoir. This study was only the second detailed fisheries inventory of the Bull River drainage. Eleven species of fish were observed in the drainage, including six salmonids species-bull trout, brown trout, westslope cutthroat trout, brook trout, rainbow trout, and mountain whitefish. Bull trout were found in the mainstem, and the Middle, East, and South forks. Only 31 bull trout were collected electrofishing, with PIT tags inserted to monitor future movements. Their low density compared to anecdotal information indicates that bull trout have declined dramatically in the Bull River drainage. Bull trout were most abundant in the East Fork drainage. Bull trout distribution in the Middle and North forks may be due to habitat limitations. Length-frequencies indicated several size-classes of bull trout, from 40-600mm. The absence of any fish older than age 3 in the 250-350mm length range suggests the presence of only the migratory life form. The presence of naturally reproducing brook trout poses hybridization risks.

The Distribution of Introgression in Westslope Cutthroat Trout Populations in the Clearwater Basin, Idaho

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Introgression from exotic trout has been identified as the greatest threat to native cutthroat trout populations in the western U.S. Genetically pure westslope cutthroat trout frequently inhabit small portions of their native range in isolated tributaries. Introgression is believed to be detrimental to the survival, fitness, and local adaptations of native species by disrupting co-adapted gene complexes, and directly affecting the productivity of the fishery. To determine the extent of introgression, we used non-coding sequences of nuclear DNA to determine the genetic status of westslope cutthroat trout at 65 sites in the North Fork Clearwater basin and at 28 sites in the Lochsa basin in north central Idaho. We found introgression in approximately 66% of the sites tested. The proportion of westslope cutthroat trout at each site showed a bimodal frequency distribution. A multinomial logit analysis did not find a statistically significant relationship between genetic status and *Onchorhynchus* sp. densities, width, gradient, pool depth, cover, or distance to stocking. Elevation was the only statistically significant variable examined. These results indicated that introgression is a substantial impact in the basin, and coincide with other fish distribution studies where native trout are found in higher elevation sites, and exotic trout are found in the lower elevation stream sites.

Cryopreservation of Salmonid Gametes in the Snake River Basin

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Spring and summer Chinook salmon and steelhead populations in the Snake River basin have significantly declined and are now listed as threatened under the Endangered Species Act. A number of these spawning aggregates are below yearly effective population size and loss of genetic diversity has likely already occurred. The cryopreservation project was initiated in 1992 to preserve male salmon genetic diversity through employing cryogenic technology and development of a germplasm repository. Our approach is to sample and cryopreserve male salmon and steelhead gametes from the major river subbasins, within the Snake River basin, assuming a metapopulation structure existed historically. The goal is to collect 100 samples per spawning aggregate for five years. Some salmon spawning aggregates are at such low levels of abundance that few samples can be obtained. Germplasm repository sites are located at two independent locations, at the University of Idaho and Washington State University, to buffer against catastrophic failure

at any one location. The repository currently stores the gametes of over 1,400 fish. The project plans to expand the scope of this project to preserve gametes from resident fish, species outside of the Snake River basin and to establish a regional germplasm repository. Recommendations are to cryopreserve gametes while the species is relatively healthy in abundance and diversity.

Novel Species-Specific Molecular Genetic Markers Identify Hybrids Between Steelhead/Rainbow Trout (*Oncorhynchus mykiss*) and Coastal Cutthroat Trout (*O. clarki clarki*)

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Coastal cutthroat trout are the only cutthroat trout subspecies that is naturally sympatric throughout its range with steelhead/rainbow trout. While virtually every existing cutthroat trout subspecies has been impacted by hybridization with introduced rainbow trout resulting in hybrid swarms, hybridization between coastal cutthroat trout and steelhead occurs infrequently and is not understood. Using representatives throughout the native ranges of coastal cutthroat trout and steelhead, we have identified numerous novel species-specific molecular genetic markers that discriminate between both species and hybrids. The markers are present 100 % in one species (or at frequencies greater than 0.99) and completely absent in the other species (or at frequencies less than 0.01). The benefits of this system are; it is user friendly, non-lethal, the markers are specific for each species, the data are easy to interpret, and the test does not require sophisticated and expensive machinery to run, interpret and analyze the data. The markers have been used to identify multiple generation hybrids in a few small creeks draining the Strait of Juan de Fuca, WA. Also, we will assess hybridization between native westslope cutthroat trout (*O. c. lewisi*) and introduced rainbow trout in North Cascade National Park, WA, and screen numerous other cutthroat trout subspecies versus rainbow trout.

Wednesday, July 19th
Morning Session- West Ballroom

Salmonid Habitat and Populations: Critical Components

Development of Protocols for Determining Bull Trout Presence and Habitat Suitability

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The Western Division of AFS was requested to assist in developing protocols for determining presence/absence and potential habitat suitability for bull trout. The general approach adopted is similar to process for the marbled murrelet, whereby interim guidelines are initially used, and the protocols are subsequently refined as data are collected. The presence/absence protocol is based on recent data on sampling efficiencies of snorkeling and electrofishing for bull trout and observed densities and spatial distribution. The interim protocol consists of 1. recommended sample sizes adjusted for varying habitat characteristics for 50m and 100m sample units with a range of 80%-95% detection probabilities for juvenile and resident adult bull trout, 2. possible habitat characteristics for stratification, 3. habitat characteristics to be measured in the sampling units, and 3. guidelines for training sampling crews. Criteria for habitat strata consist of coarse, watershed-scale characteristics (e.g., mean annual air temperature) and fine-scale, reach and habitat-specific features (e.g., water temperature, channel width). The protocols will be revised using data from this years surveys and additional research on sampling efficiencies and development of models of habitat/species occurrence.

Factors Influencing Success of Cutthroat Trout Translocations

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Establishing new populations through translocation is a prevalent management strategy in the conservation of native salmonids, but success rates for founding self-sustaining populations are generally <50%. We compared streams where translocations successfully established a naturally reproducing cutthroat trout population to those that failed, to identify factors that promote establishment and persistence of translocated populations. Models of stream-scale habitat, collected from field surveys, indicate that cold summer water temperatures, narrow stream width, and lack of deep pools limit populations. Cold summer temperatures are known to delay spawning and prolong egg incubation, which reduces the growth of fry and likely limits their overwinter survival. Furthermore, small streams with few deep pools may lack the space necessary to permit overwinter survival of a sufficient number of individuals to sustain a viable population. Models of basin-scale habitat, measured using a Geographic Information System, were not as effective as stream-scale habitat models but indicate that watershed area is useful as a coarse filter for separating successful from unsuccessful translocation sites. These habitat models will allow managers to choose future restoration sites with a high probability of success and to identify whether populations in fragments of historical habitats are likely to persist.

The Ecosystem Diagnosis And Treatment Method (EDT) In The Yakima Basin

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A significant difficulty to any watershed analysis methodology is to clearly understand how a fish species is affected as it migrates through its aquatic environment during the course of its life history. The EDT approach to watershed analysis offers a method to evaluate watershed condition for a specific fish species within a temporal and spatial context. Furthermore, the EDT methodology provides a way to assess the relative impact of a specific habitat attribute to another one for a specific fish lifestage, across all stream reaches within the watershed. This can be done for both present and historic conditions. A simple output of the EDT model views a species' performance through its aquatic environment as a 3-D map, where the x-axis represents stream reach, where the z-axis represents lifestage, and the y-axis represents species' productivity for that particular stream reach and lifestage. The peaks represent time-space areas of high productivity within the watershed, while the valleys represent the opposite. Further examination of the habitat attribute values provides an understanding as to the "why" of these productivity peaks and valleys. In the Yakima Basin the EDT model is being used to direct habitat restoration projects and salmon and steelhead hatchery supplementation programs.

A Coarse-Scale, Spatially Explicit Model for Predicting Pacific Salmon (*Oncorhynchus* spp.) Abundance as a Function of Land Cover and Land Use in the Pacific Northwest, United States

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We use counts of redds or spawning salmon to determine the relationship between habitat characteristics and fish abundance. We use the results of this relationship to identify which areas in a watershed have the highest potential for restoration or protection, given the existing landscape and land use practices. We tested our methodology in the Salmon River Basin, Idaho and use time series of chinook salmon (*Oncorhynchus tshawytscha*) redd counts, collected at 23 locations in the watershed. Abundance was compared to land use type, vegetation, hill and channel slope, water quality, geology, and climate in a spatially explicit manner using GIS software. Statistical significance among redd density and habitat attributes was tested using hierarchical linear models (HLM). We found consistent differences in redd density over time among spawning locations; certain locations consistently support greater densities of redds. Chinook salmon abundance was positively correlated with cumulative mean annual precipitation, and meadow or wetland

riparian corridors. In contrast, abundance was negatively correlated with total area of rangeland, water diversions, ambient air temperature, and average watershed slope. Covariance between most of the anthropogenic predictor variables and the climatic/landscape predictor variables precluded identification of causal relationships.

Contemporary and Historic Chinook Salmon and Coho Salmon Smolt Production Capacity Within the Lower Snohomish River Basin, WA

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The availability of rearing habitat within the lower Snohomish River basin is thought to limit chinook salmon and coho salmon production. The Snohomish valley has undergone dramatic changes since non-native peoples began to arrive in the mid-19th century. Settlers harvested timber, drained thousands of hectares of marsh, constructed dikes and levees, ditched floodplain tributaries, and managed the river for navigation through dredging and snagging. The cumulative impact of these activities has been loss and widespread degradation of rearing habitat. We quantify habitat changes over time and reconstruct pre-settlement conditions using historical accounts, maps, surveys and aerial photography. Habitat types assessed in this analysis include floodplain marshes, blind tidal slough channels, distributary sloughs, side-channel sloughs, side-channels, small floodplain tributaries, beaver ponds and main stem edge. We extrapolate regional smolt production estimates for these habitat types to contemporary and historic habitat area. The greatest production losses occurred within blind tidal slough channels and floodplain marshes. Lost productivity, and in turn potential gains in production, are used to evaluate restoration opportunities.

Functioning of Montane Landscapes to Produce Stream Habitats: Hypothesis Tests Based on Spatially Explicit Path Analysis

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We developed a priori hypotheses that were used to predict how geomorphic characteristics and landscape features would interact to produce gradients in three stream attributes; channel slope, total alkalinity, and stream width. Each hypothesis was tested in a path analysis using data from 90 reaches on second- to fourth-order streams across a fifth-order, Rocky Mountain watershed. Because most of the regressions (17 of 19) used in the path analyses exhibited spatially correlated residuals, regression models with spatially-explicit error terms often had to be used to derive accurate parameter estimates and significance tests. Based on the performance of the a priori hypotheses, we developed and tested revised versions of each hypothesis that more accurately described how stream habitat gradients were controlled, both directly and indirectly, by elements of the surrounding landscape. Our results provide insight to the functioning of montane landscapes by placing the variables effecting three stream habitat gradients into structured, hypothetical frameworks while also providing insight to the relative importance of each causal factor.

Temperature Tolerances and Habitat Conditions for Bonneville Cutthroat Trout in the Thomas Fork of the Bear River, Wyoming

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Bonneville cutthroat trout occupy only a fraction of their historical range, and some of the last remaining genetically pure populations are in the Thomas Fork of the Bear River. The creeks in this drainage experience summer water temperatures reported to be lethal to other trout. Water temperatures and water quality were monitored in the Thomas Fork during summer of 1998 and 1999 to determine if conditions may be limiting to Bonneville cutthroat trout populations. Daily maximum water temperatures averaged 24.9°C during late summer. In the laboratory, the temperature lethal to 50% of the population over a 7 day constant exposure was 24.1°C . However, when temperatures were cycled for 7 days and maximum temperatures were in the lethal range for only a few hours each day, fish did not die. This temperature scenario simulates conditions in the field. There were significant declines in activity and feeding from control diel cycle (10-20°C) to warm diel cycle (16-26°C), indicating sub-lethal effects of increased temperature. Based on our

field and laboratory results, we conclude that for the summer seasons of 1998 and 1999 water temperature may have been stressful but not acutely lethal for Bonneville cutthroat trout in the Thomas Fork drainage.

Influence of Basin Geomorphology on Presence/Absence of Brook and Brown Trout in Southeastern Wyoming: Modeling Across Spatial Scales

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Trout abundance can be predicted using watershed geomorphology as well as, or better than, local habitat variables. We demonstrate that spatial scale has an important impact on model results, changing not only the strength of predictive models, but also which variables are significant in those models. We used best-subsets logistic regression to predict presence/absence of brook trout and brown trout in the Laramie River drainage in southeastern Wyoming. Models were derived hierarchically by modeling at watershed (WS) scales and at sub-basin (SB) scales. Eight geomorphic variables (mean basin elevation, relief, area, volume, slope, aspect, perimeter, and % non-contributing area) were calculated from a 30 m digital elevation model by delineating watersheds for each sample point. Models were validated using a split-half design. Models for brook trout performed best (90% correct classification at WS scale, 60-90% at SB scale) while models for brown trout were poorer (60% correct classification at WS scale, 40-60% at SB scale). For brook trout, the best single-variable predictor at the WS scale was basin relief, whereas best predictors at the SB scale included mean basin elevation (SB1), basin area (SB2), and basin relief (SB3). At all scales brown trout presence was best predicted by basin slope.

The Reynolds Number as a Descriptor of Juvenile Salmonid Habitat and Estimator of Stream Reach Carrying Capacity

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Microhabitat measurements of individual juvenile chinook salmon holding positions were used to analyze if the Reynolds number was applicable to juvenile salmonid habitat descriptions. The Reynolds number is a dimensionless ratio of viscous to inertial forces calculated as velocity * characteristic length / kinematic viscosity. These data show that the Reynolds number calculated using several different characteristic lengths is a more precise descriptor of the holding position chosen by juvenile chinook salmon of a specific size than velocity alone. Similar Reynolds numbers for fish of similar size and shape imply similar hydraulic forces are present. In a turbulent environment characteristic of natural rivers this is not necessarily true for one-dimensional time averaged velocity measurements. The Reynolds number was then used to characterize the density of juveniles at the reach scale. These data show a negative slope with increasing Reynolds numbers indicating the importance of low velocity areas. Estimates of carrying capacity must be based on an understanding of microhabitat requirements applied at the reach scale. This requires reach scale measurements that are related to microhabitat requirements. The Reynolds number is one metric that has potential to estimate stream reach carrying capacity at the reach level.

Linking Spatially-Explicit Steelhead (*Oncorhynchus mykiss*) Abundance Records to Habitat Characteristics in the Willamette River Basin Using a Hierarchical Statistical Model

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We analyze the relationship between coarse-scale habitat characteristics and steelhead (*Oncorhynchus mykiss)* abundance. Habitat quality and quantity are key variables influencing salmon population trends in the Pacific Northwest; yet, basic relationships between fish production and coarse-scale habitat characteristics such as geology and land-use have not been established. Temporal variability in population indices makes habitat/productivity relationships difficult to detect in any one stream. We have found that, despite annual fluctuations in escapement, certain areas within the watershed consistently produce the majority of spawners. To quantify this relationship, we spatially linked redd counts to multiple layers of

habitat data available at broad spatial scales (geology, mean annual air temperature, road density, and forest cover). To test for statistical significance of observed patterns, we used a hierarchical linear model (HLM). The first step was to fit a linear regression linking habitat variables to each year of redd count data independently. In the second step of the HLM, we examined the distribution of regression coefficients from models for all years. Using this technique, we identified the suite of habitat characteristics that is associated with the most productive reaches and we predicted other locations within the basin that might support unusually high numbers of fish.

Relating Landscape and Land Use Variables to Coho Salmon (*Oncorhynchus kisutch*) Abundance in the Snohomish River, Washington State, USA

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A growing body of scientific literature suggests that abundance and distribution of Pacific salmon in Pacific Northwest rivers is determined by both stream-reach and watershed-scale habitat characteristics. We characterized these using coho (*Oncorhynchus kisutch*) salmon distribution and abundance in the Snohomish River Basin. Specific watersheds consistently supported a large proportion of the spawning coho salmon in the basin, while others contribute relatively little to the productivity of the population. The spatial distribution of coho salmon abundance did not exhibit significant variability among years even though the total number of spawning fish varied by 70%. We use spatial analysis and hierarchical linear modeling (HLM) to evaluate the hypothesis that highly productive sites share similar habitat features such as geology, wetland type, riparian condition, and certain types of land use. Preliminary results indicate that coho salmon abundance was 2 times greater at locations with forest dominated riparian or watershed areas compared to sites dominated by rural, agricultural, or urban land use. Stream reaches with unaltered wetlands also had coho salmon abundance that was 2 times greater than stream reaches with hydromodified or no wetlands. Understanding the habitat characteristics associated with productive sites can help provide context for prioritizing habitat protection and restoration.

Wednesday, July 19th
Morning Session- Center Ballroom

Native Fish Conservation and Management in the West: An Epitaph or a New Hope?

Native Fish Recovery Programs in Utah

Matthew E. Andersen, Program Coordinator, Utah Division of Wildlife Resources

The Utah Division of Wildlife Resources has developed the Native Aquatics program in order to implement conservation of native fish, amphibians, reptiles, and mollusks in the state. The most active elements of this program, and those that require the most time and money, are those that address species that are currently listed as threatened or endangered by the U.S. Fish and Wildlife Service. The Division has participated in the Upper Colorado River Fishes Recovery Program since 1988, and is participating in the implementation or development of recovery programs for desert tortoise, Virgin River fishes, and June sucker. The Division is also concerned with better understanding the distribution and population status of all species covered by the Native Aquatics section. The Division maintains a list of species at risk in the Utah, which is not officially recognized by state law, that helps prioritize conservation actions. Utah participates in Conservation Agreements as a tool for guiding the protection of sensitive species and to help prevent additional federal listings. Current Conservation Agreements have been entered into for spotted frog, least chub, Virgin spinedace, and cutthroat trout. Tasks and challenges for the future include: 1) recovering listed species and monitoring their status following recovery; 2) better understanding population status and distribution of sensitive and secure species, and conserving and protecting those species as necessary; and 3) integrating program species concerns with broader, ecosystem-based concerns, encouraging total habitat recovery and/or protection as needed.

The Bureau of Land Management and Native Fish, a Strategy for Conservation

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Fish populations have declined steadily over the past 20 years on many western lands. Presently there are over 110 federally listed, proposed, candidate or Bureau sensitive fish species on BLM administered land and within the Prairie Grasslands and Sagebrush ecosystems. Approximately eighty percent of these species are non game species. Reasons for decline are commonly understood and include: habitat degradation, harvest (on sport fishes), hatchery practices (including non-native species introductions), predation by introduced species, and water development or withdrawal. BLM administers land in lower elevations, supporting higher order streams, these streams provide habitat for a plethora of fish species including native non-game fish. Due the geographic proximity of BLM land, the agency plays a key role in the conservation of native non-game fish. BLM is developing several strategies within the Prairie Grasslands and Sagebrush ecosystems to stem the trend of decline.

Status Review of Native Fishes in Wyoming

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The objectives of this presentation are to (1) describe recent distributional changes among Wyoming fishes and the factors that may have lead to these changes, and (2) discuss an approach for prioritizing among those areas with the greatest conservation value for native fishes. A survey of the warmwater fishes in the Missouri River drainage in Wyoming was conducted during 1993-1995 and results were compared to a survey conducted during the 1960s. No species have been extirpated since the 1960s, but declines among several species were apparent. Based on data not adjusted for between-survey gear bias, 12 out of 31 (39%) native species were collected in fewer locations during the 1990s survey despite the use of more efficient sampling gear. Based on data adjusted for gear bias, the same 12 plus four additional native species (52%) showed declines. To identify streams with high conservation value, I used a diversity index that provided relative scores for 83 streams based on two criteria, species richness and fish densities. Stream "scores" were calculated based on all native species and again based only on species of concern. Current research that focuses on evaluating conservation value of Wyoming streams at different spatial scales will be briefly discussed.

Current status of Large River Species of Concern in the Missouri River and Its Major Tributaries in Montana

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There are currently six native warmwater river species found in the Missouri River and its major tributaries in Montana that have been designated Species of Special Concern by the Montana Department of Fish Wildlife and Parks (pallid sturgeon, paddlefish, sturgeon chub, sicklefin chub, blue sucker, and shortnose gar). Sauger were recently nominated and approved by the Montana Chapter of the AFS and is awaiting approval by MTFWP. The upper Missouri River Basin also contains several species that have special designations in other Missouri River states (e.g. western silvery minnow, plains minnow, flathead chub, burbot). Recent research conducted in the Missouri River Basin has given new insight on the current status of these species. While most species currently maintain stable populations within the basin, most have undergone substantial range reductions. The most imperiled species is the pallid sturgeon and recent recovery efforts include the release of hatchery-reared fish and restoring more natural flows in a tributary stream. Sauger numbers throughout Montana underwent substantial declines during the drought years of the 1980's and numbers have not recovered in much of its historic range in Montana. Major threats to all these species

include altered flow regimes, movement barriers, and habitat loss.

Community Compositions of Fishes in the Colorado River and Tributaries of Grand Canyon, Arizona

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We present current patterns of fish community structure in the Colorado River and major tributaries below Glen Canyon Dam, Arizona. Non-native salmonids (*Oncorhynchus mykiss* and *Salmo trutta)* dominated the observed fish community at all mainstem Colorado River sites sampled. Brown trout abundance is typically high in mainstem Colorado reaches near Bright Angel Creek, posing a potential regulating factor upon native fishes. Fish communities in the Little Colorado River were always dominated by native fishes, while community compositions in some smaller side tributaries underwent seasonal shifts in species abundance, alternating between winter assemblages dominated by exotic salmonids and summer and fall assemblages dominated by native fishes. Catches of young of the year and juvenile humpback chub (*Gila cypha*) were higher in the Colorado River after summer monsoon flooding events in the Little Colorado River. This increase in abundance was followed by a precipitous decrease after several months. Humpback chub have been regularly captured in two other side tributaries in Grand Canyon besides the Little Colorado River, suggesting that habitat in the lower portions of these streams is of importance for this species. Improvements in sampling gear and methodologies may allow more effective long term monitoring of humpback chub in Grand Canyon.

Providing a Context for Aquatic Species Conservation and Watershed Management on National Forest Systems Lands

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The Inland West Water Initiative is a Forest Service multi-Regional effort to gather information about the condition of watersheds and aquatic resources and water uses on the National Forests in 12 states. Its intended use is to provide a basis for prioritizing aquatic species conservation, watershed restoration and water resource protection. The database contains watershed and aquatic resource conditions and status for approximately 10,000 watersheds and 700,000 streams. Strategic questions that the Forest Service can use this information to address include: 1) Where are the critical resource values that need to be protected; 2) where are the damaged resources that need to be restored; 3) where should we act first; and 4) with whom should we act in partnership. An example will be shared in the presentation that shows a "big picture" display of the extent and confidence of what we know about watershed condition and the status of both native and non-native aquatic biota. The example will also show the extent of the "last best places" from a watershed condition and aquatic biota standpoint and how this information can be used in conjunction with others to provide a better context for making decisions on aquatic species conservation, watershed restoration and water resource protection on National Forest Systems lands. We will use basic principles of conservation biology and current thinking on watershed protection to formulate the example. This will be an exercise to share the utility of the database and does not constitute an agency plan.

Wednesday, July 19th
Morning Session- East Ballroom

Species Conservation without the ESA: How much is enough?

Recovering Native Fishes: How Much is Enough?

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The predicament that confronts native fishes in the embryonic 21st Century results from the charge given early fisheries scientists like David Starr Jordan and from society's decisions about development. Jordan's report of fisheries investigations in the Yellowstone country show that his charge was to determine which

of the food and sport fishes were most suitable for the waters of Yellowstone National Park. Fisheries people in the early years of the 20th Century introduced many game fish to waters far outside their native range, activity best termed ecological imperialism. Society's pell-mell pursuit of manifest destiny determined that damming almost all major rivers was necessary for flood control, irrigation, fueling industry, flood control, and so on. Scant attention was given populations of native fish. Fisheries managers often perceived their first duty as development and maintenance of good sport fisheries and many believed taking care of sport fish and the anglers who sought them was their only responsibility. As fisheries management matured as a profession, the scope of responsibility sharpened to stewardship of the whole fishery resource, not the sport fish part alone. The fate of many native fish was decided long before many modern fisheries managers had jobs. For example, much of the Colorado River system had been tamed (impounded and flows regulated) by 1970, with environments markedly changed from times when native fished thrived. Sponsors of petitions to list a species as threatened or endangered rarely indicate how much recovery is enough or even how much is possible. Responsible fisheries biologists can assess fish populations and the habitat that sustains them. With those data, they can plan for realistic recovery of native fish stocks. It is a safe bet that fish such as the Colorado pikeminnow, humpback sucker, and humpback chub can occupy only a fraction of their former range because much of it is artificial, having been transformed by dams into languid impoundments. The future of native fishes is bright so long as people work together and within the constraints of what habitat can offer in the way of a home for native fishes. Neither stocks of native fish nor stocks of sport fish need be maximized. They must, however, be maintained on balance with *real habitat* and the capacity of that habitat to sustain fish stocks.

Cutthroat Trout Conservation in Montana: Agreements, Actions, and Observations

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Westslope and Yellowstone cutthroat trout are both native to Montana, and both are considered species of concern. These native cutthroat trout subspecies have declined in number and distribution in many drainages in Montana for a number of reasons, including habitat alteration, dewatering, and introgression with nonnative species. Montana has recently completed cooperative conservation agreements for both subspecies. These agreements emphasize protection of genetically pure and slightly hybridized populations, and then expansion and connection of populations. Implementation of these agreements is occurring in a number of ways at a variety of levels, including interstate coordination, basin planning, population specific planning, habitat protection, habitat restoration, fishing regulations, suppression or removal of nonnatives, and population and habitat monitoring. Because of fears about ESA listing, cutthroat trout conservation planning and implementation requires extensive interagency collaboration, as well as public participation. Some of the lessons learned through these processes will be discussed.

Space, Numbers, and Movements: Exploring Persistence of Stream-Resident Cutthroat Trout Populations

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Numerous factors have contributed to declines of cutthroat trout (*Oncorhynchus clarki*) in the western United States and have resulted in most populations inhabiting small fragments of stream that may not provide sufficient space to maintain viable populations. I constructed a stage structured stochastic simulation model to explore the dynamics of isolated and connected populations of varying spatial extent as expressed through their carrying capacities. For isolated populations, a minimum population size of 2,000 individuals (> age 1) was estimated for persistence to 100 years in 95% of simulation runs. Low immigration rates (?=6 individuals/year) from source populations (5,000 and 10,000 individuals) maintained persistence in spatially limited populations that would not persist in isolation, but as correlation in the dynamics of interacting populations increased, more immigration was required to maintain persistence. When the dynamics of populations were completely synchronous, only the largest source population (carrying capacity = 10,000) could maintain spatially limited populations. Given that many extant populations are isolated, the results indicate the importance of connectivity and large population cores if remnant populations are to be maintained or restored. For populations so spatially limited that active management may be required for persistence, supplementation strategies derived from model simulations are presented.

How much is enough? A Reasonable and Practical Approach to Colorado River Cutthroat Trout Restoration in the LaBarge Watershed, Wyoming

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Colorado River cutthroat trout, *Oncorhynchus clarki pleuriticus*, (CRC) distribution once encompassed the upper Colorado River basin, including the Green River drainage. CRC populations in the Pinedale region are now found only in tributaries of the Green River. The Wyoming Game and Fish Department has been actively involved in conservation and restoration activities for CRC, particularly in the LaBarge Watershed. Currently, CRC populations in LaBarge Watershed are limited to small patches of isolated habitats. Man-made barriers are protecting the small pure populations in this watershed. Isolating the habitats was important in protecting remnant CRC populations from competition and hybridization. However, the man-made barriers allow for emigration from these isolated habitats but not immigration. This isolation decreases the subspecies chance for long-term persistence and the maintenance of genetic diversity. Increasing the cutthroat's habitat range and allowing for immigration and emigration between habitats will be the major factors assuring persistence and genetic diversity of this subspecies. The Wyoming Game and Fish Department plans to protect LaBarge Creek and 11 tributary drainages from nonnative competition and hybridization. This will connect 18 miles of LaBarge Creek and about 40 tributary stream miles allowing for interaction between local subpopulations and provide long-term persistence in the LaBarge Watershed.

How Much is Enough? The ESA Assessment for Westslope Cutthroat Trout

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On April 14, 2000, the U.S. Fish and Wildlife Service (Service) announced its finding that the westslope cutthroat trout *Oncorhynchus clarki lewisi* does not presently warrant listing as threatened pursuant to the Endangered Species Act (ESA) of 1973. That finding was based on the Service's status review for westslope cutthroat trout (WCT), which revealed that the subspecies presently inhabits about 4,275 tributaries or stream reaches that collectively encompass more than 23,000 linear miles of stream habitat, distributed among 12 major drainages and 62 component watersheds in the Columbia, Missouri, and Saskatchewan River basins. In addition, WCT presently inhabit 6 lakes in Idaho and Washington and at least 20 lakes in Glacier National Park, Montana. Although WCT stocks that formerly occupied large, mainstem rivers and lakes and their principal tributaries are reduced from their historic levels, to a degree that cannot be determined precisely because definitive historic data are limited, the Service found that viable, self-sustaining WCT stocks remain widely distributed throughout the historic range of the subspecies, most notably in headwater areas. Most of the habitat for extant WCT stocks lies on lands administered by federal agencies, particularly the U.S. Forest Service. Moreover, many of the strongholds for WCT stocks occur within roadless or wilderness areas or national parks, all of which afford considerable protection to WCT. I will discuss the process that led to the Service's finding, including key decisions that involved issues important to fisheries managers and others who are concerned about conservation of our native fishes.

Wednesday, July 19th
Afternoon Session- West Ballroom

Salmonid Restoration via Natural Colonization: Lessons from Nature and Experiments

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Colonization and Development of Stream Communities Across a 200-Year Gradient Following Glacial Recession in Glacier Bay National Park, Alaska

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During May 1997 we studied both physical and biological variables within 16 streams of different ages and contrasting stages of development following glacial recession in Glacier Bay National Park, Alaska. The number of microcrustacea and macroinvertebrate taxa, and juvenile fish abundance and diversity were all significantly greater in older streams. Microcrustacea diversity was related to the amount of instream wood and percent pool habitat while the number of macroinvertebrate taxa was related to bed stability, instream wood and pool habitat. The percent contribution of Ephemeroptera to the stream benthic communities increased significantly with stream age. Juvenile Dolly Varden were dominant in the younger streams but juvenile coho salmon abundance was greater in older streams due to increased pool habitat. The presence of upstream lakes was found to significantly influence channel stability, percent Chironomidae, total macroinvertebrate and meiofaunal abundance, and percent fish cover in downstream reaches. Stable isotope analyses indicated N enrichment from marine sources in juvenile fish and macroinvertebrates in older streams with established salmon runs. The findings are summarized in a conceptual model of stream development proposing that stream community assemblages are determined by direct interactions with the terrestrial, marine and lake ecosystems.

Relations Among Populations of Salmonids: Potentials for Recolonization

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We have examined relations among populations of salmonids in a variety of areas in the U.S. Pacific Northwest, British Columbia, and Alaska. The potential of salmonid populations to contribute to the natural recovery of locally depressed populations is dependent on a number of factors. One is the migratory behavior. In Prince William Sound, AK, we examined the genetic variation among populations of Dolly Varden, a char, and among populations of coastal cutthroat trout. Genetically, populations of Dolly Varden were much more similar than were cutthroat trout populations, suggesting the interactions among population of Dolly Varden are more frequent than that of cutthroat trout. The primary mechanisms responsible for this pattern appear to be differences in the migratory behaviors of the two species. Dolly Varden may move over long distances. In contrast, cutthroat movement is much more restrictive. Another factor influencing recolonization potential is the relation between different life-history forms. In many watersheds or river basins, there are anadromous (i.e., sea-going) and resident (i.e, non-sea-going) forms of rainbow trout and of coastal cutthroat trout. We used genetic and/or otolith microchemistry to determine potential relations between these life-history forms. Results from studies on each species from Oregon, British Columbia, and southeast Alaska have shown the relation to be variable. We have found systems where the two life histories are isolated from each other, suggesting that the potential for one form to give rise to the other is limited. In other cases, we have evidence that there are potential interactions, primarily resident forms producing anadromous progeny. Factors that influence the relation between the life history forms are not clear at this time. Based on our studies, we believe there are situations where there is potential for recovering depressed populations through natural recolonizition. Situations with the greatest potential are those where: 1) the species has relatively long movements during some portion of their life; and 2) the life-history forms are not reproductively isolated from each other.

Homing Fidelity and Natural Colonization of Steelhead in the Cedar River, WA: Using DNA to Test the Limits

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Although the homing ability of Pacific salmonids is often touted as one of the wonders of nature, there is surprisingly little data documenting the precision of homing fidelity in salmonids. In the Cedar River system, we are using highly polymorphic molecular markers and parental analysis to describe the dispersal curve for returning steelhead. By collecting egg or fry tissue samples from mapped redd locations and then collecting tissue samples from all returning adults in subsequent years, we can assign adults to specific natal redds using DNA fingerprinting. By then collecting egg or fry samples from the redds produced by the returning adults, we can assign a redd location to each spawner, again using DNA fingerprinting. We will thus know the natal location of the parents of every redd. From this, we can generate a dispersal curve with a spatial resolution at the scale of our redd map, which can be very precise. We are in the very early phases of this study and have not collected data from any returning fish, but we will discuss the basic experimental approach and describe some power analyses associated with the feasibility of the project. In a parallel study on the Cedar, the results of the DNA/fidelity study will be compared to observations of the natural recolonization process in 2002 as fish are once again allowed access to 12 river miles of habitat that have

been blocked to anadromous passage for over 90 years.

Natural Production of Anadromous Salmonids in Three Western Washington Watersheds Formerly Inaccessible to Migratory Fish

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During the 1950s the State of Washington Department of Fisheries began an aggressive program to provide upstream access to salmon around physical barriers. Dynamite was used to shape rock formations and fishways were constructed. In some cases, fish passage relied on annual trapping and hauling operations. In the late 1970s, WDF initiated a long-term wild salmon monitoring program to quantify salmon populations in a number of systems. As the program design involved complete accounting of all returning adult salmon, streams were selected in which upstream migrant enumeration was assured throughout all flows, such as at fishways around impassable barriers. This presentation describes the results of providing upstream passage to salmonids in three systems where we have monitored populations for many years. The South Fork Skykomish, which drains a 362-square mile watershed, now has annual runs of all five species of salmon, summer steelhead, and a small numbers of dolly varden. The Deschutes River, laddered in the 1950s, drains 160 mi^2 into Puget Sound at Olympia. Our data record is continuous since the 1970s. Over the last ten years coho production has severely declined and we have determined the components of poor production via smolt monitoring and coded wire tagging. The third and smallest system (50 sq. mi.) is Elk Creek, a tributary to the upper Chehalis River, which was laddered in the 1970s. We have enumerated the coho run in this stream each year since 1984. Production rates from these streams, relative to those of other systems that we monitor, are discussed as well as the rate at which colonization occurred by species. Based on these and other case studies, it appears that salmonids quickly colonize "new" habitat particularly where it is (a) contiguous to viable populations, (b) is of sufficient size and quality, and (c) survival of downstream migrants past the former obstruction is high.

Salmon Colonization of Two Watersheds in Southeast Alaska After Fish Pass Construction

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USDA Forest Service constructed fish passes around falls on Slippery Creek, near Petersburg, and Margaret Creek, near Ketchikan, Alaska, in 1988-89. Both watersheds had lakes above the waterfall barrier with resident cutthroat trout and Dolly Varden char upstream of the barrier. We investigated colonization of the watersheds by anadromous salmonids and the response of the resident fish. Both systems supported self-reproducing runs of coho and pink salmon, and steelhead trout downstream of the falls prior to fish pass installation. Colonization into the upper watershed by natural pink and coho salmon and steelhead trout below the barrier occurred immediately after the fish passes were opened. Anadromous forms of cutthroat trout and Dolly Varden also colonized the watersheds. The escapement of volunteer species was originally in proportion to the numbers below the barrier, i.e., pink salmon are the most numerous. Since fish pass construction nearly 1.8 million sockeye fry were stocked into Margaret Lake, but the adult sockeye escapement averages less than 300 fish/year. In contrast, one release of 50,000 coho pre-smolts into Margaret Lake and 700,000 coho fry into Slippery Lake have produced sustained runs of adult coho salmon of over 1000 adults/year. We assessed the habitat features and resident fish populations above the barrier and discuss features that may influence the successful introduction of anadromous salmonids.

Elwha River Salmon Restoration: Hatchery versus Natural Re-Colonization

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The Elwha River Salmon Restoration Project seeks to restore salmon populations and the ecosystem of the Elwha River through removal of two major dams that are major migratory barriers to anadromous fish. Since passage of federal legislation in 1992 aimed at restoring salmon in the Elwha River basin, planning for fish restoration has focused on use of hatcheries, where possible, to assist in restoring natural self-sustaining populations of anadromous fish throughout the river basin. Hatcheries are expected to act both as "fish refuges" as well as brood sources for certain species in the restoration process. For other species, natural re-colonization is the only means of restoration proposed, or known. Potential trade-offs in hatchery-assisted versus natural re-colonization include brood availability, uncertainties in outplant strategies, costs,

and long-term versus short-term gains in population recovery.

Wednesday, July 19th
Afternoon Session- Center Ballroom

Native Fish Conservation and Management in the West: An Epitaph or a New Hope?

Isolated Populations of Longnose Suckers in the Black Hills, South Dakota and Wyoming

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The longnose sucker (*Catostomus catostomus*) is the most widely distributed northern sucker, ranging from eastern Siberia across Canada and south to the Great Lakes, upper Missouri River system, and northern Rocky Mountains. Several isolated populations were found during the 1950's in high-discharge coldwater streams in the northern Black Hills. These may be relicts of a wider post-Pleistocene range which shrank during the warmer, drier hypsithermal interval 7,000 years ago; longnose suckers may have retreated up the Cheyenne and Belle Fourche rivers or entered the Belle Fourche via its capture of the Little Missouri River headwaters. These relict populations may now be threatened by instream flow reduction, habitat alteration, and introductions. In order to clarify the current status and possible zoogeographic origins of longnose suckers in the Black Hills, I did an extensive search of literature, museum records, and regional management agency data bases; I then conducted electrofishing surveys in several streams where significant populations were reported. My results show that large, reproducing populations now occur in only three perennial coldwater streams along a short longitudinal zone where they emerge from the Black Hills onto the plains. Historically, populations almost certainly occurred in other higher-order Black Hills streams until post-settlement water table declines made those streams intermittent. Recent records from the upper Cheyenne and Little Missouri systems suggest that both proposed hypsithermal entry routes were used. These results will provide a useful baseline for future longnose sucker management and habitat protection in the Black Hills.

Parasites and Diseases Influence the Distribution of Native and Non-Native Fishes: Examples from Western North America

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Sanctioned, illegal, or accidental introductions of non-native fishes into rivers of western North America have often resulted in dramatic shifts in fish assemblages; however, for every instance where an introduced species has established a breeding population there is probably another instance, often unrecorded or poorly documented, where establishment has not occurred. We suggest that endemic parasites and pathogens represent an under-appreciated barrier to the establishment of introduced fishes, and conversely, that exotic pathogens may actually favor invasive species at the expense of native species. Brook trout *Salvelinus fontinalis* were widely stocked in many coastal river basins of Oregon and Washington in the early 20th century but have largely failed to establish breeding populations in coastal streams. Two locations where brook trout plants have been successful are the headwaters of the Millicoma River near Coos Bay, Oregon, and a single headwater tributary (Falls Creek) of the Willapa River in southwestern Washington. Both populations are isolated by barrier falls from a snail *Juga plicifera* that hosts an intermediate stage of a flatworm causing "salmon poisoning" disease. Brook trout are absent wherever the flatworm and its snail host are present, suggesting that the parasite has limited brook trout populations, as well as other introduced salmonids, throughout the range of this pathogen. Another intriguing example occurs in central Oregon where native rainbow trout *Oncorhynchus mykiss* in the Deschutes River are usually resistant to infection by the indigenous myxosporidean parasite *Ceratomyxa shasta*. In one tributary, the Metolius River, susceptibility of native rainbow trout to *C. shasta* has apparently increased following introgression of natives with hatchery trout strains that were not resistant. Laboratory studies revealed that first-generation hybrids of genetically resistant and susceptible rainbow trout have intermediate levels of susceptibility. Parasites and diseases introduced from other regions or continents, often through transplants of exotic species, can have potentially harmful effects on native fishes. The most notorious example is the pathogen *Myxosoma*

cerebralis, which causes whirling disease in salmonids. Originally introduced to North America from Europe, whirling disease can be particularly harmful to many species of *Oncorhynchus*, as well as some *Salvelinus* and *Thymallus*. The effects on brown trout *Salmo trutta*, which is a natural host in the native range of the disease, are more benign, often enabling brown trout to dominate native salmonids in streams where whirling disease has become established. The introduction of an exotic fish tapeworm *Bothriocephalus acheilognathi* through an import of Asian grass carp *Ctenopharyngodon idella* to Utah Lake has been linked to further imperilment of this drainage system's endemic fauna. These examples show how parasites and pathogens influence the structure of fish assemblages. Attention to the management of endemic and exotic diseases should be an important component of native fish conservation programs.

Use of Geometric Morphometrics to Differentiate Gila (Cyprinidae) Within The Upper Colorado River Basin

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The field of morphometrics has undergone a technological revolution similar in nature to that experienced by molecular genetics. Both have been spurred in large part by the rapid development of computer and video hardware and software. In this study, we apply cutting-edge geometric morphometric techniques to analyze video images of 215 adult *Gila robusta* and 148 endangered *G. cypha* collected from May 1991--October 1992 at eight Colorado River basin localities (seven upper and one lower basin). The two species are sympatric at five of these locations; *G. robusta* is absent at one site, whereas *G. cypha* is missing at two others. Saggital views of each individual were videotaped and 25 morphological points (15 anatomical landmarks and 10 helping points) identified. Bookstein shape coordinates were calculated from Cartesian coordinates of these landmarks and points, while centroid size was used as a measure of body size. Shape differences were evaluated among populations of each species using MANOVA and canonical variates analysis. In *G. cypha*, variation encompassed three aspects: nuchal hump (most pronounced in Grand Canyon forms), relative head size (larger in Cataract Canyon forms), and caudal peduncle dimensions (depth tapers with shorter length in Cataract Canyon forms but is longer and uniformly deeper in those from Desolation Canyon). On the other hand, nuchal development is slight in *G. robusta*, hence only head and peduncle dimensions distinguished populations. Those individuals from Cataract Canyon had relatively shorter peduncles that (again) tapered in depth from anterior to posterior, while Desolation Canyon *G. robusta* possessed peduncles that were much longer and of uniform depth (as with *G. cypha*). Specimens from Debeque and Rifle canyons had proportionally smaller heads. Variation among all 13 populations (i.e., both species together) was evaluated using relative warp analysis, with *G. cypha* and *G. robusta* clearly separated at all sympatric locations save those from Desolation and Caratact canyons. Here, body shapes of the two species converged. Overall, shape variation in both species is clinal. While results from our geometric morphometric analysis were statistically similar to those based on distances derived from a truss analysis, the geometric approach was clearly superior in visually demonstrating phenotypic differences among populations and species, and in elucidating a geographic cline in body shape. These differences have important management implications.

Fish Community Structure in a Large Desert River Relative to Anthropogenic Influences: Verde River, Arizona, USA

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The Verde River, Arizona expands over 300 km from its headwaters to its confluence with the Salt near Phoenix, Arizona. The upper 60 km of river corridor is relatively undisturbed by humans. It is un-dammed, un-diverted, and livestock grazing has been removed. The middle 80 km passes through municipalities and an historic mining region. Here, groundwater pumping, diversions and possible changes in water quality impact the river. The lower 60 km reach lies below two mainstream reservoirs. The river contains one of the few native fish communities in Arizona. However, two major, human-induced impacts; introduction of nonnative fish species and flow modification, become increasingly detrimental with increasing distance downstream. Six years of data on the upper 60 km of river suggest natural hydrographs markedly influence the fish community. Fish community structure changes in composition as once proceeds downstream through greater, and greater anthropogenic impact. Data suggest that 1) natural flow regimes, 2) the presence of nonnative, invasive fish species and 3) mainstream dams interactively legislate fish community structure in the Verde River. Projected increase in human population in the next half century and parallel increase in water demand very like will be detrimental to all fishes.

Wednesday, July 19th
Afternoon Session- East Ballroom

Contributed Papers

Density and Size of Juvenile Salmonids in Response to the Placement of Large Woody Debris in Western Oregon and Washington Streams

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Thirty streams in western Washington and northwest Oregon were sampled during summer and winter to determine the responses of juvenile anadromous salmonid populations to artificial large woody debris (LWD) placement. Total pool area, pool number, LWD loading, and LWD forming pools were significantly greater in treatment (LWD placement) than paired reference reaches nearby during both summer and winter. Juvenile coho salmon (*Oncorhynchus kisutch*) densities were 1.8 and 3.2 times higher in treated reaches compared to reference reaches during summer and winter, respectively. The response (treatment minus reference) of coho density to artificial LWD placement was correlated with the number of pieces of LWD forming pools during summer and total pool area during winter months. Densities of age 1+ cutthroat trout (*O. clarki*) and steelhead (*O. mykiss*) did not differ between treatment and reference reaches during summer but were 1.7 times higher in treatment reaches during winter. Age 1+ steelhead density response to treatment was negatively correlated with increases in pool area during summer, but not winter. Trout fry densities did not differ between reaches, but trout fry response to treatment was negatively correlated with pool area during winter. Mean lengths of coho, cutthroat, steelhead and trout fry were similar in treatment and reference reaches.

And After The River Ran Through It, What Then?

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Many habitat improvement devices have been placed in streams throughout North America to increase trout abundance and fishing opportunity. Some fishery workers have questioned the effectiveness of such work. Proponents contend habitat improvement does help salmonids, while critics argue that such work often fails and is a waste of money. Of 71 projects that the Wyoming Game and Fish Department has been involved with since 1953, fish response was monitored at 46 projects. Habitat improvement techniques used in Wyoming proved durable and effective over time, and benefited trout fisheries statewide. Posttreatment, mean statewide wild trout abundance increased 116% and biomass doubled. Numbers of catchable wild trout, 6 inches or longer, were 88% higher and their biomass was up 95%. In mixed trout populations, where both wild and stocked fish were present, abundance increased 112% and biomass 117%. Catchables more than doubled in both numbers and biomass.

Consequences of Variable Discharge for Habitat Availability and Habitat Use by Two Species of Trout in a Wyoming Tailwater During Winter

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Winter has been identified as a critical time for trout in tailwaters. Discharge is often reduced during the winter, reducing available habitat, and cold water temperatures have been shown to result in the formation of river ice. We conducted a flow manipulation in the Shoshone River, downstream from Buffalo Bill Dam in northern Wyoming. Discharge was incrementally decreased from 2.09 m^3s^{-1} to 0.57 m^3s^{-1} from December 1998 through February 1999. The available habitat and habitat used by cutthroat trout and brown trout were monitored to look for changes in habitat use and evidence for competitive interactions among fish. Cutthroat trout were found to use pools more often that brown trout and not to be associated with discrete cover.

Brown trout were most often found in runs and associated with boulders. Movement patterns gave no evidence of competition. A shift in habitat use by cutthroat trout was noted as discharge was reduced.

Use of Slow Fill and Strobe Lights to Reduce the Entrainment of Salmon Smolts at a Navigation Lock in Seattle, Washington

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Over the past four years the Seattle District of the US Army Corps of Engineers (Seattle District) has worked cooperatively with the Washington Department of Fish and Wildlife (WDFW) and Waterways Experiment Station (WES) in developing and evaluating experimental technologies to improve smolt passage conditions at the Hiram M. Chittenden Locks (Locks). The Locks are at the outlet to the Lake Washington basin, located in the heart of the largest urban center in the Pacific Northwest. From the late 1980's to the early 1990's all Lake Washington salmon runs (sockeye, Chinook, Coho, and steelhead) had declined to near record lows. Observations in spring 1994 indicated substantial smolt mortalities during large lock normal (fast, 4-5 minute) fill events. Since that observation, scientists from several organizations have implemented a two-part strategy to improve smolt passage at the Locks consisting of providing alternative pathways to Puget Sound (smolt passage flumes) and deterring fish from entering the large lock filling culverts. Two behavioral guidance technologies, slowing the fill rate of the lock and strobe lights, are being tested in reducing the entrainment of salmon smolts into a series of 4.3 x 4.9 m culverts used to fill the large lock a 24.4 x 251.6 x 15.2 m deep navigation lock chamber. Flows into each culvert during low tides are up to 2200 cfs, with maximum instantaneous water velocities of 5.5 fps, and internal conduit velocities near 25 fps. To date, each behavioral technology has been evaluated as a separate treatment. Entrainment reduction during lengthened or slower fill times for the half-lock (fill times of approximately 6, 10, and 14 minutes) are being monitored using purse seining in the lock chamber and with split-beam hydroacoustics. Strobe lights have been evaluated at increasing scales of treatment from net pen tests to a prototype scale test with 10 lights surrounding one culvert intake. Smolt response to light guidance was monitored using underwater video during net pen testing and by single-beam hydroacoustics during the prototype test. Results will be presented for both experimental technologies from testing results in 1997, 1998 and preliminary results from spring 2000.

Adaptation of an Analysis for Temporally-Stratified Mark-Recapture Data to Estimate Smolt Abundance in Small Coastal Watersheds

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Temporally-stratified mark-recapture experiments are commonly used to estimate the abundance of smolts during their seaward migration. These designs support rigorous estimation of the probability that an individual migrating past a trap during a given period will be captured conditional on that individual migrating during that period. These estimates allow one to account for temporal variation in capture probability when expanding counts of unmarked fish to estimate abundance. In small, coastal watersheds, limits on the number of fish that can be marked in small, often depleted, populations hinder the use of mark-recapture techniques. Also, marked fish may substantially delay further migration which spreads recaptures over time—thus exacerbating difficulties in analysis arising from low numbers of marked fish. I propose algorithms to adapt Darroch's (1961) analysis for temporally-stratified mark-recapture data for application under these conditions. These algorithms attempt to compensate for small sample sizes by applying simple rules to aggregate the data in such a way that permits valid estimation of capture and migration probabilities while retaining as much information on temporal variability as possible. Evaluations using simulated data indicate that the proposed method performs well over a broad range of abundances and is insensitive to migration behaviors of marked fish.

Underwater Video Monitoring of Adult Chinook Salmon Escapement in the Secesh River and Lake Creek, Idaho

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Remote application of underwater time-lapse video technology was assessed to monitor adult spring and summer Chinook salmon escapement into spawning areas of the Secesh River and Lake Creek, Idaho, in 1998 and 1999. Underwater time-lapse videography is a passive enumeration methodology that does not trap or handle this threatened species. Secesh River drainage Chinook salmon represent a wild spawning aggregate that has never been supplemented. Adult salmon spawner abundance and migration timing was successfully determined at Lake Creek. The run at both sites was made up of two behaviorally distinct segments. The first segment was characterized by rapid upstream movement. The second segment consisted of upstream and downstream movement with little net upstream escapement. Distinct patterns in diel movement were also observed. Salmon movement was not impeded by the fish counting stations, nor was spawning displaced downstream as fish were able to move freely upstream and downstream through the structures. This methodology has the potential to provide accurate salmon spawner abundance information that may be utilized to evaluate Endangered Species Act recovery actions.

California Heritage Trout: A New Program Supporting Restoration Efforts, Providing Angling Opportunities, and Emphasizing Education for Native Trout

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California has had a Wild Trout Program to designate waters to be managed exclusively for wild trout and quality angling for nearly thirty years. The Department of Fish and Game's Threatened Trout Committee has coordinated efforts to restore threatened native trout since the mid-1970's. Now, the recently established California Heritage Trout Program combines elements from these trout programs to promote conservation of and public exposure to the rich diversity of native trout forms in California. In 1999, the Fish and Game Commission designated the first six Heritage Trout Waters which feature five different forms of native cutthroat, rainbow and golden trout. As native trout restoration and recovery efforts succeed and native fish populations expand more waters will be added to the list. The Commission's Policy establishing this new program specifically mandates that education and outreach efforts to inform the public about native trout, their habitats, and the efforts to conserve and restore these valuable parts of our natural heritage be emphasized by the Department of Fish and Game. An education/outreach plan setting goals and target audiences is under development. Expected benefits of the program are: increased public awareness about native trout and their habitats; increased opportunities to fish for, to observe, and experience native trout; stimulated local economies by additional spending of anglers seeking new native trout fishing opportunities; increased public support for further native trout restoration work; and enhanced collaborative/cooperative efforts for restoration and management of native trout. Significant challenges for the program exist in gaining funding and with changing status of Endangered Species Act listings for native trout.

River and Inmate Restoration

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The Colorado Division of Wildlife (DOW) has conducted three major river restoration projects in the past two years using inmate students enrolled in the first vocational heavy equipment technology program developed within a state prison system. Inmates with no previous heavy equipment experience are screened and selected through a stringent interview system. These students, supervised by a Colorado Department of Corrections (DOC) program manager and directed by DOW biologists, were trained to operate heavy equipment and installed a variety of river channel and in stream trout habitat treatments designed for the upper South Platte River drainage. Treatments installed to increase channel substrate diversity included pool excavation, reduction of channel width and enhancement of riffle habitats. Students also installed native materials consisting of log spurs, stumps, horizontal logs, root wads, boulder vanes and clusters plus vortex and J-hook structures. All treatments enhanced trout habitats. The presentation illustrates how two state agencies with very different missions cooperated to instruct and train students for new vocational skills and at the same time enhanced trout stream habitats. The DOC heavy equipment technology program has an advisory board representing private industry including the Colorado Contractors Association. This program

has reduced DOW river restoration costs up to 75%. Recidivism of student inmates following graduation from the DOC heavy equipment program has been low (> 6 %). Trout population response to river restoration treatments has been high.

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Invasive Species: The Good, The Bad, The Ugly

Initial Evaluation and Management Assessment of an Illegally Introduced Northern Pike (*Esox lucius*) Population in Parker Canyon Lake, Arizona

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Northern Pike (*Esox lucius)* were first introduced into Arizona to provide anglers with a unique but limited angling experience. Initially stocked in Lake Mary in northern Arizona during the 1940's, Northern Pike's range has expanded in Arizona due, in part to illegal introductions. Northern Pike were first discovered in Parker Canyon Lake in extreme southern Arizona during the summer of 1997. We evaluated possible impacts to the fishery and other fish populations if these fish were to escape from Parker Canyon Lake through a flood event or further illegal introductions. We conducted an extensive literature review and completed over 200 nets-days of surveys from December 1999 to March 2000. A total of 44 fish were weighed, measured for total length, and necropsied to determine sexual maturity and food habits. Northern pike ranged in length from 293-mm to 890-mm with a mean length of 593-mm. A management assessment of the impacts of northern pike was completed and four options were explored for the removal of this illegally introduced population.

Range Expansion, Movement, Food Availability and Stomach Content of an Illegally Introduced Northern Pike Population in a Major Salmon Producing System

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Northern Pike (*Esox lucius)* are non-indigenous to the Susitna drainage of south-central Alaska and were thought to have been established through a series of illegal introductions in the early 1950's. The Susitna drainage is a large river basin encompassing tens of thousands of square miles and is roughly the area of the state of Indiana. This system is comprised of glacial rivers, hundreds of interconnecting shallow lakes and ponds, deepwater lakes, both high and low velocity clear water tributaries, and sloughs. To date northern pike have expanded throughout most of this drainage system. Though indigenous populations of northern pike coexist with native salmonid populations in other Alaskan watersheds this is not be the case in the Susitna Drainage. This project was initiated in 1996 to study select Susitna Drainage northern pike populations and to document the impacts of northern pike expansion on native salmonid populations residing in varying habitat types. The results of these studies along with differing management scenarios are presented.

Report on the Discovery, Distribution, and Agency Reaction to the Noxious Weed Giant Salvinia, *Salvinia molesta*

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This presentation documents the discovery, distribution, and agency reaction to the noxious aquatic weed Giant Salvinia. The basic biology of the plant is presented, as is its distribution globally, in the U.S., and in Arizona-California. Potential impacts to fish populations in Arizona are discussed, as are impacts to hydroelectric production, water delivery systems, and recreational activities. Control measures are presented and current measures that are being implemented to eradicate this plant in Arizona-California are presented.

Myxobolus cerebralis: Impacts of an Exotic Parasite On Wild Trout

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Myxobolus cerebralis, a myxosporean parasite that can cause whirling disease (WD) was introduced into Colorado in the mid-1980s. Retrospective research efforts indicate whirling disease began impacting wild trout populations by the early 1990s. By 1999, wild trout populations on approximately 350- 400 miles of 10 streams had been impacted. Sentinel fish studies indicate brook, rainbow, and cutthroat trout fry are highly susceptible to the parasite. The Colorado Division of Wildlife (CDOW) is investing up to $13 million to secure water supplies and make the hatchery system less vulnerable to infection. Between 1994 and 1999, more than $1 million have been spent on WD research efforts. Annual expenditures for disease testing exceed $500,000. More than half of that money is devoted to testing for WD. The CDOW is investing heavily in intensive testing of fish and water samples to determine best management practices to ameliorate the impacts of the WD parasite on Colorado's wild trout populations.

The 100th Meridian Initiative-Preventing Spread of Aquatic Nuisance Species

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Zebra mussels were introduced into the Great Lakes in the mid-1980's through ballast water exchange. This prolific macro fouling aquatic nuisance species (ANS) rapidly spread throughout the lakes and into the Mississippi Basin. Ecosystem dynamics were altered, water delivery systems were blocked, boats and other hard surfaces were covered with zebra mussels and some native mussel species were pushed to the edge of extinction. Municipalities, boaters and other water users were impacted and wanted answers for their aquatic nuisance species problems. In response, Congress passed The Non-indigenous Aquatic Nuisance Prevention and Control Act of 1990. This Act funded the Fish & Wildlife Service and several agencies to; identify problems and solutions, educate stakeholders, control ANS, initiate a rapid response to new invasions and provide coordination for these activities. Trailered boat movement with attached adults was identified as an important pathway for new zebra mussel invasions. Adult zebra mussels can survive several days out of water. California border inspections have stopped 24 boats with attached zebra mussels since adding this ANS as to their prohibited species list in 1992. Some zebra mussels were still alive. The 100th Meridian Initiative is a partnership effort in those states straddling the 100th meridian (Texas to North Dakota) and Manitoba to prevent the westward spread of zebra mussels and other ANS. Actions include; educational outreach, boater surveys and voluntary boat inspections. How can western stakeholders expand this partnership to improve efficiency and protect valuable waters and resources?

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Contributed Papers

Modeling the Distribution, Growth, and Abundance of Juvenile Coho and Steelhead Using 3D Video Analysis

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I will present an overview of my proposed Ph.D. project. I will attempt to define the ecological mechanism responsible for habitat selection by juvenile coho salmon (*Oncorhychus kisutch)*, and steelhead trout (*O. mykiss)*. My hypothesis is that coho maximize their net energy intake rate at lower stream velocities than do steelhead. I will review published literature that provides empirical evidence for this hypothesis. I will present my methods, which include: feeding trials in flow-through aquaria, 3-D video analysis of feeding maneuvers, development of a model to predict habitat use for coho and steelhead, and tests of the model in streams in southeastern Alaska. I will discuss the potential use of the model in fisheries management and theoretical ecology.

The Yakima/Klickitat Fisheries Project: Monitoring and Evaluating Supplementation of Salmonid Populations in the Columbia River Basin

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The Yakima/Klickitat Fisheries Project (YKFP) is a multi agency study designed to test the concept that supplementation can utilize fish reared in a hatchery environment to increase the productivity of naturally producing populations of salmon. An experimental hatchery, with associated acclimation sites, was designed and constructed to facilitate this research. Only wild adult salmon from the Yakima basin will be used as brood stock. Brood stock collection and egg fertilization strategies were developed to maintain genetic diversity. Eggs are split into two groups and reared under two different regimes; the Optimum Conventional Treatment (OCT) utilizing the best current hatchery practices, and the Semi-Natural Treatment (SNT) with substrate, cover, and underwater feeders to simulate more natural stream conditions. Replicate raceways of each treatment were reared for one year, marked with passive integrated transponder (PIT) tags and coded wire tags (cwt), and volitionally released from acclimation ponds in the spring of 1999 and 2000. A monitoring program has been developed to evaluate the Post Release Survival of the outmigrating smolts and the returning adults. The results of several years of smolt outmigrations are discussed. Other programs within the project are designed to monitor and evaluate the reproductive ecology of the returning adults, determine the potential domestication and other genetic effects of supplementation, and evaluate the ecological interactions with natural populations of anadromous and resident fishes. Studies of behavior and physiology will allow us to compare the supplementation fish with naturally produced salmonids.

Quantifying the Energetic Cost of Handling Associated With Catch-and-Release Fishing: Putting Largemouth Bass Through Stressful Paces

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The objective of this research was to quantify whole-organism energetic cost from angler handling associated with catch-and-release fishing. Energetic cost of handling was quantified by measuring metabolic rates of largemouth bass using 3-L static respirometers. Approximately 12 hours before handling treatments, fish were transferred to respirometers for acclimation. Animals were exposed to simulated angler handling for 8, 4, 2, 1, or 0 min. For the first half of each interval, fish were held in a damp fish net; for the last half, fish were held vertically by the lower jaw. These treatments were intended to simulate handling by a range of experienced anglers. Upon completion of handling treatments, fish were returned to respirometers and their oxygen consumption rates were quantified for 24 hours. No mortality resulted from handling treatments. Oxygen consumption was greatest immediately after handling and declined with time. The rate of recovery varied with handling magnitude. Metabolic rates in the 8-minute treatment returned to normal in 12-16 hours. Results of this study can be used to compare the energetic cost of a socially acceptable form of anthropogenic stress (angler handling) with a socially unacceptable form of anthropogenic stress (contaminant exposure).

Application of a Conservation Approach for Use of Artificial Propagation in Salmon Recovery

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The continued decline of anadromous and resident salmonids throughout the Northwest is increasing utilization of artificial propagation as a means to reduce demographic risk and conserve genetic and life history traits of imperiled stocks. It is widely recognized that recovery will require a multifaceted approach. In many cases, the preferred management option is alteration of the current system through improved mainstem survival, ocean conditions, and spawning and rearing habitat followed by natural repopulation. Unfortunately, these improvements may not be possible in the time frame necessary to recovery stocks, at high demographic risk of extirpation, and to prevent the irretrievable loss of genetic and life history variability. We suggest that supplementation, utilizing modern aquaculture techniques such as NATURES rearing, in combination with clear goals, objectives, and monitoring and evaluation offers the highest probability of successful conservation and recovery. In the Johnson Creek drainage of central Idaho, we have designed and established a supplementation program with the goal to reduce the demographic risk of extirpation to the ESA listed Johnson Creek summer chinook salmon stock. Our efforts to design a program capable of achieving this goal have produced an approach that fishery managers may find useful. We present a method for defining the number of adults necessary to reduce demographic risk and maintain rare genetic variation, even in the absence of baseline genetic data. We then present a means of using this rough estimate

to define broodstock and escapement goals and allocation of adult returns to broodstock or escapement under a variety of adult return scenarios (a "sliding scale"). Utilization of these concepts may yield the highest probability of successful conservation and recovery.

A Risk Assessment Procedure for Evaluating Harvest Mortality on Pacific Salmonids

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The risk assessment procedure (model) presented here has been developed to assess harvest management actions on the status of salmonid populations and to determine population-specific harvest mortality levels that will not jeopardize recovery of the listed species. The model provides a coherent and objective methodology that can be consistently applied for evaluating proposed actions that may be considered under various sections of the ESA including: 4(d) rules, recovery plans, section 7 consultations and section 10 incidental take permits for salmon. The model defines maximum exploitation rates for individual populations which are projected to result in a low risk to survival and a moderately high to high probability of maintaining a sustainable population in the long term. Risk is measured in terms of the frequency that spawning escapements are above or below defined thresholds of abundance. The model is based on Monte Carlo simulations of the salmon population, given parameters describing productivity of the stock, natural mortality and maturation rates by age, annual variability in the returns, and distribution of harvest mortalities by age of fish and type of fishery. Target total harvest rates are then applied in the simulation to determine their effect on the resultant escapement levels. An example is provided for one Puget Sound Chinook population.

Poster Presentations

Using Fisheries Data Collected by the Public: The King County Salmon Watcher Program

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Since 1996, King County, Washington, has orchestrated a jointly coordinated volunteer spawning survey program in the Lake Washington Watershed. This program allows the documentation of the distribution of spawning salmon throughout the basin via an active public outreach and education program. Volunteers are trained by fisheries biologists in identification and monitoring techniques prior to surveying. Data collected include survey date, fish species, number of individuals, life stage, whether the fish are alive or dead, and any notes on the overall condition of the survey stream. Since inception, this program has grown from 76 volunteers monitoring 80 sites in 1996 to 146 volunteers monitoring 136 sites in 1999. These data can be used by policy makers and the public to better understand salmonid species in the basin and protect or enhance remaining available habitat. By using volunteers in this program, these agencies are able to collect data from far more locations than otherwise would be possible because of monetary and time constraints. These types of data will become increasingly important as more salmonid species are listed under the ESA. This poster presents the salmon distribution information amassed from the volunteer effort, information that we would not have without this program.

Developing a Protocol for Temperature Monitoring in Streams Using Digital Dataloggers

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Digital temperature dataloggers are a relatively new tool available to fishery managers. These dataloggers provide an unprecedented opportunity to collect large volumes of continuous temperature data with relatively minimal effort. Effective use of dataloggers must consider two important issues: 1) sampling and

measurement error; and 2) effective processing and data archiving. We outline various potential components of error, including 1) instrument and calibration error; 2) effect of logger housing; 3) sampling of temperature within sites; 4) sampling within larger reaches or streams; 5) sampling interval; 6) error screening. We focus on the latter two issues, which have received little treatment in existing protocols. We use an extensive data base of stream temperatures from over 1000 sites in streams in the Great Basin and Pacific Northwest to develop quantitative recommendations. We also address the issue of data processing by examining covariation among a number of temperature metrics, including summaries of temperature based on mean temperatures, maximum temperatures, cumulative exposure, and how different species of salmonids respond to these different measures. Results of these analyses will be incorporated into a regional sampling protocol for monitoring water temperatures.

Defining Habitat Fragmentation and Developing Models of Occurrence for Cutthroat Trout

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Habitat fragmentation is believed to be an important threat for many species. Most of the work on habitat fragmentation has focused on terrestrial and aquatic systems where boundaries of suitable habitat are relatively easy to identify (e.g. forested versus non-forested habitat, lakes). We describe an example of defining suitable habitat and habitat fragmentation for cutthroat trout in streams of the Great Basin. Several different models of downstream distribution limits were used in a GIS to define the size and location of continuous areas of suitable habitat (habitat patches). Patch structure defined by each of the models was used to predict the effects of patch size and isolation on occurrence of cutthroat trout. A variety of other factors (occurrence of nonnative salmonids, maximum basin elevation, and alternative measures of patch connectivity) were investigated as well. We discuss differences among the different models of habitat fragmentation, and how broad-scale (GIS) models can be used with detailed information at specific sites to prioritize management and monitoring of fish populations.

Partnership for Conservation of Native Fishes in the Northern Rocky Mountains

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At a meeting in Idaho Falls last April concerned individuals gathered to discuss the future of native fishes in the Northern Rocky Mountains. The meeting was attended by personnel from federal and state agencies, private and industry interest, and conservation groups. The meeting was convened to form a "partnership" to deal with native fish issues in Idaho, Montana, and Wyoming. **Purpose:** Our Charter establishes the mission and operating guidelines for the Partnership for Conservation of Native Fishes in the Northern Rocky Mountains. Native fishes have recognized ecological, economic, historical, and cultural values. These values need to be integrated with other management and land use priorities. The purpose of the Partnership is to facilitate conservation (including protection and restoration) of native fishes in the region. **Mission:** The Partnership shall develop and facilitate implementation of a regional conservation strategy, based on conservation biology, existing plans, and projects. The Partnership shall assist in the establishment of working relationships among stakeholder groups, act as a clearinghouse for information on funding sources for conservation projects, provide links to relevant ecological and conservation technique databases, and provide education and outreach information to the public on the values of native fishes and on the status of conservation efforts.

Fish Passage Video Monitoring Systems

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Video monitoring is used to enumerate salmonid fish passage in the Yakima Basin. Data recorded include-species, fork length, external marks, diel movement and fish ladder use patterns. The current monitoring system consists of an analog video camera, time-lapse VHS recorder and monitor. The current monitoring system records 24 or 48 hours of fish passage on to a two-hour VHS tape. A technician plays back the VHS tape using an editing recorder/player unit, and the fish related data is recorded. A digitally based video monitoring system is being developed and field-tested. This system consists of an area scan camera that is

linked directly to a computer installed with frame grabber card. The analog video signal is streamed to the PC from the camera. The generated images (~3 fps) are filtered for the presence of fish using a motion-detection based algorithm. Once the motion detector is "triggered" the fish image(s) are captured, image file(s) are created and stored to the computer hard drive. Stored along with each fish image file is its associated time stamp image file. A photo editing software program is used to sort through a series of fish images generated from fish passage events and aforementioned data is recorded.

An Acoustic System to Measure Fish Feeding Behavior in Aquaculture

John Hedgepeth, Lyle Harkness, Dale Harkness, and Shui Yang (BioSonics Inc. 4027 Leary Way NW Seattle. WA 98107; 206/782-2211, Fax 206/782-2244, bio@biosonicsinc.com).

In aquaculture, the problem of measuring feeding activity is important both to maintain optimal production and to reduce waste of feed. Detrital feed is a major concern to regulatory agencies. The purpose of the acoustic system is to be able to control feeding by using acoustic measurements from both fish and feed. The feeding monitor uses a scanning acoustic transducer to search for wasted fish feed underneath the seacage. A current meter is used to monitor speed and direction of the current. The combination of the pellet delivery location and the expected offset due to the current determine the scanning region. While at least two commercial systems exist to measure fish feeding behavior in aquaculture pens, this system is lower cost and technologically advanced because of recent developments in digital system manufacture and software design. A prototype system has been designed and tested for use in the salmon aquaculture industry in Chile.

Molecular and Karyotypic Characterization of Wild Coastal Cutthroat Trout (*Oncorhynchus clarki clarki*) and Steelhead (*O. mykiss*) Hybrids Washington State

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Novel, species-specific molecular genetic markers and karyotypes revealed the presence of multigenerational, wild coastal cutthroat trout-steelhead hybrids in two of four creeks surveyed draining the east end of the Strait of Juan de Fuca, WA. All individuals were originally sampled under the assumption they were steelhead smolt. Olsen Creek (N = 8) was composed entirely of hybrids and at least 6 were hybridized beyond the first generation. One individual from Olsen Creek was karyotyped and had 2n = 62 chromosomes. In Jansen Creek, (N = 11) 6 hybrids were observed and 3 appeared to be hybridized beyond the first generation. A hybrid was also karyotyped from Jansen Creek and had 2n = 63 chromosomes. Both karyotypes contained a much higher number of subtelocentric chromosomes compared to steelhead and both likely represented different hybrid generations. The two other creeks surveyed were Bullman Creek (N = 6) with 1 first generation hybrid, and Rassmussen Creek (N = 19) with no hybrids. Future studies involving these genetic markers will include a more detailed analysis of these specific creeks from ecological, genetic, and behavioral perspectives.

Life Out of Bounds

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This poster is a U.S. Fish and Wildlife Service display developed for public outreach on the issue of invasive aquatic species, with a focus on species and vectors that may be problematic to the West. The following is an excerpt from a display panel. "Over geologic time, the world' major ecosystems developed their own unique plants and animals, each accustomed to the other. But humans are drastically changing natural boundaries by moving species, on purpose or by accident, all over the globe. Of the thousands of non-native species that have invaded the U.S., zebra mussels alone have caused over a billion dollars damage since arriving in North America, and this number will grow much, much larger if they reach the West. Zebra mussels attach to virtually any submerged surface and can cause enormous damage to all water-dependent activities. Reaching densities of over a half-million per square yard, this nuisance species can clog power plant cooling systems, even emergency fire-fighting equipment. In the West, they would threaten hydropower dams, transportation locks, irrigation systems that agricultural economies depend, and fish passage and screening facilities -- worsening the plight of our already struggling fisheries." The display also includes a Boater's Checklist on how to prevent the spread of invasives.

What are Those Suckers? (Rio Grande Sucker Larvae and Early Juveniles: Morphological Description and Comparison With White Sucker)

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The Colorado endangered Rio Grande sucker (*Catostomus plebeius*) and introduced white sucker (*C. Commersoni*) are the only catostomids inhabiting most of the upper Rio Grande Basin in Colorado and northern New Mexico. Their larvae are broadly similar in appearance and sometimes difficult to distinguish. Rio Grande sucker typically progress in development from protolarvae through postflexion mesolarvae at a smaller size than white sucker but advance to the juvenile period at a notably larger size. Total myomere and vertebra counts average 2 or 3 units fewer for Rio Grande sucker. Morphometrics sometimes useful for identification include eye diameter, lengths to posterior margin of eye and origin of dorsal finfold, length of base of dorsal fin, and vertical depths behind eye and vent. Diagnostic characters include pigmentation along ventral midline from heart to vent, along dorsal midline from head to tail, over rest of dorsal surface, and for later larvae and early juveniles on peritoneum and lateral surfaces of body, especially along horizontal myosepta. Principal dorsal-fin-ray counts, lateral-series-scale counts, and mouth characters are diagnostic for later larvae and early juveniles once those structures have sufficiently developed.

Colorado Fishes, Overview of A Changing Fauna

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Excluding hybrids, failed introductions, and extirpated and unconfirmed species, 83 species of fish, representing 15 different families, are believed to now inhabit Colorado waters. However, barely half of these, 57% representing just 10 families, are considered native in at least some portion of the state. In many cases, a fish native to one basin has been introduced to another, particularly from eastern to western basins. For example, 34 of 47 fishes (72%) residing west of the Continental Divide are introduced species and half (17) of those are native to one or more eastern basin. Of all Colorado's fishes, 52 (63%) are considered non-game species and 75% of these are native somewhere in Colorado. In contrast, only eight of our 31 game species (26%) are native. Non-game species are predominately cyprinids and catostomids, whereas game species are mostly salmonids, centrarchids, and ictalurids. All but one endangered, threatened, or special concern species are non-game fishes. Unlike many states, a detailed guide to at least the adults of all of Colorado's fishes has not been published for nearly a half century (1952). A comprehensive guide to Colorado's fishes with detailed descriptive, diagnostic, distributional, and biological accounts, including early life history, is long overdue.

Evaluation of the Long Term Effects of Exposure to Low Flow Conditions: An Up-Date: Macroinvertebrate Colonization Study

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Water diversions from several streams in the Fraser River drainage are maintained at flow levels that may approximate streamflows generated by the standard R2CROSS instreamflow model. The objective of this study is to evaluate the long term effects of exposure to low flow conditions on aquatic biota in Rocky Mountain streams. These diversions have been in place and functional for many years, the watershed upstream of the diversions are considered as control sites; in contrast, the stream downstream from the diversions has been and continues to be effected by reduced stream-flows. Under Phase 1 of this study, I investigated the relationship between stream flows and the colonization rate by macroinvertebrates of introduced substrates. Substrates were rapidly colonized by aquatic macroinvertebrates. Macroinvertebrates were significantly ($p < 0.05$) more abundant at control sites in initial samples; however, after 46 days of colonization, no significant differences were observed between sites. Macroinvertebrate surber samples collected from the same sites were compared with colonization samples. Similar macroinvertebrate density between surber and colonization samples were recorded, despite the 10 X greater surface area of the Surber sampler. Changes in streamflows during the colonization period did not effect colonization rates of macroinvertebrates.

Ammonia dynamics in a cooling water lake: Assessing the contribution from carp

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Lone Tree Mine in north central Nevada uses a 206-ac cooling lake to lower temperatures of water from dewatering operations prior to discharge through a canal to the Humboldt River. A recent problem has been increase in unionized ammonia levels in discharged water, even though ammonia input from the dewatering operation water has not increased. Observation of large common carp in the cooling pond suggested that ammonia production from these fish in the warm productive waters of the lake might be the cause, and that control of carp in the lake would reduce ammonia concentrations. I initially used a simple ammonia balance model to assess the importance of fish ammonia production with respect to other factors such as inputs from abundant waterfowl on the lake and high primary productivity. Estimated ammonia inputs to the lake were: 100.8 kg/day from dewatering operations, 3.0 to 9.7 kg/day from birds, and from 0.6 to 60.7 kg/day for carp. Estimated ammonia outputs from the lake were: 31.3 kg/day from discharge water, 58.1 kg/day from ammonia volatilization, and from 12.3 to 603 kg/day from primary production uptake. Although there are many uncertainties in these estimates, it appears that ammonia input from carp was not sufficient to cause the observed increase in unionized ammonia in the discharge water. Instead, this increase seems to be the result of increased primary production from phytoplankton and filamentous macroalgae, resulting in elevated pH (> 8.5), which, along with high water temperatures (> 25C), causes a shift in the aquatic ammonia equilibrium away from the ionized ammonium ion toward the toxic unionized ammonia form. The final recommendation for lowering ammonia concentration in the discharge water was to lower water depth in the lake from 6 ft to 1 ft. The depth reduction would discourage residency by large fish and waterfowl, and would reduce the amount of primary production by reducing total water volume and increasing flow rate. This would not affect the cooling or ammonia volatilization processes because the lake surface would remain constant. The net effect would be reduction in total ammonia inputs from carp and birds, along with a reduction in unionized ammonia after lowering pH.

International Conference on the Ecology and Management of Wood in World Rivers

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Streamside forests provide inputs of large wood, an important element of conservation of biological diversity at landscape scales. Historically, large wood has been an important component in streams throughout the world. Research results have been applied by natural resource managers to protect and restore biodiversity, fisheries and aquatic ecosystem functions. Wood is placed in streams as part of restoration efforts, and streamside forests are actively managed to supply large wood to river networks. Transferring research results from one region to others has raised both technical and cultural questions. Synthesis of worldwide research is needed to 1) summarize the state of knowledge, 2) determine how to generalize geographically diverse information, and 3) tailor restoration and management of large wood in rivers to the different landscapes, rivers, forests, regions, and countries. An international conference will be held October 23-27 at Oregon State University to synthesize what is known around the world about large wood in streams and rivers for physical and ecological processes and stream restoration, present the status of knowledge of the physical dynamics and ecological interactions of large wood in streams and rivers in different geographical regions, create a framework for interpreting and potentially applying the results of research in different geographical regions and management systems, identify different management systems for large wood in rivers, assess physical and biological responses of large wood in stream restoration, explore links between primary information of the physical and ecological dynamics of large wood, resource management systems, and the communities and cultures in which they are applied.

Old Refrigerator Streamside Trout Egg Incubator

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The Grand Valley Chapter of Trout Unlimited applied for and received an Embrace-A-Stream grant from TU National to build and install a trout egg incubator in the Youngs Creek drainage on Grand Mesa, Colorado. The objective of the effort was to establish a self-perpetuating population of Colorado River cutthroat trout *Oncorhynchus clarki pleuriticus* in a previously renovated reservoir system. Approximately 2,500 Nanita Lake CR1 ("A+" genetic status) well-eyed eggs were placed in Whitlock-Vibert boxes inside the incubator and their progressive growth through hatch to alevin stage monitored. Several precipitation events occurred during the incubation interval which had little apparent affect on the overall success of the

effort despite increased sedimentation and reduced water flow to the incubator. Approximately 96% of the eggs hatched and exited the incubator as fry through the siphon outlet and passed down stream to Youngs Creek Reservoir #2. The Colorado Division of Wildlife hopes to establish a feral cutthroat trout spawntake at the reservoir.