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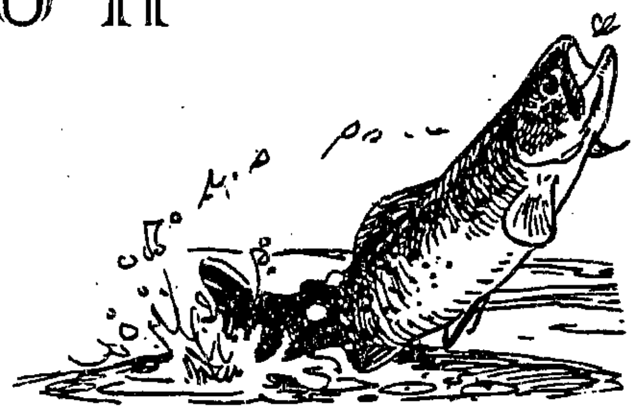

American Fisheries Society

Annual Meeting

Moscow, Idaho ❖ July 12-14, 1999

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UNIVERSITY OF IDAHO
DEPARTMENT OF FISH AND WILDLIFE RESOURCES

Western Division Annual Meeting

Moscow, Idaho
July 11-14, 1999

General Meeting Schedule

Sunday, July 11	
9:00 - 5:00	**Practical Genetics for Fisheries Biologists Shortcourse** — Forestry Bldg, Room 108
1:00 - 5:00	**Metapopulation Analysis Shortcourse** — Admin. Bldg., Room 225 **Bootstrapping Techniques Shortcourse** — Forestry Bldg., Room 10
1:00 - 6:00	**WDAFS Executive Committee meets; Executive Retreat follows** — Gold Galena/Silver Galena Rooms
1:00 - 6:00	**Trade Show and Poster Session Set-up** — Ballroom
5:30 - 7:30	**Welcome Social**, Organized by the Palouse Unit of the Idaho Chapter, AFS — Catholic Center (across from the Student Union Building)
Monday, July 12	**Ballroom**
7:00 - 5:00	**Registration** — Ballroom Foyer
8:00 - 5:00	**Trade Show and Poster Session**
8:15 - 8:30	**Welcome and Announcements** - Ken Hashagen, Program Chair
8:30 - 8:45	**Welcome/Introductory Remarks** - Bob Bilby, Western Division President and Christine Moffitt, President-Elect, American Fisheries Society
8:45 - 9:30	**Gus Rassam, Executive Director, American Fisheries Society**
9:30 - 12:00	**Plenary Session — The Pros and Cons of Dam Removal in the Snake River: Four Views** Session Chair: Ken Hashagen, California Dept. Fish and Game, Sacramento CA

9:30 - 10:00	**The Lower Snake River Dams: Why Decommissioning Makes Sense** Mr. Glen Spain, Northwest Regional Director, Pacific Coast Federation of Fishermen's Associations
10:00 - 10:30	**Break**
10:30 - 11:00	**Putting Dams in Context: Hatcheries, Harvest, Habitat, and Hydro as Integrated Risk Factors** Dr. Peter Kareiva, NOAA
11:00 - 11:30	**Why Science Says Removing the Snake River Dams Won't Work** Mr. James Buchal, Attorney and Author, Portland OR
11:30 - 12:00	**How Coyote Saved the Salmon** Mr. Donald Sampson, Executive Director, Columbia River Intertribal Fish Commission
12:00 - 1:00	**Box Lunch** (included in the registration fee)
1:00 - 2:40	**Concurrent Technical Sessions** **Session #1** Columbia River Symposium — Borah Theater **Session #2** Contributed Papers - Techniques and Technology — Gold Galena/Silver Galena Rooms **Session #3** Contributed Papers - Miscellaneous — Ballroom
2:40 - 3:00	**Break**
3:00 - 5:00	**Concurrent Sessions Continue**
5:00 - 6:00	**Fish Management Section Meeting** — Gambino's Restaurant
5:00 - 6:00	**Bull Trout Committee Meeting** — Kerouac Room
6:00 - 8:00	**Nez Perce Cultural Social** — Latah County Fairgrounds (transportation will be provided)

Tuesday, July 13

6:30 - 7:30	**Spawning Run** — Best Western University Inn Lobby
7:00 - 5:00	**Registration** — Ballroom Foyer
8:00 - 5:00	**Trade Show and Poster Session** — Ballroom
8:00 - 9:40	**Concurrent Technical Sessions** **Session #4** Beyond Hankin and Reeves Symposium — Kerouac Room **Session #5** White Sturgeon Symposium — Gold Galena/Silver Galena Rooms **Session #6** Columbia River Symposium (Con't.) — Borah Theater
9:40 - 10:00	**Break**
10:00 - 12:00	**Concurrent Technical Sessions Continue**
12:00 - 1:30	**Lunch/Business Meeting** (cost of lunch included in the registration fee) — Ballroom
1:40 - 2:40	**Concurrent Technical Sessions Continue**
2:40 - 3:00	**Break**
2:40 - 5:00	**Concurrent Technical Sessions Continue**
6:00 - 9:00	**Banquet** —Best Western University Inn Courtyard

Wednesday, July 14

8:00 - 12:00	**Trade Show and Poster Session** - Ballroom
8:00 - 11:40	**Concurrent Technical Sessions** **Session #7** Contributed Papers - Fisheries Management — Ballroom **Session #8** Contributed Papers - Fish Health and Nutrition — Gold Galena/Silver Galena Rooms **Session # 9** Conservation of Endangered Salmonids via Supplementation: A Symposium — Borah Theater
12:15	**Announcement of Best Student Paper** — Ballroom
12:30	**Trade Show Breakdown**

Thursday, July 15

8:00 - 4:00 **BLM Fish Biologists Meeting** — Best Western University Inn

Monday, July 12, 1999
Borah Theater

Session #1 — **Columbia River Symposium**
Session Chair: Ted Bjornn, University of Idaho, Moscow, ID

1:00 - 1:20 — **Assessment of the Benthic Community on Hard Substrate in Three Lower Snake River Reservoirs**

T.L. Nightengale*, 9520 Rainier Ave S #506, Seattle, WA 98118; 206/721-7936, FAX 413/828-2429; tlnight@accessone.com

D.H. Bennett, Dept. of Fish & Wildlife, Univ. of Idaho, Moscow, ID 83844-1136; 208/885-6337, FAX 208/885-9080; dbennett@uidaho.edu

1:20 - 1:40 — **A Preliminary Survey of Benthic Macroinvertebrates on Artificial Substrata in the Hanford Reach, Columbia River, Washington**

E. J. Stark, Department of Fish and Wildlife, College of Forestry, Wildlife, and Range Sciences, University of Idaho, Moscow, ID 83844-1136; 208/885-7742; star8155@novell.uidaho.edu

D.H. Bennett, Dept. of Fish & Wildlife, Univ. of Idaho, Moscow, ID 83844-1136;208/885-6337; FAX 208/885-9080; dbennett@uidaho.edu

1:40 - 2:00 — **Monitoring the Migrations of Wild Snake River Spring/Summer Chinook Salmon Smolts, 1989-1998.**

Stephen Achord*, M. B. Eppard, B. P. Sandford, and G. M. Matthews, Northwest Fisheries Science Center, National Marine Fisheries Service, National Oceanic and Atmospheric Administration, 2725 Montlake Blvd. E., Seattle, WA. 98112-2097; 509/547-7518, FAX 509/547-4181; Steve.Achord@noaa.gov

2:00 - 2:20 — **Effects of Habitat Degradation and Dams on Chinook Salmon in Northeast Oregon: Observations From the Headwaters**

Colden Baxter* and Christian Torgersen, Oregon Cooperative Fish and Wildlife Research Unit, Department of Fisheries and Wildlife, Oregon State University, Nash Hall 104, Corvallis OR 97331; (541) 737-2463, FAX (541) 737-3590; torgersc@ucs.orst.edu, baxterco@ucs.orst.edu

Joseph Ebersole, Department of Fisheries and Wildlife, Oregon State University, Nash Hall 104, Corvallis OR 97331; (541) 737-3503; FAX (541) 737-3590; ebersolj@ucs.orst.edu

Hiram Li, Oregon Cooperative Fish and Wildlife Research Unit, Biological Resources Division—U.S.G.S., Department of Fisheries and Wildlife, Oregon State University, Nash Hall 104, Corvallis OR 97331; (541) 737-1963, FAX (541) 737-3590; hiram.li@orst.edu

Bruce McIntosh, Department of Forest Science, Oregon State University, Corvallis OR 97331; (541) 750-7313, FAX (541) 750-7329; mcintosb@ccmail.orst.edu

2:20 - 2:40 **Variation in Early Life History Tactics in Local Populations of Spring Chinook Salmon**

M. Keefe, Oregon Department of Fish and Wildlife, 211 Inlow Hall- EOU, LaGrande OR 97850, 541/962-3777, FAX 541/962-3067; keefem@eou.edu

2:40 - 3:00 **Break**

3:00 - 3:20 **Predation by Resident Fishes on Juvenile Anadromous Salmonids in Lower Granite Reservoir, Snake River**

D.H. Bennett, Dept. of Fish & Wildlife, Univ. of Idaho, Moscow, ID 83844-1136; 208/885-6337; FAX 208/885-9080; dbennett@uidaho.edu

3:20 - 3:40 **PIT Tag Survival Estimates for Juvenile Salmonids through Snake and Columbia River Dams and Reservoirs**

William D. Muir*, NMFS, Fish Ecology Division, 5501A Cook Underwood Rd., Cook, WA 98605;509/538-2626; FAX 509/538-2272; bill.muir@noaa.gov

Steven G. Smith, NMFS, Fish Ecology Division, 2725 Montlake Blvd. East, Seattle, WA 98112; 206/860-3352; FAX 206/860-3267; steven.g.smith@noaa.gov

John G. Williams, NMFS, Fish Ecology Division, 2725 Montlake

Blvd. East, Seattle, WA 98112; 206/860-3277; FAX 206/860-3267; john.g.williams@noaa.gov

3:40 - 4:00 **Linking Physiology and Behavior: Survival of Juvenile Salmon in the Columbia River Estuary**

Carl B. Schreck, Thomas Stahl, Lawrence Davis, and Carol Seals*; Oregon Cooperative Fish and Wildlife Research Unit, Department of Fisheries and Wildlife, Oregon State University, 104 Nash Hall, Corvallis, OR 97331-3803; 541/737-1961, FAX 541/737-3590; Carl.Schreck@ORST.EDU

4:00 - 4:20 **Results from Recent Smolt Transportation Research**

G. M. Matthews*, NMFS, Northwest Fisheries Science Center, 2725 Montlake Blvd. E., Seattle, WA 98112-2097; 206/860-3251, FAX 206/860-3267; gene.matthews@noaa.gov

Douglas M. Marsh, NMFS, Northwest Fisheries Science Center, 2725 Montlake Blvd. E., Seattle, WA 98112-2097; 206/860-3235, FAX 206/860-3267; doug.marsh@noaa.gov

Jerrel R. Harmon, NMFS, Northwest Fisheries Science Center, 2725 Montlake Blvd. E., Seattle, WA 98112-2097; 509/843-3058, FAX 206/860-3267; jerry.harmon@noaa.gov

4:20 - 4:40 **Snake River Chinook Salmon Smolt-to-Adult Return Rate Comparisons by Migration Routes and Their Implications for Recovery**

Russell B. Kiefer, Idaho Department of Fish and Game, 1414 East Locust Lane, Nampa, ID 83686; 208/465-8404, FAX 208/465-8434; rkiefer@rmci.net

4:40 **Adjourn**

Monday, July 12, 1999
Gold Galena/Silver Galena Rooms

Session #2 — **Contributed Papers — Techniques and Technology**
Session Chair: Tim Cochnauer, Idaho Department of Fish and Game

1:00 - 1:20 — **Three Dimensional Physical and Bioenergetics Habitat in Large River Systems Using State-of-the-Art Hydroacoustics, GPS, GIS, Photogrammetry, and Computational Fluid Dynamics**

R. Craig Addley and Thomas B. Hardy, Utah State Univ., Institute for Natural Systems Engineering, Dept. of Civil and Environmental Engineering, Logan UT 84322-4110; craig@aaron.cee.usu.edu

1:20 - 1:40 — **Response of Free-Ranging Kokanee to Strobe Lights**
Melo A. Maiolie*, Idaho Fish and Game, PO Box 806, Bayview, ID 83801; 208/683-3054, FAX 208/683-3054; mmaiolie@micron.net

Bill Harryman, Idaho Fish and Game, PO Box 806, Bayview, ID 83801; 208/683-3054, FAX 208/683-3054; harryman@micron.net

Bill Ament, Idaho Fish and Game, PO Box 806, Bayview, ID 83801; 208/683-3054, FAX 208/683-3054; ament@micron.net

1:40 - 2:00 — **Use of Aerial Photographs and a GIS in Watershed-Scale, Instream-Flow Assessment**

J. Scott Covington*, United States Geological Survey, Wyoming Cooperative Fish and Wildlife Research Unit, University of Wyoming, Laramie, Wyoming 82071-3166; 307/766-5415; FAX 307/766-5400; jscoving@uwyo.edu

Wayne A. Hubert, United States Geological Survey, Wyoming Cooperative Fish and Wildlife Research Unit, University of Wyoming, Laramie, Wyoming 82071-3166; 307/766-5415; FAX 307/766-5400; whubert@uwyo.edu

2:00 - 2:20 — **Efficient Use of Data Logger Thermographs to Characterize Spatial and Temporal Gradients in Habitat of Threatened Salmonids in Multiple Stream Reaches.**

D.C. Burns*, M. Faurot, R. Nelson, and R. Uberuaga, Payette

National Forest, P.O. Box 1026, McCall, ID 83638; 208/634-0700; FAX 208/634-0744; Burns_Dave/r4_payette@fs.fed.us

2:20 - 2:40	**Application of Sonar to Estimate Trout Numbers in Standing Waters**
	Dan Yule, Fisheries Biologist, Wyoming Game and Fish Department, 3030 Energy Lane, Suite 100, Casper, WY 82604; 307/473-3415; dyule@missc.state.wy.us
2:40 - 3:00	**Break**
3:00 - 3:20	**Precision of a New Method for Collecting Habitat Data at Radio Telemetry Locations in Streams**
	Matthew R. Dare,* University of Wyoming Cooperative Fisheries and Wildlife Research Unit, P.O. Box 3166 Laramie, WY 82071; 307/766-2091; FAX 307/766-5400; mattdare@hotmail.com
	Wayne A. Hubert, University of Wyoming Cooperative Fisheries and Wildlife Research Unit, P.O. Box 3166 Laramie, WY 82071; 307/766-5415; FAX 307/766-5400; WHubert@uwyo.edu
	Thomas A. Wesche, Habitech, Inc. 410 E. Grand Ave. Laramie, WY 82070; 307/742-4902; Twesche@aol.com
3:20 - 3:40	**The Use of Two Dimensional Hydrodynamic Modeling to Evaluate Channel Rehabilitation in the Trinity River, California**
	Sean P. Gallagher*, U.S. Fish and Wildlife Service, Arcata Fish and Wildlife Office, 1125 16th St., Room 209, Arcata, CA 95521; 707/822-7201, FAX 707/822-8136; Sean_Gallagher@fws.gov,
	Jay D. Glase, U.S. Fish and Wildlife Service, Arcata Fish and Wildlife Office, 1125 16th St., Room 209, Arcata, CA 95521; 707/822-7201, FAX 707/822-8136; Jay_D_Glase@fws.gov
	Rick. R. Quihillalt, U.S. Fish and Wildlife Service, Arcata Fish and Wildlife Office, 1125 16th St., Room 209, Arcata, CA 95521; 707/822-7201, FAX 707/822-8136; Rick_ Quihillalt@fws.gov
3:40 - 4:00	**Analyzing Uncertainty: Risk Assessment, Sensitivity Analysis, and Model Validation**

Gretchen R. Oosterhout, Decision Matrix, Inc., P.O. Box 1127, Eagle Point, OR 97524; 541/826-9100, FAX 541/826-5569; dmatrix@teleport.com

4:00 - 4:20

Effects of Coded Wire Tags on the Survival of Spring Chinook Salmon, *Oncorhynchus tshawytscha*

H.L. Blankenship, Washington Department of Fish and Wildlife, 600 Capitol Way N, Olympia, WA, 98501-1091; 360/902-2748, FAX 360/902-2943; blankhlb@dfw.wa.gov

D.H. Thompson, Northwest Marine Technology Inc., 2401 Bristol Court SW, Olympia, WA, 98502; 360/754-2500, FAX 360/754-4240; dthompson@nmt-inc.com

E.C. Volk, Washington Department of Fish and Wildlife, 600 Capitol Way N, Olympia, WA, 98501-1091; 360/902-2759, FAX 360/902-2943; volkecv@dfw.wa.gov

G.E. Vander Haegen*, Washington Department of Fish and Wildlife, 600 Capitol Way N, Olympia, WA, 98501-1091; 360/902-2793, FAX 360/902-2943; vandegev@dfw.wa.gov

4:20 -4:40

Breaching of a Small Irrigation Dam on Bear Creek, Oregon

Lance W. Smith*, National Marine Fisheries Service, 525 NE Oregon Street, Suite 500, Portland, OR 97232; 503/231-2307; FAX 503/231-6893; lance.w.smith@noaa.gov

Eric Dittmer, Southern Oregon University, School of Sciences, Ashland, OR 97520

Marc Prevost, Rogue Valley Council of Governments, 155 S. 2nd Street, Central Point, OR 97502

Donald R. Burt, Medford Urban Renewal Agency, 45 S. Holly Street, Medford, OR 97501

4:40 - 5:00

Proposed Classification of Species Attributes for Pacific Northwest Freshwater Fishes

D. W. Zaroban*, Idaho Division of Environmental Quality, 1410 N. Hilton Street, Boise, ID 83706

Orma J. Smith, Museum of Natural History, Albertson College of Idaho, 2112 Cleveland Boulevard, Caldwell, ID 83605; 208/373-0405, FAX 208/373-0576, dzaroban@deq.state.id.us

Michael P. Mulvey, Oregon Department of Environmental Quality, 1712 SW 11th, Portland, OR 9810; 503/229-5983, FAX 503/229-6924; MULVEY.Mike@deq.state.or.us

Terry R. Maret, U.S. Geological Survey, 230 Collins Road, Boise, ID 83702; 208/387-1328, FAX 208/387-1372; trmaret@usgs.gov

Robert M. Hughes, Dynamac Corporation, 200 SW 35th, Corvallis, OR 97333; 541/754-4516, FAX 541/754-4716; hughesb@mail.cor.epa.gov

Glenn D. Merritt, Washington Department of Ecology, 300 Desmond Drive, P.O. Box 300, Olympia, WA 98504; 360/407-6777, FAX 360/407-6884; GMER461@ECY.WA.gov

5:00 **Adjourn**

Monday, July 12, 1999
Ballroom

Session #3 — **Contributed Papers -Miscellaneous**
Session Chair: Jody Brostrom, Idaho Department of Fish and Game

1:00 - 1:20 — **Estimating Winter Salmonid Abundance in Small Western Washington Streams: A Comparison of Three Techniques**

Philip Roni* and Andrew Fayram, National Marine Fisheries Service, Northwest Fisheries Science Center, 2725 Montlake Blvd. E., Seattle, WA 98112; 206/860-3307; FAX 206/860-3267; phil.roni@noaa.go

1:20 - 1:40 — **Preliminary Evaluation of the Effectiveness of a Deflection Louver Combined with Discharge Variations in Reducing Entrainment of Sockeye Salmon Smolts into the BC Hydro Seton Generating Facility, Lillooet, B.C., CANADA.**

D.C. Schmidt and R.E. Vanderbos*, RL&L Environmental Services, 201 Columbia Avenue, Castlegar, BC V1N 1A2; 250/365-0344, FAX 250/365-0988; dschmidt@rll.ca; rvandenbos@rll.ca

B. Stables, Biosonics, Inc., P.O. Box 485, Sumas WA 98295; 360/988-5411, FAX 360/988-5411; biosumas@compuserve.com

B.W. Hebden, BC Hydro, 1155 McGill Road, Kamloops, B.C., V2C 5L1; 250/371-6927, FAX 250/371-6946; bryan.hebden@bchydro.bc.ca

1:40 - 2:00 — **Geomorphic Influences on Temperature Attributes of Small Mountain Streams**

Daniel J. Isaak* and Wayne A. Hubert, U.S. Geological Survey, Wyoming Cooperative Fish and Wildlife Research Unit, University of Wyoming, Laramie, WY 82071; 307/766-5415, dano@uwyo.edu, whubert@uwyo.edu

2:00 - 2:20 — **Use of Fluctuating Asymmetry in a Genetic Monitoring Program for Salmon in the Snake River Basin**

Orlay W. Johnson, National Marine Fisheries Service, Conservation Biology Division, 2725 Montlake Blvd. East, Seattle, Washington, 98112; 206/860-3253, FAX 206/860-3267;

orlay.johnson@noaa.gov

Monitoring Performance of River Restoration Projects

S. B. Bauer*, Pocket Water Inc., 8560 Atwater Drive, Boise, ID 83714; 208/376-3263; sbauer@micron.net

S. R. Clayton, P.Goodwin, G.S. Beattie , and A.W. Minns , Ecohydraulics Research Group, College of Engineering, University of Idaho, 800 Park Boulevard, Suite 200, Boise, ID 83712; 208/364-4081, pgoodwin@uidaho.edu

BREAK

CLAWS 2---Invasion of the Chinese Mitten Crab, Effects on a Fish Protection Facility

Lloyd Hess*, Brent Bridges, Scott Siegfried, and Sarah Wynn, U.S. Bureau of Reclamation, RR#1 Box 35, Byron, CA 94514-9614; 209/833-0340, FAX 209/833-0387; lhess@mp.usbr.gov

Variations in Movement Patterns of Rainbow Trout in Several Southwest Alaska Watersheds

E. Eric Knudsen*, USGS, Alaska Biological Science Center, 1011 East Tudor Rd., Anchorage, AK 99503; 907/786-3842, FAX 907/786-3636; eric_knudsen@usgs.gov

F. Jeffrey Adams, U.S. Fish and Wildlife Service, King Salmon Fishery Resource Office, P.O. Box 277, King Salmon, AK 99613, 907/246-3442, FAX 907/246-4237; jeff_adams@mail.fws.gov

Mark J. Lisac, U.S. Fish and Wildlife Service, Togiak National Wildlife Refuge, P.O. Box 270, Dillingham, AK 99576, 907/842-1966, FAX 907/842-5402; mark_lisac@mail.fws.gov

Douglas Palmer, U.S. Fish and Wildlife Service, Kenai Fishery Resource Office, P.O. Box 1670, Kenai, AK 99611, 907/262-8963, orlay.johnson@noaa.gov

2:20 - 2:40

Monitoring Performance of River Restoration Projects

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S. R. Clayton, P.Goodwin, G.S. Beattie , and A.W. Minns , Ecohydraulics Research Group, College of Engineering, University of Idaho, 800 Park Boulevard, Suite 200, Boise, ID 83712; 208/364-4081, pgoodwin@uidaho.edu

2:40 - 3:00

BREAK

3:00 - 3:20

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3:20 - 3:40

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Mark J. Lisac, U.S. Fish and Wildlife Service, Togiak National Wildlife Refuge, P.O. Box 270, Dillingham, AK 99576, 907/842-1966, FAX 907/842-5402; mark_lisac@mail.fws.gov

Douglas Palmer, U.S. Fish and Wildlife Service, Kenai Fishery Resource Office, P.O. Box 1670, Kenai, AK 99611, 907/262-8963, FAX 907/262-7145; douglas_palmer@mail.fws.gov

3:40 - 4:00

Providing Spawning and Nursery Flows for the Endangered June Sucker, *Chasmistes liorus*, in a Manipulated System: An Evolving Process

Christopher J. Keleher*, Central Utah Water Conservancy District, 355 West University Parkway, Orem, UT 84058; 801/226-7147, FAX 801/226-7150; ckeleher@cuwcd.com

Daryl Devy, Central Utah Water Conservancy District, 355 West University Parkway, Orem, UT 84058; 801/226-7117, FAX 801/226-7150

4:00 - 4:20 **Consideration of Evolutionary Life History Strategies and Adaptation in the Decline and Recovery of Salmonid Stocks: An Old Idea for a New Crisis**

Michael Hurley, M&M Environmental Enterprises, 1201 N 16th St, Boise, ID 83702; (208) 388-1139; mhurley@rmci.net

4:20 - 4:40 **Changing Trends in Management of Aquatic Species Systems in Utah - An Overview**

M. Jane Perkins, Neotenic Enterprises, 675 East 200 South, Provo, UT 84606 and University of Phoenix, Utah Campus, General Studies Program; 801/374-9737, NEO10IC@AOL.COM

4:40 **Adjourn**

Tuesday, July 13, 1999
Kerouac Room

Session #4	**Symposium: Beyond Hankin and Reeves** Session Chairs: Bruce Hansen, USFS, Corvallis OR and Dr. Glenn Chen, USFS, Logan UT
	Plenary Session
8:00 - 8:30	**Small Stream Survey Designs: How and Why They Work and Where to Use Them** David G. Hankin, Department of Fisheries, Humboldt State Univ., Arcata CA 95521; 707/826-3683, FAX 707/826-3682; dgh1@axe.humboldt.edu
8:30 - 9:00	**Basinwide Visual Estimation of Habitat and Fish Populations in the Southern Appalachians** C. A. Dolloff, Southern Research Station, Department of Fisheries and Wildlife, Virginia Tech, Blacksburg, VA 24061-0321; 540/231-4864; adoll@vt.edu
9:00 - 9:30	**A Retrospective on the Design and Application of Basin Surveys Over the Past Ten Years: Success or Failure?** J.L. Kershner, Fish Ecology Unit, USDA Forest Service-Washington Office, Fisheries and Wildlife Department, Utah State University, Logan, UT 84322-5210; 435/797-2500, FAX 435/797-1871; kershner@cc.usu.edu
9:30 - 10:00	**Break**
10:00 - 10:30	**Interpreting the Results from the Hankin and Reeves Methodology: Consideration of Multiple Watersheds** G. H. Reeves, Pacific Northwest Research Station, 3200 SW Jefferson Way, Corvallis, OR 97331; 541/750-7314, FAX 541/750-7329; greeves/r6pnw_corvallis@fs.fed.us
	Contributed Papers
10:30 - 10:50	**The Use of Two-phase Sampling with Universal Estimates of Bias: Salmonid Abundance in the Oregon Coast Range and**

Spotlight Counts of the Nocturnal Banded Kokopu in New Zealand.

Brendan J. Hicks*, C. D. McCullough, and James D. Hall, Department of Biological Sciences, University of Waikato, Hamilton, New Zealand; hicksbj@waikato.ac.nz

10:50 - 11:10 **Influence of Multi-scale Spatial/Temporal Variability on Selection of Sampling Designs and Statistical Estimators for Estimating Status and Trend of Juvenile Salmonid Abundance and Habitat**

George W. Weaver, Research Mathematician, USFS, 3200 Jefferson Way, Corvallis, OR 97331; (541) 758-7779; weaver@stat.orst.edu

11:10 - 11:30 **Increasing Efficiency and Quality of Calibration at the Sampling Unit Scale**

P.J. Connolly, US Geological Survey, Columbia River Research Laboratory, 5501-A Cook-Underwood Rd., Cook, WA 98605; 509/538-2299 ext.269, FAX 509/538-2843; patrick_connolly@usgs.gov

11:30 - 11:50 **Application and Extension of the Hankin and Reeves Methodology: Making Sense of the Data from the Micro to the Macro, Minimizing Sampling Intensity of At-risk Species, and Neat Things You Can Do With GIS.**

Jeffrey M. Dambacher*and Kim K. Jones, Oregon Department of Fish and Wildlife, 28655 Highway. 34, Corvallis, OR 97333; dambachj@ucs.orst.edu; joneski@fsl.orst.edu

James D. Hall, Department of Fisheries and Wildlife, Oregon State Univ., Corvallis, OR 97331; james.hall@orst.edu

11:50 - 1:30 **Lunch**

1:40 - 2:00 **Using Geography and Remote Sensing to Put the Continua Back in the "River Continuum"**

C.E. Torgersen* and C.V. Baxter, Oregon Cooperative Fish and Wildlife Research Unit, Department of Fisheries and Wildlife, Oregon State University, Nash Hall 104, Corvallis OR 97331;

541/737-2463, FAX 541/737-3590; torgersc@ucs.orst.edu, baxterco@ucs.orst.edu

B.A. McIntosh, Department of Forest Science, Oregon State University, Corvallis OR 97331; 541/750-7313, FAX 541/750-7329; mcintosb@ccmail.orst.edu

H.W. Li, Oregon Cooperative Fish and Wildlife Research Unit, Biological Resources Division—U.S.G.S., Department of Fisheries and Wildlife, Oregon State University, Nash Hall 104, Corvallis OR 97331; 541/737-1963, FAX 541/737-3590; hiram.li@orst.edu

K. Wright, Department of Fisheries and Wildlife, Oregon State University, Nash Hall 104, Corvallis OR 97331; 541/737-2463, FAX 541/737-3590; wrightk@ucs.orst.edu

2:00 - 2:20 **Use of Hankin and Reeves Methodology in Basin Surveys and Statistical Sample Surveys to Characterize Patterns and Processes of Stream Habitat at Multiple Scales in Oregon**

Kim K. Jones*, Jeffrey M. Dambacher, Barry Thom, and Charles Stein, Oregon Department of Fish and Wildlife, 28655 Highway 34, Corvallis,OR 97333; joneski@fsl.orst.edu

2:20 - 2:40 **Assessing Stream Habitat: Scale Dependency, Controlling Factors, and Habitat Dynamics**

Michael Hurley, M&M Environmental Enterprises, 1201 N 16th St., Boise, ID 83702; (208) 388-1139; mhurley@rmci.net

2:40 - 3:00 **Break**

3:00 - 3:20 **Stream Surveys: If They Are the Answer, What is the Question!**

B.B. Roper, Idaho Panhandle National Forest, 3815 Schreiber Way, Coeur d'Alene, ID 83815; 208/765-7488; FAX 208/765-7307; broper/r1_ipnf@fs.fed.us

3:20 - 3:40 **Regional Estimation of Juvenile Coho Abundance in Streams**

Scott W. Overton, Department of Statistics (Emeritus), Oregon State University, Kidder Hall #44, Corvallis, OR 97331

Trent L. McDonald*, Western EcoSystems Technology, Inc., 2003 Central Ave, Cheyenne, WY 82001; tmcdonald@west-inc.com

3:40 - 4:00 **Field Implementation of a Modified Hankin & Reeves Stream Survey Design**

C.D. Moyer, USDA Forest Service, Pacific Northwest Research Station, Forestry Sciences Laboratory, 3200 S.W. Jefferson Way, Corvallis, OR 97331; 541/758-7790, FAX 541/758-7760; cmoyer/r6pnw_corvallis@fs.fed.us

4:00 - 4:20 **Application of the Modified Hankin and Reeves Protocol to Estimate the Distribution and Abundance of Juvenile Salmonids in Coastal California Streams**

T. H. Williams*, NMFS Southwest Fisheries Science Center, Santa Cruz/Tiburon Laboratory, 3150 Paradise Drive, Tiburon, CA 94920; 415/435-3149, FAX 415/435-3675; Thomas.Williams@noaa.gov

P. Adams; Pete.Adams@noaa.gov

M. S. Mohr; Michael.Mohr@noaa.gov

M. Bowers; Michael.Bowers@noaa.gov

4:20 - 4:40 **Panel Discussion and Wrap-Up** - Hankin, Reeves, Kershner, and Dolloff

4:40 **Adjourn**

Tuesday, July 13, 1999
Gold Galena/Silver Galena Rooms

White Sturgeon Symposium
Session Chairs: Paul Anders, Univ. of Idaho, Center for Salmonid and Freshwater Species at Risk, Moscow, ID and Madison Powell, University of Idaho, Center for Salmonid and Freshwater Species at Risk, HFCES, Hagerman, ID

Welcome and Introduction, Paul Anders and Madison Powell

Artificial Production

Restoring Productivity of Reproductively-Challenged Reservoir Populations of White Sturgeon Using Supportive Breeding Techniques

B.L. Parker* and A.J. Talbot, Columbia River Inter-Tribal Fish Commission, 729 NE Oregon Street, Suite 200, Portland, OR 97232: 503/238-0667, FAX 503/235-4228; parb@critfc.org, tala@critfc.org)

Conservation Aquaculture and Endangered Species: Theory Behind the Practice

P.J. Anders, University of Idaho, Center for Salmonid and Freshwater Species at Risk, Moscow, ID 83844-2260; 208/885-2823, FAX 208/885-5968; ande9662@uidaho.edu

Fecundity and Egg Size in Iteroparous White Sturgeon

Joel Van Eenennaam and Serge Doroshov*, Univ. of California, Davis CA 95616-8125; 530/752-2058, FAX 530/752-0175; sidoroshov@ucdavis.edu

Genetics/Molecular Ecology

Genetic Diversity in White Sturgeon, *Acipenser transmontanus*, of British Columbia

Tuesday, July 13, 1999
Gold Galena/Silver Galena Rooms

Session #5 — **White Sturgeon Symposium**
Session Chairs: Paul Anders, Univ. of Idaho, Center for Salmonid and Freshwater Species at Risk, Moscow, ID and Madison Powell, University of Idaho, Center for Salmonid and Freshwater Species at Risk, HFCES, Hagerman, ID

8:00 - 8:20 — **Welcome and Introduction, Paul Anders and Madison Powell**

Artificial Production

8:20 - 8:40 — **Restoring Productivity of Reproductively-Challenged Reservoir Populations of White Sturgeon Using Supportive Breeding Techniques**

B.L. Parker* and A.J. Talbot, Columbia River Inter-Tribal Fish Commission, 729 NE Oregon Street, Suite 200, Portland, OR 97232: 503/238-0667, FAX 503/235-4228; parb@critfc.org, tala@critfc.org)

8:40 - 9:00 — **Conservation Aquaculture and Endangered Species: Theory Behind the Practice**

P.J. Anders, University of Idaho, Center for Salmonid and Freshwater Species at Risk, Moscow, ID 83844-2260; 208/885-2823, FAX 208/885-5968; ande9662@uidaho.edu

9:00 - 9:20 — **Fecundity and Egg Size in Iteroparous White Sturgeon**

Joel Van Eenennaam and Serge Doroshov*, Univ. of California, Davis CA 95616-8125; 530/752-2058, FAX 530/752-0175; sidoroshov@ucdavis.edu

Genetics/Molecular Ecology

9:20 - 9:40 — **Genetic Diversity in White Sturgeon, *Acipenser transmontanus*, of British Columbia**

S. McKay, Agriculture and Agri-Food Canada, Molecular Genetics Section, Saskatoon Research Centre, 107 Science Place, Saskatoon S7N 0X2; 306/956-2843; SASKRES.mckaysh@EM.AGR.CA

C. Smith, Centre for Environmental Health, Biology, University of Victoria, P.O. Box 3020 STN CSC, Victoria, B.C.V8W 3N5; 250/472-4072 FAX 250/472-4075; ctsmith@uvic.ca

S. Pollard*, Ministry of Fisheries, P.O. Box 9359 Station Provincial Government, Victoria, B.C. V8W 9M2; 250/356-7005 FAX 250/387-9750; sue.pollard@gems5.gov.bc.ca

B. Koop, Centre for Environmental Health, Biology, University of Victoria, PO Box 3020 STN CSC, Victoria, B.C.V8W 3N5; 250/472-4072; 250/472-4075; bkoop@uvic.ca

9:40 - 10:00 **Break**

10:00 - 10:20 **Sire and Dam Effects on Growth Rate in White Sturgeon**

Jeff Rodzen* and Bernie May, Dept of Animal Science, Meyer Hall, Univ. of California, Davis CA 95616; 530/752-6351; jarodzen@ucdavis.edu

10:20 - 10:40 **Phylogeographic Distribution of White Sturgeon mtDNA Haplotypes in the Columbia River Basin: Preliminary Results**

P.J. Anders, University of Idaho, Center for Salmonid and Freshwater Species at Risk, Moscow, ID 83844-2260; 208/885-2823, FAX 208/885-5968; ande9662@uidaho.edu

M.S. Powell *, University of Idaho, Center for Salmonid and Freshwater Species at Risk, HFCES, Hagerman, ID 83332; 208/837-9096, FAX 208/837-6047; fishdna@micron.net

Growth/Physiology/Pathology

10:40 - 11:00 **Cortisol Stress Response of White Sturgeon to Capture and Handling**

J.A.. North, Oregon Department of Fish and Wildlife, 17330 SE Evelyn Street, Clackamas, OR 97015; 503/657-2000 ext. 410, FAX 503/657-6823; john.a.north@state.or.us

11:00 - 11:20 **Observed Deformities in White Sturgeon from Two Columbia River Reaches**

L. C. Burner, Oregon Department of Fish and Wildlife, 17330 SE Evelyn Street, Clackamas, Oregon 97015; 503/657-2000 ext. 411, FAX 503/657-6823; lisa.c.burner@state.or.us)

11:20 - 11:40 **Increased Growth Rate of White Sturgeon with the Administration of Growth Hormones**

G.T. Schelling*, M.T. Casten, and R.W. Hardy, Department of Animal and Veterinary Science, Aquaculture Research Institute, University of Idaho, Moscow, ID 83844; 208-885-7310, FAX 208-885-6420, gschelling@uidaho.edu

11:40 - 12:00 **Viral Infections in Wild White Sturgeon from the Columbia River Basin**

Scott E. LaPatra*, Clear Springs Foods, Inc., Research Division, P.O. Box 712, Buhl, ID 83316; 208/543-3456; FAX 208/543-4146; scottl@clearsprings.com

B.L. Parker, Columbia River Inter-Tribal Fish Commission, Portland, OR

J.M. Groff, School of Veterinary Medicine, Univ. of California, Davis CA

H.M. Engelking and J. Kaufman; Oregon Department of Fish and Wildlife, Department of Microbiology, Oregon State University, Corvallis, OR

12:00 - 1:30 **Lunch**

1:40 - 2:00 **Environmental Contaminants in the Kootenai River System: Potential Effects on Reproduction in White Sturgeon**

Gretchen O. Kruse, M.S. Candidate, University of Idaho, and Sr. Fisheries Technician, Idaho Dept. of Fish and Game, 2750 W. Kathleen Ave., Coeur d Alene ID 83815; 208/769-1414, FAX 208/769-1418; gkruse@idfg.state.id.us

Conservation Management

2:00 - 2:20 **Status of White Sturgeon in Reaches from Lower Salmon Falls to the Salmon River, ID**

Ken Lepla* and Jim Chandler, Idaho Power Company, Boise, Idaho

2:20 - 2:40 **White Sturgeon Resource Conservation Area: Is it Time?**

T. Cochnauer, Idaho Department of Fish and Game, 1540 Warner, Lewiston, ID 83501; 208-799-5010; FAX 208-799-5012; *tcochnau@IDFG.STATE.ID.US*

2:40 - 3:00	**Break**
3:00 - 3:20	**Spawning Behavior of Kootenai River White Sturgeon and a Predictive Model** Vaughn L. Paragamian and Gretchen Kruse, Idaho Department of Fish and Game, 2750 Kathleen Ave., Coeur d' Alene, ID 83814
3:20 - 3:40	**Trawl and Haul: A Free Ride for Columbia River White Sturgeon** T. A. Rien* and J. A. North, Oregon Department of Fish and Wildlife, 17330 SE Evelyn Street, Clackamas, OR 97015; 503/657-2000 ext. 404, FAX 503/657-6823, tom.a.rien@state.or.us
3:40 -4:00	**Factors Affecting Spawning and Recruitment of White Sturgeon** M.J. Parsley, U.S. Geological Survey, Western Fisheries Research Center, Columbia River Research Laboratory, 5501A Cook-Underwood Road, Cook, WA 98605: 509/538-2299, FAX 509/538-2843; michael_parsley@usgs.gov
4:00 - 4:20	**The Effect of Impoundment on the Productivity of White Sturgeon in the Columbia River** John DeVore, 2108 Grand Boulevard, Vancouver, WA 98661; 360/906-6710; DEVORJJD@dfw.wa.gov
4:20 - 4:40	**White Sturgeon in the Columbia River Basin of British Columbia** Jay Hammond, BC Ministry of Environment, Lands and Parks, Suite 401 - 333 Victoria Street, Nelson, BC V0G 2G0; 250/354-6343; FAX 250-354-6332; jhammond@nelson.env.gov.bc.ca
4:40 - 5:00	**Concluding Remarks, Paul Anders and Madison Powell**

5:00 **Adjourn**

Sponsors:

University of Idaho, Aquaculture Research Institute
University of Idaho, Center for Salmonid and Freshwater Species at Risk
University of Idaho, Hagerman Fish Culture Experiment Station

Tuesday, July 13, 1999
Borah Theater

Session #6	**Columbia River Symposium (Continued)** Session Chair: Ted Bjornn, University of Idaho, Moscow ID
8:00 - 8:20	**Snake River Salmon Recovery: Separating "D" Chaff from "D" Wheat** Edward C. Bowles*, Charles E. Petrosky, and Russell B. Kiefer, Idaho Department of Fish and Game, P.O. Box 25, Boise, ID 83707; ebowles@idfg.state.id.us
8:20 - 8:40	**Status and Expected Time to Extinction for Snake River Spring Chinook Stocks** Phillip R. Mundy, Fisheries and Aquatic Sciences, Lake Oswego, OR 97034-1744; 503-699-9856; mundy@teleport.com
8:40 - 9:00	**An Assessment of Lower Snake River Hydrosystem Alternatives on Survival and Recovery of Snake River Salmonids (A-fish Appendix)** John G. Williams*, NMFS, Northwest Fisheries Science Center, 2725 Montlake Blvd. East, Seattle, WA 98112; 206/860-3277; FAX 206/860-3267; john.g.williams@noaa.gov Peter Kareiva, NMFS, Northwest Fisheries Science Center, 2725 Montlake Blvd. East, Seattle, WA 98112; 206/860-3403; FAX 206/860-3267; peter.kareiva@noaa.gov
9:00 - 9:20	**Why it Sucks to be a Pacific Lamprey in the Columbia River Basin** Doug Hatch*, John Netto, Rian Hooff, Blaine Parker, Mark Wishnie, Chris Beasley, Mike Wakeland, and André Talbot, Columbia River Inter-Tribal Fish Commission, 729 NE Oregon Street, Suite 200, Portland, OR 97232; 503/238-0667
9:20 - 9:40	**Migration Passage Patterns of Pacific Lamprey at Bonneville Dam, 1996-1998** A.L. Matter*, J.J. Vella, and L.C. Stuehrenberg, Fish Ecology Division, Northwest Fisheries Science Center, National Marine Fisheries Service, National Oceanic and Atmospheric

Administration, 2725 Montlake Boulevard East, Seattle, WA 98112; 206/860-3367, FAX 206/860-3267; alicia.matter@noaa.gov

9:40 - 10:00 **Break**

10:00 - 10:20 **Laboratory Evaluation of Adult Pacific Lamprey Swimming Performance**

Christopher Peery*, Ted C. Bjornn, Richard Piaskowski, and Rudy Ringe, Idaho Cooperative Fish and Wildlife Research Unit, University of Idaho, Moscow, ID 83844; 208/885-7617, FAX 208/885-9080; bjornn@uidaho.edu

10:20 - 10:40 **Effect of Water Temperature in Adult Fishways and Forebays at Ice Harbor and Lower Granite Dams on Salmon and Steelhead Passage**

P. J. Keniry* and T. C. Bjornn, Idaho Cooperative Fish and Wildlife Research Unit, Rm. 103, College of FWR, University of Idaho, Moscow ID 83844-1141; 208/885-4526, FAX 208/885-9080; pkeniry@uidaho.edu

10:40 - 11:00 **Perspective on the Temperature Issue in the Columbia River: Is There a Problem?**

Gerald R. Bouck (Retired), 9691 SW Alsea Dr., Tualatin OR 97062; 503/692-4907; grbouck@aol.com

11:00 - 11:20 **Fallback by Adult Salmon and Steelhead at Columbia and Snake River Dams, and its Impact on Upriver Passage, Final Distribution, and Survival**

M.L. Keefer* and T.C. Bjornn , Idaho Cooperative Fish and Wildlife Research Unit, College of Forestry, Wildlife and Range Science, University of Idaho, Moscow, ID 83844-1141; 208-885-7614, FAX 208-885-9080

11:20 - 11:40 **Passage of Adult Steelhead at Dams and into Tributaries in the Columbia River Drainage as Assessed with Radio Telemetry**

M.A. Jepson*, M.L. Keefer, and T.C. Bjornn, Idaho Cooperative Fish and Wildlife Research Unit, U.S. Geological Survey, Biological Resources Division, University of Idaho, Moscow, ID 83844-1141

11:40 - 12:00	**Passage of Adult Chinook Salmon at Dams and Into Tributaries in the Columbia River Drainage as Assessed with Radio Telemetry**
	T.C. Bjornn* and M.L.Keefer, Idaho Cooperative Fish and Wildlife Research Unit, U.S. Geological Survey, Biological Resources Division, University of Idaho, Moscow, ID 83844-1141; bjornn@uidaho.edu
	L.C. Stuehrenburg, Northwest Fisheries Science Center, National Marine Fisheries Service, Seattle, WA 98112
12:00 - 1:30	**Lunch**
1:40 - 2:00	**Subyearling Chinook Salmon Early Life History Timing and Survival in the Snake River**
	W. P. Connor* and T. C. Bjornn, Idaho Cooperative Fish and Wildlife Unit, University of Idaho, Moscow ID 83843
2:00 - 2:20	**Natural Production of Fall Chinook Salmon from Adult Outplants in the Umatilla River, Oregon.**
	S.M. Knapp, Oregon Department of Fish and Wildlife, 80866 Hwy 395 No., Hermiston, OR 97838; 541/567-5318; FAX 541/567-0293; odfwhrd@orednet.org
2:20 - 2:40	**Adapting From Mitigation to Conservation: A Case History of the Grande Ronde Basin Chinook Salmon Hatchery Program**
	R. Carmichael, Oregon Department of Fish and Wildlife, 211 Inlow Hall- EOU, LaGrande OR 97850, 541/962-3777, FAX 541/962-3067, rcarmich@eou.edu
2:40 - 3:00	**Break**
3:00 - 3:20	**Putting Our Management Where Our Mouth Is: Supportive Breeding Within the South Fork Salmon River Metapopulation.**
	Chris Beasley*, André Talbot, and Doug Hatch, Columbia River

	Inter-Tribal Fish Commission, 729 NE Oregon St., Suite 200, Portland, OR 97232
3:20 - 3:40	**Wrap-up and Discussion (Bjornn)**
3:40	**Adjourn**

Wednesday, July 14, 1999
Ballroom

Session #7 | **Contributed Papers — Fisheries Management**
Session Chair: Pete Bisson, USFS, Olympia WA

8:00 - 8:20 **An Update on the Redfish Lake Sockeye Salmon, *Oncorhyncus nerka*, Recovery Program: Hatchery Supplementation and Lake Fertilization**

Bert Lewis,* Shoshone Bannock Tribe, P.O. Box 306, Ft. Hall, ID. 83203; 208/238-3759; salmon1@cyberhighway.net

Jay Pravecek, Idaho Department of Fish and Game, 1414 Locus Ln., Nampa, ID 208/465-8404; jpravece@idfg.state.id.us

8:20 - 8:40 **Spawning Ecology of Fluvial Westslope Cutthroat Trout in the Blackfoot River Drainage, Montana**

D. A. Schmetterling, Montana Fish, Wildlife and Parks, 3201 Spurgin Road, Missoula, MT 59804; 406/542-5514, FAX 406/542-5529; dschmett@bigsky.net

8:40 - 9:00 **Native Fishery Management in Yellowstone Park: Westslope Cutthroat Trout Restoration**

Jeff Lutch, National Park Service, Center for Aquatic Resources, P.O. Box 168, Yellowstone National Park, WY 82190; 307/344-2285, FAX 307/344-2323; Jeff_Lutch@nps.gov

9:00 - 9:20 **Predatory Influence of Selected Predator Fishes on Kokanee, Lake Pend Oreille, Idaho**

D.T. Vidergar and D.H. Bennett, University of Idaho, Department of Fish & Wildlife Resources, CFWR, Rm. 105, Moscow, ID 83844-1136; 208/885-6434, FAX 208/885-9080; vide0231@novell.uidaho.edu

9:20 - 9:40 **Managing for Basic Yield Trout Fisheries in the Presence of Walleye Populations in Three Wyoming Reservoirs**

Paul Mavrakis and Dan Yule, Fisheries Biologists, Wyoming Game

and Fish Department, 3030 Energy Lane, Suite 100, Casper, WY 82604;307/473-3413; pmavra@missc.state.wy.us

9:40 - 10:00 **Break**

10:00 - 10:20 **Winter Microhabitat Fidelity, Growth, and Survival of Juvenile Coho Salmon in Prairie Creek, California**

Ethan Bell*, Graduate Student, Fisheries Department, Humboldt State University, Arcata, CA 95521; 707/840-9722; bell@humboldt1.com

Terry Roelofs and David Hankin, Fisheries Department, Humboldt State University, Arcata, CA 95521; tdr1@axe.humboldt.edu

Walter Duffy, California Cooperative Fisheries Research Unit, Humboldt State University, Arcata, CA 95521; wgd7001@axe.humboldt.edu

10:20 - 10:40 **Bull Trout Distribution, Status, and Conservation in the Clearwater Basin**

G. Servheen*, Idaho Department of Fish and Game, 1540 Warner Ave, Lewiston, ID 83501; 208-799-5010; 208-799-5012; faxgservhee@idfg.state.id.us

T. Cochnauer, Idaho Department of Fish and Game, 1540 Warner Ave, Lewiston, ID 83501; 208-799-5010; FAX 208-799-5012; tcochnauer@idfg.state.id.us

S. Russell, Nez Perce National Forest, Rt. 2, Box 475, Grangeville, ID 83530; 208-983-1950, FAX 208-983-4099; srussell/r1_nezperce@fs.fed.us

C. Johnson, Bureau of Land Management, Rt. 3, Box 181, Cottonwood, ID 83522; 208-962-3245; FAX 208-9623275; c40johns@id.blm.gov

J. Capurso, Clearwater National Forest, Powell Ranger District, Lolo, MT 59847; 208-942-3113; FAX 208-942-3311; Capurso@montana.com

J. Dupont, Idaho Department of Lands, P.O. Box 670, 701 River Ave, Coeur d'Alene, ID 83816; 208-769-1525; FAX 208-769-1524; dlands@nidlink.com

D.Stewart, Idaho Dept. Of Environmental Quality, 300 W. Main, Grangeville, ID 83530; 208-983-0808; FAX 208-983-2873; dstewart@camasnet.com

D.Weigal, Nez Perce Tribe, P.O. Box 1701, Orofino, ID 83544; 208-476-7269; FAX 208-476-0719; weigeld@clearwater.net

T. Cundy, Potlatch Corporation, 805 Mill Rd. Lewiston, ID 83501; 208-799-4135; FAX 208-799-1707; twcundy@potlatchcorp.com

R. Roseberg, U.S. Fish and Wildlife Service, P.O. Box 18, Ahsahka, ID 83520; 208-476-7242; FAX 208-476-3252; ralph_roseberg@fws.gov

M. Faler, U.S. Fish and Wildlife Service, P.O. Box 18, Ahsahka, ID 83520; 208-476-7242; FAX 208-476-3252; mike_faler@fws.gov

10:40 - 11:00 **Temperature Requirements for Threatened Bull Trout from the Pacific Northwest**

Jason Selong*, Thomas E. McMahon, Biology Department, Fish and Wildlife Program, Montana State University, Bozeman, MT 59717; 406/994-2492; ubitm@montana.edu

Frederic T. Barrows, U.S. Fish and Wildlife Service, Bozeman Fish Technology Center, Bozeman, MT 59715; 406/587-9265; rbarrows@montana.campus.mci.net

Alexander V. Zale, Montana Cooperative Fishery Research Unit, Montana State University, Bozeman, MT 59717; 406/994-2380; zale@montana.edu

11:00 - 11:20 **Can "Resident" Bull Trout Populations Reestablish a Migratory Life History Form?**

M. Lee Nelson* and Thomas E. McMahon, Biology Department/Fish and Wildlife Program, Montana State University, Bozeman, MT 59717; 406/994-2492; FAX 406/994-7479; ubitm@montana.edu

Russell F. Thurow, U.S. Forest Service, Rocky Mountain Research Station, Boise, ID 83840; rthurow/rmrs_boise@fs.fed.us

11:20 - 11:40	**Community Structure of Westslope Cutthroat Trout and Brook Trout Populations in Small Tributary Streams in the Clark Fork River Basin**

Don J. Conklin, Jr., Paul L. Winkle*, and James W. Chadwick, Chadwick Ecological Consultants, Inc., 5575 South Sycamore St. #101, Littleton, CO 80120; 303/794-5530, FAX 303/794-5041; chadeco@aol.com

11:40	**Adjourn**

Wednesday, July 14, 1999
Gold Galena/Silver Galena Rooms

Session #8 **Contributed Papers - Fish Health and Nutrition**
Session Chair: Ken Hashagen, California Department of Fish and Game

8:00 - 8:20 **Myxobolus Cerebralis Infection in Rainbow Trout, *Oncorhynchus mykiss*, and Brown Trout, *Salmo trutta*, Exposed Under Natural Stream Conditions**

Thomas J. Baldwin*, Washington Animal Disease Diagnostic Laboratory, Washington State University, Pullman, WA 99164, tjb@vetmed.wsu.edu

E. Richard Vincent, Department of Veterinary Microbiology and Pathology, Washington State University, Pullman, WA 99164

Ronald M. Silflow, Montana Fish, Wildlife and Parks, Bozeman, MT 59715

Danielle R. Stanek, Department of Veterinary Microbiology and Pathology, Washington State University, Pullman, WA 99164

8:20 - 8:40 **Fish Nutrition for Sustainable Aquaculture**

J.A. Green* and R.W. Hardy, University of Idaho, Hagerman Center for Sustainable Aquaculture, 3059F National Fish Hatchery Rd., Hagerman, ID 83332; 208/837-9096, FAX 208/837-6047; gree9524@uidaho.edu

8:40 - 9:00 **Gill Structural Changes as a Potential Indicator of Eutrophic Stress**

Hilary M. Lease*, James A. Hansen, Harold L. Bergman, and Joseph S. Meyer, University of Wyoming, Department of Zoology and Physiology, Laramie, WY 82071-3166; 307/766-4837, FAX 307/766-5625; hlease@uwyo.edu

9:00 - 9:20 **Variation in Body Condition (*Wr*) of Juvenile Rainbow Trout in Relation to Physiological Measures of Starvation and Activity**

Darin G. Simpkins,* Wyoming Cooperative Fish and Wildlife

Research Unit, Department of Zoology and Physiology, University of Wyoming; Laramie, WY 8207; 307/766-2091; FAX 307/766-5400; simpkins@uwyo.edu

Dr. Wayne A. Hubert, Wyoming Cooperative Fish and Wildlife Research Unit, Department of Zoology and Physiology, University of Wyoming, Laramie, WY 82071; 307/766-5415; FAX 307/766-5400; whubert@uwyo.edu

Dr. Carlos Martinez del Rio, Department of Ecology and Evolutionary Biology, University of Arizona, Tucson, AZ. 85721; 520/626-3329; cdelrio@u.arizona.edu

9:20 - 9:40

The Use of Environmental Variables as Predictors for Habitats with Increased Risk of *Myxobolus cerebralis* Infections

Monica Hiner* and Christine Moffitt, Department of Fish and Wildlife Resources, Univ. of Idaho, Moscow, ID 83844-1136; hine5915@uidaho.edu

Douglas Burton and Steven Elle, Idaho Department of Fish and Game, Eagle Fish Health Laboratory, 1800 Trout Road, Eagle, ID 82616

9:40 - 10:00

Break

Contributed Papers - Miscellaneous

10:20 - 10:40

Responses of Sculpins, Salmonids, and Macroinvertebrates to Stream Habitat Conditions, Sediment, and Metals

C. A. Mebane, Idaho Division of Environmental Quality, 1410 N. Hilton, Boise, Idaho 83706; 208/373-0502; FAX 208 373 0576; cmebane@deq.state.id.us

10:40 - 11:00

Density and Growth of Tailed Frog Tadpoles, *Ascaphus truei*, in Two Idaho Streams

Kirk Lohman, Department of Fish and Wildlife, University of Idaho, Moscow, ID 83844; klohman@uidaho.edu

11:00 - 11:20

Amphibian Malformations: Real or Perceived?

Robert H. Gray, RH Gray & Associates, 2867 Troon Ct., Richland,

WA 99352; 509/372-0804, FAX 509/372-3515;
rhgray@ix.netcom.com

11:20 - 11:40

Summer Habitat Use by Inland Redband Trout in the Kootenai River Drainage, Montana

Clint C. Muhlfeld*, Montana Department of Fish, Wildlife, and Parks, 490 N. Meridian Rd., Kalispell MT 59901; clintamy@bigsky.net

David H. Bennett, Department of Fish and Wildlife, University of Idaho, Moscow ID 83844

Brian Marotz, Montana Department of Fish, Wildlife, and Parks, 490 N. Meridian Rd., Kalispell, MT 59901

11:40 - 12:00

Declivity in Steelhead Trout Recruitment at the Keogh River Over the Past Decade

Ward, B.R., Ministry of Fisheries, Fisheries Research and Development Section; 2204 Main Mall, University of British Columbia, Vancouver, B.C., Canada, V6T 1Z4; Bruce.Ward@gems8.gov.bc.ca

12:00

Adjourn

Wednesday, July 14, 1999
Borah Theater

Session #9	**Conservation of Endangered Salmonids Via Supplementation: Are We Heading in the Right Direction?** Session Chairs: Bill Mavros, Nez Perce Tribe and Cleve Steward, Sustainable Fisheries Foundation
8:00 - 8:20	**Supplementation: What are the Current Controversies?** Bill Mavros, Nez Perce Tribe, McCall, ID; 208/634-5290; billm@nezperce.org Cleve Steward, Sustainable Fisheries Foundation; 425/670-3584; csteward@wolfenet.com
8:20 - 8:40	**Lessons from Alaska: Elements of a Successful Supplementation Program** Bruce A. Bachen, Seattle Public Utilities, 206/684-7935; bruce.bachen@ci.seattle.wa.us
8:40 - 9:00	**Supplementation and Genetic Conservation: The Policy Trap** David Greer* and Brian Harvey, World Fisheries Trust, 202-505 Fisgard St., Victoria, B.C. V8W 1R3; worldfish@coastnet.com
9:00 - 9:20	**Strategic Stock Enhancement: The Use of Supplementation to Assist Rebuilding of Threatened Coho Populations on the Skeena and Thompson Rivers.** R. Gregory Bonnell, Fisheries and Oceans Canada, Pacific Region, Habitat and Enhancement Branch, 360-555 West Hastings Street, Vancouver, B.C., Canada, V6B 5G3; 604/666-3285; bonnellg@pac.dfo-mpo.gc.ca
9:20 - 9:40	**Genetic Conservation Role of Salmon Hatcheries in the Columbia River Basin: Can Artificial Propagation Confer a Net Benefit to Naturally Spawning Populations?** Donald E. Campton, U.S. Fish & Wildlife Service, Abernathy Fish Technology Center, 1440 Abernathy Creek Road, Longview, WA 98632; 360/425-6072; Don_Campton@fws.gov
9:40 - 10:00	**Break**

10:00 - 10:20	**Allocation of Brood Stock Between Stream and Hatchery: The Criterion of No Net Decline in Future Population Size** Phillip R. Mundy, Fisheries and Aquatic Sciences, Lake Oswego, OR 97034-1744; 503/699-9856; mundy@teleport.com
10:20 - 10:40	**Using Parentage Identification to Make Direct Estimates of Reproductive Success of Naturally-Spawning Supplementation Fish: Sampling Requirements and Practical Considerations** Paul Moran*, Linda K. Park, Perry Thornton, and Jay Hesse, Nez Perce Tribe, Department of Fisheries Resources Management, P.O. Box 365, Lapwai, ID 83540; 206/860-3245; paul.moran@noaa.gov Timothy A. Whitesel, Oregon Department of Fish and Wildlife, 211 Inlow Hall, Eastern Oregon University, La Grande, OR 97850 Robin S. Waples, Conservation Biology Division, NW Fisheries Science Center, 2725 Montlake Boulevard East, Seattle, WA 98112-2097
10:40 - 11:00	**Tests of Supplementation for Fish Conservation and Recovery** André J. Talbot*, Jennifer Phillips, Doug R. Hatch, and Chris Beasley, Columbia River Inter-Tribal Fish Commission, 729 NE Oregon St., Suite 200, Portland, OR 97232
11:00 - 11:20	**The Yakima Fisheries Project: Evaluating the Role of Supplementation in Rebuilding Salmon Populations in the Columbia Basin** David E. Fast, Research Manager, Yakama Indian Nation Fisheries Program, 771 Pence Road, Yakima, WA 98902; 509/966-5291; FAX 509/966-7406; yinykfp@wolfenet.com
11:20 - 12:00	**Panel Discussion**
12:00	**Adjourn**

ABSTRACTS

(By Session, By Time)

Session 1

Columbia River Symposium

1. Assessment of the Benthic Community on Hard Substrate in Three Lower Snake River Reservoirs

T.L. Nightengale*, 9520 Rainier Ave S #506, Seattle, WA 98118; 206/721-7936, FAX 413/828-2429; tlnight@accessone.com)

D.H. Bennett, Dept. of Fish & Wildlife, Univ. of Idaho, Moscow, ID 83844-1136; 208/885-6337; FAX 208/885-9080; dbennett@uidaho.edu

We evaluated the benthic macroinvertebrate community residing on rip-rap shorelines in Lower Granite, Little Goose, and Lower Monumental reservoirs from August 1993 through September 1995 using barbecue basket samplers filled with artificial substrate (concrete cones) exposed for 8 weeks in shallow (ca. 1.7 m) and deep (ca. 8 m) waters. The amphipod *Corophium* spp. was the most prevalent macroinvertebrate, accounting for over 45% of the density and biomass for the period of sampling. *Corophium* numbers and biomass increased dramatically in the fall, resulting in density estimates exceeding 2,000 individuals$\cdot m^2$ and 2.0 $g\cdot m^2$. Seasonal community composition showed an increased contribution of midge larvae (Chironomidae) in numbers and biomass in spring samples, whereas caddisfly larvae (Trichoptera) contributed more in the fall, and gammarid amphipods showed their highest seasonal numbers and biomass in winter samples. All reservoirs showed seasonality in density and biomass, with increases in spring, peaks in the late-summer to fall, and decreases in the early winter. Density and biomass estimates varied spatially within each reservoir, although those in Lower Granite Reservoir showed a significant trend of density and biomass decreasing from upstream to downstream sites. Several taxa of macroinvertebrates that were seasonally abundant in each of the lower Snake River reservoirs have been previously found to be abundant in stomachs of both resident and anadromous fishes.

2. A Preliminary Survey of Benthic Macroinvertebrates on Artificial Substrata in the Hanford Reach, Columbia River, Washington

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The Hanford Reach, the last free-flowing section of the Columbia River, provides critical habitat for wild fall chinook salmon, *Oncorhynchus tshawytscha*. Although free flowing, the Hanford

Reach is affected by substantial changes in discharge from hydroelectric operations of Priest Rapids Dam, immediately upstream. Fluctuations in discharge result in wide changes in water levels that can strand biota. We conducted a preliminary survey of benthic macroinvertebrates on artificial substrata in 1998 to determine required sample size, colonization period, substrate type, and sampling locations to evaluate effects of diel water level fluctuations on benthic macroinvertebrates. Artificial substrata consisted of barbecue baskets containing concrete cones and construction. Five replicates of each substrate type were collectively attached to a strand, with six replicate strands deployed at each of three sites. Three strands were retrieved from each site at 4 and 6 weeks. Total invertebrate densities ranged from 500 to 120,140 m^{2}. Macroinvertebrate fauna was low in diversity and dominated primarily by Chironimidae (midges) and Trichoptera (caddisfly) larvae; both taxa accounted for approximately 87% of the macroinvertebrate fauna by density. Colonization of barbecue baskets and 6 week exposures accounted for significantly higher densities and standing crops of invertebrates than brick substrates and 4 week exposures. However, we anticipate using bricks and the shorter exposures because of variance and sorting considerations. Determining the ecological impacts of fluctuations in water level on macroinvertebrates will assist in developing hydropower operational plans to lessen effects on potential food organisms for resident and anadromous fishes in the Hanford Reach, Columbia River.

3. Monitoring the Migrations of Wild Snake River Spring/Summer Chinook Salmon Smolts, 1989-1998.

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Before 1989, information on the migrational characteristics of Snake River spring/summer chinook salmon smolts, *Oncorhynchus tshawytscha,* from individual wild populations was scarce. During summers 1988 through 1998, we PIT tagged wild parr in natal streams. Each subsequent spring and summer, tagged smolts were detected at juvenile bypass systems at dams on the lower Snake and Columbia rivers. Annually, since 1992, this real-time migrational information has been used for management of the hydropower system. Goals are to 1) characterize the migration timing of different wild stocks at traps and dams, 2) determine if consistent patterns are apparent, and 3) determine what environmental factors influence migration timing.

At Lower Granite Dam, annual migrational timings were consistently protracted and were highly variable among streams and years. However, some trends have been observed for a few stocks. In addition, for combined stocks, we observed 2-week migrational timing shifts between relatively warm and cold years. Over all years, peak detections coincided with variable flows before 9 May, but coincided with peak flows from 9 May to 31 May. This trend suggests that reserved water will provide more benefit to wild smolts if it is utilized after the first week of May, particularly during low flow years.

4. Effects of Habitat Degradation and Dams on Chinook Salmon in Northeast Oregon: Observations From the Headwaters

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Stream habitat conditions for juvenile chinook salmon in subbasins of the upper John Day and Grande Ronde range from degraded to pristine. Multiple studies on the behavior, abundance, and distribution of juvenile and adult chinook across this wide range of environmental conditions raise some questions about the relative effects of habitat degradation in the headwaters versus passage problems caused by dams in the Columbia Basin. We examined the mid-summer distribution and abundance of juvenile chinook salmon in the Middle and North Forks of the John Day River, the Upper Grande Ronde River, and the Wenaha River in order to assess potential effects of water temperature across a range of thermal environments. Population densities of juvenile chinook salmon were highest in the Wenaha River, followed by the Upper Grande Ronde, North, and Middle Forks of the John Day River, respectively. In contrast, densities of returning adult chinook were highest in the North Fork of the John Day River, followed by the Middle Fork, the Wenaha, and the Upper Grande Ronde. We speculate that discrepancies between juvenile chinook density and adult returns reflect differences in biological potential between pristine and degraded headwater streams as well as the cumulative impacts of dams in the Columbia Basin.

5. Variation in Early Life History Tactics in Local Populations of Spring Chinook Salmon

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We have been documenting the in-basin migration patterns of juvenile spring chinook salmon originating in three streams in the Grande Ronde River basin. Salmon from all three local populations undertake fall and spring outmigrations from areas of adult spawning and early juvenile rearing. The proportion of fall and spring migrants varies among populations and

between years. However, some consistent patterns are evident. The proportion of fish that leave the Upper Grande Ronde River in the fall has been low relative to the proportions of Upper Grande Ronde spring migrants and fall migrants from other populations. In Catherine Creek and the Lostine River, considerable numbers of outmigrants have been captured while moving during winter months. We also have made annual estimates of overwinter survival in juvenile rearing areas and estimates of survival to Lower Granite dam for fall- and spring-migrating salmon. A preliminary look at the data for Catherine Creek and the Lostine River populations indicated that survival estimates were consistently higher for fish that exhibited the predominant migration tactic. Patterns that describe different early life history tactics exhibited by fish from these populations appear to be emerging.

6. Predation by Resident Fishes on Juvenile Anadromous Salmonids in Lower Granite Reservoir, Snake River

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Managers have identified the loss of juvenile anadromous salmonids in Lower Granite Reservoir, Snake River, Idaho-Washington as one potential source of mortality. Lower Granite Reservoir is the first of four reservoirs on the Lower Snake River and may account for the highest amount of predation as a result of slower salmonid travel times and increased water clarity. We have quantified the predatory loss of juvenile anadromous salmonids to northern pikeminnow, *Ptychochelius oregonensis*, smallmouth bass, *Micropterus dolomieu,* black crappie, *Pomoxis nigromaculatus,* white crappie, *P. annularis,* channel catfish, *Ictalurus punctatus,* and yellow perch, *Perca flavescens,* in Lower Granite Reservoir. All of these predators can afford significant predation losses although wide annual variation in consumption has been observed. Smallmouth bass, both black and white crappies, and yellow perch consume primarily subyearling chinook salmon, *Oncorhynchus tshawytscha*, a strain of chinook salmon that rears and migrates through the reservoir when conditions are more favorable for predation. Current predator and reservoir management strategies have been effective at reducing northern pikeminnow abundance and reducing resident fish predation on juvenile anadromous salmonids. Other fish management alternatives could be employed if deemed necessary to reduce resident fish predation on juvenile anadromous salmonids.

7. PIT Tag Survival Estimates for Juvenile Salmonids through Snake and Columbia River Dams and Reservoirs

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PIT-tagged spring/summer yearling chinook salmon, sub-yearling fall chinook salmon, and steelhead, each with a unique tag code, were released above or at Lower Granite Dam each year from 1993 through 1999 and detected at PIT tag detection and diversion systems at downstream dams during their migration to the Pacific Ocean. A multiple recapture model was used to estimate their survival. Additional releases were made at Snake River dams to evaluate survival through specific routes of passage. Survivals ranged from 86.5 to 93.4% (turbine), 92.7 to 100% (spillway), and 95.3 to 99.4% (bypass) for yearling chinook salmon and steelhead. During the spring migration, per project survivals ranged from 87 to 92% for yearling chinook salmon and 84 to 95% for steelhead. Per project survivals averaged greater than 90% for both species in years with high flow and spill conditions. Survival through the Snake River was much lower for sub-yearling fall chinook salmon during the summer migration, especially from release in the free-flowing Snake River to Lower Granite Dam. Relationships among flow, travel time, and survival were weak or non existent during the spring for yearling chinook salmon and steelhead, while significant relationships were found among flow, temperature, turbidity and survival for sub-yearling fall chinook salmon during the summer migration.

8. Linking Physiology and Behavior: Survival of Juvenile Salmon in the Columbia River Estuary

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Human structures and intervention may influence physiological condition of juvenile salmonid migrants and produce fish with varying smoltification levels at the time they reach the estuary, causing saltwater entry behavior which influences their vulnerability to avian predators. Radiotelemetry was used to monitor barged and run-of-the-river (ROR) yearling spring chinook in the Columbia River estuary. Survival down-river from Bonneville Dam for each of our releases (10 releases; N=20-50/release) was 70-100%. Travel speed ranged from 0.7-3.7 mph. Large-scale migration patterns and variability in saltwater entry location exist, with no clear differences between barged and ROR fish. A large number of smolts remained near the surface (<4 m) and in freshwater as long as possible, making them vulnerable to avian predation. Mortality due to avian predators ranged from 5-30%/release (mean=17%). Indices of stress, smoltification, and disease were measured pre- and post-migration. These data indicate no differences between barged and ROR fish, though all were stressed to varying degrees and BKD levels were low. Laboratory experiments indicated that saltwater preference increased as the season progressed or for ROR fish, though this is dependent on BKD levels. These experiments show that several physiological factors interact to determine saltwater entry behavior.

9. Results from Recent Smolt Transportation Research

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In 1995, the National Marine Fisheries Service PIT tagged spring/summer chinook salmon smolts at Lower Granite Dam (LGR) to compare adult returns of fish migrating inriver vs those transported around the remaining seven mainstem dams. Complete adult returns indicated overall (including multiple-bypassed inriver fish) transport-to-inriver-adult-return ratios (TI) of 1.9 for hatchery fish and 2.1 for wild fish. For hatchery and wild fish respectively, T/Is were 1.4 and 1.7 for inriver fish bypassed only at LGR. Inspection of the data by date of tagging revealed that SARs of transported wild and hatchery smolts increased overnight by approximately 8 and 3 times, respectively, during the first week of May and remained high for the remainder of the spring. SARs of inriver-migrating fish trended downward through time. Adjusted for time of ocean entry, the T/I for hatchery fish bypassed only at LGR was 1.8. Regression analysis showed a weak negative relationship between river flows and SARs of inriver migrating fish.

10. Snake River Chinook Salmon Smolt-to-Adult Return Rate Comparisons by Migration Routes and Their Implications for Recovery

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We compared smolt migratory years 1994 - 1996 smolt-to-adult return rates of Snake River wild/natural chinook salmon for the three mainstem migration routes currently available to these smolts (collection and transportation, collection and bypass, or uncollected). Our results indicate that when compared to uncollected smolts, collecting and transporting Snake River wild/natural chinook salmon smolts may provide some benefit in low flow years, but provides no benefit and may actually reduce adult return rates in average or better flow years. This is contrary to most of the results reported for transportation evaluation studies. The main reason for this disparity is that the experimental "controls" used in the transportation evaluation studies were not true controls. Our results indicate that these experimental "controls" did not return as well as the uncollected in-river migrants they were supposed to represent. We discuss the implications of these results on the options for recovery of Snake River chinook salmon.

Session 2

Contributed Papers — Techniques and Technology

1. Three Dimensional Physical and Bioenergetics Habitat in Large River Systems Using State-of-the-Art Hydroacoustics, GPS, GIS, Photogrammetry, and Computational Fluid Dynamics

R. Craig Addley* and Thomas B. Hardy, Utah State Univ., Institute for Natural Systems Engineering, Dept. of Civil and Environmental Engineering, Logan UT 84322-4110; craig@aaron.cee.usu.edu

Physical habitat in riverine ecosystems provides a template that biological processes are constrained to operate within. Characterization of the physical template and potential changes to the physical template in both space and time are essential for understanding many biological processes. Unfortunately, physical habitat in riverine systems is both spatially and temporally variable. This makes accurate characterization of the physical habitat difficult. We show how the existing technologies of acoustic doppler current profiling, GPS, GIS, photogrammetry, and computational fluid dynamics can be combined to accurately characterize large river systems in space and time. We also show how this characterization can be used to assess the bioenergetics, growth, and survival potential of riverine fishes as a function of the flow regime.

2. Response of Free-Ranging Kokanee to Strobe Lights

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We tested the response of kokanee, *Oncorhynchus nerka,* to strobe lights. Our hope was to develop a method to minimize kokanee entrainment losses at Dworshak Reservoir; a large hydroelectric facility. Testing was conducted on wild, free-ranging fish in their natural environment (ie. the pelagic region of two large Idaho lakes). Split-beam hydroacoustics were used to record the distance kokanee moved away from the lights as well as the density of kokanee in the area near the lights. In control tests, where the strobe lights were lowered into the lake but kept turned off, kokanee remained within a few meters of the lights. Once the lights began flashing kokanee quickly moved away from the light source. Kokanee were found to move

20 to 40 m away from the lights when Secchi transparencies were 3 to 5 m. Fish moved an average of 119 to 135 m away from the lights in clear water with Secchi transparencies of 10 to 17 m. Kokanee densities near the lights were significantly lower ($p=0.07$ to $p=0.00$) when the lights were turned on than in control samples with no lights flashing. Flash rates of 300, 360, and 450 flashes/min elicited strong avoidance responses from the fish. Kokanee remained at least 24 m away from the lights during our longest test that lasted for 5 h 50 min. Kokanee appeared to be responding to strobe light brightness below our ability to measure; < 0.0001 lux.

3. Use of Aerial Photographs and a GIS in Watershed-Scale, Instream-Flow Assessment

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Watershed-scale approaches to assessing trout habitat and instream flows will be valuable tools for resource managers. We developed an approach that can estimate trout habitat quality and predict trout abundance at natural and less than natural low flows for low-gradient, alluvial-valley streams in Wyoming. The approach utilizes information from 1:40,000-scale color, infrared aerial photographs to predict instream cover for trout over homogenous stream reaches of 400 m or less. Estimates of elevation, channel slope, and stream width for each reach can be derived from 7.5-minute topographic maps. Estimates of trout cover, elevation, channel slope, and stream width were used as independent variables in a multiple–regression model to predict trout abundance in each reach under natural low flows. Another model was used to predict the reduction in trout abundance within each reach as late-summer flows are reduced to various levels less than the natural averages. A geographic information system (GIS) was used to summarize the information on habitat features, trout abundance, and influences of reduced flows for each reach and to extend the estimates to entire streams within the watershed. To illustrate the potential application of the approach, we assessed the potential benefits to trout populations from re-establishing late-summer flows in streams that are annually de-watered in the Salt River Valley of western Wyoming. The approach has numerous potential applications for fisheries management agencies across the central Rocky Mountains.

4. Efficient Use of Data Logger Thermographs to Characterize Spatial and Temporal Gradients in Habitat of Threatened Salmonids in Multiple Stream Reaches.

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Species of salmonids listed under the Endangered Species Act in the Snake River basin of Idaho have cold water temperature needs. From multiple miniature thermographs deployed in multiple stream reaches collected from 1994 through 1998, statistics are used to display habitat suitability for salmonid life stages. Statistics for time series are compared to Idaho State water quality standards and the Forest Service's natural conditions database. Downloaded thermograph records show spatial and temporal heterogeneity that can be related to the potential for various stream reaches to provide habitat for multiple life stages of salmonids listed under the Endangered Species Act. Implications for study design and thermograph deployment are discussed.

5. Application of Sonar to Estimate Trout Numbers in Standing Waters

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Job obligations of fisheries biologists are increasing at an alarming rate. New and rapid tools for decision making are needed to meet these increasing demands. For many years sonar has been used to enumerate forage fish and kokanee populations but few researchers have attempted to use sonar to count trout. The major drawback has been the inability of a vertically aimed transducer (down-looking) to effectively sample surface waters where many trout species are found. Recent advancements in computer processing allow for sonar data to be collected by two transducers simultaneously (fast-multiplexing) with one pointed vertically and the other horizontally (side-looking). We used fast-multiplexing to sample 11 trout waters in Wyoming during the summers of 1997 and 1998. Sonar estimates of open water fish were partitioned to species based on the catch of fish in a 30-ft deep purse seine. This sampling indicated that trout were numerically dominant offshore and largely absent from nearshore waters. Offshore trout distributions were typically homogenous and 95% confidence intervals around population estimates were small. Sonar estimates of fish per acre and seine catch were also strongly correlated. Because data collection is rapid and inexpensive we believe that sonar in conjunction with purse seining will become increasingly important to Wyoming trout management in the 21st century.

6. Precision of a New Method for Collecting Habitat Data at Radio Telemetry Locations in Streams

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We developed a habitat measurement technique to incorporate the location error that is intrinsic in the use of radio telemetry when identifying fish locations. This technique is based upon the measurement of 19 habitat variables within a 2-m radius of the point where the fish location is identified by triangulation. This 12.5-m^2 area is termed the area of probable occurrence (APO). Measurements were taken by three observers in 40 APOs in a variety of wadable habitats. The greatest precision was obtained for depth and velocity. There was higher variation in visual substrate estimates, primarily associated with smaller substrate types (e.g., gravel). There were small variations between observers for visual estimates of the area of cover. Variations between observers do not reflect a degree of biological significance that diminishes the quality of the habitat measurements.

7. The Use of Two Dimensional Hydrodynamic Modeling to Evaluate Channel Rehabilitation in the Trinity River, California.

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The Physical Habitat Simulation System (PHABSIM) has been used extensively to predict habitat (Weighted Usable Area) (WUA) changes due to changes in discharge from Trinity Dam. During the late 1980's flow-habitat relationships from PHABSIM initiated pilot channel rehabilitation projects intended to increase salmon habitat. A 12-year flow evaluation of the Trinity River recommends increased flows and channel modifications for habitat rehabilitation. The PHABSIM is limited to predicting changes in WUA due to changes in discharge. Two-dimensional modeling predicts changes in WUA resulting from changes in flow and changes in channel morphology. We conducted a preliminary study of the utility of the cdg2d model for evaluating changes in WUA due to channel rehabilitation in the Trinity River. Model data collection, calibration, and validation were conducted for a rehabilitated and a control site. Chinook salmon location and density was significantly correlated with habitat suitability predictions at both sites. Predicted chinook and coho salmon and steelhead fry WUA was higher at the rehabilitation site. The control site model was used to predict changes in WUA based on a hypothetical channel morphology. Two-dimensional modeling appears to be a useful tool for evaluating habitat changes in the Trinity River.

8. Analyzing Uncertainty: Risk Assessment, Sensitivity Analysis, and Model Validation

Gretchen R. Oosterhout, Decision Matrix, Inc., PO Box 1127, Eagle Point, OR 97524; 541/826-9100, FAX 541/826-5569; dmatrix@teleport.com

As biologists and decision-makers have become increasingly skeptical about predictive models in fisheries and land management, it has become clear that in order to be credible and useful, models must systematically analyze sources and impacts of uncertainties. Some of the most powerful tools for analyzing uncertainty are Monte Carlo sampling methods, multivariate sensitivity analysis, and cumulative uncertainty analysis. This paper describes the use of such tools on two recent projects: a stochastic simulation model of chinook and sockeye salmon life histories that was developed as a risk assessment and data prioritization tool for a fish passage feasibility evaluation; and a multi-level sensitivity analysis and validation effort applied to a deterministic analysis of a proposed land exchange. The emphasis of this paper is on where, how, and when different tools for analyzing uncertainty are most useful, where they may be problematic, and how to get started using them.

9. Effects of Coded Wire Tags on the Survival of Spring Chinook Salmon, *Oncorhynchus tshawytscha*

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The coded-wire tag (CWT) identification system is widely used for fisheries management throughout the world. Few researchers have investigated the effects of CWT implantation and adipose marking on survival. At three Columbia River hatcheries, we compared survival of spring chinook salmon marked with CWT and otolith marks to the survival of controls marked only with otolith marks. We hypothesized that both groups would return in the same proportion they were released. For several years, we collected otoliths, CWT and scales from returning adults. We observed different responses to coded wire tagging at the three hatcheries, but found no significant difference between hatcheries ($F=1.1$, $P=0.39$). We then tested whether the ratios of the proportion of CWT fish returning to the proportion of CWT fish released were significantly different from 1, the ratio we would expect if the same proportion of CWT fish returned as were released. We found no significant difference between the proportion released and the proportion returning to the hatcheries ($t=0.68$, $P>0.25$). We concluded that coded wire tags did not reduce the survival of spring chinook; tagged adult spring chinook returned to the hatchery at the same rate as untagged fish.

10. Breaching of a Small Irrigation Dam on Bear Creek, Oregon

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Jackson Street Dam was built in 1960 for irrigation diversion on Bear Creek in Medford, Oregon, resulting in a barrier to salmon and steelhead migration, loss of stream habitat, eutrophication, and an algae choked impoundment in downtown Medford. The 1998 breaching reduced the 11-ft dam to a series of three small concrete steps, thereby providing fish passage and restoring a free flowing stream within the former impoundment. A replacement diversion was built upstream of the dam site before breaching to provide water to the irrigation district. The new diversion is three feet high, equipped with effective fish passage facilities, and removed from October to April when irrigation is not needed. Major factors affecting the breaching project were the large number of stakeholders involved, underestimation of the project's cost and time frame, testing the new diversion before breaching the old dam, unexpected complications, perseverance of key project supporters, and lack of opposition to the project. Lessons learned from the project that may be applicable to other dam removal efforts include recognizing the importance of: stakeholder collaboration, a volunteer lead agency or organization, consideration of the project owner's needs, educating the public about the project, accurate budget development, and realistic expectations.

11. Proposed Classification of Species Attributes for Pacific Northwest Freshwater Fishes

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Fish assemblages integrate physical and chemical habitat conditions and are used to evaluate the condition of water resources in the Pacific Northwest. To facilitate such evaluations, we classified each of the 132 freshwater fish species known to occur in the Pacific Northwest (Idaho, Oregon, Washington) by its origin, overall pollution tolerance, adult habitat, adult feeding, and water temperature preference. Recommendations from regional fishery experts, published literature, and the aggregate experience of the authors were used to classify species. The attribute classifications were responsive to human disturbance of aquatic habitats when applied to fish assemblages sampled from throughout the region. Our attribute classification of fish species promotes use of fish assemblages to evaluate water resource conditions regionally and fosters greater acceptance of biological measures of water resource quality.

Session 3

Contributed Papers -Miscellaneous

1. Estimating Winter Salmonid Abundance in Small Western Washington Streams: A Comparison of Three Techniques

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We compared the relative efficiency of day snorkeling, night snorkeling, and multiple-removal electrofishing at estimating juvenile coho salmon, *Oncorhynchus kisutch*, and trout, *Oncorhynchus* spp., abundance during winter in four small western Washington streams. Salmonid abundance was estimated within individual habitats in 75-m stream reaches at low to moderate winter flows and water temperatures less than 7.0 °C. On average, night snorkeling accounted for 84.8% and day snorkeling 7.0% of electrofishing abundance estimates. When trout and coho counts were compared separately, night snorkel counts averaged 113% and 81.2% of electrofishing estimates for coho and trout, respectively. Length frequency distributions from night snorkeling and electrofishing were significantly different, and many larger fish (>160 mm) observed during snorkel surveys were not captured during electrofishing surveys. Night snorkeling appears to represent an accurate, cost effective and benign method of enumerating juvenile salmonids during winter months under moderate flows, low fish densities, and low temperatures. In contrast, day snorkeling appears inadequate under most winter conditions due to daytime concealment behavior of salmonids at low temperatures. Winter night snorkel surveys can be conducted under a variety of flow conditions that preclude electrofishing and provide critical information on juvenile salmonid abundance during winter months. Finally, night snorkel surveys may represent a useful alternative for winter abundance estimates in areas were endangered salmonids may be present.

2. Preliminary Evaluation of the Effectiveness of a Deflection Louver Combined with Discharge Variations in Reducing Entrainment of Sockeye Salmon Smolts Into the BC Hydro Seton Generating Facility, Lillooet, B.C., CANADA.

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A 150-m deflection louver line was installed in the approach channel, fronting Seton Dam, near Lillooet BC, in an attempt to divert sockeye salmon smolts into Seton River to reduce mortality associated with passage through the Francis turbine. Fish diversion rates associated with reductions in powerplant discharge combined with increases in discharge into Seton River were also evaluated. We measured abundance of sockeye salmon with inclined plane traps installed in the powerplant intake canal and in Seton River downstream of the diversion dam. Trap capture efficiencies were estimated through mark recapture experiments and by use of split beam hydro-acoustics. Preliminary results indicated fish previously captured, dyed and released apparently had a high level of trap avoidance compared with fish caught for the first time. Temporal and spatial changes in the release of marked fish showed some promise of reducing this bias. Reduction of discharge in the power canal from ~120 m3/s to ~102 m3/s and finally to ~93 m3/s, when combined with the deflection louver, resulted in essentially a complete diversion of the migrating sockeye salmon smolts into Seton River. Concurrent with the decrease in discharge to the power canal was an increase in discharge through Seton Dam to Seton River from an initial value of 21 m3/s to 25 m3/s. However, at the ~93 m3/s discharge in the power canal, removal of the louver panels did not result in a corresponding decrease in fish diversion effectiveness. Further studies are planned for the spring of 2000.

3. Geomorphic Influences on Temperature Attributes of Small Mountain Streams

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Stream temperature regimes play an important role in structuring aquatic communities by determining species distributions and densities, mediating species interactions, and facilitating the growth of individuals. Stream temperatures have been modeled successfully as a function of air temperature in landscapes with little topographic relief, but this approach in not warranted in montane settings where stream microclimates are altered by complex topographies. We used USGS digital elevation data to construct digital terrain models for 26 second- and third-order watersheds where we also collected stream temperature data. ESRI's Spatial Analyst and 3-D Analyst extensions were used in Arc/View to quantify watershed metrics that we subsequently used in a path analysis model to describe linkages between stream temperature attributes and watershed geomorphologies. Preliminary results suggest that geomorphic attributes of small watersheds exhert a strong influence on average stream temperatures and stream temperature variation.

4. Use of Fluctuating Asymmetry in a Genetic Monitoring Program for Salmon in the Snake River Basin

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Juvenile chinook salmon and steelhead were collected in 1989 and 1990 from wild, natural, and hatchery populations in Idaho and Oregon within the Snake River basin. The purpose of the program was to evaluate the long term effects of outplanting hatchery-reared fish on natural and wild populations. The experimental design involves monitoring genetic and meristic characters in yearly samples. Seven bilateral meristic characters were identified that show promise as indicators of asymmetry. Indices of asymmetry developed from these paired characters were evaluated as indicators of developmental stability, which has been shown to be correlated with levels of genetic/environmental variability in other fish species. Few consistent patterns in fluctuating asymmetry values (FA) were detected in hatchery versus natural or wild populations, but population asymmetry analysis revealed lower overall levels of FA in some drainages than in others. No correlation was found between the level of asymmetry and the level of heterozygosity within individual fish.

5. Monitoring Performance of River Restoration Projects

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In recent years, the performance of ecological restoration and enhancement efforts has come under increasing public scrutiny and typical questions include:"*having spent millions of dollars on restoration, how do we know that these management strategies really have helped the resource?*", and "*has the enhancement project performed according to the original design expectations?*"

These questions can be partially answered through monitoring programs, although it is often difficult to decide upon an appropriate level of effort. These important questions are being considered at the Red River Meadow restoration site, a tributary to the Clearwater River in the Columbia Basin. As early as the turn of the century, reaches of the Red River were channelized through mining and agricultural activities. As a result of this and subsequent management activities, channel reaches have incised, resulting in degraded aquatic and riparian habitat. The Lower Red River Meadow Restoration Project is an ecosystem enhancement effort to restore natural, physical, and biological processes and functions to establish high-quality habitats for fish and wildlife, targeting chinook salmon, *Oncorhynchus tshawytscha*, steelhead trout, *Oncorhynchus mykiss*, and bull trout, *Salvelinus confluentus*.

The strategy for assessing whether management actions have achieved their restoration objectives at Red River include application of a model to simulate the hydrologic conditions and evolution of the river corridor after project implementation.

Characteristics that are thought to be indicators of channel process and health of the habitat are being monitored. Examples of the parameters include channel planform and dimensions, bank erosion, pool/riffle sequence, residual pool depth, micro-habitat features, riparian vegetation transects, fish population density, and the number of salmon redds. To fully understand the response of the channel over 12,000 survey points are included in the project GIS and the exact alignment of over 75 cross-sections is measured annually.

Physical characteristics are quantifiable, but this project is also attempting to verify the adequacy of these physical parameters as surrogates for fisheries and wildlife enhancement. Is the adage "create the habitat and they will come" accurate and how do fish and wildlife utilize the created or enhanced habitat? Non-intrusive surveillance methods are being developed at the site in an attempt to view how wildlife and fish utilize the different habitat types and to quantify the usage.

6. CLAWS 2---Invasion of the Chinese Mitten Crab, Effects on a Fish Protection Facility

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A video and poster showing the problems caused by the introduction and population explosion of the Chinese Mitten Crab in the Sacramento/San Joaquin Delta of California. This presentation is orientated to the impacts on the Tracy Fish Collection Facility and actions taken to alleviate the problems.

7. Variations in Movement Patterns of Rainbow Trout in Several Southwest Alaska Watersheds

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Adult rainbow trout movement patterns were studied using radio telemetry in seven different Southwest Alaska watersheds over the past 10 years. We compared and contrasted results among the watersheds to determine whether there were general similarities in seasonal movement and to reveal possible ecological explanations for observed movements. Telemetry data provided information on distance traveled from overwintering, to spawning, to summer feeding, and back to overwintering habitats. The data also generally indicated the number of population groups having similar life history patterns within each watershed. These biological characteristics were then related to various watershed features to discern ecological/habitat relationships. In general, we found wide variation in movement patterns among the watersheds although there was noteworthy seasonal movement in all watersheds. Movements appeared to be influenced by watershed features such as presence or absence of lakes, turbidity patterns, salmon runs (as a food source), and possibly thermal refuge for overwintering. Rainbow trout in some watersheds exhibited multiple life history groups as related to configuration and availability of the various watershed features. The implications for fishery management are that each watershed must be managed with an understanding for the movement patterns, population structuring, reproductive rates, and aggregation in critical habitats that have evolved within that watershed.

8. Providing Spawning and Nursery Flows for the Endangered June Sucker, *Chasmistes liorus*, in a Manipulated System: An Evolving Process

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The endangered June sucker is endemic to Utah Lake, Utah, and ascends the Provo River from mid-May to mid-June to spawn. The hydrology of the Provo River has been altered by the presence of two reservoirs, which store spring runoff and provide water for irrigation and culinary purposes, and numerous direct use irrigation diversions. The altered flow regime of the river has been identified as a factor contributing to a lack of recruitment to the wild June sucker population. Because of their limited numbers and logistical constraints, it has been difficult to collect sufficient information on June sucker reproductive biology to determine precisely what flows are required to attract adults to the river and provide suitable conditions for spawning, incubation of eggs, and nursery of young-of-year. As a result of this lack of information, the position has been taken that the best way to ensure that adequate flows are provided is to mimic the conditions in which the species evolved, or what occurred naturally. This was attempted with past flow recommendations that targeted providing a percentage of the flows that occur in the river above controlling facilities (reservoirs and diversions). Water management agencies had difficulties in providing flows in this manner (i.e., managing reservoir releases in winter to deliver a percentage of an unknown during the spring runoff) which has led to the development of this approach. Synthesized natural historic flows (gage data minus trans-basin import water) were analyzed for the period of record (1950-1995). Runoff patterns showed considerable variation over the period of record, however, a few

trends were apparent: the duration of runoff was longer, the peak flow was higher and tended to occur later in wetter years. Target flow regimes were developed for "dry," "moderate," and "wet" year scenarios based on historic trends. An implementation schedule for daily flows was developed which provides flexibility in the event that weather patterns shift and also identifies the quantity of water necessary for each of the three scenarios. The results of an attempt at implementing this approach for the 1999 runoff season will be presented.

9. Consideration of Evolutionary Life History Strategies and Adaptation in the Decline and Recovery of Salmonid Stocks: An Old Idea for a New Crisis

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Life history diversity is as important a concept at the population scale as biodiversity is for ecosystem assessment and management. Life history is a powerful interpretive tool for habitat - organism relations and adaptation to environment. Both life history and habitat diversity are essential for persistence and production of populations. However, the emphasis of traditional fisheries management on commodity production and numeric goals has led to and even emphasized reduction in life history diversity. Life history is a vague concept which can be broken down into four interrelated subjects. Life history theory is useful to generate hypothesis that relate tradeoffs and benefits of adaptive traits to environmental conditions. Examples are presented for hypothesized life history trait/ habitat relations emphasizing chinook salmon. Loss of one life history trait, that of size, has serious potential cumulative consequences for reduction in fitness. Migration behavior is used to establish life history types at various scales for chinook. and illustrates the need for maintaining both habitat and life history diversity. Life history diversity needs to be included in population assessment, recovery strategies and monitoring. But first we need to strengthen and formalize the definition of life history and life history types, traits, and analysis.

10. Changing Trends in Management of Aquatic Species Systems in Utah - An Overview

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Management of aquatic species systems has been a dynamic process focusing historically on narrow goals and target sportfish species to one involving entire aquatic communities. Management actions conducted by early pioneers in the 1800's were associated with release of sportfish species in specific areas for food and recreational purposes. Management practices continued for several decades to focus on single species management, often times without realizing the potential impacts these actions would have on the aquatic system. More recently, particularly over the past decade or so, a growing trend has been taking place, due in part to the

growing awareness and concern for aquatic ecosystems and the species they support. Management practices are being broadened from a "single species" approach to one of a "community" or "ecosystem" approach incorporating both nonnative and native species (fish, amphibians, reptiles, mollusks) issues. The importance of healthy habitats to species communities has given rise to habitat enhancement projects that benefit all aquatic species. Native species declines have resulted in the development of conservation agreements, identification of native hatchery needs, and maintenance of genetic integrity. Detrimental interactions between nonnative and native species and the introduction of diseases such as whirling disease, has made the establishment of stocking and transfer protocols necessary. Management is now looking at ways to balance public demand for recreational sportfishing opportunities with maintenance of healthy aquatic habitats and native species biodiversity. One way that aquatic resource managers are undertaking this new trend in Utah is by looking at aquatic system needs on a basin wide scale. This paper presents a overview of the management plans currently being developed by the Utah Division of Wildlife Resources for the hydrologic drainage units in Utah.

<u>Session 4</u>

Beyond Hankin and Reeves: A Symposium

1. Small Stream Survey Designs: How and Why They Work and Where to Use Them

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I begin by comparing and contrasting the merits and assumptions of three alternative survey designs for estimation of fish abundance in small streams: (a) two-stage designs relying strictly on electrofishing with removal-method estimation, (b) a two-phase design based on single diver counts at the first phase and electrofishing with removal-method estimation at the second phase, and (c) a new two-phase design based on single diver counts at the first phase but with application of a decision rule to determine calibration method at the second phase (if first phase count <=20 fish, then use repeated dive counts and the method of bounded counts; otherwise use electrofishing with removal-method estimation). Primary units are natural habitat units for all schemes and the current recommended habitat stratification consists of riffles, runs, shallow pools (< 1.1 m max. depth), deep pools (1.1 - ?? m max. depth), and an "other units" stratum (cacades, extremely deep pools, overly complex habitat, etc.) in which fish abundance cannot be quantitatively assessed using either electrofishing or repeated diver counts.

Appropriate circumstances for use of the three alternative survey designs depends on several factors including at least: (1) typical water clarity and (2) bottom substrate. Scheme (a),above, is most suitable for turbid streams, scheme (b) is most suitable for clear stream with silty bottoms or substantial habitat complexity, and scheme (c) is most suitable in clear streams with low sediment substrates. ESA-based restrictions on electrofishing take may to a certain degree influence choice of survey design, but they should not lead to use of scheme (c) under unfavorable circumstances for its application. For all schemes, numerous practical application problems still require resolution; these problems are identified and relevant questions are posed.

Finally, it should be recognized that these alternative survey designs are merely sophisticated (and efficient) methods or tools for estimation of fish abundance in a long reach of stream or in an entire stream. Given such tools, it becomes possible to address questions of variation in fish abundance at basin or watershed, even regional, scales, but additional layers of survey design research and/or development of long-term experimental designs will be required to allow investigation of rsearch and management questions that appear to be of interest.

2. Basinwide Visual Estimation of Habitat and Fish Populations in the Southern Appalachians

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In the last ten years, the Basinwide Visual Estimation Technique (BVET; Hankin and Reeves (1988)) has been adopted by researchers and managers in the southeastern U.S. as a primary tool for inventory of habitat and fish populations at the stream reach, stream segment, and watershed scales. The BVET has been used to inventory habitat and fish for studies ranging from comparison of characteristics of wilderness watersheds to intensive research on the chronic effects of acid precipitation. Although the primary use of BVET has been to provide baseline habitat and population information for trout and other common coldwater fish species, more than 500 species of fish inhabit the waters of the southern U.S. The BVET has been used to determine the distribution and abundance for many of these fishes including rare or threatened and endangered species such as the candy darter, *Etheostoma osburni*, blackside dace, *Phoxinus cumberlandensis*, and Smoky madtom, *Noturus baileyi*. The BVET also has been used to inventory habitat and fish in long (> 100 km) contiguous reaches of medium-sized rivers. Experimental and potential new uses of the BVET include inventory of attributes of riparian zones and additional fish species in habitats that are less amenable to standard diver counts.

3. A Retrospective on the Design and Application of Basin Surveys Over the Past Ten Years: Success or Failure?

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The publication of the paper "Estimating Total Fish Abundance and Total Habitat Area in Small Streams Based on Visual Estimation Methods" by Hankin and Reeves in 1988 resulted in a re-examination of stream inventory practices and resulted in a renewed interest in gathering stream inventory data. As a result, thousands of miles of stream inventory data has been collected by state and federal agencies throughout the United States using this "basin-wide" approach. The collection of systematic inventory information has been used in project scale analyses, as well as large scale analyses of habitat in areas like the interior Columbia basin. These inventories have resulted in a rich storehouse of data that can be used to define reference conditions, establish baselines, and develop insights into the variability of stream systems. At the same time, questions have been raised as to the replicability of the protocols used in these surveys, the usefulness of survey variables, appropriate analyses and interpretation of information, and the value of these inventories given the cost. If basin-scale inventories are to remain a valuable tool, re-examination of the foundation, the questions to be answered, and the techniques used must be addressed.

4. Interpreting the Results from the Hankin and Reeves Methodology: Consideration of Multiple Watersheds

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The methodology of Hankin and Reeves (1988) provided a technique for quantifying attributes of in-channel habitat and fish populations at the watershed scale. Several researchers and management agencies, particularly in the western United States, adopted this technique. The result was the quantification of individual parameters (e.g., habitat unit composition and size, number of pieces of large wood, etc.) within a watershed. Many times such data are collected for monitoring purposes, particularly to set baselines or standards for evaluating conditions. This is certainly appropriate for a given watershed but examination of multiple watersheds and an interpretation of the results requires a different framework for interpretation of results than if one were looking at an individual watershed. This framework for examination of multiple watersheds is lacking currently. Such a framework requires consideration of temporal aspects of watershed conditions and results in a frequency distribution of conditions rather than single values. The failure to apply a framework that is appropriate for multiple watersheds has important implications for management of fish populations and their habitat.

5. The Use of Two-phase Sampling with Universal Estimates of Bias: Salmonid Abundance in the Oregon Coast Range, and Spotlight Counts of the Nocturnal Banded Kokopu in New Zealand.

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The need for rapid techniques to estimate fish populations in streams has lead to four separate problems that have been addressed by the Hankin-Reeves sampling technology (e.g., Hankin & Reeves 1988; Dolloff et al. 1993). These problems are:

1. The use of a rapid counting technique in place of a more time-consuming method, requiring an estimate of the ratio between the two;
2. The use of subsampling to further reduce the sampling effort;
3. The use of stratification to improve the precision of population estimates;
4. The estimation (and reduction) of the variance of the population estimates.

This sampling approach was based on Cochran's (1977) classic work, which demands that the ratio estimate of the bias of the rapid technique is developed independently for each stream. However, applications have frequently departed from this purist application. For instance, if the objective of sampling is to compare populations in a number of different streams, there is a temptation to develop universal ratio estimates of . Such liberties at best undermine the concept of unbiasedness inherent in Cochran's original presentation, and at worst invalidate both the population and variance estimates. We report on an application of the Hankin and Reeves method in Oregon Coast Range streams, and offer some thoughts on future developments of the technique using banded kokopu in New Zealand streams as an example.

6. Influence of Multi-scale Spatial/Temporal Variability on Selection of Sampling Designs and Statistical Estimators for Estimating Status and Trend of Juvenile Salmonid Abundance and Habitat

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Over the past decade, considerable effort has been devoted to determine sampling design/statistical estimator strategies for estimation of status and trend of environmental/ecological populations in general and salmonid populations in particular. The work has produced useful theoretical and practical results for scientists and managers. The exact allocation of sampling resources and selection of statistical estimators for any particular population would benefit from information regarding the magnitude of variability the population exhibits in space and time at different scales. In particular, the selection of optimal monitoring strategies for estimation of status and trend of juvenile salmonid habitat and abundance in aquatic networks depends on the (usually unknown) patterns of variability in space and time of these attributes. This presentation will give estimates of spatial and temporal variability of juvenile salmonid abundance and habitat from the reach to basin scale using available data. The talk seeks to briefly summarize the influence of spatial temporal variability on sample design/statistical estimator selection, present the actual spatial-temporal variability using some available data sets, and motivate discussion about the implications of this variability on monitoring efforts for juvenile salmonid abundance and habitat.

7. Increasing Efficiency and Quality of Calibration at the Sampling Unit Scale

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If a large number of units are to be sampled by a rapid method, such as snorkeling, and the results are to be calibrated with a slower method, such as the removal method using electrofishing, a premium is often placed on the time available for calibration efforts. To save time, the calibration step usually needs to be restricted to the minimum number of units acceptable. If a minimum number of units are to be sampled, returning from the field with invalid data from one or more units can not be tolerated. When using electrofishing, conducting fewer removal passes can save time for investigators and cause less stress for fish. Without flexibility in the number of passes to be conducted, sampling protocols can be insensitive to units that have exceptionally high or low populations, have exceptionally high or low catchabilities, or have a combination of both. To help investigators while in the field, I developed figures to show the relationship between catch pattern during removal passes and precision of population estimates. In addition, I developed tables that list acceptable ranges of observed catch from two and three removal passes that will prompt the investigators as to when a third or fourth pass is necessary. Use of these tables in the field will insure that a field crew has a tool to judge the quality of calibration data they collect before leaving the site.

8. Application and Extension of the Hankin and Reeves Methodology: Making Sense of the Data from the Micro to the Macro, Minimizing Sampling Intensity of At-risk Species, and Neat Things You Can Do With GIS.

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While the Hankin and Reeves methodology is designed to answer the question of how many fish there are, equally important is the search for what factors control their abundance. Patterns of fish abundance and habitat utilization offer important clues to factors that regulate fish production within a basin. By employing indices of habitat utilization at the habitat unit scale, a linkage can be made between smaller and larger scales of study. Studies of microhabitat utilization offer important clues for observed patterns at the habitat unit scale, the importance of which is made clear at the basin scale. Such a perspective provides for a richer context for the management of fish habitat.

We briefly explore several modifications and extensions of the H&R methodology. We have adopted an electrofishing-only approach to estimate resident trout populations in Eastern Oregon streams. This is based on the relatively shallow depth of eastside streams, but also on the realization that the number of units that need to be electroshocked to obtain a valid snorkel count correction factor is similar to that needed for a viable estimate using only electroshocking. Our studies of at-risk species of resident salmonids, across different basins, suggest an underlying pattern between total population density and first stage variance that can be used a priori to determine minimum sample sizes. These studies have also benefited from the application of GIS technology for selection of sample units. This approach is currently being extended to a multibasin level for a status review of redband trout, *Oncorhynchus mykiss* ssp., in six separate drainages of the Great Basin.

9. Using Geography and Remote Sensing to Put the Continua Back in the "River Continuum"

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Methods of sampling biota and measuring physical habitat in stream ecology have utilized predominantly a site-based approach that provides limited information on the continuum of spatial patterns and processes so important in aquatic ecosystems. Certain biotic and abiotic environmental variables can be measured only at the site level, but many important variables such as physical habitat, water temperature, and fish distribution patterns can be measured continuously in space. In addition, advances in geographic data acquisition and analysis have made large-scale studies of continuous data sets more feasible than in the past. Investigations of continuous patterns of stream habitat, temperature, and fish distribution in several streams of the John Day basin and in the Wenaha River in northeastern Oregon have (1) facilitated assessment of biotic and abiotic patterns and patchiness at multiple spatial scales, and (2) revealed a more "continuous" picture of stream fishes and their habitat than can be detected using a site-based approach. Understanding how spatial heterogeneity in the physical environment relates to the distribution of stream fishes as well as how these patterns change over time will be increasingly important for freshwater fish management in rivers fragmented by human activities.

10. Use of Hankin and Reeves Methodology in Basin Surveys and Statistical Sample Surveys to Characterize Patterns and Processes of Stream Habitat at Multiple Scales in Oregon.

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The Aquatic Inventories Project has used the Hankin and Reeves methodology to characterize stream habitat in Oregon since 1990. Surveys have been conducted statewide in over 10,000 kilometers of stream. The methodology has traditionally been used in the context of census, or basin surveys to describe habitat and processes at the site, reach, and watershed scale. In 1998, we incorporated the Hankin and Reeves methodology in statistical sample surveys to describe status and trend of habitat characteristics at a basin and regional level. The sample surveys are being conducted in Western Oregon as part of the Oregon Plan for Salmon and Watersheds and for assessment of redband trout populations in the interior Great Basin of south-central Oregon.

One benefit of the Hankin and Reeves methodology is the ability to incorporate the data onto a geographic information system by dynamic segmentation. We integrated the data using fourth scale hydrologic unit coverages as a base. The data were made spatially explicit by calibrating the route of each stream. Two scales of analysis are maintained in the GIS by the creation of two separate route events that contain either reach or habitat unit level information. Hierarchical organization of the data and GIS integration permits flexibility in data manipulation, stratification by ecological or geographical criteria, and multiple scales of analysis. For example, comparisons of habitat conditions by strata allows corresponding comparisons to life histories, survival, and production of salmon populations, or to land management activities. Spatial presentation facilitates the application of the information to research and monitoring programs, and to the development of management plans.

11. Assessing Stream Habitat: Scale Dependency, Controlling Factors, and Habitat Dynamics

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Though basin surveys were a significant step in surveying fish distribution at the basin scale, significant time and monetary resources have been sunk into regional application of this method without much thought. The actual use of basin wide surveys often exceeds the limits of the intended application of the method. The use of basin surveys is too often an example of "bottom up" data collection, where data is collected from survey or monitoring protocol and then used to answer questions asked after data collection. This is a symptom of "objective-less data collection" where a method is emphasized over goals and objectives. One basic rule I try to follow is: You need to ask the right question to get the right answer. That means designing data collection around some theoretical/methodological framework and stated objectives, which I consider a "top down" approach. There is a scale dependency for questions asked and answered, associated methods, and process/pattern relations of habitat. Multi-scaled habitat investigations can be enhanced with the use of "controlling" or "driving" factors related to habitat composition and dynamics in context of a hierarchical classification scheme. Examples of habitat patterns and dynamics related to watershed geomorphology in the Oregon Coast Range are presented.

12. Stream Surveys: If They Are the Answer, What is the Question!

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State and federal fish biologists have spent a large portions of their budgets in recent years surveying streams with methods that can be traced back to those described by Hankin and Reeves (1988). A cursory review of the published literature indicates few of these studies have substantially increased our understanding of either fish biology or the relationships between land management and stream conditions. In contrast, several recent articles have been published questioning the reliability of using stream surveys as a monitoring tool. Published concerns with these methods, however, have not slowed the use the of these surveys as standards for riparian protection. Currently Riparian Management Objectives, which are derived from stream surveys, are being utilized for Endangered Species Act (1973) consultation and as standards for stream protection. Because stream surveys collect data at the scale of a habitat unit or stream reach their use as watershed standards is inappropriate. The application of these reach scale standards will result in homogenization stream of conditions at the watershed scale. Instead of continuing to rely on these methods we need to focus on understanding how watershed processes shape stream characteristics. Failure to do so will almost certainly result in the loss of the watershed in the attempt to protect the stream.

13. Regional Estimation of Juvenile Coho Abundance in Streams

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Estimation of the number of fish in a small stream is a difficult problem. The problem is made more difficult when an estimate of fish abundance is desired for a system of small streams spread over a large area or region. We assume techniques for estimation of abundance on a single stream (or stream segment) are known and present a method for regional estimation by making recommendations for sample frame construction, sample selection, and statistical estimators. We say little about the particular single stream method employed because we feel estimation of fish numbers on a single stream and selection of which streams to sample are separate topics. Our methods target estimation of juvenile coho salmon (*Oncorhynchus kisutch*) abundance in coastal streams of Northern California and Southern Oregon during summer. Straightforward modifications of the methods can be made to sample other salmonids such as steelhead (*Oncorhynchus mykiss*) or other trout species such as cutthroat trout (*Oncorhyncus clarkii*). The three-year life cycle of coho makes it desirable to conduct surveys in three successive years so that estimates encompass three independent age classes. We propose a three-year rotating systematic sample and advocate estimation of a three-year moving average to summarize the population.

14. Field Implementation of a Modified Hankin & Reeves Stream Survey Design

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Implementation of the following important changes to the widely used Hankin and Reeves survey design for juvenile salmonids in small streams are discussed: (a) a slightly more complex habitat stratification, (b) an "on-the-spot" unit selection method, (c) reduced reliance on electrofishing for the second phase sample, and (D) use of repeated diver counts to estimate fish abundance when first phase counts are small. Habitat is stratified into shallow pools, deep pools, riffles, runs, and an "other" category. Adaptive Sequential Independent Sampling (ASIS) maintains random unit selection and eliminates "prior" knowledge of the units selected which is common with Systematic Sampling. Use of repeated diver counts for estimating abundance when first phase dive counts are low (<20) reduces electrofishing effort and prevents use of electrofishing at low fish densities when removal method estimation is often ineffective. This modified survey design should be of particular interest for low-density surveys of threatened or endangered races of salmonids. I discuss my experiences in field implementation of these modifications to the Hankin and Reeves survey design.

15. Application of the Modified Hankin and Reeves Protocol to Estimate the Distribution and Abundance of Juvenile Salmonids in Coastal California Streams

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Summer surveys of juvenile salmonids in coastal basins of California are commonly used to assess the distribution and abundance of populations of Pacific salmonids. The double sampling/ratio estimation design of Hankin and Reeves has provided a method to sample at a stream-level. Recent modifications suggested by Hankin are of particular interest for management and conservation of threatened and endangered species because of the reduction in electrofishing effort, increased statistical validity, and reduction in sampling variance. In addition, Overton has proposed a method to estimate fish numbers at larger spatial scales incorporating stream-level estimates. We surveyed two coastal basins to assess the efficacy of these recent modifications to determine abundance and distribution of coho salmon and steelhead. Eight stream segments (approximately 1.6 km) were selected from a possible 32 segments across approximately 100 km of stream. We incorporated adaptive sequential independent sampling (ASIS) to select sampling units at the first and second phases and used multiple snorkel passes (bounded counts) instead of electrofishing depletion estimates in units with less than 20 fish (determined during phase I). The distribution and intensity of our sampling effort provides for an evaluation of the promises of these procedures at both the within- and among-basin scales.

Session 5

White Sturgeon Symposium

1. Restoring Productivity of Reproductively-Challenged Reservoir Populations of White Sturgeon Using Supportive Breeding Techniques.

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White sturgeon in the Columbia River Basin upstream of Bonneville Dam are greatly restricted in their movements due to the presence of numerous hydroelectric dams, creating separate resident reservoir populations. Among many resident populations, successful recruitment is limited, and in some maybe absent entirely. When surveyed, these reproductively-challenged populations generally consist of only a few scattered adult fish. The apparent lack of recruitment and few remaining adult sturgeon have created a unique opportunity to test supportive breeding as a restoration tool for white sturgeon. The objective is to determine the efficacy of using supportive breeding to restore production among reproductively-challenged populations. Sexually mature sturgeon from recruitment limited reservoir(s) are brought to a hatchery for supportive breeding. Resultant offspring will marked and released at ages 0+, 1+, and 2+. This process will be repeated for several years to maximize genetic variability and ensure sufficient numbers among the released age groups. Monitoring will include survival rates and growth among the pooled age classes, genetics and entrainment rates. Recommendations will be made regarding the risks and merits of this strategy as a restoration tool.

2. Conservation Aquaculture and Endangered Species: Theory Behind the Practice

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Persistence and viability of endangered fish populations are profoundly affected by the size and structure of the population, as well as their genetic variability and adaptive potential. When fish populations get too small, population size (specifically Ne, effective population size) may become a better predictor of recovery success than hypothesized outcomes of available management strategies. Populations with very low Ne values can suffer from reduced viability and persistence through linked mechanisms of reduced gene flow, genetic drift, reduced within-population genetic variation and inbreeding fitness depression. These populations may ultimately face high risks of extinction. In such extreme cases, such as threatened or endangered populations, it becomes difficult to develop a fisheries management strategy that facilitates population recovery. Thus, maintaining an adequate Ne is necessary for natural population viability and persistence mechanisms to function properly.

Conservation aquaculture represents an adaptive, creative set of approaches that prioritize preservation of wild populations, along with their locally adapted gene pools and characteristic phenotypes and behaviors. Although not proposed as a panacea, timely implementation of appropriately designed conservation aquaculture programs can protect Ne, reduce demographic and genetic bottlenecking, inbreeding fitness depression and loss of unique and important locally adapted genes, thereby theoretically reducing extinction risk.

3. Fecundity and Egg Size in Iteroparous White Sturgeon

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Sturgeon have a long reproductive life and repeated breeding cycles. In culture, females mature at a median age 8 years and spawn biennially. We examined the effects of iteroparity on individual fecundity and size of fully grown oocytes in domestic broodstocks reared for caviar (n=240) and repeated breeding (n=20). Data analysis revealed increases in mean fecundity (from 160 to 412 th eggs) and oocyte diameter (from 3.5 to 3.8 mm) during three consecutive ovarian cycles. The effect of iteroparity on reproductive development was significant and independent from the effect of body size. High reproductive value of iteroparous females is important for the aquaculture and fishery management of white sturgeon.

4. Genetic Diversity in White Sturgeon, *Acipenser transmontanus*, of British Columbia

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White sturgeon in British Columbia is a red-listed species in both the Fraser and Upper Columbia Rivers. As part of a major provincial initiative to better understand white sturgeon biology and develop a recovery plan, a research project was initiated to describe within-species genetic diversity at twolevels including major evolutionary groupings and finer-scale population structure. The first component evaluated sequence variation in the mitochondrial DNA control region for six putative populations from the Fraser and Columbia rivers. Observed haplotypes fell into four divergent groups. These four groups were not strongly geographically segregated suggesting that differentiation predates present-day distribution. However, significant differences in haplotype diversity were observed with the lower Fraser and lower Columbia containing greater variation than upper portions of these rivers. Parallel nuclear DNA microsatellite and more detailed mtDNA RFLP analyses are currently underway to consider finer-scale population differences among and within geographic groups. The results of this study will have implications in management and recovery efforts for white sturgeon populations in British Columbia.

5. Sire and Dam Effects on Growth Rate in White Sturgeon

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A major focus of white sturgeon aquaculture is meat and caviar production. The authors are currently developing a breeding program for white sturgeon, the accuracy of which depends on an accurate assessment of genetic parameters affecting growth rate. A preliminary estimate of the magnitude of sire and dam effects was assessed using a cross classified design from three sires and three dams in a common environment. This experimental design allows estimation of additive genetic and maternal environmental variance components, thus yielding an estimate of heritability. Progeny were assigned to family based on micro-satellite variation. Variation in body weight and length at six months age was found to be highly maternally influenced while sire effects were non-significant, yielding a low estimate of heritability. Future work will involve the creation of many full- and half-sib families to increase the numbers of sires and dams to increase the robustness of genetic parameter estimates.

6. Phylogeographic Distribution of White Sturgeon mtDNA Haplotypes in the Columbia River Basin: Preliminary Results

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White sturgeon, *Acipenser transmontanus*, migration has been documented among Columbia River reservoirs, suggesting some degree of gene flow, especially among adjacent reservoirs. To date, definition and structure of specific white sturgeon populations in the Columbia Basin, and their genetic and phylogeographic relationships remain unclear. This represents a critical data

gap currently hindering white sturgeon management and conservation. The objective of this research is to define white sturgeon populations, and their inter- and intrapopulational genetic variation, gene flow, and phylogeography in the Columbia Basin. Preliminary results of mtDNA D-loop length polymorphism analyses suggest 3-4 haplotypes (haplotypes observed in >5% of individuals in sample area) are commonly shared throughout the Columbia Basin, with additional haplotypes observed only among samples downstream of Bonneville Dam, or observed in the upper Columbia Basin (Kootenai River/Kootenay Lake). The wide distribution and similar frequencies of shared haplotypes supports hypotheses of extensive pre-dam migration and gene flow by white sturgeon between and among diverse areas of the Columbia Basin.

7. Cortisol Stress Response of White Sturgeon to Capture and Handling

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The physiological effect of capture, handling, and release of white sturgeon, *Acipenser transmontanus,* in recreational and commercial fisheries, population monitoring studies, and supplementation programs is poorly understood. We evaluated the plasma cortisol response of white sturgeon exposed to an acute stressor to determine its utility as a measure of stress for this species. Mean plasma cortisol of undisturbed captive juvenile white sturgeon was 13.4+/- 3.4 ng/mL which increased significantly in response to a stressor, followed by a return to near basal levels within 23 h. Increasing amounts of handling caused progressively higher plasma cortisol concentrations but results were not significantly different. Confinement resulted in further increases of plasma cortisol. Plasma cortisol concentrations varied widely between and within capture-method test groups, apparently due to the duration and severity of the stressor. The plasma cortisol response of fish caught by angling was positively correlated with landing time, which, for white sturgeon, is dependent upon fish size. Catch-and-release fishing likely has less of an effect on juvenile and small adult white sturgeon because these fish can be landed quickly. Large adult fish often require more time to land, resulting in elevated plasma cortisol concentrations that may adversely affect fish health and reproduction.

8. Observed Deformities in White Sturgeon from Two Columbia River Reaches

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We sampled two functionally isolated populations of white sturgeon, *Acipenser transmontanus,* to measure the occurrence of physical deformities. In the Columbia River estuary we found the frequency of all deformities among white sturgeon to be 8.1% while in The Dalles Reservoir the frequency was 11.7%. The most common deformity observed in white sturgeon from the estuary was an additional row of lateral scutes on both sides of the fish. In The Dalles Reservoir the most prevalent malformation was misshapened fins, which typically presented itself as bilateral curled pectoral fins, followed by abnormal barbels manifested as shortened or forked barbels. The frequency of misshapened fins was significantly greater among white sturgeon in The Dalles Reservoir than in the estuary. Although no causal relationship has been determined, there is evidence that Columbia River sediment is contaminated with organic pollutants that are known to be harmful to aquatic organisms. Further study is needed to evaluate whether the observed deformities have an environmental or genetic basis.

9. Increased Growth Rate of White Sturgeon with the Administration of Growth

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The slow growth of white sturgeon results in low production and propagation. It would be desirable to increase propagation rate for wild fish populations, as well as for aquaculture meat and caviar production. It is the objective of this work to see if growth rate can be increased, and subsequently see if the time to first spawning is reduced. The growth studies involved bovine somatotropin (bST) administration to sturgeon grown in 16° C water in raceways and fed a commercial trout diet. In trial 1 the bST treatments consisted of the intraperitoneal injections of 0, 40,80 and 120 µg bST/g of body weight every 3 weeks. The sturgeon weighed 1100 g at the beginning of the trial. In trial 2 the initial somatotropin treatments consisted of the intraperitoneal injections of 0 and 80 µg bST/g of body weight of fish weighing 350 g every 3 weeks, but later in the trial the bST treatment was changed to 120 µg bST/g of body weight every 6 weeks. In trial 1 relative growth rates were increased considerably ($P<0.01$) for all three dosage levels of bST and resulted in relative gain responses of 100, 239, 292 and 249 % for the 0, 40, 80 and 120 µg bST treatments respectively. Trial 2 resulted in relative gains of 100 and 373 % ($P<0.01$). In summary, white sturgeon exhibited a drastic increase in growth rate in response to bST administration.

10. Viral Infections in Wild White Sturgeon from the Columbia River Basin

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White sturgeon, *Acipenser transmontanus*, are susceptible to a variety of viral, bacterial, and fungal diseases. The viruses that have currently been reported include the white sturgeon iridovirus (WSIV), white sturgeon herpesvirus-1 (WSHV-1), white sturgeon herpesvirus-2 (WSHV-2), and the white sturgeon adenovirus (WSAV). Previously, these viruses have only been identified in cultured populations. However, these cultured fish were all spawned from wild white sturgeon broodstock. A survey of lower Columbia River juvenile (<1-year old) wild white sturgeon was conducted in the fall of 1994, 1996, and 1997. Fish were collected by standard methods and either nonlethally sampled and released or held in captivity using virus-free water supplies. Captive sturgeon with morbidity and mortality were sampled for virus isolation and histological examination. In 1994, a virus identical to WSHV-2 was isolated and two previously undescribed viruses were detected in 1996. Additionally, an adeno-like virus similar to the enteric adenovirus previously described in white sturgeon from California was isolated in cell culture. A WSIV infection in wild white sturgeon from the Columbia River was also diagnosed in 1997. These observations provide evidence that viral pathogens are normally present in wild stocks and need to be considered in the development of management strategies.

11. Environmental Contaminants in the Kootenai River System: Potential Effects on Reproduction in White Sturgeon.

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In, 1994, the Kootenai River white sturgeon was listed on the federal register as an endangered species. Presently, the population consists of few fish younger than 20 years of age. Spawning and recruitment have been documented with few embryos and larvae surviving to recruitment age. Environmental contaminants have been shown to induce adverse effects on survival and development of fish embryos and larvae. Several classifications of environmental contaminants are contributed to the Kootenai River system within and above sturgeon reproductive and rearing areas. During this study, ovarian tissue was removed from mature female sturgeon. The tissue was analyzed for concentrations of organochlorine, organophosphate, organonitrate, and carbamate pesticides, PCBs and nine metals. Blood samples were also taken, from the mature female sturgeon, to determine reproductive hormone concentrations. Three batches of sturgeon eggs were reared in Kootenai River water, for 13 days, to determine uptake from water, sediment, and suspended solids. The results of this study summarize ovarian tissue concentrations of several contaminants, blood hormone levels in relation to tissue concentrations, and uptake by developing embryos exposed to Kootenai River water, soil, and suspended solids in the water.

12. Status of White Sturgeon in Reaches from Lower Salmon Falls to the Salmon River, ID

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A survey of white sturgeon, *Acipenser transmontanus,* was conducted in seven reaches of the Snake River from Lower Salmon Falls Dam (RKm 922) to the mouth of the Salmon River (RKm 303) as part of Idaho Power Company's efforts to relicense its mainstem hydroelectric projects. The status of sturgeon varied considerably between river segments from viable, reproducing populations to very few individuals with no detectable recruitment. Sizeable sturgeon populations remaining in the Snake River are found below Hells Canyon and upstream between C.J. Strike and Bliss dams. Reaches with low numbers of fish and little or no evidence of recent reproduction occupied several middle sections between Hells Canyon and Swan Falls and upstream of Bliss Dam. Key factors limiting sturgeon in many of these reaches include hydrologic conditions during critical spawn months, water quality and river fragmentation. The least successful river segments containing only remnant numbers of wild sturgeon were consistent with relatively short reach lengths and low reservoir retention rates.

13. White Sturgeon Resource Conservation Area: Is it Time?

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Designation of a Resource Conservation Area is an avenue for scientists to bring attention to unique environments and their associated fauna and flora species. White sturgeon, *Acipenser transmontanus,* were found historically in streams with access to the Pacific Ocean from the Aleutian Islands to central California. Their range and abundance have become reduced due to man's activities since the late 1800's. Construction of dams has isolated around 20 populations of white sturgeon. Many of these populations are severely depressed because of the absence of necessary habitat or other life history needs. To better understand how sturgeon populations respond to management actions, some populations should be allowed to exist with minimal influence by man. The Hells Canyon reach of the Snake River in Idaho, Oregon, and Washington is an ideal candidate for designation of a conservation area as man's influences are relatively minimal and the white sturgeon population is sustaining itself under present conditions. This natural resource can be used as a living laboratory to gain important population dynamics knowledge. The designation as a Resource Conservation Area will still allow for present uses of the river and the white sturgeon population.

14. Spawning Behavior of Kootenai River White Sturgeon and a Predictive Model

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The Kootenai River white sturgeon, *Acipenser transmontanus,* is an Endangered Species. The objectives of this study were to determine how environmental factors stimulated spawning migration. We monitored 50 reproductively mature sturgeon with telemetry from 1991 through

1997. Migration to the spawning reach occurred soon after the onset of local runoff and rising temperature. Males migrated first, at 5.5 to 12.1 ° C, while females at slightly warmer temperatures. Females left first, staying an average of 12.5 d. Males spent an average of 30 d. Abrupt decreases in flow caused some females to abandon the spawning reach. After spawning, 63% of the females moved to Kootenay Lake, while 52% of the males remained in the river. Females appeared most sensitive to environmental conditions. Temperature was important to female migration, river stage was second. A Logistic Regression model correctly predicted movement to the spawning area 92% of the time. Our model will provide a tool for risk assessment of spawning ,approximate migration or spawning time, water management decisions, effects of temperature fluctuations, and will be useful to our study by predicting spawning migration.

15. Trawl and Haul: A Free Ride for Columbia River White Sturgeon.

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During 1994 and 1995, we transplanted 8,449 white sturgeon, *Acipenser transmontanus,* (30-92 cm fork length) from the free-flowing reach of the Columbia River downstream from Bonneville Dam to The Dalles Reservoir (~100 km upstream). In 1997, we recaptured 774 of the transplanted fish. The distribution of transplanted white sturgeon was similar to "native" fish in the reservoir, and growth of transplanted fish was more than 11 cm per year. An estimate of abundance showed about 90% of transplanted fish were still alive in 1997. Mortality rates associated with the two release years will be discussed.

16. Factors Affecting Spawning and Recruitment of White Sturgeon

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Recognition of the biotic and abiotic factors that control production of white sturgeon, *Acipenser transmontanus*, is essential to properly manage fisheries and highly perturbed riverine systems for this species. The abundance of fish within a cohort is the result of the number of eggs spawned and the subsequent mortality that occurs and continually reduces the numbers of embryos, yolk-sac larvae, young-of-the-year, and juvenile white sturgeons. Extensive research on various aspects of the life history of this species has been conducted during the past 13 years by a variety of entities. In this presentation, I draw upon those studies and review known or suspected factors that influence white sturgeon populations during their embryonic and early juvenile stages. I show that although our knowledge of white sturgeon ecology has expanded considerably, we have little knowledge of the causes of mortality in early life stages or what should be acceptable or expected levels of mortality at each life stage.

17. The Effect of Impoundment on the Productivity of White Sturgeon in the Columbia River

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Columbia River white sturgeon, *Acipenser transmontanus*, have been subjected to impoundment and the effects of hydrological control of the river for over 60 years. Recent studies have determined that discrete populations of white sturgeon are essentially isolated by Columbia River hydroelectric projects with very little migration either upstream or downstream of dams. These populations exhibit significant decreases in productivity relative to the unimpounded population downstream from Bonneville Dam. Potential yield predicted for the most productive impounded population studied to date was 1.3 kg/hectare in John Day Reservoir, while the unimpounded lower Columbia River could sustain yields of 16.3 kg/hectare at current levels of recruitment. Significant differences in growth rate, reproductive potential, natural mortality, and recruitment accounted for differential productivity. The unimpounded population benefitted from the larger forage base, consistently favorable hydrologic conditions that influence the quantity and quality of spawning habitat, and access to marine areas. Recommended alternatives for restoring lost productivity of impounded sturgeon include natural flow regimes for areas where spawners and quality spawning habitats persist, providing effective passage structures at dams, transplants of juveniles from healthy populations to underseeded impoundments, and artificial propagation in areas where recruitment is critically low or nonexistent.

18. White Sturgeon in the Columbia River Basin of British Columbia

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White sturgeon in the Columbia and Kootenay drainages in British Columbia are at risk of extinction. They occur in many large lakes throughout the basin however, due primarily to hydroelectric development, there does not appear to be sufficient, if any, natural recruitment to these populations. Intensive investigations in the Kootenay River, Kootenay Lake, Arrow Reservoir and Columbia River downstream of the Hugh Keenleyside Dam have failed to document the presence of larval/juvenile fish even though spawning events have been confirmed in all these systems. Provincial management staff were involved in the development of the Kootenai River White Sturgeon Recovery Plan and are presently starting work with US federal, state, and tribal agencies to develop an assessment/recovery plan for white sturgeon in the Columbia River downstream from Keenleyside to the Grand Coulee Dam. There are a number of remnant populations throughout the basin that presently have few fish remaining in them. A decision must be made as to whether to allow these populations to go extinct or enter into a more radical recovery mode using some form of aquaculture as is proposed for the Kootenay River system.

Session 6

Columbia River Symposium

1. Snake River Salmon Recovery: Separating "D" Chaff from "D" Wheat

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Wild Snake River salmon and steelhead stocks are imperiled. The primary factor limiting recovery is direct and delayed mortality associated with the hydropower system on the lower Snake and Columbia rivers. Of the options being considered for recovery, restoring a natural river in the lower Snake is the best and only way to ensure a high likelihood of recovery and is the most risk averse option given the range of current assumptions and uncertainties.

Stock performance during the 1950s and 1960s, prior to completion of the lower Snake River dams, provides a reasonable template for recovery. Since this period, stocks have declined by approximately 90%. Efforts to compensate for the effects of the completed hydropower system have failed to reverse declines. These efforts focused on smolt collection and transportation, flow augmentation, turbine intake screening, and dissolved gas abatement. Estimates of "D" values, relative survival of transported vs. inriver migrants and estimates of reservoir-reach survival have been used to justify status-quo operations. This justification is not defensible.

Effectiveness of recovery efforts can be best evaluated by comparing relative survival of similar upriver and downriver stocks. These indicator stocks have similar life-history strategies, migration timing and age-structures. The primary difference is the number of dams and reservoirs they encounter during migration. Prior to completion of the lower Snake River dams, upriver and downriver stocks performed similarly. Since completion of the lower Snake River dams, upriver stocks have performed two- to ten-times worse than their downriver counterparts. Recent recovery efforts have not narrowed this gap appreciably. Additional recovery measures that leave the lower Snake River dams and reservoirs operational can improve survival, but fail to provide the two- to ten-fold improvements necessary to get upriver stocks back on par with their downriver counterparts.

2. Status and Expected Time to Extinction for Snake River Spring Chinook Stocks

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Two models, the Salmon Recovery Index, or SRI, and the Doomsday Clock, or Clock were developed to make salmon spawning escapement data more informative to salmon recovery professionals and the public. The SRI developed in this paper provides an easily understood measure that accurately captures the condition of salmon populations. The Clock provides a measure of the expected time until extinction for salmon spawning populations, called demes. Using data provided by Idaho Fish and Game, the SRI and the Clock demonstrate that the existence of Snake River spring and summer chinook demes is precarious and that their future could be grim indeed. If present conditions prevail, the Clock predicts that all five brood lines of the Snake River spring and summer chinook will be extirpated between 2008 and 2017. Unless current conditions change for the better, there is only a remote possibility that more than one of the thirteen demes studied will have spawners after 2045. This situation could change for the worse, because the strongest deme, Poverty Flats of the Salmon River, has had lower than expected return rates in the last three complete brood years, 1991 - 1993. The SRI indicates that the processes leading to the extinctions predicted by the Clock have been underway in 15 of the 19 salmon generations completed between 1980 and 1998. The short hiatus in the extinction process that occurred during the generations ending in 1985 - 1988 is responsible for the spring and summer chinook spawners currently returning to the Snake River. The Clock model demonstrates that all demes other than the Imnaha River should have been extirpated by 1998 without the exceptionally high R/S levels experienced during the generations ending 1985 - 1988. A ray of hope is provided by the reproductive potential that is evident in the thirteen demes of this study. In brood years 1980 - 1983, the average deme produced at the rate of more than two future spawners per spawner. The work was commissioned and supported by Trout Unlimited, Portland, Oregon. The work was commissioned and supported by Trout Unlimited, Portland, Oregon.

3. An Assessment of Lower Snake River Hydrosystem Alternatives on Survival and Recovery of Snake River Salmonids (A-fish Appendix)

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The NMFS Northwest Fisheries Science Center has released a draft Anadromous Fish Appendix related to hydrosystem alternatives. The potential improvements in salmonid stocks as a result of restored habitats or improved hatchery practices were not explored in detail. Analyses related to the hydrosystem indicate that breaching dams is most risk adverse across the widest range of assumptions and scenarios. However, there are plausible sets of assumptions under which breaching yields little or no improvement – most notably if differential delayed transportation mortality is low for spring/summer chinook salmon and extra mortality is not hydrosystem related. A 5- to 10-year period might provide sufficient additional information to determine effects of transportation under the present hydropower configuration. There are risks involved in gathering additional information. If data reveal transportation mortality is, in fact, substantial, the species suffer an approximately 8% (or greater) chance of failing to exceed the survival escapement threshold. There is no simple answer – there are only trade-offs between potential risks and benefits. Scientific efforts can collect data and estimate risks, but only policy can decide what level of risk is acceptable given the many other constraints surrounding such important decisions.

4. Why it Sucks to be a Pacific Lamprey in the Columbia River Basin

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Lampreys are a very ancient anadromous species. From the fossil record, they are estimated to be at least 280 million years old. Pacific lampreys are important in Native American culture and are a traditional food resource. Additionally, lampreys are a endemic species that may have provided beneficial effects for Pacific salmon in terms of recruiting marine nutrients to spawning areas, being an alternative prey item for marine mammals, and avian predators. Pacific lampreys also provide us with a unique indicator stock since they share similar life history requirements with salmonids. However, unlike anadromous salmonids, the Pacific lamprey is not highly prized or utilized by non-Indians, consequently, recent declines in lamprey abundance and distribution had gone largely unnoticed by regional fishery managers. An estimate of Pacific lamprey passage at Bonneville Dam reached a peak of 375,000 in 1960 and has declined to approximately 40,000 in 1997. Dams impact Pacific lamprey in numerous ways during migrations. There appears to be heavy mortality associated with turbines and screens during the downstream migration and returning adults have difficulties negotiating existing fish ladders. Losses of over 50% have been reported between entrance and exits of fish ladders. We used radio telemetry to examine the migration habits of adult Pacific lamprey in the lower Columbia River. Preliminary results indicate that lamprey migration patterns differ greatly from salmonids. At certain times, generally early in the migration season, tagged lamprey swam upstream rapidly reaching migration rates of 50 km/day. During other times, tagged fish would remain stationary for up to 3 months before continuing an upstream migration. Ecosystem management, preservation, and restoration requires us to closely investigate habits and requirements of this unique species and then implement changes to the system so that this species may exist for another 300 million years.

5. Migration Passage Patterns of Pacific Lamprey at Bonneville Dam, 1996-1998

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Populations of Pacific lamprey, *Lampetra tridentata*, like those of other northwest anadromous fish species, have significantly declined in abundance in recent years. For 3 years, we have evaluated migration passage patterns of surgically-implanted radio-tagged adult Pacific lamprey in

the lower Columbia River to gain insight into factors affecting their survival. Fish traveled quickly from release sites upstream to Bonneville Dam. Although more than 85% were detected at collection channel entrances, less than half of these lamprey successfully passed above Bonneville Dam. After entering the collection channels from the tailrace, the median fishway passage time from last collection channel record to the top of a ladder was approximately 1 day.

We discuss potential problem areas that may decrease Pacific lamprey passage success. Water velocity, both at entrance sites and in fishway transition areas, may inhibit successful dam passage. As identified from arrival site and collection channel entrance and exit use, lamprey may prefer slower water velocities. Future studies will continue to evaluate lamprey behavior at Bonneville Dam and analyze migrational behavior at upstream tributaries and dams. In addition, flow velocity and other hydraulic conditions in existing fish ladders will be studied, and potential for redesign will be analyzed.

6. A Laboratory Evaluation of Adult Pacific Lamprey Swimming Performance

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We evaluated the swimming performance of adult Pacific lamprey, *Lampetra tridentata*, through 9-m long sections of PVC pipe at various flow levels to determine what factors may be limiting their passage at Columbia River Dams. We found that lamprey readily passed through both 20- and 31-cm diameter PVC pipes at low water velocities (0.15-0.7 m/s), but the percentage of lamprey passing through the pipes decreased, and time to pass increased, at water velocities of 1.4 m/s or higher. Passage performance was also poor when two transitional steps were added along the length of the pipe, presumably because of the high velocity and shallow depth that occurred at the steps. Lamprey in the fishway at Bonneville Dam (observed with an underwater camera) averaged about 4 minutes to swim upstream through the submerged orifice (2.4 m/s water velocity). Movement was achieved through a repetitive process of attaching to the bottom of the fishway, swimming forward a short distance, and then re-attaching. We believe conditions in fishways at Columbia River dams inhibit upstream passage of adult Pacific lamprey, and is an important factor in their decline in abundance in the Columbia River. In 1999, we are using a flume designed to mimic conditions in fishways to further evaluate lamprey swimming performance and to test methods to improve their passage.

7. Effect of Water Temperature in Adult Fishways and Forebays at Ice Harbor and Lower Granite Dams on Salmon and Steelhead Passage

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Water temperatures were monitored in the adult fishways and forebays of Lower Granite and Ice Harbor dams from 1995 through 1998 to assess the need and potential for improving fishway temperatures during summer and early fall. Temperatures in summer frequently exceed 21°C and the potential exists for delays in migration of adult salmonids due to thermal barriers. Water temperatures in the adult fishways were monitored using temperature recorders set to record hourly readings. Temperature changes from top to bottom of fish ladders were usually less than 0.5 °C, but differences of up to 2 °C were observed. Temperature profiles were recorded biweekly from July through September in the forebays of the two dams. The forebays of both dams tended to be homothermus with less than 2 °C difference between top and bottom. Releases from upstream reservoirs increased this difference. There is a potential to cool water in the fish ladder at Lower Granite Dam by 2-3 °C with releases from Dworshak Dam. We monitored migration rates of adult salmonids equipped with radio transmitters in 1996 - 1998. After preliminary analysis we saw no difference in time for fish to pass or proportion of fish that successfully pass the dams between summer or spring and fall migrating fish.

8. Perspective on the Temperature Issue in the Columbia River: Is There a Problem?

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Currently there is concern that the Columbia River is being warmed excessively and that removing dams would cool the water, hence help endangered salmon. This was examined along several lines. The historical concern for temperature in the Columbia River has waxed and waned over 50 years. So far, temperature has not been sustained as a priority concern for Columbia River salmon. Migration timing and annual temperature patterns place relatively few salmon stocks at risk from temperatures, either cold or warm. To address the role of dams on heating, peak summer temperatures were compared in 1998 between the relatively undeveloped Frazer River (British Columbia) and the highly developed, but more southerly Columbia River. Both rivers had maximum temperatures in the low 70's. Further, the effects of mainstem dams on salmon, including speculated temperature increases, are not readily apparent from run sizes due to a plethora of compounding influences. The literature on temperature effects to specific Columbia River stocks is minimal and incomplete. The result is a dilemma: extrapolating the incomplete literature is necessary, but predicts that these runs should be gone from the combined effects of temperatures, diseases, predation, turbine mortality, and gas supersaturation. While mid-Columbia upriver bright fall chinook might be at risk from seasonal high temperatures, their numbers have generally increased since 1980. Thus, recruitment analyses seem necessary to take the whole live cycle into account, including compensating factors and local adaption. This technology has been use in hatcheries for decades, and should be applied by environmental agencies to satisfy Section 303 (d) (1) (D) of the Clean Water Act of 1987.

9. Fallback by Adult Salmon and Steelhead at Columbia and Snake River Dams, and Its Impact on Upriver Passage, Final Distribution, and Survival

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We outfitted 2,825 spring and summer chinook salmon, *Onchorhynchus tshawytscha*, 577 sockeye salmon, *O. nerka*, and 1,745 steelhead, *O. mykiss* with radio transmitters at Bonneville Dam in the 3 years 1996, 1997, and 1998. We monitored upriver passage past dams, through reservoirs, and into tributaries primarily with fixed antennas/receivers in fishways, dam tailraces, and tributary mouths. Between 11% and 15% of chinook and sockeye salmon and 6% of steelhead that passed Bonneville Dam fell back over the dam. Fallback rates at Bonneville Dam, which included multiple fallbacks by individual fish, ranged from 6% to 21%. Fallback percentages at The Dalles Dam were similar to those at Bonneville Dam, and decreased at upriver dams. Fallback rates tended to increase with flow, spill, and turbidity, and relatively few fish fell back during no spill.

In 1996, upriver migrations by chinook salmon were about 5 days longer for fish that fell back than for fish that did not fall back; multiple fallbacks delayed fish an additional 4 to 8 days. Survival to tributaries was 75.7% for chinook salmon that did not fall back, 70.5% for fish that fell back at Bonneville Dam, and 72.7% for fish that fell back at any dam.

10. Passage of Adult Steelhead at Dams and into Tributaries in the Columbia River Drainage as Assessed with Radio Telemetry

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In 1996, we trapped 770 adult steelhead at Bonneville Dam and outfitted them with radio transmitters. The fish were released downstream of the dam and monitored as they migrated upstream past dams, through reservoirs, and into tributaries in the Columbia and Snake rivers. Success and rates of passage at the dams were assessed along with rates of passage through reservoirs. Wandering behavior, as characterized by entrance and exit frequencies into and from tributaries, was described. We compared length frequency distributions and migration behaviors for steelhead passing Bonneville Dam before and after 1 September 1996 ('A' run versus 'B' run). We also described the distribution of final observations of the tagged fish, noting those harvested, those entering tributaries and hatcheries, and those found dead along the migration route.

11. Passage of Adult Chinook Salmon at Dams and into Tributaries in the Columbia River

Drainage as Assessed with Radio Telemetry

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In 7 of the 8 years 1991 through 1998, a total of 5,095 adult spring and summer chinook salmo was trapped at Ice Harbor, John Day, and Bonneville dams and outfitted with radio transmitters. The fish were released near the dams and monitored as they migrated upstream past each of the dams, through reservoirs, and into tributaries in the Columbia River. Success and rates of passage at the dams, behavior during migration, and minimum survival of the tagged fish was assessed for each group each year. More than 90% of the salmon released downstream from Ice Harbor and Bonneville dams returned and passed over the dams where they were outfitted with transmitters. Median times for salmon to pass individual dams ranged from less than a day at most dams to 1.6 d at Lower Granite Dam with average flow conditions. Fallback rates for salmon with transmitters were 16.4%, 20.5%, and 16.9% at Bonneville Dam in 1996 to 1998. Survival of fallback salmon to tributaries or upstream dams was nearly as high as for those that did not fall back at one or more dams (72.7% versus 75.7%) in 1996. For salmon tagged in 1996, the final destination was determined for 80%, and the other 20% could not be accounted for as being harvested, entering tributaries and hatcheries, or found dead along the migration route.

12. Subyearling Chinook Salmon Early Life History Timing and Survival in the Snake River

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Rearing subyearling chinook salmon, *Oncorhynchus tshawytscha,* ($\geq$60 mm) were captured in the Snake River and tagged with Passive Integrated Transponders to allow an investigation of the effects of early life history timing on survival. An approach was tested for dividing each year of catch data into three emergence cohorts. The approach produced three cohorts each with different release dates and dates of passage at Lower Granite Dam. Lower Granite Dam is the first of eight dams that must be passed for smolts to reach the sea.. Survival to the tailrace of Lower Granite Dam was estimated for each cohort separately for the years 1995 to 1998. Survival was significantly different among the three cohorts ($N = 11$; $P = 0.0077$). Flow and water temperature during migration in Lower Granite Reservoir were highly correlated ($N = 11$; $r = -0.75$; $P = 0.008$). Acknowledging this correlation, we conducted two separate least-squares regressions using survival as the dependent variable. Survival to the tailrace of Lower Granite Dam was positively related to mean summer flow ($N = 11$; $r^2 = 0.74$; $P = 0.001$) and negatively

related to mean summer water temperature (N = 11; $r^2 = 0.75$; $P = 0.001$). We propose that subyearling chinook salmon that emerged early survived at higher rates than late emerging fish because early emerging fry smolted and migrated seaward earlier under more favorable water conditions.

13. Natural Production of Fall Chinook Salmon from Adult Outplants in the Umatilla River, Oregon.

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The success of the production program for upriver bright fall chinook salmon in the Umatilla River has been variable since being initiated in the mid-1980's. Low survival and high out-of-basin exploitation has resulted in low adult return rates from releases of subyearling and yearling fall chinook salmon. This has limited the reestablishment of a desired natural spawning population. To augment natural production, surplus adult fall chinook salmon from Priest Rapids and Ringold hatcheries in the mid-Columbia were transferred to the mainstem Umatilla River in 1996, 1997, and 1998. Observations indicated that fish readily spawned. Resulting production from outplants varied among years possibly due to flow conditions and the number of adults outplanted. However, migrant abundance estimates in some years indicated that this strategy could be successful in supplementing natural production, particularly if flows were stable during the incubation and rearing period.

14. Adapting From Mitigation to Conservation: A Case History of the Grande Ronde Basin Chinook Salmon Hatchery Program

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We initiated a chinook salmon hatchery program in the Grande Ronde basin in the late 1970s to compensate for adult losses that resulted from construction of the four lower Snake River dams. The hatchery program was implemented primarily to restore tribal and recreational fisheries while maintaining wild populations in the wilderness habitats of the Minam and Wenaha rivers. Non-local hatchery stocks were used for production throughout the 1980s and early 1990s. The program achieved little success in meeting management objectives and significant numbers of hatchery fish strayed into and spawned in the Minam and Wenaha rivers. In addition, two major policy rulings influenced the direction of the program. In 1990, ODFW adopted a Wild Fish Management Policy that established guidelines for hatchery straying and in 1992 Grande Ronde chinook salmon were listed under the Endangered Species Act. In response to these factors we refined the objectives for the hatchery program from mitigation to conservation. We have implemented major program changes to achieve conservation management objectives. We have discontinued use of non-local stocks and have initiated a captive broodstock program. We will release the first smolts produced from captive broodstock in April 2000. New production approaches and facilities are being developed to accommodate the captive and conventional supplementation programs.

15. Putting Our Management Where Our Mouth Is: Supportive Breeding Within the South Fork Salmon River Metapopulation.

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Analysis of the limited electrophoretic data available for the South Fork Salmon River (SFSR) indicates that genetic stock structure of spring/summer chinook is stable neither temporally (between years) nor geographically (as a sub-basin). Estimates of gene flow between putative populations within the SFSR suggest that within sub-basin genetic stock structure is shaped by gene flow from the McCall enhancement program. Currently, stocks within the SFSR appear to be resilient to the influence of immigration by adults from the McCall enhancement component (putative populations display dissimilar allelic frequencies). However, with adult to adult return rates below replacement in least one tributary (Johnson Creek), and low abundance overall within the SFSR, the influence of the McCall enhancement program is likely to increase. We propose that the SFSR functions as a metapopulation, within which the McCall stock is an important component. Unfortunately, loss of genetic stock identity within the SFSR is possible due to declines in stock size coupled with the influence of adults from the McCall enhancement program. However, we suggest that this potential risk does not result from operation of the McCall Hatchery enhancement program per se, rather it arises from a lack of management action aimed at protecting all components of the metapopulation. We discuss the potential risks to the loss of genetic identity of the putative populations within the SFSR, and management actions that could be implemented.

16. Tests of Supplementation for Fish Conservation and Recovery

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The Umatilla River Basin in northeast Oregon once supported large populations of spring and fall chinook, coho, and steelhead. Although historic annual returns were not documented, according to conservative estimates, average yearly runs approached 15,000 to 25,000 fish. Human activities in the basin have caused habitat simplification, irrigation diversions have seasonally eliminated streamflow and dam construction has created migration barriers. From 1920 until the late 1980s, as a result of continued human disturbances chinook and coho salmon ceased spawning in the Umatilla River. The primary goal of the plan was to reestablish Umatilla salmon populations through a comprehensive project including flow enhancement, habitat restoration and supplementation.

The Imnaha River Basin also supported a healthy run of spring Chinook. As a result of the precipitous rate of decline, attributed to mainstem passage problems, the tribal and recreational fisheries were stopped in the 1970's, and were listed as threathened under the ESA in 1992. Natural progeny to parent ratios were almost always below replacement. In 1982, a supportive breeding program was established and, since the early 1990's, has resulted in a reduced rate of decline. The goal of the program was to restore the natural-spawning population by enhancing production. It is generally acknowledged that this project is an example of successful supplementation.

These examples of supplementation programs were successful in developing wild fish management plans using supportive breeding techniques. Hatcheries are used to provide substantial boosts in productivity and survival while maintaining wild fish life history characteristics, thus enhancing the persistence of local populations.

We will discuss the definitions of a successful supplementation project in the ocntext of the present two case studies, and the hypotheses that are or should be tested. Elements of successful supplementation programs will be highlighted.

Session 7

Contributed Papers - Fisheries Management

1. An Update on the Redfish Lake Sockeye Salmon, *Oncorhyncus nerka*, Recovery Program: Hatchery Supplementation and Lake Fertilization.

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In the past 30 years, the unique Redfish Lake stock of *O. nerka*, in the Sawtooth Valley, Idaho, has experienced a dramatic decline. Since it was listed as an endangered species in 1991, the Redfish Lake sockeye salmon stock has been the focus of an intensive recovery program. In 1992, the National Marine Fisheries Service designated the Sawtooth Valley lakes and streams as critical spawning and nursery habitat. A captive brood stock of the anadromous form of this stock has been developed as an extinction safety net and to provide individuals for stocking. A variety of release strategies have been evaluated including the release of pre-spawn adults, egg boxes, direct lake release, and in-lake net pen rearing of pre-smolts, and direct smolt releases. Outmigrant data suggests that volitional spawning represents a viable supplementation option. Data analysis found that fish released as pre-smolts from a within basin hatchery had higher overwinter survival than other strategies. Whole lake fertilization was implemented to enhance productivity and increase juvenile fish food resources. Lake fertilization increased primary productivity, chlorophyll a, and zooplankton biomass. There was a concomitant increase of *O. nerka* biomass and abundance associated with supplementation.

2 Spawning Ecology of Fluvial Westslope Cutthroat Trout in the Blackfoot River Drainage, Montana

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I studied seasonal movements and habitat use of 22 fluvial westslope cutthroat trout, *Oncorhynchus clarki lewisi*, from 1997 through 1999 in the Blackfoot River drainage and the characteristics of 32 redds in 1998. Sixteen fish made spawning migrations and two spawned in both years. Spawning migrations occurred during the rising limb of the hydrograph, and lasted an average of 10 days (range 1-14 days). Fish moved both up and downstream an average of 31 km (range 3-73 km) to spawning tributaries and staged at the mouths of tributaries for up to 14 days before entering near the peak in the hydrograph. They remained in tributaries for an average of 27 days (range 4-63 days); duration differed significantly by tributary size and flow year.

Spawning occurred as flows subsided after peak discharge in four tributaries. Neither repeat spawner spawned within 3 km of their previous year's location. Most redds (79%) were located upstream of the tailspill of pools in freshly deposited bed material. After leaving tributaries, fish moved both up and downstream to overwintering areas and made no movements (>100m) thereafter. Since fish move quickly near the peak of the hydrograph, stream crossings (e.g., culverts) can deleteriously affect migrations.

3. Native Fishery Management in Yellowstone Park: Westslope Cutthroat Trout Restoration

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National Park Service management policies mandate protection of native species, which prompted the Aquatic Resources Center in Yellowstone National Park to expand its native fishes restoration program by focusing on westslope cutthroat trout, *Onchorhynchus clarki lewisi*. Project objectives were to identify genetically pure populations of unknown genetic structure and to initiate an experimental pilot study to restore westslope cutthroat trout in a reach of Canyon Creek isolated by an artificial barrier. Beginning in1997, genetic samples were collected from purported westslope cutthroat trout (WSCT) from Cougar Creek, Fan Creek and its tributaries (north fork, east fork, and Stellaria Creek), Gniess Creek, Grayling Creek, and Specimen Creek. Only Fan Creek contained genetically pure westslope cutthroat individuals, although sample sizes were small (n=5). To prepare Canyon Creek, we began removing non-native trout with electrofishing using multiple pass depletion methods. Nearly 5,000 brook trout, *Salvelinus fontinalis*, brown trout, *Salmo trutta*, and rainbow trout, *Oncorhynchus mykiss*, were removed in 1997, with an additional 6,430 fish removed in 1998. Surveys in spring 1998 located trout that were fin-clipped the previous fall and released below the barrier. Subsequent improvements to the barrier were made, and no trout marked since the reconstruction have been collected upstream.

4. Predatory Influence of Selected Predator Fishes on Kokanee, Lake Pend Oreille, Idaho

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Lake Pend Oreille, Idaho has produced the world record rainbow trout (kamloops), *Oncorhynchus mykiss*, and bull trout, *Salvelinus confluentus*, and supported a commercial harvest of kokanee, *O. nerka*, and opossum shrimp, *Mysis relicta*. In the last 40 years, the sport fishery for kokanee, rainbow, and bull trout have declined, while the sports fishery for lake trout, *S. namaycush*, has increased. To identify possible reasons contributing to the decline of kokanee we are examining the impacts of selected predatory fishes on kokanee abundance and survival in Lake

Pend Oreille. We trained volunteers through an extensive public education effort to correctly tag and document recaptures of kamloops, bull trout, and lake trout. Population abundance for kamloops, bull trout, and lake trout seem to be similar. Dietary analysis from Lake Pend Oreille shows that kamloops, bull trout, and lake trout over 406 mm rely heavily on kokanee as a prey item, constituting more than 75% of the diet. Bioenergetic modeling indicates that kamloops, bull trout, and lake trout over 406 mm collectively are consuming more than 50% of the kokanee biomass produced per year. Our results indicate that kamloops, bull trout, and lake trout constitute one source of mortality to sub-adult/adult kokanee in Lake Pend Oreille.

5. Managing for Basic Yield Trout Fisheries in the Presence of Walleye Populations in Three Wyoming Reservoirs

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From 1992 through 1996, 1.3 million hatchery trout were coded-wire tagged (CWT) as part of a study to optimize our use of hatchery trout. Three North Platte River reservoirs (2,500, 20,000, and 22,000 surface acres) that are stocked with catchable-size trout were studied. Catchable-size trout are used to minimize losses to walleye. The CWT information in concert with a 15 month creel survey allowed us to optimize our stocking regime by manipulating strain, size, and season trout are stocked. These results were used to develop a model that predicts the number of stocked trout needed to meet a catch rate goal by water.

6. Winter Microhabitat Fidelity, Growth, and Survival of Juvenile Coho Salmon in Prairie Creek, California

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Coho salmon, *Oncorhynchus kisutch*, stocks in California have declined over 90% since the 1940's, indicating a need to better understand their habitat requirements. Winter habitat has been shown to be crucial to the ability of coho salmon to survive their first year in stream residence, and thus is of vital importance to successful out migration. In this mark and recapture study, 1000 juvenile coho salmon were implanted with passive integrated transponder (PIT) tags. The

objectives were to determine survival of individual juvenile coho salmon in specific habitat units, measure the degree of microhabitat fidelity, determine growth rates of juvenile coho salmon in specific habitat units, and assess movement of juvenile coho salmon between microhabitat units. In addition, the effect of a 15-year flood on microhabitat fidelity of juvenile coho salmon was assessed. Recapture rates of juvenile coho salmon varied from 0% to 71% among habitat units. The mean instantaneous growth rate was 0.04% for all recaptures, and varied among habitat units. All detected movements were in the downstream direction, and ranged from 4 meters to 3433 meters. After a 15-year flood, 15.8% of individual juvenile coho salmon tagged in main channel pools were recaptured. The recapture rate in alcoves after the flood was 41.8% and 47.2% in backwaters. As individuals are recaptured at out-migrant traps, over-winter survival data specific to habitat units will be estimated.

7. Bull Trout Distribution, Status, and Conservation in the Clearwater Basin

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Under the State of Idaho's Bull Trout Conservation Plan, a technical advisory team has assessed bull trout status in six sub-basins; the North Fork Clearwater, the Lochsa-Selway, the South Fork Clearwater, the Lower Salmon and Snake, the mid-Salmon River, and the lower Clearwater River. Building on this information, we describe the status and conservation of bull trout in entire basin based on research on bull trout historical distribution and potential limiting factors in priority watersheds. We describe management and monitoring needs in the basin to conserve bull trout populations and habitats, restore priority habitats, and help achieve bull trout recovery.

8. Temperature Requirements for Threatened Bull Trout from the Pacific Northwest

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Although widely regarded as having among the most stringent requirements for cold temperatures among salmonids, specific thermal requirements for survival and growth of threatened bull trout are unknown. Such data are critical to develop and evaluate thermal criteria for land management and reintroduction programs. We conducted long-term (60 d) experiments of survival and growth of juvenile bull trout at 12 constant temperatures ranging from 7.5-26 °C. Survival of test fish was ≥98% at temperatures of 7.5-18 °C. However, no fish survived test temperatures of 22, 24, and 26 °C. Time to 100% mortality was 24 hr at 26 °C, 10 days at 24 °C, and 38 days at 22 °C. Seventy-nine percent of test fish survived for 60 d at 20 °C, suggesting that the upper incipient lethal temperature for juvenile bull trout is between 20 and 22 °C. Maximum growth occurred at 12 °C, and declined sharply at temperatures ≤10 and ≥ 18 °C. Fish held at temperatures ≥ 16 °C displayed elevated incidence of jaw and ventral sores indicative of reduced osmoregulatory function. Bull trout optimal growth and upper lethal temperatures are lower than co-ocurring brook trout, rainbow trout, and brown trout, suggesting a possible mechanism for replacement of bull trout by these nonnative salmonids, and for the high degree of isolation of remaining populations.

9. Can "Resident" Bull Trout Populations Reestablish a Migratory Life History Form?

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Though once migratory, many remaining bull trout populations now persist as non-migratory "residents" isolated in headwater streams. Isolation through habitat changes and the loss of a migratory life-form increases the extinction risk of these populations. The goal of this study was to determine if resident bull trout still produce a downstream dispersing component capable of reestablishing a migratory life-form. Downstream dispersal was evaluated with picket-weir and fry traps on three tributaries to the lower Bitterroot River. Study basins had relatively high densities of bull trout (12 C 30 fish/100 m). In 1996 and 1997, a series of traps was operated spring through fall seasons in stream sections with bull trout and 1.0 to 6.5 km below presumed population boundaries. If these populations maintain both resident and migratory life-forms, then downstream movement should be significant. Alternatively, if selection has favored a non-migratory life-form, then downstream movement below the resident populations should be absent or rare. A total of 215 bull trout was caught in 1045 trapping days; of these, only 6 were captured at lower traps considered outside resident population boundaries. Dispersal of bull trout was very low or absent in two tributaries. In contrast, large numbers of brown trout, cutthroat trout, and mountain whitefish were captured at downstream traps. Limited out-migration from another tributary suggests one stream still maintains a remnant migratory component. These findings suggest reestablishment of a migratory life-form from resident bull trout populations may be a slow process even if those conditions that selected against migration are corrected.

10. Community Structure of Westslope Cutthroat Trout and Brook Trout Populations in Small Tributary Streams in the Clark Fork River Basin

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Westslope cutthroat trout, *Oncorhynchus clarki lewisi*, populations have decreased dramatically, compared to historical levels. Locating strong, viable populations becomes very important for species recovery. In 1997, tributary streams in the Clark Fork River basin were sampled as part of a baseline aquatic biological survey for the rerouting of a pipeline. Many of these streams had never been quantitatively sampled, or had not been sampled in many years. A total of 25% of the study sites in headwater tributary streams had trout communities composed entirely of brook trout, *Salvelinus fontinalis*, 44% had sympatric trout populations, 12% had only cutthroat trout, and 19% were fishless. Elevation did not appear to be related to the presence or absence of either species, although channel slope was significantly (negatively) related to the presence of brook trout. Although most brook trout and cutthroat trout populations contained YOY, brook trout more commonly exhibited populations with balanced size structures. Adults of both species had maximum lengths of approximately 180 mm, reflecting the small size of these streams. Brook trout had greater densities and biomasses than cutthroat trout, in sympatric and allopatric populations.

Session 8

Fish Health and Nutrition / Miscellaneous

1. Myxobolus Cerebralis Infection in Rainbow Trout, *Oncorhynchus mykiss*, and Brown Trout, *Salmo trutta*, Exposed Under Natural Stream Conditions

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From early April into mid June 1977, sequential groups of juvenile rainbow and brown trout were each exposed for 10 days to M. cerebralis by immersion in a stream inhabited by infected wild trout. Trout were subsequently killed and heads and gill arches examined histologically. A grading scheme to quantify lesion severity was developed and applied. Percent infection, lesion severity scores, and effects of water temperature and flow rates on percent infection and lesion severity scores, and resulting pathology were determined. Percent rainbow trout infected with M. cerebralis is significantly higher than percent brown trout infected for each exposure period. Percent rainbow trout infected in exposure periods later in the calendar year are significantly higher than those in earlier periods. The overall average lesion severity score is significantly higher in rainbow versus brown trout. Lesion severity scores in rainbow trout increased over time. Significant correlations exist between water temperature and percent rainbow trout infected and accompanying lesion severity scores. In rainbow trout, ventral calvarium is the most common site of M. cerebralis replication, followed by gill arches. In brown trout, lesions are virtually confined to gill arches.

2. Fish Nutrition for Sustainable Aquaculture

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As the world human population continues to increase, demand for seafood will increase proportionately. The harvest of ocean-caught fish reached a maximum in the late 1980's and is no

longer increasing, and most of the world's ocean fish stocks are already either fully exploited or over-exploited. To meet the needs of a growing human population for food fish, aquaculture production will have to increase substantially in the next century. The extent of environmental impacts of this expanded aquaculture production will be in part determined by the nutritional formulation of feeds for cultured fish and shellfish. To decrease reliance on limited fisheries resources (i.e., fish meal), aquaculture feeds will have to be formulated to contain increasing proportions of more abundant protein sources such as grains, legumes, and rendered byproducts of poultry, beef and pork production. Diet formulation of aquaculture feeds is also an important factor influencing the magnitude of effects of aquaculture effluent on eutrophication of receiving waters. Reducing dietary phosphorus to near the nutritional requirement of the fish can minimize phosphorus excretion, and attention to amino acid composition and lipid content may lead to reduced nitrogen excretion relative to fish production.

3. Gill Structural Changes as a Potential Indicator of Eutrophic Stress

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The Lost River sucker, *Deltistes luxatus*, a federally listed endangered species endemic to Upper Klamath Lake, Oregon, is currently suffering a drastic population decline. Extreme eutrophic conditions,which occur in this lake during summer cyanobacterial blooms, are thought to contribute to sucker decline; adverse water quality conditions include elevated ammonia concentrations, and elevated pH. We analyzed structural changes in gills of larval Lost River suckers continuously exposed for 30 days to a series of elevated ammonia concentrations at pH 9.5. Exposure concentrations <0.37 mg NH_3-N/L (unionized ammonia nitrogen) did not significantly decrease survival, growth, whole-body-ion content, or swimming performance. However, based on qualitative analysis using high-resolution light microscopy, we observed structural changes in gills of suckers exposed to 0.37 mg NH_3-N/L, compared to gills of control suckers; changes include increased diffusion distance, increased numbers of chloride cells on secondary lamellae, appearance of mitotic figures, and infiltration of white blood cells into the lymphatic space. Because our results suggest gill structural changes may be a more sensitive indicator of ammonia stress in this species than are more traditional sublethal indices, gill histopathology might be a useful tool for monitoring health of Lost River suckers in Upper Klamath Lake and other eutrophic systems.

4. Variation in Body Condition (*Wr*) of Juvenile Rainbow Trout in Relation to Physiological Measures of Starvation and Activity

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Overwintering trout frequently endure long periods of limited food resources that can lead to depletion of body reserves, declines in body condition, and mortality. We monitored relative weight (W_r), proximate body composition, hematological parameters, and survival of both starved and fed (satiation) juvenile rainbow trout, *Oncorhynchus mykiss*, over 150 d at 7.5 °C to assess the effects of starvation and activity on physiological health. Active (forced to reside in current velocity of 15 cm/s) and inactive (no current) fish did not differ significantly in W_r among starved or fed treatments. Unfed fish lost 30% of their initial body weight, but active fish had higher levels of body protein than did inactive fish. Unfed fish showed lower liver- and gut-somatic indices values than fed fish, and both somatic indices were positively related to W_r. Hematocrit levels declined by 40% in inactive unfed fish, but only by 20% in active unfed fish, suggesting a compensatory mechanism to conserve metabolic ability by active fish. Between 120 and 150 d, mortalities of active unfed fish were observed, but not among inactive unfed fish or fed fish. Our results suggest that starvation alone may not cause overwinter mortality of juvenile rainbow trout. Body condition (W_r) and somatic indices may be useful to assess physiological health of overwintering trout when combined with other physiological indicators.

5. The Use of Environmental Variables as Predictors for Habitats with Increased Risk of *Myxobolus cerebralis* Infections

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Whirling disease, caused by *Myxobolus cerebralis*, is suspected to be responsible for the decline of free-ranging trout populations in Montana and Colorado. Our objectives were to understand the distribution of the parasite within Idaho and create epidemiological models that identify environmental variables that may be used as predictors for at-risk habitat types. Prevalence and severity of *M. cerebralis* infections are not uniform within infected areas, likely due to environmental variables that affect the distribution of the intermediate host, *Tubifex tubifex*, and possibly the production of the infective stage of the pathogen by *T. tubifex*.

We conducted10-day sentinel exposures of rainbow, *Oncorhynchus mykiss*, and cutthroat trout, *O. clarki*, in several drainages within Idaho to determine disease prevalence and infection levels. We constructed multiple regression equations to evaluate temperature, temperature coefficient of

variation, and oligochaete abundance as environmental predictors to define other areas of high risk within Idaho. Average water temperature, diurnal temperature fluctuations, and the abundance of benthic invertebrates within the order Oligochaeta and family Chironomidae were positively correlated with level of infection.

6. Responses of Sculpins, Salmonids, and Macroinvertebrates to Stream Habitat Conditions, Sediment, and Metals

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In 1994, the IDEQ began a state-wide program of monitoring macroinvertebrate and fish communities and habitat features of streams. To help interpret the survey results, we used stream habitat and macroinvertebrate community indices. Seven macroinvertebrate community metrics were combined into a macroinvertebrate biotic index (MBI), and 11 channel morphology, riparian condition, and substrate features were combined into a stream habitat index (HI). We evaluated these indices by comparing the HI results to fish population surveys and comparing the MBI results to habitat ratings, percentage fine sediments measured by Wolman pebble counts, and copper concentrations. MBIs decreased with increasing percentages of fine sediments measured either across the bankfull or instream widths. MBI scores decreased with increasing copper. One metric, EPT taxa, was more responsive to both copper and sediment than was the multimetric MBI. HI scores corresponded well to age class structure of salmonids, but not sculpins. Both salmonid and sculpin age classes declined with increasing percentages of fine surface sediments. Sculpin age classes had a graded decline with increasing fine sediments, whereas salmonids were more variable. High percentages of fine sediment located either in the instream or dry portions of stream channels were associated with effects to both macroinvertebrates and fish.

7. Density and Growth of Tailed Frog Tadpoles, *Ascaphus truei*, in Two Idaho Streams

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Larval tailed frogs, *Ascaphus truei*, are the most conspicuous herbivore in many small forested streams in the Pacific Northwest, but few estimates have been made of their abundance and little is known about the age structure of populations. In northern Idaho, tailed frogs require at least 3 years to complete transformation from tadpole to adult and, during the summer, 3 distinct age classes are discernable in stream populations. I investigated tailed frog populations in two streams in northern Idaho over a 3-year period. My objectives were to estimate the densities of tailed frog tadpoles and to compare the age structure of populations in two different streams over time. I also estimated the growth rates of first year tadpoles based on monthly changes in length. Mean annual densities ranged from 1.7 to 10.0 individuals/m^2 in one stream and from 2.3 to 4.9

individuals/m^2 in the other. Age structure was generally stable within years, but year class strength varied both between streams and among years. First year larval growth rates varied significantly both between streams and among years. These results suggest that several years of data may be required to accurately assess population trends of stream amphibians with prolonged larval periods.

8. Amphibian Malformations: Real or Perceived?

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Amphibian populations have been declining worldwide and several species have become extinct in recent decades. Concurrent with population declines, reports of malformed amphibians have been increasing. Reports include external deformities such as missing and extra arms and legs, missing eyes and mandibles, and internal abnormalities involving the bladder, digestive system, and testes. Natural phenomenon such as limb amputations during predation attempts by other animals and parasitism, xenobiotic chemicals (herbicides, insecticides, fertilizers, and others), and UV-B or other radiation (either directly or indirectly by triggering production of toxicants from non-toxic chemicals) have all been linked to amphibian abnormalities. The reported increase in amphibian abnormalities may also reflect an increase in the number of scientists studying the problem. Although deformed frogs were noted as far back as the 1700s, statistically valid historical data on the nature of the problem are lacking.

From 1968 through 1971, I studied the natural history, effective breeding size, and seasonal, annual and geographic variation in color morph frequencies of cricket frogs, *Acris crepitans*, in Illinois to evaluate the potential adaptive significance of polymorphism in the species. Cricket frogs from seven different populations were marked for later identification and followed for three years. Cricket frogs from 28 other populations in Illinois were sampled at least once. A detailed review of my field notes showed that the frequency of abnormalities recorded throughout Illinois was 0.39 % and that most oddities involved missing arms and legs (0.32 %) rather than extra limbs (0.07 %). Missing limbs may reflect attempted predation by other animals (e.g., fish) while extra limbs would indicate developmental errors. Only seven confirmed deformities (extra or deformed arms, deformed digits, underdeveloped mouth) were recorded in almost 10,000 frogs examined. Resurveying the same areas studied in 1968 through 1971 would indicate if the frequency of malformations in Illinois cricket frogs has changed over the last 30 years. Statistically based field surveys must be conducted to establish the extent and distribution of amphibian malformations. Malformations in amphibians could signal problems for fish that inhabit the same water bodies.

9. Summer Habitat Use by Inland Redband Trout in the Kootenai River Drainage, Montana

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The reported decline in the abundance, distribution, and genetic diversity of Columbia River inland redband trout, *Oncorhynchus mykiss gairdneri*, has prompted fisheries managers to better understand the habitat requirements of redband trout to identify critical habitat and develop effective conservation strategies. We used microhabitat, mesohabitat, and macrohabitat analyses to examine summer habitat use and distribution of redband trout in two watersheds in the Kootenai River drainage, Montana. Microhabitat analyses revealed that juvenile (36-125 mm) and adult (≥ 126 mm) redband trout preferred deep microhabitats (≥ 0.4 m) with low to moderate velocities (≤ 0.5 m/s) along the thalweg. Conversely, young-of-year (≤ 35mm) redband trout selected slow water (≤ 0.1 m/s) and shallow depths (≤ 0.2 m) located in lateral areas of the channel. Results of a discriminant functional analysis using five microhabitat variables indicated that total depth, followed by mean water column velocity, were the primary variables that differentiated habitat use among size-classes of redband trout. Size-specific trends in microhabitat use appeared to be ontogenetic. Mesohabitat analyses demonstrated that young-of-year, juvenile and adult redband trout strongly selected pool habitats and avoided riffles; runs were used generally as expected by juveniles and adults and more than expected by young-of-year based on availability. Pools were significantly slower, deeper and contained more total cover than riffles and runs. Macrohabitat analysis indicated that redband trout density was positively related to the abundance of pools and negatively related to stream gradient. Pool-to-riffle ratio, gradient and stream size combined accounted for 73.7% of the variation in the density of redband trout among 23 stream reaches in five streams.

10. Declivity in Steelhead Trout Recruitment at the Keogh River Over the Past Decade

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Survival and return of un-harvested winter-run steelhead trout, *Oncorhynchus mykiss*, at the Keogh River, B.C. declined after 1990. Adult returns averaged 1,168 fish from 1976 to 1990 but were significantly lower from 1991 to 1998 (mean = 187). Forty wild females returned to the 35-km river in 1995/96, 20 in 1996/97, and <10 in 1997/98. The positive linear relation between smolts and returns was significantly lower after 1990, and no longer correlated to smolt size. Smolt-to-adult survival averaged 15% (1976 to 1989), but recently averaged 3.5% (1990 to 1995). Smolts steadily declined to < 1000 by 1998 from an average annual count of 7,000. Smolts per spawner from 1991 to 1994 were, on average, 70% lower than previous estimates based on the same spawner abundance. Recruitment scenarios based on survival histories during

freshwater and marine life stages indicated adult recruits are currently below replacement and unsustainable if conditions continue or worsen. Factors influencing steelhead in the ocean and freshwater are likely similar for other salmonids; harvest impacts must be reduced and appropriate stock re-building measures implemented.

<u>Session 9</u>

.Conservation of Endangered Salmonids Via Supplementation: Are We Heading in the Right Direction?

1. Supplementation: What are the Current Controversies?

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What is the current status of efforts to use hatchery fish to supplement the natural production of wild endemic stocks of salmonids? This session will address the policy, biological, and management issues associated with supplementation along the west coast of North America. Several case studies will also be presented to determine if we are heading in the right direction with our programs and if we are leaning from past experience.

2. Lessons from Alaska: Elements of a Successful Supplementation Program

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Salmon hatcheries have been under increasing pressure to minimize adverse impacts on wild salmon populations and improve their overall effectiveness. While performance varies considerably among hatcheries, the.need for hatchery reform is generally accepted. This paper focuses on one element of hatchery reform, the oversight and management structure of hatcheries. The enhancement program in Alaska provides an opportunity to examine an alternative model and may provide useful ideas, particularly if the ideas can be adapted to meet local needs.

The primary goals of the oversight and management structure in the Alaskan non-profit hatchery program are to protect of wild stocks and provide accountability to both regulators and user groups. Some of the tools used to achieve these goals include annual management plans, annual reports, user group-controlled boards, the method of financing, fish transport permits, regional planning teams, newsletters and public meetings. Non-profit organizations and the State work closely together to plan production and harvest. Cooperation is fundamental to developing the data needed for evaluation. This system of governance results in a healthy tension between the user groups' focus on harvesting adult returns and the State's requirements to protect wild stocks.

An example of how increased emphasis may be placed on oversight of hatchery programs in the Northwest is included in plans for the Cedar River sockeye hatchery. Operational guidelines for this hatchery near Seattle will include mechanisms that encourage accountability and oversight to increase the likelihood that the supplementation program will be effective without causing significant harm.

3. Supplementation and Genetic Conservation: The Policy Trap

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If supplementation is an attempt to enhance salmon while avoiding the genetic excesses of past hatchery programs, then it could safely be argued that supplementation is a form of genetic conservation. At the very least, supplementation and genetic conservation go hand in hand. As evidence we present several cases where First Nations and government, in Canada and the United States, have begun collecting salmon genetic resources for use in broodstock programs tailored to individual rivers.

However, collecting and using genetic resources are activities governed by the International Convention on Biological Diversity, and both activities raise important issues of access, ownership, exploitation and benefit sharing. The pace of implementation of articles of the Convention now demands that organizations consider these issues and create policy that rationalizes and justifies their activities. First Nations in particular will be concerned that genetic conservation activities proceed in accordance with Article 8j of the Convention (equitable sharing of benefits).

In this paper we describe a project to survey existing policies for fish genetic conservation and to assist local and indigenous communities in developing their own. Our project is global but there is a strong North American focus. We discuss case studies where collection of fish genetic material for breeding programs raises issues of ownership and benefit sharing, and propose a checklist of policy issues that organizations involved in supplementation programs should consider.

4. Strategic Stock Enhancement: The Use of Supplementation to Assist Rebuilding of Threatened Coho Populations on the Skeena and Thompson Rivers.

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Strategies for outplanting hatchery-produced juvenile salmonids by the Department of Fisheries and Oceans (DFO) have been modified and refined over the past 20 years to address ecological, genetic and disease concerns. Several studies in Canada, the United States and abroad have highlighted the risks associated with supplementation. In 1997, a severe decline in returning coho populations was observed. As part of the Pacific Fisheries Restructuring and Adjustment Program, the Strategic Stock Enhancement Program was announced by the Canadian Minister of

Fisheries and Oceans (DFO) in 1998. This program complements fleet reduction and fisheries management actions to reduce density dependent and independent mortality of coho. Strategies for the enhancement of some severely affected coho populations of the Thompson and upper Skeena Rivers were developed co-operatively by specialists in genetics, stock assessment and enhancement in consultation with the provincial agency, communities, user groups and First Nations. The strategies include the analysis of mircrosatellite DNA and phenotypic characters to identify population groupings and monitor changes; sperm cryopreservation; evaluation of habitat and stock productivities; studies of paired tributaries (release and no release); protocols for brood stock selection, mating, rearing and release; and monitoring of juvenile density and production and adult returns.

5. Genetic Conservation Role of Salmon Hatcheries in the Columbia River Basin: Can Artificial Propagation Confer a Net Benefit to Naturally Spawning Populations?

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Many populations of salmon and steelhead in the Columbia River Basin are listed as *threatened* or *endangered*. Populations upstream of multiple hydropower dams are especially imperiled. For example, naturally spawning populations in the Snake River have consistently exhibited adult replacement (spawner:recruit) ratios less than 1.0 over the past 15 years, due primarily to extremely low smolt-to-adult survivals (<0.5%). In contrast, many hatchery populations in that same region are achieving adult replacement rates greater than 1.0 because of high (>80%) egg-to-smolt survivals that are compensating for very low (<0.5%) smolt-to-adult survivals. Artificial propagation is thus one tool that can theoretically sustain anadromous salmonid populations, and their respective genetic resources, where existing migratory conditions inhibit or prevent the self-sustainability of naturally-spawning populations. However, managing hatcheries for this conservation purpose requires that natural reproduction and artificial propagation be integrated in a manner that allows hatchery and wild fish to be managed as two components of a single gene pool. The two components may be quite different demographically, but their genetic constitutions must be the same or nearly so. This conservation mandate also requires that hatchery-produced fish spawn naturally and contribute positively to the production of naturally-produced smolts. Conceptually, the objectives of such hatchery programs are to (1) maintain a demographic buffer against future population declines, (2) maintain existing levels of genetic diversity, (3) increase the number of naturally-produced smolts, (4) increase the number of returning adults in order to provide a harvestable surplus, and (5) use the hatchery as a "genetic repository" for recovery. Two hatchery programs for chinook salmon in the Snake River drainage appear to be achieving most of these objectives; however, determining whether those programs are providing an overall net benefit to the naturally spawning population is substantially more difficult to ascertain. Many unanswered questions and untested hypotheses need to be resolved, particularly regarding the genetic and environmental components of reproductive success and other fitness traits of hatchery-origin fish under natural conditions. All possible efforts should be expended to address these questions and hypotheses because artificial propagation may be the only pro-active tool directly available to salmonid biologists for maintaining genetic resources of imperiled populations. This places extreme demands on understanding the overall benefits and risks associated with such programs, particularly when genetic conservation is the primary goal.

6. Putting Our Management Where Our Mouth Is: Supportive Breeding Within the South Fork Salmon River Metapopulation.

Chris Beasley*, André Talbot, and Doug Hatch, Columbia River Inter-Tribal Fish Commission, 729 NE Oregon St., Suite 200, Portland, OR 97232

Analysis of the limited electrophoretic data available for the South Fork Salmon River (SFSR) indicates that genetic stock structure of spring/summer chinook is stable neither temporally (between years) nor geographically (as a sub-basin). Estimates of gene flow between putative populations within the SFSR suggest that within sub-basin genetic stock structure is shaped by gene flow from the McCall enhancement program. Currently, stocks within the SFSR appear to be resilient to the influence of immigration by adults from the McCall enhancement component (putative populations display dissimilar allelic frequencies). However, with adult to adult return rates below replacement in least one tributary (Johnson Creek), and low abundance overall within the SFSR, the influence of the McCall enhancement program is likely to increase. We propose that the SFSR functions as a metapopulation, within which the McCall stock is an important component. Unfortunately, loss of genetic stock identity within the SFSR is possible due to declines in stock size coupled with the influence of adults from the McCall enhancement program. However, we suggest that this potential risk does not result from operation of the McCall Hatchery enhancement program per se, rather it arises from a lack of management action aimed at protecting all components of the metapopulation. We discuss the potential risks to the loss of genetic identity of the putative populations within the SFSR, and management actions that could be implemented.

7. Allocation of Brood Stock Between Stream and Hatchery: The Criterion of No Net Decline in Future Population Size

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Quantitative methods that help managers understand when it is appropriate to remove brood stock from a naturally spawning population, or to add hatchery brood stock to a naturally spawning population are available in the literature. The present study adds to these methods based on the criterion of no net decline in the expected future recruitment resulting from the allocation. The model helps managers make allocation decisions that prevent or minimize decline in future production. The approach recommended is to set up and solve two simultaneous linear stock recruitment equations to find an optimum allocation of spawners between the two populations. The method is illustrated by allocating the escapements for two salmon populations, hatchery and natural, from the Imnaha River (Oregon) watershed. The allocation decision was found to be most critically important for conservation of the resource when both populations

exhibit different long-term downward trends in their productivities (dual sink populations). The age-structured production (stock-recruitment) from two spring chinook salmon populations (hatchery and natural) in the Imnaha was found to be linear with a negative slope over the last two generations. It was also found that standard methods of setting escapement objectives that rely on maximizing yield based on a nonlinear stock-recruit model do not apply to these chinook salmon populations. To support management by escapement objective alternate escapement goal methods had to be employed. Management for escapements is important because the escapement goal strategy is best suited to protecting the long-term productivity of salmon populations. Although the low productivities of the Imnaha River chinook will preclude reaching the desired escapement goals in the foreseeable future, the appropriate allocation of escapements between the two sink populations can minimize the rate of decline in joint population size. The model could also be used to understand how escapements might be allocated to maximize future production of the joint sink populations.

8. Using Parentage Identification to Make Direct Estimates of Reproductive Success of Naturally-spawning Supplementation Fish: Sampling Requirements and Practical Considerations

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A critical information gap in Pacific salmon conservation has been the lack of data regarding relative reproductive success of hatchery and wild fish spawning naturally. The use of multilocus microsatellite genotypes in natural populations to infer parentage provides a fundamentally new approach to research of this kind. In preparation for a current study in NE Oregon, computer simulations were used with microsatellite data for a Snake River steelhead population to estimate: 1) the confidence of parentage assignment, and 2) sample size of juveniles required to detect changes in proportional representation of wild and hatchery fish (relative to the numbers of adults passed over a weir). Several interesting points emerged from this exercise. If genotyping error rates are low, and all or nearly all potential parents have been sampled, then reasonable numbers of microsatellite markers (18, in this case) provide considerable power to assign parentage, even when the number of potential parents is large (600-900). It was noted, however, that genotyping error rates combine with missing parents (i.e., not included in the sample) to substantially reduce successful parentage determination. In this system, with a large proportion of hatchery fish (reducing sampling variance), we expect reasonable power to detect differences as small as 2% with juvenile samples of approximately 200. In addition to sampling requirements and questions of statistical power, we also discuss some of the logistical issues associated with studies of this kind, as well as some opportunities for exciting tangential studies of kinship and local adaptation that arise from this experimental design.

9. Tests of Supplementation for Fish Conservation and Recovery

André J. Talbot*, Jennifer Phillips, Doug R. Hatch, and Chris Beasley, Columbia River Inter-Tribal Fish Commission, 729 NE Oregon St., Suite 200, Portland, OR 97232

The Umatilla River Basin in northeast Oregon once supported large populations of spring and fall chinook, coho, and steelhead. Although historic annual returns were not documented, according to conservative estimates, average yearly runs approached 15,000 to 25,000 fish. Human activities in the basin have caused habitat simplification, irrigation diversions have seasonally eliminated streamflow and dam construction has created migration barriers. From 1920 until the late 1980s, as a result of continued human disturbances chinook and coho salmon ceased spawning in the Umatilla River. The primary goal of the plan was to reestablish Umatilla salmon populations through a comprehensive project including flow enhancement, habitat restoration and supplementation.

The Imnaha River Basin also supported a healthy run of spring Chinook. As a result of the precipitous rate of decline, attributed to mainstem passage problems, the tribal and recreational fisheries were stopped in the 1970's, and were listed as threathened under the ESA in 1992. Natural progeny to parent ratios were almost always below replacement. In 1982, a supportive breeding program was established and, since the early 1990's, has resulted in a reduced rate of decline. The goal of the program was to restore the natural-spawning population by enhancing production. It is generally acknowledged that this project is an example of successful supplementation.

These examples of supplementation programs were successful in developing wild fish management plans using supportive breeding techniques. Hatcheries are used to provide substantial boosts in productivity and survival while maintaining wild fish life history characteristics, thus enhancing the persistence of local populations.

We will discuss the definitions of a successful supplementation project in the ocntext of the present two case studies, and the hypotheses that are or should be tested. Elements of successful supplementation programs will be highlighted.

10. The Yakima Fisheries Project: Evaluating the Role of Supplementation in Rebuilding Salmon Populations in the Columbia Basin

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The Yakima/Klickitat Fisheries Project (YKFP) is a Tribal, State, and Federal cooperative program to rebuild salmon populations in the Yakima and Klickitat basins through habitat improvement, supplementation, and reintroduction of extirpated species. The Cle Elum

Supplementation and Research Facility is the first step in this tiered program. This facility is designed to test the concept that supplementation can utilize fish reared in a hatchery environment to increase the productivity of naturally reproducing populations of salmon. An experimental hatchery 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. Five raceways of each treatment were reared for one year, marked with PIT tags and coded wire tags, and released from acclimation ponds in the spring of 1999. A monitoring program has been developed to evaluate the Post Release Survival of the outmigrating smolts and the returning adults. Other programs are designed to monitor and evaluate the reproductive success of the returning adults, determine the 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. Results of the first year of outmigrating smolts will be reported.

POSTER ABSTRACTS

(Alphabetical, By Author)

Poster Abstracts

1. Cryopreservation of Adult Male Spring/Summer Chinook Salmon and Steelhead Gametes

Robyn Armstrong, Salmonid Gamete Preservation Project Leader, Nez Perce Tribe Department of Fisheries Resource Management, McCall Field Office, 125 South Mission Street, P.O. Box 1942, McCall, ID 83638; 208/634-5290, FAX 208/634-4097; robyna@nezperce.org

Steelhead, Oncorhynchus mykiss, and chinook salmon, Oncorhynchus tshawytscha, populations in the Northwest are decreasing. Detrimental conditions causing these decreases can be improved in some cases, but time is required. The Nez Perce Tribe strives to ensure availability of a representative genetic sample of the original male population by establishing and maintaining a germplasm repository. Our approach has been to sample and preserve chinook salmon and steelhead genetic diversity within the major river subbasins in the Snake River basin. Gamete cryopreservation permits the creation of a genetic repository, but is not a cure for decreasing fish stock problems. The Nez Perce Tribe has been funded since 1997 by the Bonneville Power Administration to coordinate gene banking of male gametes from spring/summer chinook salmon and steelhead in the Snake River basin. A total of 536 viable chinook cryopreservation samples was taken from Lostine River, Little Sheep, Big, Johnson, Lake, Marsh and Capehorn creeks, the South Fork Salmon River weir, and Sawtooth (upper Salmon River) and Lookingglass (Imnaha River) hatcheries. There were 252 steelhead gamete cryopreserved from Johnson Creek, Dworshak (North Fork Clearwater), Oxbow (Snake River), Pahsimeroi, and Wallowa (Little Sheep Creek) hatcheries. These frozen sperm samples from the Snake River basin, from as early as 1992, are in storage, in duplicate, at the University of Idaho and Washington State University.

2. Nonspecific Cytotoxic Cells of Homozygous Clones of Rainbow Trout, *Oncorhynchus mykiss*

Jason Evenhuis, R. Wesley Leid, Gary Thorgaard, and Sandra Ristow, Department of Animal Sciences, Washington State University, Pullman WA 99164-6351; 509/335-1002, FAX 509/335-4246; ristow@wsu.edu

Nonspecific cytotoxic cell (NCC) activity is the teleostean equivalent of natural killer (NK) cell activity in mammals. We have been investigating nonspecific cytotoxic cells of the peripheral blood of homozygous cloned rainbow trout and have shown that fish of the OSU 142 strain have little NCC activity in the peripheral blood while the Hot Creek strain maintains high activity. Nonspecific cytotoxic cell activity is manifested not only against the target YAC-1, but the NCC of trout can kill K-562, the target most often utilized to test human NK activity, and IM-9, target cells killed by catfish NCC effectors. The segregation of NCC activity in 26 doubled haploid progeny of the OSU 142 X Hot Creek rainbow trout has shown that the inheritance of this trait is consistent with it being associated with one gene. Current research is focusing on isolation of

NCC in Percoll gradients so that the cDNAs associated with the phenotypic expression of NCC can be isolated and characterized. We are fractioning lymphocytes on continuous and discontinuous Percoll gradients and determining the refractive index and NCC activity of each fraction.

3. The Use of Two Dimensional Hydrodynamic Modeling to Evaluate Channel Rehabilitation in the Trinity River, California.

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Jay D. Glase, U.S. Fish and Wildlife Service, Arcata Fish and Wildlife Office, 1125 16th St., Room 209, Arcata, CA 95521; 707/822-7201, FAX 707/822-8136; Jay_D_Glase@fws.gov

Rick. R. Quihillalt, U.S. Fish and Wildlife Service, Arcata Fish and Wildlife Office, 1125 16th St., Room 209, Arcata, CA 95521; 707/822-7201, FAX 707/822-8136; Rick_ Quihillalt@fws.gov

The Physical Habitat Simulation System (PHABSIM) has been used extensively to predict habitat (Weighted Usable Area) (WUA) changes due to changes in discharge from Trinity Dam. During the late 1980's flow-habitat relationships from PHABSIM initiated pilot channel rehabilitation projects intended to increase salmon habitat. A 12-year flow evaluation of the Trinity River recommends increased flows and channel modifications for habitat rehabilitation. The PHABSIM is limited to predicting changes in WUA due to changes in discharge. Two-dimensional modeling predicts changes in WUA resulting from changes in flow and changes in channel morphology. We conducted a preliminary study of the utility of the cdg2d model for evaluating changes in WUA due to channel rehabilitation in the Trinity River. Model data collection, calibration, and validation were conducted for a rehabilitated and a control site. Chinook salmon location and density was significantly correlated with habitat suitability predictions at both sites. Predicted chinook and coho salmon and steelhead fry WUA was higher at the rehabilitation site. The control site model was used to predict changes in WUA based on a hypothetical channel morphology. Two-dimensional modeling appears to be a useful tool for evaluating habitat changes in the Trinity River.

4. CLAWS 2---Invasion of the Chinese Mitten Crab, Effects on a Fish Protection Facility

Lloyd Hess, Brent Bridges, Scott Siegfried, and Sarah Wynn, U.S. Bureau of Reclamation, RR#1 Box 35, Byron, CA 94514-9614; 209/833-0340, FAX 209/833-0387; lhess@mp.usbr.gov

A video and poster showing the problems caused by the introduction and population explosion of the Chinese Mitten Crab in the Sacramento/San Joaquin Delta of California. This presentation is orientated to the impacts on the Tracy Fish Collection Facility and actions taken to alleviate the problems.

5. Serological Responses of Homozygous Clones of Rainbow Trout, Oncorhynchus mykiss, to a Vaccine Strain of Infectious Hematopoietic Necrosis Virus

Scott LaPatra*, Clear Springs Foods, Buhl, ID 83316

Richard Dixon, Christi Pedrow, and Sandra Ristow, Washington State University, Department of Animal Science 114, New Exptl. Animal Lab Bldg., Pullman WA 99164-6351; 509/335-0165, FAX 509/335-4246;ristow@wsu.edu

The objective of this work was to examine the response of homozygous clones of rainbow trout to vaccination by the 100 X pass Nan Scott Lake (NSL) strain of the infectious hematopoietic necrosis virus (IHNV). Adult rainbow trout of the Hot Creek Strain (YY males maintained in a recirculating system at 12C) were injected with 1 X 10e5 pfu of NSL on day 0. Two months later they were injected with 1 X 10e7 pfu and at four months with 2 X 10e7 pfu of the Nan Scott Lake virus. Fish were bled at monthly intervals for 10 months. Serum from each of the animals was analyzed by complement neutralization and by Western Blot against purified Nan Scott Lake virus and against 220-90, a virulent form of IHNV. Highest complement neutralization titers were achieved four months after the first injection, the fish reaching peak titers of 320, 640 and 1280. When sera were analyzed by western blot, an unexpected result was found. Although the sera showed some reaction to the G protein of IHNV, reactions against M1, a matrix protein of the virus, and to an unidentified protein of 86kD (present in the purified reduced NSL preparation in very small quantity) predominated.

6. Watershed-Scale Water Resource Management Strategies Applied by United States Agencies

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The traditional water resource management strategy is institutionalized Interactive Natural-science-based Management (INM). INM is characterized by agency professionals managing water resources with little social review or stakeholder involvement in their management decisions. Collaborative strategies for decision-making can provide a framework for approaching water resource management problems by incorporating multiple stakeholders with diverse interests in a target watershed. A telephone survey of water resource management agencies within the United States indicated that their management strategies are changing from traditional INM to more collaborative watershed-scale approaches. Thirty agencies reported they were currently applying collaborative watershed-scale management strategies. Review of their

management strategy documentation showed that while over half were applying collaboration, only eight were applying a complete Collaborative Natural- and Social-science-based Management (CNSM) strategy at the watershed scale. Ultimately, weaknesses of the INM strategy will necessitate adoption of new decision-making strategies based upon collaboration of stakeholders throughout a target watershed.

7. Evaluating the Population-level Impact of Lake Trout, *Salvelinus namaycush,* on Cutthroat Trout, *Oncorhynchus clarki bouvieri*, in Yellowstone Lake, Yellowstone National Park, WY

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Non-native lake trout, *Salvelinus namaycush,* have established a reproducing population within Yellowstone Lake. This population of introduced predators poses a serious threat to both the indigenous cutthroat trout, *Oncorhynchus clarki bouvieri*, and the entire aquatic ecosystem. Using a bioenergetics approach, I combined data on diet, distribution, growth, and population structure to estimate the population-level predatory impact on the cutthroat trout population. Small cutthroat trout are highly vulnerable, however, most size classes have some susceptibility to this predatory threat. An average piscivorous lake trout consumes 59 cutthroat trout each year and large numbers of small lake trout are now growing into piscivorous size classes. Given this apparent population expansion of lake trout, they will soon have the potential to seriously impact the cutthroat trout population if current control measures prove ineffective. However, high levels of natural production by cutthroat trout increases the resistance and resilience of this population to this perturbation. This analysis demonstrates the negative impact of an introduced predator into an ecologically isolated ecosystem and also demonstrates the value of a nearly natural functioning ecosystem for the persistence of native species.

8. Cloning, Characterization, and Structure of the Natural Killer Cell Enhancement Factor (NKEF)-like Gene from Homozygous Clones of Rainbow Trout, Oncorhynchus mykiss

Hui Zhang, Jason Evenhuis, Gary Thorgaard, and Sandra Ristow, Washington State University Departments of Animal Sciences and Zoology, 114 New Exptl. Animal Lab Bldg., Pullman WA 99164-6351; 509/335-0165; FAX 509/335-4246; ristow@wsu.edu

Natural killer cell enhancement factor belongs to the antioxidant protein family. In the human, NKEF has the ability to enhance natural killer cell cytotoxic activity in vitro. The cDNAs of NKEF from three strains of rainbow trout have been cloned from the splenic cDNA library of OSU 142 and by RT-PCR for the Hot Creek (HC) and Arlee (AR) strains. All three cDNA sequences have high similarity. HC has 99% sequence similarity with both OSU and AR. OSU and AR have only one nucleotide difference in the cDNA sequence. All three sequences have the same deduced NKEF peptide, which contains 199 amino acids. The 6.5kb genomic DNA of OSU containing NKEF was sequenced. It contains 6 exons and 5 introns. Using Pst I to digest intron 5 (3.2kb), an RFLP is produced between OSU and HC. By comparing the RFLP genotype and the Nonspecific cytototoxic cell (NCC) activity (teleostean equivalent of NK activity) of OSU and HC and their doubled haploid progeny, no relationship between the NKEF genotype and NCC activity of the doubled haploids was found. The cDNA and amino acid sequence of trout NKEF have high similarity with human, rat, and carp sequences, indicating that NKEF is a very conserved gene.

9. Cloning, Mapping, and Sequence Analysis of the T Cell Receptor beta Chain Gene from Homozygous Clones of Rainbow Trout, Oncorhynchus mykiss

Hui Zhang, Gary Thorgaard, and Sandra Ristow, Washington State University Departments of Animal Sciences and Zoology, 114 New Exptl. Animal Lab Bldg., Pullman WA 99164-6351; 509/335-0165; FAX 509/335-4246; ristow@wsu.edu

The T cell receptor (TCR) is a highly polymorphic heterodimer important in antigen recognition. TCR genomic regions contain multiple genes, and rearrangement confers diversity on the TCR. We sought to characterize genes of the TCR in homozygous rainbow trout (RBT). A cDNA of the TCR beta chain was cloned and sequenced from an OSU142 splenic library. This gene (1.4 kb) encodes a polypeptide of 236 amino acids. A pair of primers amplified a 340 bp sequence from the variable region of the gene. The primers also amplified genomic DNA from OSU142 and Arlee in PCR. Both genomic DNAs yielded multiple bands. Results obtained by cloning and sequencing the bands indicate that they derive from different v beta genes. Each fragment contains an intron composed of the simple repeat (GA)n of 100 to 246bp. Four v beta genes have been isolated from OSU 142 and three from Arlee. A pair of primers based on the largest intron specific for OSU142 was designed and amplified the genomic DNA from doubled haploids (DH) of OSU X Arlee. Of 71 DH screened, 32 retained the OSU genotype, and 39 are the Arlee genotype. The TCR beta gene was mapped on the linkage groups of the rainbow trout.

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1991 WESTERN DIVISION AMERICAN FISHERIES SOCIETY
ANNUAL MEETING AT A GLANCE

Sunday, July 11

Time	Ballroom	Borah Theater	Silver/Gold Galena Room	Kerouac Room	Other
9:00 am 5:00 pm					Practical Genetics for Fisheries Biologists Forestry 108
1:00 5:00 pm					Metapopulation Analysis Admin 225
1:00 5:00 pm					Bootstrapping Techniques Forestry 10
1:00 6:00 pm	Trade Show & Poster Session Set-up		WDAFS Governing Board Meeting & Chapter Officers' Retreat		
5:30 7:30 pm					Welcom Social Catholic Center (across from SUB)

Monday, July 12

Time	Ballroom	Borah Theater	Silver-Gold Galena Room	Kerouac Room	Other
8:00 am 5:00 pm	Trade Show & Poster Session				
8:00 am 12:00 noon	Welcome and Plenary Session				
12:00 noon 1:00 pm	Luncheon Presentation				
1:00 5:00 pm	Tech Session #3	Tech Session #1	Tech Session #2		
5:00 6:00 pm					Fish Management Section Meeting Gambino's
6:00 9:00 pm					Nez Perce Social Latah County Fairground

Tuesday, July 13

Time	Ballroom	Borah Theater	Silver-Gold Galena Room	Kerouac Room	Other
6:30 7:30 am					Spawning Run Best Western Lobby
8:00 am 5:00 pm	Trade Show & Poster Session				
8:00 am 5:00 pm		Tech Session #6	Tech Session #5	Tech Session #4	
12:00 1:30 pm	Business Lunch and Meeting				
6:30 11:00 pm					Banquet Best Western Courtyard

Wednesday, July 14

Time	Ballroom	Borah Theater	Silver-Gold Galena Room	Kerouac Room	Other
8:00 am 12:00 noon	Trade Show & Poster Session				
8:00 am 12:00 noon	Tech Session #7	Tech Session #9	Tech Session #8		
12:15 pm	Best Paper Awards Presentation				
12:30 pm	Trade Show & Poster Session Take-down				

Thursday, July 15

8:00 am 4:00 pm					BLM Fish Biologists Meeting Best Western