CHANGE AND CONTINUITY: CELEBRATING 50 YEARS OF FISHERIES IN THE WEST

AMERICAN FISHERIES SOCIETY
MONTANA CHAPTER

M
AFS American Fisheries Society
University of Montana Student Sub-Unit

AMERICAN FISHERIES SOCIETY
WESTERN DIVISION

THANK YOU TO OUR MEETING SPONSORS

STURGEON ($3,000 OR >)

RDG RIVER DESIGN GROUP

BLM Fisheries

BULL TROUT ($2,000 OR >)

AVISTA

Northwest Power and Conservation Council

Oregon RFID

Geum Environmental Consulting, Inc.

WESTSLOPE CUTTHROAT TROUT ($1,000 OR >)

Walleyes Unlimited of Montana

Northern Region USFS Striving for Excellence — Caring for the Land • Serving People

HDR

CONFLUENCE

Jack Turner — Turner Enterprises, Inc.

Wildlife Biology — The University of Montana

SAUGER ($500 OR >)

Washington Department of Fish and Wildlife

Montana Association of Fish & Wildlife Biologists

Morrison Maierle

engineers • surveyors • planners • scientists

TABLE OF CONTENTS

Koessler Lake, South Fork Flathead River drainage, Montana. Photo by Lynda Fried

LETTERS OF WELCOME

Greetings AFS members and guests,

Welcome to Big Sky Country! Thank you for joining us at the University of Montana in beautiful Missoula, Montana, for the 42nd annual meeting of the Western Division of the American Fisheries Society (AFS) and the 50th annual meeting of Montana Chapter of AFS. This is the Montana Chapter's golden anniversary and we plan to showcase and commemorate a half-century of exceptional science, stewardship, and dedication to the aquatic resources our members, residents, and guests hold dear. We welcome the many active and retired fisheries professionals who accepted our invitation to celebrate this important milestone.

The theme of this year's meeting is "Change and Continuity: Celebrating 50 Years of Fisheries in the West." Though AFS was formed in 1870, many chapters have recently celebrated their 50th anniversaries. We owe a great deal of gratitude to the biologists, managers, educators, and many others who have dedicated themselves to the research, management, and conservation of our aquatic resources. This meeting is a wonderful opportunity to reflect on our collective history while honoring and learning from those who came before us. From improvements in our scientific understanding and advancements in technology and statistical methods, to helping shape and respond to changing societal values, we all share in a rich and honorable professional legacy. And while the past half-century has been marked by significant changes, the vital role served by the American Fisheries Society has remained a constant: by promoting the professional development and education of our members, advancing fisheries and aquatic science, and informing policy-making and public perception, we have enabled the conservation of fishery resources and aquatic ecosystems and the many benefits they provide.

We are immensely proud of this meeting's technical program quality, and thank the meeting planners, plenary speakers, and oral and poster presenters for their contributions. We are also excited about the many extracurricular activities that will take place during the week, including several unique field trips, a stimulating tradeshow and social, a special off-site celebration of the Montana Chapter's 50th anniversary, and several student-organized events. This will all culminate in a grand banquet and auction on Thursday night.

As we come together during these few days in Missoula – exchanging information, laughing and debating while sharing science, telling stories, renewing old acquaintances and making new ones – please take time to reflect on the value and privilege of being able to openly share the work we are passionate about, serving as a voice for sound science and resource management. Help us celebrate the rich history of our profession and ensure that AFS's commitment to professional excellence, open communication, and public service continues uninterrupted into the future.

We look forward to celebrating with you, honoring the joint legacy of the Western Division AFS and the Montana Chapter, and enjoying the company and good cheer of colleagues and friends.

Most Sincerely,

Cleveland R. Steward III
President
Western Division AFS

Leslie Nyce
President
Montana Chapter AFS

Brian Missildine
President Elect
Western Division AFS

Amber Steed
President Elect
Montana Chapter AFS

LETTERS OF WELCOME

Welcome to
The Montana Chapter of the American Fisheries Society
50th Anniversary Celebration

Join us in celebrating the Montana Chapter's exceptional science, stewardship and dedication to our Big Sky Country's aquatic resources. Fifty years ago, on May 25, 1967, C. J. D. Brown and George Holton sent a letter to fisheries workers in Montana to poll the interest in creating the Montana Chapter of the American Fisheries Society. Forty-one fisheries workers from around the state responded with a resounding, YES. The first official Chapter meeting took place at the Montana Club in Helena, MT in November of 1967. Robert Hutton, AFS Executive Director, gave the keynote address, "What makes a successful chapter." Since that time, the Chapter has served as a forum for Montana's fisheries professionals to communicate with each other and to advocate for the use of science in sound decision making in the management of our diverse aquatic resources. We have come a long way in the last 50 years. In 1989, our Chapter was honored with the Western Division Chapter of the Year Award followed up with back to back American Fisheries Society Chapter of the Year Awards in 1990, 1991. From its original 15 members to our current 220 members, the Montana chapter continues to grow in strength and diversity.

The last half-century has brought challenges in fish species, aquatic resource, and user group fishery management within the backdrop of an increasing human population. Chapter members have served and participated throughout the American Fisheries Society, assisting our Chapter's efforts in aquatic resource science and management and also being recognized for those efforts on several occasions. We have made significant gains, and continue those efforts in biological understanding, as well as evolving and improving technological, predictive and analytical capabilities.

We have scheduled all of the 50th Anniversary events within a 24 hour period, in hopes that will help facilitate meeting attendance for many of our past members. The Chapter will be hosting an anniversary booth throughout the Trade Show showcasing memorabilia, and highlighting past events and accomplishments of our Chapter. On the afternoon of Wednesday, May 24, we will present the Montana Chapter's 50th Anniversary Symposium. Past Chapter presidents will review the highlights and challenges of the past five decades in an informative and sometimes entertaining retrospect. Later that same day, plan to join us for our Anniversary Social along the banks of the Clark Fork River at Caras Park, a landmark Missoula outdoor venue. Dance to the Big Sky Mudflaps, a favorite Montana band, and eat delicious barbeque style food provided by the Notorious PIG, another of Missoula's favorites. While you are there, try your luck at the Corn-Hole tournament, a fund raiser for the Chapter. No doubt, local microbrews will also be available to quench your thirst from all that dancing and socializing. This Social will certainly be a great opportunity to meet new and of course visit with old friends and colleagues. Finally, on Thursday, May 25 at 12pm the Chapter's Business Luncheon will be held. Along with annual Chapter business, the 50th Anniversary Committee will also have the stage. Who knows what will happen?

MTAFS 50th Anniversary Committee

ADDITIONAL MEETING SPONSORS

Montana Fish, Wildlife & Parks

MONTANA TROUT UNLIMITED BITTERROOT CHAPTER

CLARK FORK COALITION

GREAT BURN BREWING

BITTER ROOT WATER FORUM

PLANNING COMMITTEES

2017 Western Division of the American Fisheries Society Annual Meeting Planning Committees

GENERAL MEETING ORGANIZATION
Cleve Steward – President, Western Division AFS
Leslie Nyce – President, Montana Chapter AFS

AWARDS
Adam Sepulveda – Chair
Tom Keegan

ARRANGEMENTS AND ACCOMMODATIONS
Michele Weaver – Chair
Pat Saffel
Andrew Whiteley

BUDGET AND FINANCE
Travis Neebling – Co-chair
Scott Opitz – Co-chair

SOCIALS AND ENTERTAINMENT
Lisa Eby – Co-chair
Michelle McGree – Co-chair
Tracy Wendt – Co-chair
Jon Hanson
Paul Hooper
Paul Parson
David Schmetterling
Jeff Shearer
Scott Spaulding
Adam Sepulveda

MTAFS 50TH ANNIVERSARY
Amanda Bryson – Co-Chair
Joe DosSantos – Co-Chair
Chris Clancy
Jim Darling
Wade Fredenberg
Janet Hess-Herbert
Chris Hunter
Larry Peterman
Brad Shepard

PROGRAM
Brian Missildine – Co-chair
Amber Steed – Co-chair
Robert Al-Chokhachy
Peter Brown
Laura Burckhardt
Chris Guy
Mike Meeuwig
Eric Oldenburg
Pat Saffel
Will Schreck
Lora Tennant
Jackie Watson

PUBLICITY AND OUTREACH
Leslie Nyce – Co-Chair
Amber Steed – Co-chair
Tracy Wendt – Co-chair
Jim Bowker
Mary Beth Loewen
Al Zale

EVENT MANAGEMENT AND REGISTRATION
Alison Colotelo – Co-chair
Scott Opitz – Co-chair
Amanda Bryson
Kellie Carim
Nathan Cook

FUNDRAISING
Will McDowell – Co-chair
Earl Radnoski – Co-chair
Dan Brauch
Addie Dutton

STUDENT ACTIVITIES
Addie Dutton – MSU Co-chair
Marty Etchemendy – UM Co-chair

TRAVEL GRANTS
Casey Hackathron
Brian Missildine
Jackie Watson

TRADE SHOW
Debbie Oja – Co-chair
Ron Pierce – Co-chair

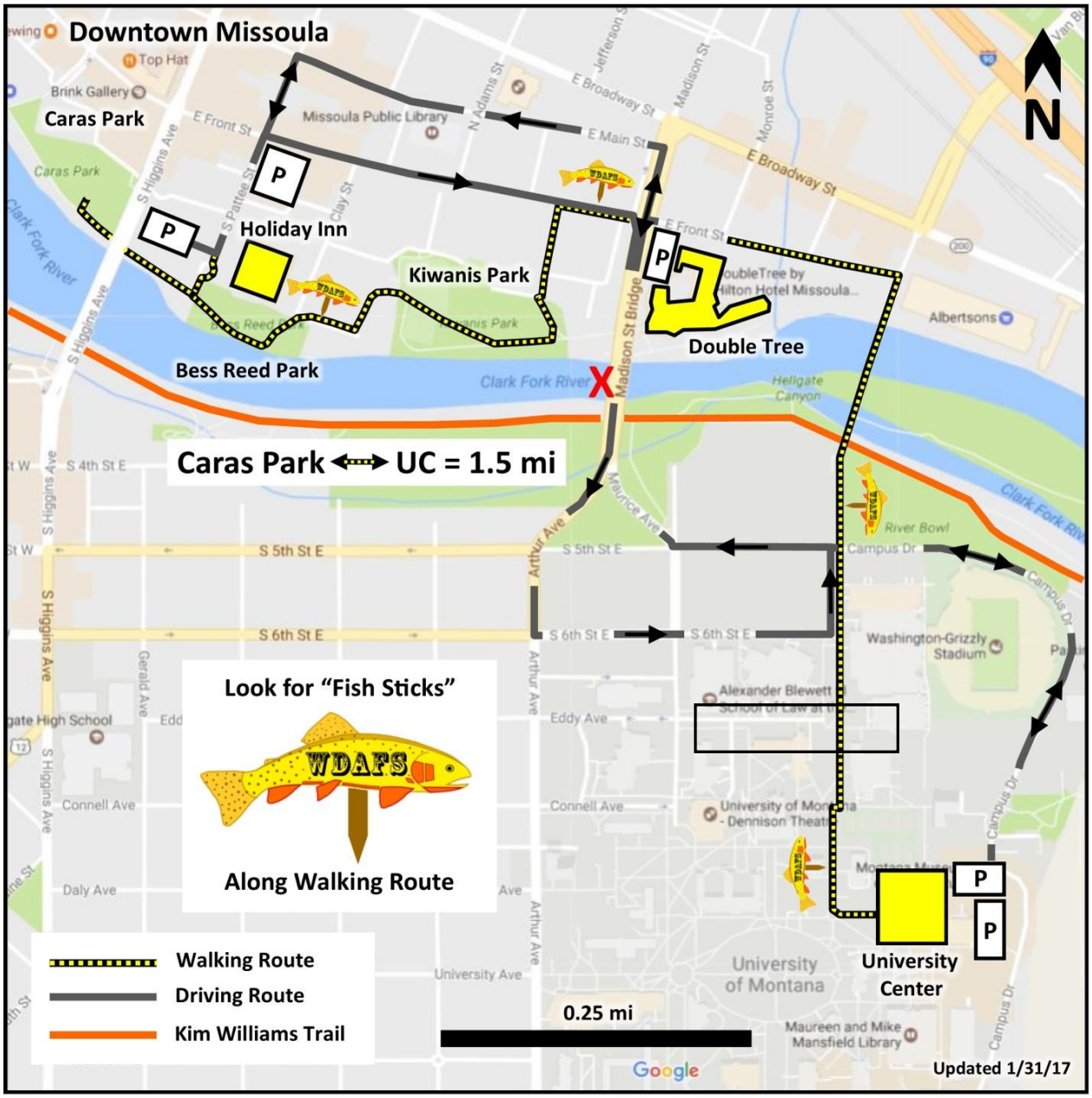
VOLUNTEERS AND STUDENT WORKERS
Zach Klein
Bruce Roberts

WEBSITE
Katie Rayfield

SWAG
Travis Horton
Dan Mahony

MISSOULA WALKING MAP

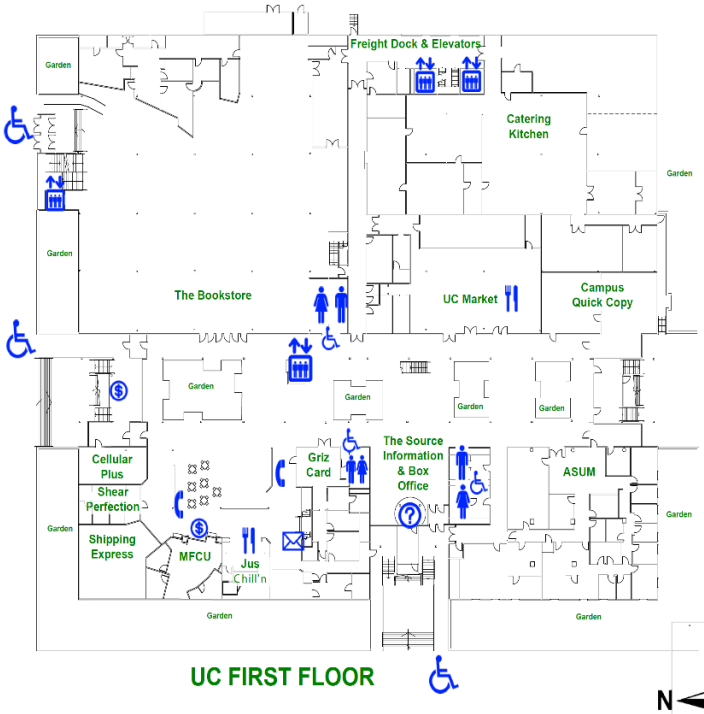
Madison Street Pedestrian Bridge Closed - Alternate Walking Route



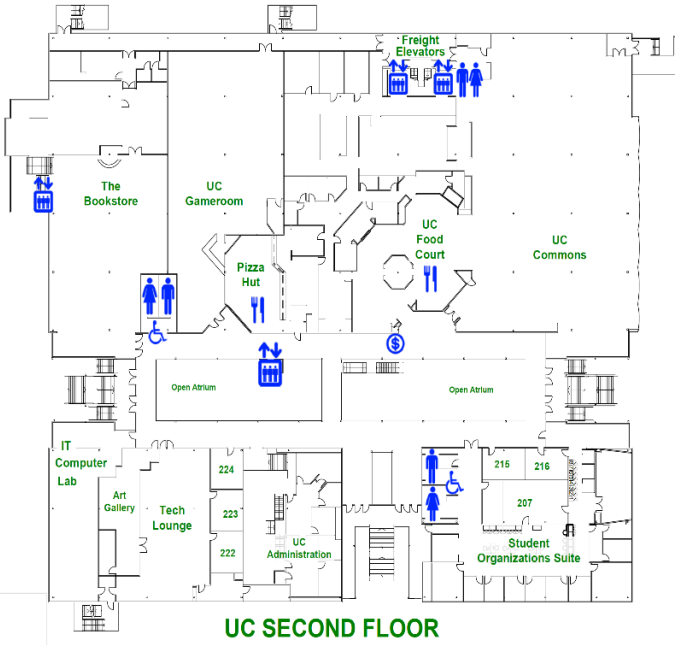
FOLLOW THIS LINK FOR AN INTERACTIVE MAP OF MISSOULA WITH POINTS OF INTEREST:

https://drive.google.com/open?id=1j7IFzRVqMfzuevUTnMChXHzY5sM&usp=sharing

UM UNIVERSITY CENTER MAP



UC FIRST FLOOR



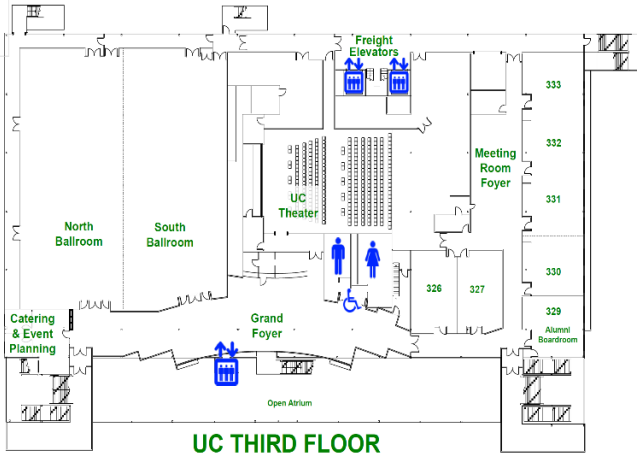
UC SECOND FLOOR

LEGEND

- Information
- Accessible
- Elevator
- Phone
- ATM
- Food
- Mail

UNIVERSITY CENTER

The University Center is an accessible facility. Every effort will be made to accommodate any reasonable request for access to facilities, programs and services in the UC.



UC THIRD FLOOR

THANK YOU UNIVERSITY OF MONTANA STUDENT SUB-UNIT FOR CO-HOSTING THIS EVENT!

American Fisheries Society
University of Montana Student Sub-Unit

SCHEDULE AT A GLANCE

DATE/TIME	EVENT	LOCATION	ROOM(S)
Sunday, May 21st			
10:00 am – 5:00 pm	WDAFS Executive Committee Meeting	Holiday Inn	Parlor C
	MT Executive Committee Meeting	Off site	Off site
Monday, May 22nd			
By Appointment	Media Room	University Center	329
8:00 am – 5:00 pm	Registration Open	University Center	Grand Foyer/Concession
8:00 am	Continental Breakfast	University Center	Grand Foyer
9:00 am – 5:00 pm	Trade Show and Poster Set-Up	University Center	UC Commons
9:00 am – 5:00 pm	Designing Beautiful Figures in R	University Center	330
10:00 am – 2:00 pm	Publish or Perish	University Center	332
9:00 am – 5:00 pm	Field Trips	Off site	Off site
3:00 pm – 6:00 pm	A/V equipment check & Talk Loading area	University Center	Grand Foyer
3:20 pm – 3:40 pm	Afternoon break with refreshments	University Center	UC Commons
5:00 pm – 6:00 pm	Volunteer Meeting (moderators, judges, and all other volunteers)	University Center	332
6:00 pm – 10:00 pm	Welcome Social	University Center	Ballroom N&S
Tuesday, May 23rd			
By Appointment	Media Room	University Center	329
7:00 am – 5:00 pm	Registration Open	University Center	Grand Foyer
7:00 am – 5:00 pm	A/V equipment check & Talk Loading area	University Center	Grand Foyer
8:00 am	Continental Breakfast	Dennison	Dennison
8:00 am – 12:00 pm	Poster set up	University Center	UC Commons
9:00 am – 10:00 pm	Trade Show Open	University Center	UC Commons
9:00 am – 12:00 pm	Plenary Session	Dennison	Dennison
10:35 am – 10:50 am	Morning break	Dennison	Dennison
12:00 pm – 1:20 pm	Lunch on your own		
1:20 pm – 5:40 pm	Oral presentations	University Center	6 rooms (330, 331, 332, 333, 326/327, Theater)
3:00 pm – 3:20 pm	Afternoon break with refreshments	University Center	UC Commons
5:00 pm – 6:00 pm	What Matters to You? Meet and Engage with AFS Leaders	University Center	332
5:45 pm – 6:15 pm	MTAFS SSCC and RMCC meetings	University Center	Theater
6:00 pm - 10:00 pm	Trade Show and Poster Social	University Center	UC Commons
7:30 pm - 10:00 pm	Student Mentoring and Social Event (registration required)	University Center	Ballroom N&S

SCHEDULE AT A GLANCE

DATE/TIME	EVENT	LOCATION	ROOM(S)
Wednesday, May 24th			
7:00 am	Spawning Run	Off site	Off site
7:00 am – 5:00 pm	Registration Open	University Center	Grand Foyer
7:00 am	Continental Breakfast	University Center	UC Commons
7:00 am - 5:00 pm	A/V equipment check & Talk Loading area	University Center	Grand Foyer
7:00 am - 5:30 pm	Trade Show Open and Posters on Display	University Center	UC Commons
8:00 am – 12:00 pm	Oral presentations	University Center	6 rooms (330, 331, 332, 333, 326/327, Theater)
10:00 am – 10:20 am	Morning break	University Center	UC Commons
12:00 pm – 1:20 pm	WDAFS Business Lunch (WDAFS members only, registration required)	University Center	Ballroom N&S
1:20 pm – 5:20 pm	Oral presentations	University Center	5 rooms (331, 332, 333, 326/327, Theater)
3:00 pm – 3:20 pm	Afternoon break with refreshments	University Center	UC Commons
5:30 pm – 6:30 pm	Western Native Fish Committee Meeting	University Center	333
6:00 pm – 10:00 pm	50th Anniversary of MT Chapter Celebration Social	Caras Park	Caras Park
Thursday, May 25th			
7:00 am	Continental Breakfast	University Center	UC Commons
8:00 am – 12:00 pm	Registration	University Center	Grand Foyer
7:00 am - 11:00 pm	Trade Show Open and Posters on Display	University Center	UC Commons
8:00 am – 12:00 pm	Oral presentations	University Center	5 rooms (330, 331, 332/333, 326/327, Theater)
10:00 am – 10:20 am	Morning break	University Center	UC Commons
11:00 am – 4:00 pm	Trade Show and Poster Display take down	University Center	UC Commons
12:00 pm – 1:20 pm	MTAFS Business Lunch (MTAFS members only, registration required)	University Center	Ballroom N&S
1:20 pm – 4:40 pm	Oral presentations	University Center	5 rooms (330, 331, 332/333, 326/327, Theater)
3:00 pm – 3:20 pm	Afternoon break	University Center	Grand Foyer
6:00 pm – 11:00 pm	Banquet, awards, auction & raffle	University Center	Ballroom N&S
Friday, May 26th			
9:00 am – 5:00 pm	Field trips	Off site	Off site

*All events are open to all (unless otherwise noted in parenthesis).

CONTINUING EDUCATION — University Center

Designing Beautiful Figures in R

Instructor: Timothy Walsworth, a post-doctoral research associate at the University of Washington.

Workshop Description: Well-designed, eye-catching figures can improve the ability of your audience to grasp and remember the core concepts and results of your research. In this one-day workshop, we will explore how to design beautiful, impactful graphics using the base graphics system in the R Statistical Computing Language. We will cover basic principles of data visualization, customizing the basic plotting functions in R, producing multi-panel figures, and basic color theory. Participants can apply the concepts presented in this course to design more effective figures for their future publications and presentations. Participants should be familiar with the basic commands and syntax of the R programming language.

Workshop duration: 9:00 AM – 5:00 PM
Location: Room 330

'Publish or Perish' Avoiding Common Pitfalls Before You Hit Submit

Instructor: Vaughn Paragamian, a retired fisheries research principal biologist from Idaho Fish and Game, former associate editor for North American Journal of Fisheries Management, a life AFS member, and currently a fisheries consultant.

Workshop Description: Preparing a manuscript for publication and getting it published is no easy task even for most seasoned veterans. The workshop is intended for the young and old novice at preparing a manuscript for journal submission. I specifically consider the manuscript organization, style guidelines, and what is expected in the Introduction, Methods, Results, Discussion, and References. The workshop will also consider the submission process including dealing with the editorial process and harsh reviews.

Workshop duration: 10:00 AM – 2:00 PM
Location: Room 332

Flathead River, British Columbia. Photo by Amber Steed

TUESDAY, MAY 23

PLENARY SESSION **DENNISON THEATER** **9:00 AM – 12:00 PM**

9:00 – 9:30 AM: **Welcome by Missoula Mayor John Engen, Leslie Nyce (MTAFS), and Cleve Steward (WDAFS)**

9:30 - 10:00 AM

LYNN SCARLETT

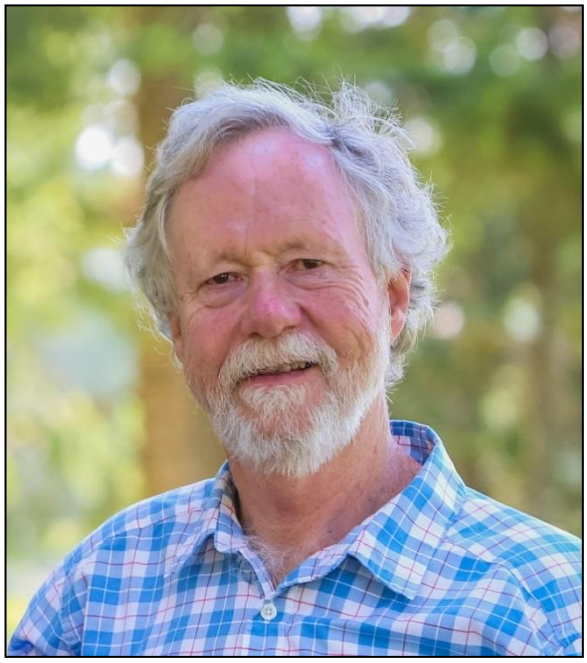
Former Deputy Secretary and Chief Operating Officer of the U.S. Department of the Interior, Lynn Scarlett is worldwide Managing Director for Public Policy at The Nature Conservancy and Global Climate Strategy Lead. In these roles, Scarlett directs all policy in the United States and the 70 countries in which TNC operates. Scarlett also served at Interior as the Acting Secretary of the Interior in 2006. While Interior's Deputy Secretary, Scarlett initiated and chaired the Department's Cooperative Conservation Working Group and its first-ever Climate Change Task Force. She chaired the nation's Wildland Fire Leadership Council. She served on the Executive Committee of the President's Management Council. She is author or co-author of publications on climate change adaptation; ecosystem services; large landscape conservation; and science and decision making. She chairs the Science Advisory Board of NOAA, co-chairs the Landscape Conservation Cooperatives Council established in 2014 by the U.S. Department of the Interior, and co-chairs the National Academy of Sciences Sustainability Roundtable. She received her Bachelor's and Master's degrees in political science from the University of California, Santa Barbara, where she also completed her Ph.D. coursework and exams in political science and political economy.

ABSTRACT:

Changing conditions test our abilities to manage water and fisheries well and respond to change effectively. In addressing these challenges, we must work at scales relevant to sustaining healthy lands and waters and thriving communities. We must also be nimble to adapt amid change, yet we face challenges in predicting ecological responses in complex ecosystems and communities across a range of spatial scales. And we face challenges of governance—do our institutions support interdisciplinary science and multi-agency decision making. Lynn Scarlett will focus on these challenges and how to effectively take knowledge to action.

PLENARY SESSION CONTINUED **DENNISON THEATER** **9:00 AM – 12:00 PM**

10:05 – 10:35 AM
FRED W. ALLENDORF



Dr. Fred Allendorf is a Regents Professor Emeritus at the University of Montana. He has worked in collaboration with Montana Fish, Wildlife and Parks on the effects of hybridization with rainbow trout on conservation of native cutthroat trout since 1976. His overarching research philosophy has been that the most exciting basic research questions in genetics are also those that have valuable practical applications in conservation and fisheries.

He received his Ph.D. in Fisheries and Genetics from the University of Washington in 1975, and he was a postdoctoral scholar at the University of Aarhus in Denmark and Nottingham University in England. He has been a Fulbright Scholar at Victoria University of Wellington in New Zealand and at the University of Western Australia. He was elected a Fellow of the American Association for the Advancement of Science (AAAS) 1987, and he was elected President of the American Genetic Association in 1997. He received the American Fisheries Society's Award of Excellence in 2011, and received the Molecular Ecology Prize from the journal Molecular Ecology in 2015. The second edition of his co-authored book Conservation and the Genetics of Populations was published in 2013.

ABSTRACT:

A career in fisheries genetics: Darwin and the Buddha. At the beginning of my career in 1971, there was not a single published estimate of an allele frequency in any natural population of fish from North America. Today, millions of salmon and trout from western North America have been genotyped at many loci, and whole genome sequences are available for many fish species. This tremendous advance in basic science has provided a wide array of applications of genetics to fisheries management. In my experience, effective application of genetics to fisheries involves a synthesis of basic and applied research. This is especially true for salmonid fishes, which have unusual patterns of genetic inheritance because of their polyploid evolutionary ancestry. Charles Darwin became the first conservation geneticist when he applied his basic scientific understanding of inbreeding depression to the management of isolated populations of deer. Today, the application of science to conservation and management has been diminished because we live in a post-truth world in which facts are often less influential in shaping public policy than are ideology and personal beliefs. In my 35 years of teaching evolution, I struggled with students who accepted creationism in this post-truth world. In my experience, science and Zen practice provide complementary approaches for uncovering the truth about the world in which we live.

PLENARY SESSION CONTINUED **DENNISON THEATER** **9:00 AM – 12:00 PM**

10:55 – 11:25 AM

JOE MARGRAF

Joe Margraf is the current President of the American Fisheries Society. He retired at the end of August 2016 as supervisor of U.S. Geological Survey Cooperative Fish and Wildlife Research Units in the western US. He served in the Coop Unit program since 1980 at Ohio, West Virginia, Maryland, and Alaska, where he was major advisor for over 50 graduate students and on the graduate committees of over 75 others. He has authored or co-authored over 100 publications and technical reports and over 100 presentations for scientific meetings. Joe has been an AFS member since 1972 and life member since 1984.
He received his BS degree in Fisheries from Cornell University, and MS and Ph.D. degrees from Texas A&M University. Joe is Past President of the Education Section, the Fish Habitat Section, and the Western Division. He also served six years as the AFS Constitutional Consultant. He has received both the AFS Distinguished Service and Meritorious Service awards, and was in the inaugural group of AFS Fellows. He and his wife presently live in Pagosa Springs, CO.

ABSTRACT:

I explore the issue of how do we get young people interested in fisheries biology? Does the answer really lie in the principal that we need to get young folks interested in fishing and the great outdoors? I will expound on the importance of fisheries biology (management and science) and why it should be one of the careers of choice. I will talk from the perspective of a person who has dedicated the majority of their career trying to figure out what it is we really do and how it relates to the human condition.

PLENARY SESSION CONTINUED **DENNISON THEATER** **9:00 AM – 12:00 PM**

11:30 AM – 12:00 PM

BETHANN GARRAMON MERKLE

Bethann Garramon Merkle is an artist, writer, and science communicator specializing in visual storytelling. She is passionate about a) integrating drawing into education, research, and communication efforts, and b) the role stories play in shaping public perspectives of science and ecology topics. She has taught all ages and collaborates with entities like the Ecological Society of America, Harvard Forest, and the Wyoming chapter of The Wildlife Society to deliver art-science integration courses to the public as well as science educators, researchers, and biologists-in-training.

Her current research topics are efficacy of drawing as a science learning and teaching tool and creativity in science. On staff with the Wyoming Migration Initiative, she helps researchers with broader impacts initiatives, provides communication skills training, and create images that convey research results. Her work has been published in or commissioned by outlets and organizations such as American Scientist, the Biodiversity Institute, Ecology and Society, Fair Chase, Mother Earth News, Montana Outdoors, Parks Canada, The Nature Conservancy, The Wildlife Professional, University of New Mexico Press, and Western Confluence. Visit www.ecologicallytruestory.org for more information about her current personal projects: an exploration of ecosystems where tortoises and hares coexist and a survey of ecological concepts in children's books.

ABSTRACT:

The history of art and science are closely intertwined. Prior to the advent of cameras, scientific inquiry required drawing. For centuries, people with an interest in the natural world were trained to draw what they observed. The work of Leonardo da Vinci, Maria Sybilla Merian, John James Audubon, and the maps drawn by Samuel Champlain and the Lewis and Clark expedition are prime examples. Their sketch-filled journals and illustrations persist as tangible records of discoveries, adventures, and personal experiences. Even in the digital age, illustrations possess the power to transfix us. Furthermore, research has demonstrated that drawing can still be a powerful part of science education and engagement efforts.

SYMPOSIA **UNIVERSITY CENTER** **1:20 – 5:40 PM**

TITLE: Advances in Applications of Fish Hard Part Microchemistry: Concepts and Techniques
ORGANIZERS: Samuel Bourret, Montana Fish, Wildlife and Parks; Timothy Linley, Pacific Northwest National Laboratory
LOCATION: Room 330
TIME: 1:20-5:00 PM
DESCRIPTION: Our understanding of the environmental life history of marine, diadromous, and freshwater fish has advanced substantially since the inception of hard part microchemistry techniques in the 1980s. These advances are attributable to the integration of elemental and isotopic markers to construct discriminating signatures in the environment, improvements in the accuracy and precision of instruments to quantify these markers, and the development of a statistical framework to analyze the resulting data. This progress has enabled application of hard part microchemistry to a broad range of fishery science and management issues such as stock identification, recruitment, and conservation. Coupled with their chronological properties, chemical analysis of calcified structures has also proved to be a powerful technique to resolve movement and habitat use over a wide range of spatial and temporal scales. Speakers in this symposium will highlight recent advances in microchemistry techniques and provide examples of how this tool is being used to address some of the most important issues facing fisheries management and conservation today. As habitat degradation, illegal fish introductions, land conversion, and climate change continue to alter aquatic environments, there is a growing need for progressive management to address these challenges. Hard part microchemistry provides a valuable tool to elucidate life-history responses and can complement traditional tagging and genetic techniques to assess the resiliency of fish populations to ecological change.

TITLE: Overcoming the Communication Breakdown Between Scientists and Stakeholders
ORGANIZERS: John Harrison, Northwest Power and Conservation Council; Jennifer Anders, Northwest Power and Conservation Council; Nancy Leonard, Northwest Power and Conservation Council
LOCATION: Room 331
TIME: 1:20-4:40 PM
DESCRIPTION: In a 2015 online survey of U.S. members of the American Association for the Advancement of Science (there were 3,748 responses) 84 percent said the public's knowledge about science "specifically the lack thereof" is a major problem for the scientific field. Why? Three quarters of all respondents said too little science education is the major factor. The purpose of this symposium is not to argue for more STEM education, but to: 1) highlight some of the obstacles leading to communication breakdown between scientists and stakeholders, and 2) suggest ways to improve your communication with the public (e.g., landowners whose property you might work on, industry representatives who might support your work or be threatened by it, and policy-makers whose votes could determine funding for your agency and perhaps even your work). Today, scientists need to be able to communicate across a broad spectrum of platform from Twitter and Facebook (according to Pew Research, 62 percent of American adults get their news from social media) to speeches and written reports to emails to in-person conversations. This symposium brings together communication professionals from the worlds of science, policy, and the news media to help you improve your science communication.

SYMPOSIA **UNIVERSITY CENTER** **1:20 – 5:40 PM**

TITLE: Reconnecting Non-Anadromous Fish Populations
ORGANIZERS: Joe Maroney, Kalispel Tribe of Indians; Shana Bernall, Avista
LOCATION: Room 332
TIME: 1:20 – 4:00 PM
DESCRIPTION: The need for fish passage facilities (both upstream and downstream) has been widely accepted for anadromous fish. Historically, there has been considerable controversy between resource agencies and hydropower operators about the need for fish passage for riverine or non-anadromous fish due to restricted movements. However, the paradigm is beginning to change in respect to providing passage for these fish. In recent years, with the innovation of small radio transmitters capable of tracking the movement of fishes, biologist's understanding of the migratory habits of fish has been enhanced. There is a growing body of evidence that some non-anadromous fish make significant migrations that could be impeded by hydropower facilities, dams and diversions. The construction of hydropower dams on major river tributaries has isolated upper basin populations, and eliminated the downstream fluvial or adfluvial life history forms dependent on upstream spawning habitat. Blocking those migrations has had a deleterious effect on these fishes, particularly Bull Trout, Westslope Cutthroat Trout and sturgeon. Connectivity impairment and fragmentation caused by dams and diversions are a Primary Threat in many core areas throughout the ESA listed range of Bull Trout.

Within the last decade, FERC relicensing and settlement agreements throughout the United States have required that upstream and/or downstream fish passage be provided at many of these hydroelectric facilities for non-anadromous fish populations. The need for passage for these fish is likely species- and site-specific. This session will focus on several examples of providing upstream and downstream passage at several facilities for non-anadromous fish. Innovative technologies for moving fish around these projects and ways to monitor success will be discussed. Presentations will discuss how information and knowledge about fisheries, hydrology, hydraulics, hydropower operations and fish behavior inform how fish passage can be achieved.

TITLE: Review of Fish Passage/Barrier Projects: Research, Application, and Lessons Learned
ORGANIZERS: Dan March, HDR; Erin Ryan, U.S. Fish and Wildlife Service; Mike Garello, HDR; Dan Harmon, HDR
LOCATION: Room 333
TIME: 1:20 – 5:40 PM
DESCRIPTION: A mixture of short presentations with a focus on fish passage/barrier projects that discuss recent research endeavors, case studies, and lessons learned from practice. A review of laboratory based studies (i.e., swimming capability, technical fishway passage, etc.) from the past few years will transition to a discussion on field assessments and AOP work. The session will be rounded out with several talks on how fish passage/barrier projects transition from concept to design to implementation, design/construction considerations for remote sites and issues associated with removal of natural fish barriers.

TUESDAY, MAY 23

SYMPOSIA **UNIVERSITY CENTER** **1:20 – 5:40 PM**

TITLE: Environmental DNA 2.0: What is eDNA Doing for Fisheries Today?
ORGANIZERS: Taylor Wilcox, National Genomics Center for Wildlife and Fish Conservation; Michael Schwartz, National Genomics Center for Wildlife and Fish Conservation
LOCATION: Room 336/337
TIME: 1:20 – 5:40 PM
DESCRIPTION: Environmental DNA (eDNA) sampling uses genetic material in water samples to infer species presence. This method has been touted as a powerful new tool for fisheries promising sensitive species detection, non-invasive abundance estimates, and low-cost whole community data. These are lofty expectations for a new technology. In this symposium we explore how eDNA sampling is actually being used to understand the ecology of aquatic systems and inform the management of fisheries today. The field of eDNA sampling has matured to move beyond methods development and is now a part of the toolbox available to researchers and managers across the globe. In this symposium we draw from recent examples that highlight the many ways that eDNA sampling is currently being applied to answer pressing questions in fisheries science and management.

TITLE: Reservoir and Lake Fish Dynamics Under a Climate of Change and Multi-Year Drought
ORGANIZERS: Phaedra Budy, U.S. Geological Survey, Utah Cooperative Fish and Wildlife Research Unit, Utah State University; Jereme Gaeta; Utah State University
LOCATION: Theater
TIME: 1:20 – 5:40 PM
DESCRIPTION: In the Intermountain West, the changing climate and extended drought have resulted changes in both the magnitude and variability of lake and reservoir elevation. Many reservoirs are currently at half pool, and some are being fluctuated dramatically over short time periods to meet water development demands. This change in hydrologic regime and volume likely has important implications for both fish assemblages as well as for managing popular and economically-valuable fisheries. However, the effects of these changes are currently underappreciated, understudied, and rarely considered collectively (i.e., across trophic level, across system). In this symposium, we will start with several talks on the changing climate, the altered hydrologic regime and volume, and associated physical changes to reservoirs including limnological (temperature, oxygen), and structural changes (littoral habitat). We will then move up the food web from observed or predicted effects of these altered ecosystems to primary and secondary production. The remainder of the symposium will be about the effects of these altered ecosystems on fishes at individual, population, and community levels. This section will include bioenergetic and trophic effects as well as recruitment bottlenecks and habitat limitations. Finally, we will close with a section on anticipated or observed effects on ecosystem services, fisheries, and management implications. The symposium will be initiated with a talk introducing what we believe are the key issues and concluded with a panel discussion of where to go next (research and management needs).

SPECIAL SESSION

LOCATION: ROOM 332
TIME: 5:00 – 6:00 PM

WHAT MATTERS TO YOU? MEET AND ENGAGE WITH AFS PRESIDENT JOE MARGRAF, AFS EXECUTIVE DIRECTOR DOUG AUSTEN, AND WESTERN DIVISION AFS OFFICERS

AFS members are invited to a "town hall" type meeting live and via Skype with National and and Western Division AFS officers. Participants will be encouraged to ask questions, raise issues, and engage in informal discussions about the future of AFS. This is your chance to speak up and get your professional society to focus on matters that are important to you.

To us, sustainability means that our business choices are community-based, ecologically sound, socially just, economically viable, and that they will continue to be so for future generations. Central to our goal of sustainability is purchasing locally and sustainably produced goods, conserving water and energy, reducing and diverting waste, educating our community, and collaborating with campus and community partners. We are very proud of our environmental friendliness and sustainability.

We are at 75% Green in our purchasing of cleaning chemicals and paper supplies. Also to note – we use a microfiber mop system to clean floors, tables and windows cutting down on paper products and cleaning floors using less water and chemicals. We also use a concentrate foaming hand soap that not only is Green, but since it is a foam – a person uses less soap per use. The bottles in the dispensers are refillable so there is less plastic being tossed after a bottle is emptied. We use all recyclable or compostable paper goods depending on the hot or cold beverages, NO Styrofoam. Our cups for cold beverages are #1 recyclable and our hot cups are Earthchoice compostable

The Farm to College program is a local procurement program designed to bring more responsibly raised and grown Montana products to campus. The Farm to College program not only means better food for our guests, it also means a better future for agriculture here in Montana.

All of our Salmon is sustainably caught Alaskan Salmon sourced for us by a local company.
All of the beef served at your event will be Montana Beef, all of the shrimp Is Wild Caught USA Shrimp.
We use Cravens Coffee. Harvest For The World and Mexican Water Process Decaf are the blends served at your event. Both are certified organic and fair trade.

Any food that is still usable goes to the Poverello Center and Food Bank, the remaining unusable food gets composted. If you want to know more about UM Catering and UM Dining emphases on suitability on a daily basis you can look at our sustainability page - http://www.umt.edu/dining/Sustainability/default.php

Holland Lake, Montana. Photo by Leo Rosenthal

TUESDAY, MAY 23

TRADE SHOW AND POSTER SOCIAL **UNIVERSITY CENTER COMMONS** **6:00 – 10:00 PM**

No.	Poster Title	Author
	Student Posters	
1-1	Reproductive Strategies of White Sands Pupfish Inhabiting Stable and Variable Habitats	Adam Baca
1-2	PIT Tag Retention in a Native Catfish	Timothy D'Amico
1-3	Columbia River Northern Pike - Investigating the Movement and Life History of an Invasive Freshwater Predator in British Columbia, Canada	Dan Doutaz
1-4	Using Otoliths to Describe Brown Trout Growth Patterns in the Upper Clark Fork River	Martin Etchemendy
2-1	Reconstructing Temperature-Mediated Growth in Juvenile Chinook Using Otolith Oxygen Isotopes	Katherine Gillies-Rector
2-2	Alternatives to Mechanically Deflating Swim Bladders: Potential Physiological Method in Recreational and Commercial Fisheries	Joshua Goff
2-3	Instream Structures Increase Pool Habitat for Cutthroat Trout in Simplified Headwater Streams	Tyson Hallbert
2-4	Life History Diversity in Post-Spawn Female Steelhead Trout Assessed Using Plasma Estradiol-17B: Relationship with Growth and Energy Reserves	Laura Jenkins
3-1	Population Characteristics and the Influence of Discharge on Bluehead Suckers and Flannelmouth Suckers	Zachary Klein
3-2	Using USGS StreamStats to Evaluate Relationships Between Fish Populations and Flow Regime	Larissa Lee
3-3	An Alternative Approach to Designing Fish Passage Structures: Design, Construction, and Operation of a Full-scale Indoor Research Fishway	Tyler Swarr
3-4	Using Juvenile Fish Composition to Examine Adult Walleye Use of the Missouri River Upstream of Canyon Ferry Reservoir	Tanner Traxler
4-1	Physiological Responses of Fishes to Stressors Associated with Oil and Natural Gas Development	Richard Walker

TUESDAY, MAY 23

TRADE SHOW AND POSTER SOCIAL **UNIVERSITY CENTER COMMONS** **6:00 – 10:00 PM**

No.	Poster Title	Author
	Professional Posters	
4-2	Improving Reservoir Fish Habitat: A Story on Building Relationships and Saving Money	Amberle Jones
4-3	Deer Creek Floodplain Enhancement Project: A modern Approach to Process-Based Ecosystem Restoration	Kate Meyer
4-4	French and Moose Creek Restoration Project Case Study	Matt Barnes
5-1	Jeep in a Creek: Evaluating Riparian OHV Roads, Effects to Aquatic Fauna, and Restoration Efficacy in a Central Rocky Mountain Headwater Stream	Matthew Fairchild
5-2	The Merced River S.A.F.E Plan - Riverine and Riparian Restoration	Jarvis Caldwell
5-3	Kootenai River Habitat Restoration Program	Susan Ireland
5-4	Environmental DNA (eDNA) Sampling for Aquatic Species	Thomas Franklin
6-1	Upper Snake River Climate Change Vulnerability Assessment	Scott Hauser
6-2	Big Biology Meets Microclimatology: Defining Thermal Niches of Trout and other Species for Conservation Planning using Large Interagency Databases	Dan Isaak
6-3	The Crowd-sourced NorWeST Temperature Database and Massive Microclimate Scenarios for Streams and Rivers of the American West	Dan Isaak
6-4	Suppression of Nonnative Salmonids to Benefit Migratory Bull Trout in an Open System: An Update of the Effort on the East Fork Bull River, Montana	Sean Moran
7-1	Investigation of the Suitability of Insect Meals as Protein Sources for Rainbow Trout	Cheyenne Owens
7-2	A Map and Database of Westslope Cutthroat Trout Hybridization Zones Throughout Idaho and Montana Streams	Mike Young
7-3	Trophic Plasticity of a Renowned Piscivore: Dietary Patterns of Northern Pike in its Native and Invasive Ranges of Alaska	Nate Cathcart
7-4	Using Standard Benthic Macroinvertebrate Sampling to Derive Food Web Metrics in Salmon-bearing Streams	Sean Sullivan

SPAWNING RUN

7:00 AM at University of Montana River Bowl – Visit runwildmissoula.org/runwild/ for more information.

SYMPOSIA — UNIVERSITY CENTER — 8:00 AM – 5:20 PM

TITLE: Transformation of the Upper Clark Fork River Basin: A Story of Success; Challenges, and the Collaboration that is Making It Happen!
ORGANIZERS: Doug Martin, Montana Department of Justice Natural Resource Damage Program; Vicki Watson, University of Montana Watershed Clinic; Pat Saffel, Montana Fish, Wildlife & Parks
LOCATION: 330
TIME: 8:40 AM – 12:00 PM
DESCRIPTION: Mining activity from the 1880s through 1970s reduced the trout population of the Upper Clark Fork River Basin to about 1/5 of its potential. At times, the river ran red with mining waste, affecting aquatic life from Butte to Missoula, where the Blackfoot and Bitterroot Rivers joined the CFR, and dilution provided a partial solution. Superfund remediation efforts began in the 1980s, and in 1990 the State of Montana started efforts that went far beyond remediation, aimed at restoring the basin's fisheries. Montana departments of Fish, Wildlife and Parks, Environmental Quality and the Natural Resource Damage Program teamed up with local governments and local citizen groups, such as Trout Unlimited, Clark Fork Coalition, and Watershed Restoration Coalition to implement projects, large and small, that are transforming the river basin, returning native fish to reaches where they have been absent or severely depressed for a century.

TITLE: The Human Element of Aquatic Restoration: Working with Stakeholders to Plan and Implement Restoration
ORGANIZERS: Tracy Wendt, Big Thompson Watershed Coalition; Eric Berntsen, Kalispel Tribe Natural Resources Department
LOCATION: 332
TIME: 8:00 AM – 12:00 PM
DESCRIPTION: The best restoration design alone will not lead to project success without active stakeholder participation and buy-in from the beginning. Humans are, and always have always been, a key part of aquatic ecosystems and our actions and input are critical in developing successful restoration strategies. As a restoration project evolves from idea to fruition, it traverses through the hands of project sponsors, funding entities, design teams, regulatory agencies, and construction firms, each of which must have a firm grasp of the project's intended outcome. This symposium will feature examples of how the human element was considered in aquatic restoration projects across the West, including tools and techniques for relationship-building, leveraging of collaborative partnerships, and strategies for working together. Many projects around Missoula, Montana including those featured in field trips at this meeting, are prime examples of collaboration in river restoration and will be showcased in this symposium.

SYMPOSIA **UNIVERSITY CENTER** **8:00 AM – 5:20 PM**

TITLE: Invasive Species and Fishery Management - An Examination of Current Issues
ORGANIZERS: Bob Wiltshire, Invasive Species Action Network; Leah Elwell, Western Regional Panel on Aquatic Nuisance Species
LOCATION: 333
TIME: 8:00 AM – 4:40 PM
DESCRIPTION: In recent years aquatic invasive species have become a major concern for the fishery profession. This symposium will cover many aspects of aquatic invasive species issues as they relate to fishery managers. There will be three primary focus areas of the symposium.
Invasive Sport Fish: the impacts of invasive fish species on native populations is of major concern to most fishery professionals. While some of these invasives have no sport value, very often the problems are created by non-native sportfish. In this session we will provide an overview of selected invasive sport fishes followed by a facilitated discussion of how to approach management of sport fish that have become invasive.
Aquatic Invasive Species of Concern: this session will provide information about a number of aquatic invasive species which are of significant concern to fishery professionals. Rather than provide typical presentations which are focused on a project, this session will feature overview presentations that discuss the species, its impacts, the current distribution of the species and what types of management actions are being taken.
Current and Emerging Issues: This session will focus on issues that are particular relevance for fishery workers. It will combine presentations on emerging threats, new management techniques and technologies, timely issues and examinations of management options and strategies and how they are applied in various situations.
Participants in this symposium will gain a better understanding of the diversity of aquatic invasive species issues and how they can impact on fishery programs. All presenters are recognized topic experts and the symposium is being developed in cooperation with the Western Regional Panel on Aquatic Nuisance Species.

TITLE: Fifty Years of Fisheries Genetics: Allozymes to Genomes
ORGANIZERS: Fred Allendorf, University of Montana; Ryan Kovach, U.S. Geological Survey
LOCATION: 336/337
TIME: 8:00 AM – 5:20 PM
DESCRIPTION: No field of fisheries biology has advanced more rapidly over the last 50 years than genetics. Genetic data now inform everything from harvest of the most abundant fishes to conservation of the rarest. Members of the Western Division of the AFS were international pioneers in the application of genetics to fisheries beginning with work at the National Marine Fisheries Service in the 1950s aimed to identify the continent of origin of salmon caught in the Pacific Ocean. Population genetic data and theory now are integrated into nearly every facet of fisheries conservation and management in marine and freshwater environments. In light of the theme for the meeting, the purpose of this symposium is to describe the development of fisheries genetics over the last 50 years and how these advances resolve conservation or management problems. Furthermore, we will highlight how ongoing or potential advances will chart the course of fisheries genetics into the future. In particular, we will feature how genomics can address previously intractable questions that are directly relevant to management and conservation (e.g., the genomic basis of inbreeding and outbreeding depression, functional trait variation, etc.). Continuity and historical context are crucial elements of this symposium. Speakers will highlight where we have come from, where we are going, and what this means for management and conservation.

WEDNESDAY, MAY 24

SYMPOSIA **UNIVERSITY CENTER** **8:00 AM – 5:20 PM**

TITLE: The Yellowstone River: A Lot Can Change in 692 Miles
ORGANIZERS: Leanne Roulson, HydroSolutions Inc.
LOCATION: Theater
TIME: 8:00 – 10:40 AM
DESCRIPTION: The Yellowstone River has a reputation as the longest undammed river in the contiguous United States. It is also known for spectacular falls in Yellowstone National Park, blue-ribbon trout fishing, beautiful scenic floating, unpredictable spring runoff, and broad, winding channels. All of this variety creates management challenges and can lead us to view as disjunct sections. How are we working with the river and what have we learned from some of the recent events along the Yellowstone.

TITLE: Montana Chapter AFS - 50th Anniversary Symposium
ORGANIZERS: Joseph DosSantos; Retired; Amanda Bryson, Montana Fish, Wildlife and Parks
LOCATION: Theater
TIME: 1:20 – 5:20 PM
DESCRIPTION: The 2017 Montana Chapter meeting will mark the 50th anniversary of the Montana Chapter - American Fisheries Society, celebrating the exceptional science, stewardship and dedications to the Big Sky Country's aquatic resources. The last half-century has not only brought challenges in fish species, aquatic resource, and user group fishery management within the backdrop of an increasing human population, but also significant gains in biological understanding, as well as evolving technological, predictive and analytical capabilities. Chapter members have served and participated throughout the American Fisheries Society, helping our Chapter's efforts in aquatic resource science and management to be recognized on several occasions. We invite you to join us for an afternoon of informative, and sometimes entertaining retrospective view of the Montana Chapter.

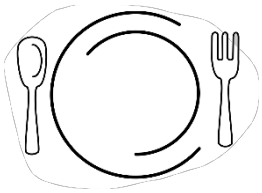
AQUATIC FILMS
LOCATION: Theater
TIME: 10:40 AM – 12:00 PM
DESCRIPTION: Two films will be presented for your viewing enjoyment, The Memory of Fish (54 min) and The Lost Fish (24 min). The Memory of Fish is an award-winning documentary by reelblue, LLC describing the restoration of the Elwha River in northwestern Washington state. Advertised as "a portrait of one man, the wild salmon he loves, and his fight to free a river," this is a moving tribute to one of many river restoration efforts currently underway. The Lost Fish is a Freshwater Illustrated's feature film – a collaborative with the Columbia River Intertribal Commission and the U. S. Fish and Wildlife Service – that captures the plight of the Pacific Lamprey, and the passion and determination of those working to ensure their survival.

MT CHAPTER 50TH ANNIVERSARY CELEBRATION SOCIAL

WEDNESDAY **CARAS PARK** **6:00 – 10:00 PM**

Come join us in celebrating the 50th Anniversary of the Montana Chapter AFS along the banks of the Clark Fork River at Caras Park, a landmark Missoula outdoor venue. Dance to the Big Sky Mudflaps, a favorite Montana band, and eat delicious barbeque provided by the Notorious PIG, another of Missoula's favorites. Local microbrews will also be available to quench your thirst from all that dancing and socializing. Meet new and of course visit with old friends and colleagues, you just never know who will be there! You don't want to miss out!

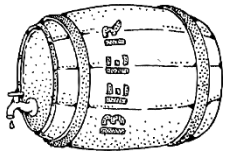
Enjoy music from the Big Sky Mudflaps!



Dine on delicious barbeque provided by the Notorious PIG!

THE NOTORIOUS P.I.G. BBQ

Commemorative 50th Anniversary 16 oz. silipints® will be available for $10 to enjoy the local microbrews!



https://www.missouladowntown.com/caraspark/

Enjoy fantastic views from Caras Park!

AMERICAN FISHERIES SOCIETY MONTANA CHAPTER

American Fisheries Society
50th Anniversary Celebration
Montana Chapter
1967 - 2017

SYMPOSIA **UNIVERSITY CENTER** **8:00 AM – 4:40 PM**

TITLE: Native Non-Game Fishes: Ecological Insights and Management Approaches
ORGANIZERS: Luke Schultz, U.S. Geological Survey; Nate Cathcart, University of Alaska-Fairbanks; Phil Branigan, Idaho Cooperative Fishery Research Unit
LOCATION: 330
TIME: 8:00 – 11:00 AM
DESCRIPTION: For the past fifty years in western North America, aquatic ecosystems have been characterized by water development, introduced species, and increased urbanization, while at the same time experiencing changes in climate, policy, and perspectives on nongame species. Despite the challenges many native fishes and unique endemic populations remain, albeit several occupy only fractions of their historical ranges. Accordingly, animals that have experienced population declines from these stressors have received more protections through formal policies such as the Endangered Species Act and have benefited from a greater general awareness of the ecology of aquatic systems. This symposium will serve as an avenue to offer insights into native fish conservation through a variety of concepts, approaches, and techniques. In keeping with the theme of the WDAFS meeting, we would like to showcase changes or continuity of native fishes (or native fish assemblages) and their habitats, and the ecological insights and management approaches that are linked with these dynamics. This symposium will consider topics relating to all native fishes, but presentations on native game fish should be considered within the context of native communities.

TITLE: Shifting Distributions of Fish Assemblages in Western Rivers: Patterns, Drivers, and Implications
ORGANIZERS: Adam Sepulveda, U.S. Geological Survey, Northern Rocky Mountain Science Center; Al Zale, U.S. Geological Survey, Montana Cooperative Fishery Research Unit; Robert Al-Chokhachy, U.S. Geological Survey, Northern Rocky Mountain Science Center; David Schmetterling, Montana Fish, Wildlife and Parks
LOCATION: 331
TIME: 8:00 – 10:00 AM
DESCRIPTION: Longitudinal changes in stream fish assemblages follow a predictable environmental gradient. Coldwater fishes such as trout occupy the headwaters, warmwater fishes such as minnows dominate downstream reaches, and coolwater fishes such as pike occur in the transition zone. Climate-induced warming and changes in discharge are predicted to result in substantial longitudinal contractions of coldwater fishes and expansions of cool and warmwater fishes. In the West, much attention has already focused on the probable contractions of distributions of coldwater salmonids, but sparse information exists about other coldwater species and most cool and warmwater fishes, many of which are nonnatives that have the potential to expand upstream and consume salmonids. In this symposium, we will share research that underscores how these distributional shifts in fish assemblages can have desirable, negative, and unanticipated consequences on socioeconomically important sport fisheries, fish populations of conservation concern, and aquatic ecosystems.

SYMPOSIA **UNIVERSITY CENTER** **8:00 AM – 4:40 PM**

TITLE: Forging Stronger Links Between Freshwater Food Web Ecology and Fisheries Management
ORGANIZERS: Erik Schoen, University of Alaska-Fairbanks; Mark Wipfli, Alaska Cooperative Fish and Wildlife Research Unit
LOCATION: 332/333
TIME: 8:00AM – 2:00 PM
DESCRIPTION: Aquatic food webs and fisheries are intrinsically linked: food web interactions support and constrain the productivity of fisheries, and fisheries management can have cascading effects on ecosystems. However, scientists and managers must bridge a gap between disciplines to fully capitalize on these links. Fisheries biologists working in lakes and streams have pioneered many of the central concepts in food web ecology, including trophic cascades, bioenergetics, spatial subsidies, and the non-consumptive effects of predators. However, scaling this rich body of research up to the large spatial and temporal scales relevant to fisheries managers has often proven challenging. Likewise, management actions such as changes in harvest, fish stocking, lake or stream fertilization, and invasive species management can provide valuable scientific insights, but in practice this requires careful monitoring and controls that can challenge the capacity of management agencies. This symposium highlights the connections between aquatic food-web research and management of river, lake, reservoir, and anadromous fisheries with the goal of forging stronger links between these fields. The session will showcase research with direct implications for fisheries management and conservation, as well as management- and conservation-oriented talks with direct scientific implications. Topics may include but are not limited to the responses of food webs and fisheries to perturbations such as climate change, invasive species, and habitat loss or restoration. Synthesis studies drawing on multiple ecosystems are particularly encouraged.

TITLE: Climate Vulnerability in Freshwater and Marine Ecosystems of Western North America: Sensitivity, Exposure, and Capacity for Adaptation
ORGANIZERS: Jeff Falke, U.S. Geological Survey, Alaska Cooperative Fish and Wildlife Research Unit; Jason Dunham, U.S. Geological Survey, Forest and Rangelands Ecosystem Science Center
LOCATION: 336/337
TIME: 8:00 – 11:00 AM
DESCRIPTION: Aquatic ecosystems of Western North America are rapidly changing owing to global climate change. However, much uncertainty surrounds our understanding of how changes to the physical environment will affect the biology and ecology of aquatic organisms to influence vulnerability at the population scale. Vulnerability assessment should be considered along three axes: sensitivity, exposure, and adaptive capacity. Recent research has moved beyond the effects of global change on species distributions to include behavioral thermoregulation, phenology, physiology, and landscape-scale assessments to the physical environment. The goal of this symposium is to bring together aquatic scientists from across a broad range of disciplines and representing a diverse array of ecosystems to share their recent research on aquatic species climate vulnerability in Western North America. These studies will cover the range from basic to applied biology, ecology, and management.

THURSDAY, MAY 25

SYMPOSIA **UNIVERSITY CENTER** **8:00 AM – 4:40 PM**

TITLE: Environmental Flow: Using Instream Flow and Water Policy to Benefit Western Fisheries
ORGANIZERS: Pat Saffel, Montana Fish, Wildlife & Parks; Andy Brummond, Montana Fish, Wildlife & Parks; Pat Byorth, Trout Unlimited; Tracy Wendt, Big Thompson Watershed Coalition
LOCATION: Theater
TIME: 8:00 AM – 4:20 PM
DESCRIPTION: Fish need water and so does everything else. Water is the foundation for a way of life in the west, as well as aquatic ecology and fisheries. Finding a balance between water use for agriculture, industry, communities and instream flow has been a challenge. Trends of decreasing water supply and increasing demand are further stressing water allocation policy and practice. The Western Division AFS meeting offers a unique opportunity to bring experts together to learn from each other about the basic need of fish: water. This symposium seeks to inform fishery professionals about 1) the basics of water law and policy, 2) tools used to conserve water and improve instream flow, and 3) the state of the science regarding the ecological responses to instream flow. To enhance learning, a key element of this symposium is comparing and contrasting socio-political, practitioner and scientific experiences.

BANQUET, AWARDS, AUCTION, AND RAFFLE **UC BALLROOM N& S** **6:00 – 11:00 PM**

GUEST SPEAKER: KURT FAUSCH
TIME: 7:00 – 7:20 PM

Kurt Fausch is a professor in the Department of Fish, Wildlife, and Conservation Biology at Colorado State University, where he has taught for 35 years. His research collaborations in stream ecology and fish conservation have taken him throughout Colorado and the West, and worldwide, including to Hokkaido in northern Japan. His experiences were chronicled in the PBS documentary *RiverWebs*, and the 2015 book *For the Love of Rivers: A Scientist's Journey*, which recently won the Sigurd Olson Nature Writing Award. He has received lifetime achievement awards from the American Fisheries Society (Award of Excellence) and the World Council of Fisheries Societies (International Fisheries Science Prize), and served as the acting director of the Graduate Degree Program in Ecology at Colorado State University.

PRESENTATION: *WHAT IS ESSENTIAL ABOUT RIVERS FOR FISH, AND HUMANS?*
Ongoing human effects on freshwater ecosystems, including a changing climate, demand that fisheries ecologists and managers plan for the utmost in resilience in watersheds in the West, and throughout the world. Recent research indicates that many stream fishes can move long distances to find the essential habitats they need to survive, grow, and reproduce, but only when habitats are connected. Beyond the needs of fish, however, what will cause humans to want to conserve rivers, and their watersheds? A four-decade journey as a scientist has convinced me that we humans need more from rivers than simply water to drink and grow crops, and fish to see and catch. Ensuring these essential values will require bringing them to the fore and fostering a new ethic for rivers.

FROM MT CHAPTER HISTORY

George Holton, one of the founding fathers of the Montana Chapter AFS was a kind and inspiring mentor to many of our members. He was amongst the first of over 400 Fish and Wildlife graduate students from Montana State University. His 1952 M.S. thesis entitled, "A Trout Population Study on a Small Creek in Gallatin County, Montana" contained excerpts from an Alfred Lord Tennyson poem, *The Brook*.

I come from haunts of coot and hern,
I make a sudden sally
And sparkle out among the fern,
To bicker down a valley.

By thirty hills I hurry down,
Or slip between the ridges,
By twenty thorpes, a little town,
And half a hundred bridges.

Till last by Philip's farm I flow
To join the brimming river,
For men may come and men may go,
But I go on for ever.

I chatter over stony ways,
In little sharps and trebles,
I bubble into eddying bays,
I babble on the pebbles.

With many a curve my banks I fret
By many a field and fallow,
And many a fairy foreland set
With willow-weed and mallow.

I chatter, chatter, as I flow
To join the brimming river,
For men may come and men may go,
But I go on for ever.

I wind about, and in and out,
With here a blossom sailing,
And here and there a lusty trout,
And here and there a grayling,

And here and there a foamy flake
Upon me, as I travel
With many a silvery waterbreak
Above the golden gravel,

And draw them all along, and flow
To join the brimming river
For men may come and men may go,
But I go on for ever.

I steal by lawns and grassy plots,
I slide by hazel covers;
I move the sweet forget-me-nots
That grow for happy lovers.

I slip, I slide, I gloom, I glance,
Among my skimming swallows;
I make the netted sunbeam dance
Against my sandy shallows.

I murmur under moon and stars
In brambly wilderness;
I linger by my shingly bars;
I loiter round my cresses;

And out again I curve and flow
To join the brimming river,
For men may come and men may go,
But I go on for ever.

TECHNICAL SESSIONS SCHEDULE

TUESDAY 5/23/2017, 1:20 – 3:00 PM

*STUDENT PRESENTATION

	Advances in Applications of Fish Hard Part Microchemistry: Concepts and Techniques	Overcoming the Communication Breakdown Between Scientists and Stakeholders	Reconnecting Non-Anadromous Fish Populations	Review of Fish Passage/Barrier Projects: Research, Application, and Lessons Learned	Environmental DNA 2.0: What is eDNA Doing for Fisheries Today?	Reservoir and Lake Fish Dynamics Under a Climate of Change and Multi-Year Drought
Room	**330**	**331**	**332**	**333**	**336/337**	**Theater**
Moderator	**Sam Bourret**	**Nancy Leonard**	**Joe Maroney**	**Dan March**	**Taylor Wilcox**	**Phaedra Budy**
1:20 PM	Quantifying Individual Based Migration Strategies to Understand Selection on Juvenile Life-History for a Salmon Population in an Altered Landscape **Jens Hegg***	When Science Speaks: Improving Your Communication with the Press, the Public, and Policy Makers **Nancy Leonard and John Harrison**	Malad River Rainbow Trout Passage: Past Success Informing Future Design **Steve Brink**	A Baseline Swimming Assessment for Arctic Grayling: Characterizing the Volitional Swimming Performance of Arctic Grayling to Inform Passage Studies **Erin Ryan**	Environmental DNA 2.0: What is eDNA Doing for Fisheries Today? **Taylor Wilcox**	Resiliency and Vulnerability of Lentic Ecosystems and Communities to Multiyear Drought: What is Known and What Remains Uncertain **Jereme Gaeta**
1:40 PM	Evaluation of Fin Rays and Scales as Nonlethal Alternatives to Otoliths for Assessing Natal Origins in Salmonids **Jaclyn McGuire***	The Communications Secret the Pros Don't Want You To Know About **Tom Dickson**	An Automated Imaging System to Monitor Rainbow Trout Passage **Steve Brink**	Arctic Grayling and Denil Fishways: A Study to Determine How Water Depth Affects Passage Success of Arctic Grayling Through Denil Fishways **Matt Blank**	Spatio-temporal Distributions of Bull Trout and Rainbow Trout in the Bruneau-Jarbidge Rivers Wilderness **David Pilliod**	Drought Effects on Lake and Reservoir Levels in the American West **Sarah Null**
2:00 PM	Quantifying the Shifting Habitat Mosaic of Pacific Salmon Using Otolith Microchemistry and Dendritic Isoscapes **Sean Brennan**	Drawn to Science: Communicating Visually for Diverse Purposes and Audiences	Whooshh Fish Passage - Non-Anadromous Species Reconnectivity **Todd Deligan**	Steep Grade Ahead – Developing Fishway Design Criteria for Small-bodied Great Plains Fishes **Tyler Swarr***	Phased Approach for Monitoring Recolonization by Anadromous Fish of a Large, Transboundary Watershed **Matthew B. Laramie**	Drought May Compound Effects of Climate Warming on High Elevation Lakes **Kyle Christianson***
2:20 PM	Natal Origins and Migration Behavior of Kokanee Salmon in Lake Roosevelt **Tim Linley**	**Bethann Garramon Merkle**	Transport-to-Adult Return Rates Among Adfluvial Bull Trout Transported as Juveniles Downstream of Hydroelectric Dams in the Lower Clark Fork River **Eric Oldenburg**	Whitewater Parks: Implications for Fish Habitat and Fish Passage **Matt Kondratieff**	Turning Genomic Data into eDNA Assays for Detection of a Cryptic Invasion Front **Travis Seaborn**	Multiyear Drought-Driven Changes in Zooplankton Community Structure with Implications for Fish Conservation in a Large Shallow Lake **Kevin Landom**
2:40 PM	Egg vs. Water: Maternal and Incubation Water Contributions to Otolith 87Sr/86Sr **Jill Janak**		Reconnecting Migratory Westslope Cutthroat Trout Populations in the Lower Clark Fork River Following Years of Blockage **Shana Bernall**	Lolo National Forest: 15 Years of Aquatic Organism Passage **Shane Hendrickson**	Detecting Spawning of Threatened Chum Salmon Over a Large Spatial Extent Using eDNA: Implications for Monitoring Recolonization **Kris Homel**	*Mysis diluviana* Responses to Severe Drought in Three Montane Reservoirs **Brett Johnson**

TECHNICAL SESSIONS, TUESDAY 5/23/2017, 3:20 – 5:40 PM

*STUDENT PRESENTATION

	Advances in Applications of Fish Hard Part Microchemistry: Concepts and Techniques	Overcoming the Communication Breakdown Between Scientists and Stakeholders	Reconnecting Non-Anadromous Fish Populations	Review of Fish Passage/Barrier Projects: Research, Application, and Lessons Learned	Environmental DNA 2.0: What is eDNA Doing for Fisheries Today?	Reservoir and Lake Fish Dynamics Under a Climate of Change and Multi-Year Drought
Room	**330**	**331**	**332**	**333**	**336/337**	**Theater**
Moderator	**Sam Bourret**	**Nancy Leonard**	**Joe Maroney**	**Erin Ryan**	**Taylor Wilcox**	**Jereme Gaeta**
3:20 PM	The Influence of Rainbow Trout Hybridization on Natal Site Fidelity **Samuel L Bourret**	What Reporters Look For **Robert Chaney**	Conservation of Bull Trout in the Lower Clark Fork River: Evaluating the Effects of Passage, Nonnative Trout Suppression, and Habitat Restoration **Douglas Peterson**	Swimming Performance of Sauger in Relation to Fish Passage **Kevin Kappenman**	Monitoring Pacific Lamprey Distribution and Re-introduction in the Wenatchee River: an eDNA Pilot Study **Ann Grote**	The Effect of Multiyear Drought on Habitat Availability and Tributary Connectivity with Implications for Bear Lake Sculpin & Bonneville Cutthroat Trout **Hayley Glassic***
3:40 PM	Quantifying Hypoxia Exposure in Fishes Using Redox-Sensitive Chemical Markers in Otoliths **Benjamin Walther**	How to Talk about Science so that People Want to Listen and Get Involved **Patrick Ortmeyer**	An Evaluation of Variables Influencing Cutthroat Trout Colonization and Abundance in Newly Accessible Habitats Above Previously Blocking Road Culverts **Travis Schill**	Design and Construction Considerations for Remote Fish Barriers **Dan March**	Using Environmental DNA to Evaluate Invasive Species Eradication Efforts **Adam Sepulveda**	The Effect of Lake Level on Forage and Lahonton Cutthroat Trout in Pyramid Lake, Nevada **Gary Thiede**
4:00 PM	The Use of Strontium Isotope Ratios 87Sr:86Sr in Otoliths and Fin Rays to Inform Ecology, Conservation, and Management of Fishes in California **Jim Hobbs**	Four Secrets to Help Non-scientists Understand (or at least appreciate) the Science Behind the Issue **Jennifer Anders**		Restoration of a Legacy Fish Passage Barrier in the Upper Salmon River Drainage, Idaho **Chad Wiseman**	No Fish Left Behind: Environmental DNA Sampling to Ensure Successful Fish Eradication **Kellie Carim**	Water Clarity, Drought and Length-Weight Relationships of the Endangered June Sucker and Sport Fishes in a Highly Eutrophic Utah Lake **Ryan Dillingham**
4:20 PM	Estimating Behavioral Diversity of Salmonids in the Upper North Platte River Using Otolith Microchemistry **Lindsy Ciepiela***	**Panel Discussion - Ask Your Questions and Get Answers from Reporters, Policy-Makers, and Outreach Specialists**		Fish Passage at Remote Natural Barriers **Shaun Bevan**	At the Forefront: Evidence of the Applicability of Using Environmental DNA to Quantify the Abundance of Fish Populations in Natural Lentic Waters **Stephen Klobucar***	Do Reservoirs Trophic Niche Spaces Become More Crowded Under a Warmer, Drier Climate? **Phaedra Budy**
4:40 PM	Stable Isotope Analyses on Otoliths of Pacific Salmon **Yongwen Gao**			Harmony Ditch Diversion, It's Not Always Harmony **Erin Leonetti**	The Promise and Pitfalls of Fish Enumeration Using eDNA: Spatiotemporal Dynamics of Salmon DNA in a Spawning Stream **Michael Tillotson***	Finding a Way to Create Robust Fisheries in a Changing Environment **Craig Walker**
5:00 PM			**What Matters to You? Meet and Engage with AFS President Joe Margraf, AFS Executive Director Doug Austen, and Western Division AFS Officers (5-6pm)**	Regulatory Considerations for New Fish Passage Technologies **Alison Colotelo**	The Range-wide, eDNA-Based Inventory of Bull Trout: Early Results and an Ongoing Invitation **Michael Young**	**Round Table Discussion - Organization of a "Fisheries" Perspective Article**
5:20 PM				Perspectives on Restoring Connectivity and Anadromy Upstream of Impassable Dams in the Elwha and Skokomish Systems, Washington **Kathryn Sutton**	The Aquatic eDNAtlas for the American West: All Species, All Streams Through Crowd-sourcing and One Interagency Database **Dan Isaak**	

	Transformation of the Upper Clark Fork River Basin: a Story of Success, Challenges, and the Collaboration that is Making It Happen!	Contributed Presentations: Inland Fisheries Ecology and Management	The Human Element of Aquatic Restoration: Working with Stakeholders to Plan and Implement Restoration	Invasive Species and Fishery Management - an Examination of Current Issues	Fifty Years of Fisheries Genetics: Allozymes to Genomes	The Yellowstone River: A Lot Can Change in 692 Miles
Room	**330**	**331**	**332**	**333**	**336/337**	**Theater**
Moderator	**Vicki Watson**	**Mike Meeuwig**	**Tracy Wendt**	**Bruce Farling**	**Fred Allendorf**	**Leanne Roulson**
8:00 AM		2017 State of the Salmonids: Fish in Hot Water **Patrick Samuel**	A Collaborative Approach to Restoration and Flood Recovery on the Big Thompson River **Tracy Wendt**	Invasive Species and Fisheries Management: an Examination of Current Issues **Leah Elwell**	Fifty Years of Fisheries Genetics: Allozymes to Genomes **Fred Allendorf**	An Introduction to the Yellowstone River **Leanne Roulson**
8:20 AM		Temporal Variability in the Distribution and Abundance of a Desert Trout Associated with Stream Drying **Mike Meeuwig**	Collaborating to Develop a Watershed Action Plan **David Ward**	Western Lake Trout Woes - Revisited **Wade Fredenberg**	Some Neat Stuff in Fishery Genetics I Have Stumbled Across Over the Years	Mountain Whitefish Kill and Proliferative Kidney Disease in the Yellowstone River, Montana **Scott Opitz**
8:40 AM	Symposium Introduction **Vicki Watson**	The Salmonid Population Viability Project: Modelling Trout Viability in a Desert Landscape **Helen Neville**	Culture Clash and Partnership? Challenges of Implementing Watershed Restoration for Threatened and Endangered Species in Culturally-Significant Areas **Rob Lawler**	Evaluation of Suppression Methods Targeting Non-native Lake Trout Embryos in Yellowstone Lake **Nathan Thomas***	 **Robin Waples**	Aquatic Ecological Diversity Shifts Along the Yellowstone River Continuum from Trout to Sturgeon **David Stagliano**
9:00 AM	The Upper Clark Fork River: A History of Use, Abuse and Reuse **Matt Vincent**	How Many Fish Live in that River Network? A Scalable Population Estimator that uses Spatial Stream Network Models and Nonrandom Fish Density Datasets **Dan Isaak**	Implementing Process-Based Restoration in Harvey Creek, Washington, USA **Eric Berntsen**	The Northern Pike, You Should be Afraid...Be Very Afraid **Joe Maroney**	Use of Local Westslope Cutthroat Trout Stocks for Genetic Conservation **Matthew C. Boyer**	Yellowstone River Channel Migration Easement Program **Wendy Weaver**
9:20 AM	Remediation/Restoration of the Upper Clark Fork River Basin: Uncertainty, Challenges, and Successes	Describing Interactions Between Bull Trout and Lake Trout in Priest Lake, Idaho **Derek Entz***	Stream Restoration on Medicine Lodge Creek, Wyoming **Laura Burckhardt**	Invasive Northern Pike are Associated with Range Contractions of Three Native Cyprinids **Allison Stringer***	Playing God with Guppies: Testing Whether Genetic Rescue Works Using a Model Experimental System **W. Chris Funk**	Yellowstone River: A Tale of Two Spills **Alicia Stickney**
9:40 AM	 **Douglas Martin**	Are Brown Trout Negatively Impacting Yellowstone Cutthroat Trout? **Robert Al-Chokhachy**	O'Dell Springs Creek and Wetland Restoration: 13 Years of Successful Partnerships and Collaboration **John Muhlfeld**	Non-Native Trout as Invasive Species Affecting Native Fish Species **Bradley Shepard**	The Genomics of Adaptation: Lessons from Threespine Stickleback **Paul Hohenlohe**	Competing Interests on the Yellowstone: Pallid Sturgeon and the Intake Diversion Dam **Aaron Hall**

TECHNICAL SESSIONS, WEDNESDAY, 5/24/2017, 10:20 AM – 12:00 PM

*STUDENT PRESENTATION

	Transformation of the Upper Clark Fork River Basin: a Story of Success, Challenges, and the Collaboration that is Making It Happen!	Contributed Presentations: Inland Fisheries Ecology and Management	The Human Element of Aquatic Restoration: Working with Stakeholders to Plan and Implement Restoration	Invasive Species and Fishery Management - an Examination of Current Issues	Fifty Years of Fisheries Genetics: Allozymes to Genomes	The Yellowstone River: A Lot Can Change in 692 Miles
Room	**330**	**331**	**332**	**333**	**336/337**	**Theater**
Moderator	**Vicki Watson**	**Mike Meeuwig**	**Eric Bernsten**	**Bruce Farling and Bob Wiltshire**	**Fred Allendorf**	**Leanne Roulson**
10:20 AM	Fisheries Response to Remediation and Restoration Actions in the Upper Clark Fork Basin **Jason Lindstrom**	Fish Movement Patterns in the Smith River Watershed in Central Montana. **Michael Lance***	Create, Visualize, and Share 3D Models Using UAS Technology for River Restoration **Ryan Richardson**	Forecasting With a Mechanistic Model the Invasion and the Management of Brown Trout in the Logan River, Utah **Christophe Laplanche**	Selection Against Rainbow Trout Admixture Across Populations, Environments, and the Genome **Ryan Kovach**	**The Shape of a River** (12 min) **Ocean Media Institute film** *SYMPOSIUM CONCLUDED*
10:40 AM	Scale and Permanence: Fish Response to the Removal of Milltown Dam, MT **David Schmetterling**	Results from Acoustic Tracking of Redband Trout Tagged in Lake Roosevelt Tributaries **Bryan Witte***	Reach-Scale Restoration on Nevada Creek: Balancing Habitat Improvments With Traditional Agriculture in the Blackfoot Valley Montana **Ron Pierce**	Illegal Fish Introductions in Montana **Jim Vashro**	Using Genomic Data for Conservation: Range-Wide Demographic and Genetic Structure of Longfin Smelt **Mandi Finger**	*AQUATIC FILMS*
11:00 AM	Monitoring Fisheries Responses to Restoration in the Upper Clark Fork River Basin **Nathan Cook**	Rufus Woods Rainbow Trout Supplementation: A Six Year Overview of Creel Monitoring and Evaluation **Jeff Caisman**	Montana Stream Permitting Guide **Bruce Anderson**	**Moderated Discussion on Invasive Fish Issues** **Bruce Farling**	Patterns of Rainbow Trout/Westslope Cutthroat Trout Hybridization in Montana and Northern Idaho **Kevin McKelvey**	**The Memory of Fish** (54 min)
11:20 AM	Floodplain Remediation and Restoration in the Upper Clark Fork River Basin, Montana **Amy Sacry**	Using Hypolimnetic Oxygenation to Enhance a Mesotrophic Lake Coldwater Fishery **Benjamin Cross**	Stream Restoration to Improve Human Overwintering and Rearing Habitat **Warren Colyer**	What's the Deal with Invasive Crayfish in the West? A Case Study of Rusty Crayfish **Mathis Messager***	Legacy Introductions and Climatic Variation Explain Spatiotemporal Patterns of Invasive Hybridization in a Native Trout **Clint Muhlfeld**	**reelblue, LLC film**
11:40 AM	Changes in Climate, Flows and Algae Levels in the Clark Fork River **Vicki Watson**	Examining the Drivers of Cold-Water Refuges in a Large Impounded River **Francine Mejia**	The Dolores River Restoration Partnership; Reflecting on Seven Years of Watershed Restoration and Collaboration **Michael Jensen**	Introduced American Bullfrog Spread in the Yellowstone River **Adam Sepulveda**	Duplicate Loci and Gene Mapping in Fisheries Genetics: Allozymes to Next-Generation Sequencing **Garrett McKinney**	**The Lost Fish** (24 min) **Freshwaters Illustrated film**

TECHNICAL SESSIONS, WEDNESDAY, 5/24/2017, 1:20 – 3:00 PM

*STUDENT PRESENTATION

	Contributed Presentations: Emerging Technologies	Contributed Presentations: Habitat and Restoration	Invasive Species and Fishery Management - an Examination of Current Issues	Fifty Years of Fisheries Genetics: Allozymes to Genomes	Montana Chapter AFS – 50th Anniversary Symposium
Room	**331**	**332**	**333**	**336/337**	**Theater**
Moderator	**Leo Rosenthal**	**Lora Tennant**	**Bob Wiltshire and Leah Elwell**	**Ryan Kovach**	**Craig Barfoot**
1:20 PM	Whooshh Fish Passage - Results from 2016 Studies **Todd Deligan**	Distinctions in Vegetation and Fish Assemblages Among Wetland Types According to Dominant Features in Large, Shallow Lakes **Leo Bodensteiner**	Flowering Rush Facilitation of Northern Pike **Peter Rice**	Saving the Spandrels? Adaptive Genomic Variation in Conservation and Fisheries Management	Introductory Remarks, Session Overview, and Reflections on the Formation of the Chapter **Leslie Nyce, Craig Barfoot, William Gould**
1:40 PM	Evaluation of an Electric Fish Barrier on an Irrigation Canal on the Lower Gunnison River, Colorado **Dan Kowalski**	Recovery of Fish Populations and Physical Channel Characteristics in Streams Impacted by Catastrophic Debris Flows **Jason Walter**	Everything You Wanted to Know About Rock Snot. A Brief History of *Didymosphenia geminata* **Leah Elwell**	**Devon Pearse**	Early Years of the Chapter **Ron Marcoux**
2:00 PM	When Tiny Bubbles Cause Big Problems: A Systematic-Type Review of Gas Bubble Trauma in Freshwater Fishes **Naomi Pleizier***	Fish Out of Water - Regulating and Restoring Floodplain Function **Marjorie Wolfe**	Phosphorus Enrichment as a Management Strategy for Didymo Nuisance Mats in the Kootenai River, Libby, MT **Katie Vivian**	Experimental Test of Genetic Rescue in Isolated Populations of Brook Trout **Zachary Robinson***	Not Easy Being Native: The Fine Line Between Fish Icon and Cut Bait **Wade Fredenberg**
2:20 PM	Sustainable Agro-based Earthen Pond Integrated Carp Fish Farming in Pakistan: Prospects of Transfer of American Fish Feed Technologies **Muhammad Naeem Khan**	Deer Creek Floodplain Enhancement Project: A Modern Approach to Process Based Ecosystem Restoration **Kate Meyer**	Montana's Response to Invasive Mussel Detections **Patrick Saffel**	Parentage Based Tagging of a Natural Coho Salmon Population to Assess Hatchery Influence **Hayley Nuetzel***	MCAFS Advocacy Through the Years **Chris Hunter**
2:40 PM	Development of a Fully-Integrated Field eDNA Sampling and Detection System **Austen Thomas**	Riparian Vegetation, Instream Habitat, and Aquatic Biota Differences within Riparian Grazing Exclosures **Daniel Dauwalter**	Dreissenid Prevention Across the Pacific Northwest **Stephen Phillips**	Two Million Genotyped Fish and Counting: What We've Learned About Genetic Stock Identification in Salmon **Lisa Seeb**	Advocacy on the Ground and in the Water **Pat Clancey**

TECHNICAL SESSIONS, WEDNESDAY, 5/24/2017, 3:20 – 5:20 PM

*STUDENT PRESENTATION

	Contributed Presentations: Emerging Technologies	Contributed Presentations: Habitat and Restoration	Invasive Species and Fishery Management - an Examination of Current Issues	Fifty Years of Fisheries Genetics: Allozymes to Genomes	Montana Chapter AFS – 50th Anniversary Symposium
Room	**331**	**332**	**333**	**336/337**	**Theater**
Moderator	**Leo Rosenthal**	**Gary Thiede**	**Leah Elwell**	**Ryan Kovach**	**Craig Barfoot**
3:20 PM	A Video Based Electroshocking Platform to Identify Lamprey Ammocoete Habitats: Field Validation and New Discoveries in the Columbia River Basin **Evan Arntzen**	Montane Meadow Restoration in the Sierra Nevada: Understanding the Potential Impacts to Native Fish Communities **Lora Tennant**	Ecotechnology in the Age of Invasive Species **Todd Deligan**	Genome Wide Association and FST-Outlier Tests Reveal Candidate Adaptive Loci in a Unique Lacustrine Life History of a Threatened Trout **Helen Neville**	Aquatic Habitat Protection and Stream Access Montana Style, the Role of MCAFS **Larry Peterman and Jerry Wells**
3:40 PM	Estimating Pallid Sturgeon Larval Drift in the Missouri River Downstream of Fort Peck Dam Using a 3D Hydro-Acoustic River Mapper, River Analyzer **Brian Marotz**	Ecological Restoration Along the Kootenai River: Linking Food Web, Wildlife Habitat, and Aquatic Habitat **Thomas Parker**	The Efficacy of Using Electrical Waveforms to Kill the Embryos of Invasive Common Carp at Malheur Lake **Will Simpson**	Genetic Monitoring of Reintroduced Spring Chinook Salmon **Kathleen O'Malley**	Diversity Within the Chapter **Leanne Roulson**
4:00 PM	Wanted: Dead or Alive. Determining Fish Status from Mobile PIT Antenna Detection Data **Ben Stout***	Kootenai River Pool Ladder: Reach-Scale Habitat Restoration for Native Fish and Wildlife Species **Matt Daniels**	Life History Flexibility May Facilitate Colonization of Diverse Habitats by Invasive Brook Stickleback **Paul Spruell**	Demography and Genetics of a Salmonid Metapopulation **Andrew Whiteley**	Professional Networking and Team Building: Fear and Loathing at Montana AFS **Brad Shepard**
4:20 PM	Monitoring Natural-Origin Adult Chinook Salmon Escapement using Dual-frequency Identification Sonar in the Secesh River, Idaho **Clark Watry**	Fisheries Habitat Conservation... Montana Fish, Wildlife & Parks' Aquatic Habitat Protection, Mitigation and Restoration/Enhancement Programs and Legacy **Bruce Rich**	Evaluation of Potential Translocation Sites for Hornyhead Chub **Brian Hickerson***	Domestication and Fitness Decline in Hatchery Steelhead: Why Does it Happen So Fast? **Michael Blouin**	Science: It Was Good While It Lasted **David Schmetterling**
4:40 PM	Necessity-Driven Changes to Fisheries Monitoring in a Fragile Ecosystem: From Codends to Cameras **David Ayers**	Kootenai River Restoration Opportunities: A Riparian Habitat Suitability Analysis **Selita Ammondt**		Isolation, Migration, and Local Recruitment Drive Persistence of Cutthroat Trout in Tributaries near American Falls Reservoir **Daniel Bingham**	**General Reminiscence: Open Mic Session**
5:00 PM				Symposium Endnote: Why Has Genome Science Had Such a Profound Effect on the Conservation of Pacific Salmonids? **Jim Seeb**	

	Native Non-Game Fishes: Ecological Insights and Management Approaches	Shifting Distributions of Fish Assemblages in Western Rivers: Patterns, Drivers, and Implications	Forging Stronger Links Between Freshwater Food Web Ecology and Fisheries Management	Climate Vulnerability in Freshwater and Marine Ecosystems of Western North America: Sensitivity, Exposure, and Capacity for Adaptation	Environmental Flow: Using Instream Flow and Water Policy to Benefit Western Fisheries
Room	**330**	**331**	**332/333**	**336/337**	**Theater**
Moderator	**Nate Cathcart**	**Robert Al-Chokhachy**	**Mark Wipfli**	**Jeff Falke**	**Pat Saffel**
8:00 AM	Riverscape Genomics of Speckled Dace Differ by Basin in Western North America **Steven Mussmann***	Shifting Fish Distributions in the Yellowstone River with a Focus on Introduced Smallmouth Bass **Adam Sepulveda**	Can Short-Term Nutrient Additions Lead to Long-Term Recovery of Pacific Salmon? **Joseph Benjamin**	Climate Vulnerability and Salmonids in Alaska: Hind- and Forecasting Freshwater Growth and Phenology Across Species and Habitats **Jeff Falke**	Our Future in a Warming, Water-Stressed World **Robert Glennon**
8:20 AM	Taxonomic Revisions for Cutthroat Trout: What Can This Charismatic Sportfish Teach Us to Address Taxonomic Uncertainty in Other Fishes? **Luke Schultz**	Range Boundary Dynamics Reveal Drivers and Limits of Smallmouth Bass Distribution in Pacific Northwest Streams **Erika Rubenson***	Using Food Webs to Guide Conservation Propagation of Pallid Sturgeon **Addie Dutton***	A Remote Sensing and Occupancy Estimation Approach to Quantify Spawning Habitat Use by Fall Chum Salmon Along the Chandalar River, Alaska **Chelsea Clawson***	
8:40 AM	Stonecat Ecology in St. Vrain Creek **Timothy D'Amico***	In Defense of Resident Bull Trout **Chris Clancy**	Foraging Ecology and Production of Rio Grande Cutthroat Trout in the Face of Mounting Ecological Pressures **Brock Huntsman**	Migration Patterns of Adult Chinook Salmon in Two Southeast Alaska Transboundary Rivers **Kristin Neuneker***	An Overview of Water Law for Fisheries Biologists
9:00 AM	Distribution of and Habitat Use by the Salish Sucker, an Endemic Species West of the North Cascades **James Helfield**	Wyoming's Powder River Sturgeon Chub: Here, Gone, and Back Again **Bill Bradshaw**	Linking Spatial and Food Web Complexity: Perspectives from a River-Floodplain and Implications for Restoration and Salmonid Conservation **James Paris***	Drought and Water Availability in Western Riverscapes **Jason Dunham**	
9:20 AM	Olympic Mudminnow, Where Art Thou? **Lauren Kuehne**	Understanding Multiple Impacts of Hydrologic Alteration on Native Fish Communities in the Rio Grande, Texas and Mexico **Brian Laub**	Growth and Foraging Patterns of Juvenile Chinook and Coho Salmon in Three Geomorphically Distinct Sub-Basins of the Kenai River **Benjamin Meyer***	Climate Warming Rates of Salmon and Trout Rivers in the West: Implications for Conservation and Management **Dan Isaak**	**Tom Annear and Laura Ziemer**
9:40 AM	Examining Distribution and Habitat Preferences of Native Fishes in a Coastal Basin of Washington State **Marie Winkowski**	Otolith Microchemistry Reveals Inter-Annual Shifts in the Quality of Juvenile Sockeye Salmon Habitats in a Remote Alaskan Watershed **Timothy Walsworth**		Climatic Variation and Linkages to Patterns of Yellowstone Cutthroat Trout Growth, Condition, and Behavior **Robert Al-Chokhachy**	Squeezing Water from Stones: Developing an Instream Flow Program in Utah. **Paul Burnett**

TECHNICAL SESSIONS, THURSDAY, 5/25/2017, 10:20 AM – 12:00 PM *STUDENT PRESENTATION

	Native Non-Game Fishes: Ecological Insights and Management Approaches	Forging Stronger Links Between Freshwater Food Web Ecology and Fisheries Management	Climate Vulnerability in Freshwater and Marine Ecosystems of Western North America: Sensitivity, Exposure, and Capacity for Adaptation	Environmental Flow: Using Instream Flow and Water Policy to Benefit Western Fisheries
Room	**330**	**332/333**	**336/337**	**Theater**
Moderator	**Luke Schultz**	**Mark Wipfli**	**Jeff Falke**	**Pat Byorth**
10:20 AM	Do Spawning and Rearing Habitat Contribute to the Recruitment Bottleneck of Imperiled Bluehead Sucker? **Bryan Maloney***	Can Amphibians Help Conserve Native Fish? **Niall Clancy***	Accounting for Adaptive Capacity and Uncertainty in Assessments of Species' Climate Change Vulnerability: Applications to Threatened Salmonids **Alisa Wade**	Evaluating the Transferability of Flow-Ecology Relationships Across Space, Time, and Trait Guilds **William Chen***
10:40 AM	Spatial Positioning in a Desert Tributary Network Affect Larval Growth, Recruitment, and Community Associations of an Imperiled Migratory Catostomid **Nate Cathcart**	Ecological Tradeoffs Between Commercial Salmon Fisheries and Foraging Opportunities for Trout **Timothy Cline***	The 2015 Columbia River Salmon Migration-An Omen for the Future in a Warming World? **Jeff Fryer**	Restoring Streamflow in Coastal California **Matt Clifford**
11:00 AM		Effects of Nonnative Brown Trout on the Foraging Ecology of Rio Grande Cutthroat Trout **Quintin J. Dean***		Restoring Streamflow in Oregon's Deschutes Basin: Tailoring Tools to Context **Kate Fitzpatrick**
11:20 AM		Exploring the Isotopic Niche in Rocky Mountain-Great Plains Fish Communities **Bryan Maitland***		Instream Flow Protection in Washington State: Mitigation Challenges and Opportunities **Kiza Gates**
11:40 AM		Can We Manage Resource Subsidies and Food Webs to Benefit Fishes and Fisheries? **Mark Wipfli**		Colorado's Water Plan: Stream Management Planning and Watershed Health **Chris Sturm**

	Contributed Presentations: Environmental Biology	Contributed Presentations: Salmon and Hatcheries	Forging Stronger Links Between Freshwater Food Web Ecology and Fisheries Management	Contributed Presentations: Genetics	Environmental Flow: Using Instream Flow and Water Policy to Benefit Western Fisheries
Room	**330**	**331**	**332/333**	**336/337**	**Theater**
Moderator	**Kari Dammerman**	**Paul Kusnierz**	**Mark Wipfli**	**Matt Boyer**	**Christopher Estes and Tracy Wendt**
1:20 PM	Sound Passages in Migration of Semipelagic Icefish **Ryszard Traczyk**	Evaluating the Size Selectivity of Mid-Water Trawls for Sampling Kokanee **Zachary Klein***	Partnering to Preserve Natural Diversity, Ecosystem Health, and Subsistence Fishing Opportunities Across the Yukon River Basin. **Aaron Martin**	Ash Meadows Amargosa Pupfish: Genetic Effectiveness Monitoring **Mary Peacock**	Environmental Flow Restoration: Perspective from the Trenches **Jedediah Whiteley**
1:40 PM	Saving Genetic Material in Growth of the Otolith **Ryszard Traczyk**	A Comparative Analysis of the Bristol Bay, Southeast, and Kenai River Fisheries: Tracking Stakeholder Participation over the Last 15 Years **Meagan Krupa**		Juvenile Sampling of Bull Trout for Genetic and Population Monitoring **Stephen Amish**	Forecast Informed Reservoir Operations: A Tool to Manage Flows for Fisheries, Water Supply, and Flood Control in California's Russian River Watershed **David Manning**
2:00 PM	Changes in Water Chemistry and Biological Communities Associated with Metal Mining in Streams in the North Cascades **Brooke Bannerman***	Spawning Area Residence Related to Freshet Timing in an Ocean-type Chinook Salmon Population **Roger Dunlop**		Responding Rapidly: Use of Real-Time Genetic Analysis and Genetic Monitoring to Conserve Bull Trout in the Lower Columbia River. **Brice Adams**	Environmental Streamflow Restoration in the Eastern Cascades through Large Scale Irrigation Improvements and Improved Water Management **Aaron Penvose**
2:20 PM	Mercury, Selenium and Microbial Dynamics in Water and Sediment During High- and Low-Flow, Bighorn Lake, Bighorn National Recreation Area, MT/WY **Elliott Barnhart**	A Potential Success Story of a Conservation Hatchery **Jennifer Von Bargen**		Genotype-Environment Interactions Increase Summer Growth of Hybrid Rainbow x Cutthroat Trout in Three Wild Populations **Jeffrey Strait***	Multi-Scale Response of Migratory Native Trout to Irrigation-Based Restoration in the Blackfoot Valley, Montana **Ron Pierce**
2:40 PM	Evaluating the Distribution of Estrogenic Effects Below Wastewater Treatment Plants: Estrogen Persistence and Fish Movement **Jordan Anderson***	Columbia River Basin Steelhead Kelt Reconditioning Research **Andrew Pierce**		Introgression between Native Redband Trout and Coastal Origin Hatchery Rainbow Trout in the Northern Great Basin **Patrick DeHaan**	Total Dissovled Gas Levels Below Foster Dam and Implications for Chinook Salmon and Steelhead Populations **Ryan Flaherty**
3:00 PM	**Break**				
3:20 PM		Parentage Based Tagging Reveals Overestimation of the Proportion of Natural-origin Chinook Salmon and Steelhead in the Columbia River Basin **Daniel J. Hasselman**		Adaptation to Residency in Rainbow Trout Above Barriers to Migration: Alternative Molecular Pathways Towards a Predictable Phenotype **Matthew A. Campbell**	Fine Tuning the Relationship Between Shovelnose Sturgeon Spawning and Discharge in a Tributary to the Missouri River, Montana **Anne Tews**
3:40 PM		Evaluating Minijack Rates in Spring Chinook: Comparing Minijack Rates Based on Spring Plasma 11-ketotestosterone Levels with Rates Based on Fall GSI **Lea Medeiros**			Restoring Flow and Rehabilitating Diversion Structures in the Lostine River, Oregon: Benefits to Chinook Salmon Spawning Migration **Aaron Maxwell**
4:00 PM		Monitoring and Evaluation Programs at National Fish Hatcheries in the Columbia River Gorge **Kari Dammerman**			The Yellowstone Concerto and the Hidden History of Film in Environmental Protection Movements **Nick Bergmann**

Responding Rapidly: Use of Real-Time Genetic Analysis and Genetic Monitoring to Conserve Bull Trout in the Lower Columbia River

Brice Adams [α]
US Fish and Wildlife Service

Patrick DeHaan, Jeremiah Doyle

The Lewis River, WA represents one of two spawning populations of Bull Trout *Salvelinus confluentus* in the lower Columbia River basin. This watershed is fragmented by three mainstem hydroelectric dams that prevent fish from migrating upstream and returning to spawning tributaries. The goal of this project was to establish a long-term monitoring program for Bull Trout in the Lewis River using genetic stock identification to aid in passage of adult Bull Trout collected below impassable dams. Beginning in 2010, the Abernathy Fish Technology Center (AFTC) developed a genetic baseline for the upper Lewis River watershed using juvenile Bull Trout collected from the three main spawning tributaries. Assignment simulations indicated that juvenile fish could be assigned back to their population of origin with high confidence. From 2011 through the present, PacifiCorp has initiated an effort to capture adult Bull Trout below migratory barriers and use genetic assignment tests to inform upstream passage to spawning tributaries. In addition, tissue samples from juvenile fish collected in the three main spawning tributaries are annually sampled to facilitate ongoing evaluation and improvement of the original juvenile baseline and for genetic monitoring of the populations. The resulting dataset has allowed us to provide population assignment information for 141 captured Bull Trout and to recently begin tracking the effective number of breeders in each spawning tributary.

Are Brown Trout Negatively Impacting Yellowstone Cutthroat Trout?

Robert Al-Chokhachy [α]
U.S. Geological Survey

Adam Sepulveda

Brown Trout *Salmo trutta* are a socioeconomically valuable sportfish throughout the West. Recently in many streams of Montana, Brown Trout have been expanding their distribution into headwater streams, which has led to concern of the potential impacts to native Cutthroat Trout *Oncorhynchus clarkii* populations. To address this concern, we initiated a comprehensive study to investigate the impacts of Brown Trout to a headwater population of Yellowstone Cutthroat Trout *Oncorhynchus clarkii bouvieri* (YCT) in Duck Creek, a tributary to the Yellowstone River. An allopatric population of YCT exists above a natural barrier, below which the species is sympatric with Brown Trout. We quantified potential interspecific effects by conducting (1) a dietary study of both populations using gastric lavage and stable isotope approaches and (2) comprehensive mark-recapture study to evaluate patterns of growth and survival across age classes of YCT in allopatric and sympatric locations. An index of diet overlap of 0.82 suggests considerable similarity in diets between the 2 species in sympatry-a pattern consistent with stable isotope data. We found YCT to have significantly lower condition and growth rates in the presence of Brown Trout which likely led to the observed lower survival when sympatric with Brown Trout. Our results highlight the concerns of shifting distributions of Brown Trout to headwater populations of Cutthroat Trout, particularly given the importance of headwater populations as key sources of recruitment within connected stream networks.

Climatic Variation and Linkages to Patterns of Yellowstone Cutthroat Trout Growth, Condition, and Behavior

Robert Al-Chokhachy [α]
U.S. Geological Survey, Northern Rocky Mountain Science Center

Brad Shepard, Adam Sepulveda

Given, the strong influence of climate and hydrologic regimes on the phenology, demographic, and life-history patterns of inland trout, there is growing concern as how changes in climate may influence native trout populations. To address this uncertainty, we initiated a mark-recapture field study in 2011 in tributaries in Spread Creek (n = 3), WY and the Shields River, MT (n =3) to empirically quantify how climatic change will influence populations of Yellowstone Cutthroat Trout *Oncorhynchus clarkii bouvieri*. We used multiple sampling events within and across years to evaluate how climate may be linked with patterns of condition, growth, survival, and behavior. We also examined how phenology was tied to climatic patterns using existing weir and trap data from WY. Our results illustrate the strong ties between fluvial cutthroat trout and hydrology. Within resident populations, we our results indicate the importance of streamflow in driving fish growth and condition in our study streams. Our movement data indicated emigrants from tributary streams to have significantly lower condition than resident fish, suggesting the importance of condition in factors influencing emigration. For resident populations, we observed considerably lower survival for larger fish, suggesting selection towards smaller individuals. Together our results provide important insights into the factors influencing the demographic and life-history patterns of cutthroat trout.

Fifty Years of Fisheries Genetics: Allozymes to Genomes

Fred Allendorf [α]
University of Montana

Ryan Kovach

No field of fisheries biology has advanced more rapidly over the last 50 years than genetics. Genetic data now inform everything from harvest of the most abundant fishes to conservation of the rarest. Members of the Western Division of the AFS were international pioneers in the application of genetics to fisheries beginning with work at the National Marine Fisheries Service in the 1950s aimed to identify the continent of origin of salmon caught in the Pacific Ocean. Population genetic data and theory now are integrated into nearly every facet of fisheries conservation and management in marine and freshwater environments. In light of the theme for the meeting, the purpose of this symposium is to describe the development of fisheries genetics over the last 50 years and how these advances resolve conservation or management problems. Further, we will highlight how ongoing or potential advances will chart the course of fisheries genetics into the future. In particular, we will feature how genomics can address previously intractable questions that are directly relevant to management and conservation (e.g., the genomic basis of inbreeding and outbreeding depression, functional trait variation, etc.). Continuity and historical context are crucial elements of this symposium. Speakers will highlight where we have come from, where we are going, and what this means for management and conservation.

Juvenile Sampling of Bull Trout for Genetic and Population Monitoring

Stephen Amish [α]
University of Montana

Matt Boyer, Robb Leary, Seth Smith, Angela Lodmell, Gordon Luikart

The presence of family spatial structure can bias results for some genetic estimators like the effective population size per generation (Ne) or the number of successful spawners per year (Nb). Ideally samples should contain a representative but random subset of individuals from all families while providing the minimum sample size required for precise estimates. We used juvenile Bull Trout *Salvelinus confluentus* samples from three cohorts (age-0, age-1, age-2) collected from multiple stream reaches in each of three different streams to test for the effects of family structure on estimates of Nb. Similar to published results for Brook Trout *Salvelinus fontinalis*, we found that samples from multiple stream reaches were required to account for family structure and accurately estimate Nb. Strong clustering of full sib pairs existed at distances up to approximately 600m, especially in age-0 fish, suggesting a minimum distance between sampling transects to reduce the potential of family bias. In addition, we examine Nb estimates across a 6-year period and compare them to redd counts.

Kootenai River Restoration Opportunities: A Riparian Habitat Suitability Analysis

Selita Ammondt [α]
River Design Group, Inc.

Chris Nelson, Matt Daniels, Norm Merz, Gregory Hoffman, Dwight Bergeron

Riparian and aquatic habitat conditions on the Kootenai River downstream of Libby Dam, Montana, are influenced by the dam's effects on natural riverine processes. Libby Dam operations have altered flow and sediment regimes downstream of the dam by reducing peak flow magnitude, changing the timing (seasonality) of the hydrograph, and retaining the upstream sediment supply. Kootenai River temperature and nutrient regimes, which support primary productivity of the food web, have also been modified. The net result of these changes is a less dynamic river and an altered ecosystem that affects fish and wildlife resources along the river corridor. As part of a collaborative effort, the Kootenai Tribe of Idaho, Montana Fish Wildlife and Parks, and the U.S. Army Corps of Engineers retained River Design Group, Inc. to identify restoration opportunities on a 62-mile reach of the Kootenai River between Libby Dam, Montana and Moyie Springs, Idaho. A restoration suitability analysis was conducted, with emphasis on vegetation communities which support Kootenai River food web ecology. A hydraulic model was completed for the study area, and riparian vegetation communities were surveyed at reference locations. Existing vegetation categories were then compared with flow magnitude and flow duration, target flows for vegetation recruitment and establishment were identified, and mapping of riparian habitat potential and restoration opportunities was completed.

Four Secrets to Help Non-scientists Understand (or at least appreciate) the Science Behind the Issue

Jennifer Anders [α]
Northwest Power and Conservation Council

Scientists are experts in their field, yet they are not always effective at communicating their knowledge to decision makers and stakeholders. Decision makers, on the other hand, are often impatient and expect simple answers to complex questions. If scientists don't appreciate this dynamic, they risk being misunderstood or completely ignored. With careful planning, however, this language barrier can be overcome. Here are four key steps to deliver an effective message and ensure that you are understood: (1) Know your audience (2) Make them feel smart (3) Tell them once, tell them twice, tell them three times (4) Know what you want from them, and don't be afraid to ask for it.

Evaluating the Distribution of Estrogenic Effects Below Wastewater Treatment Plants: Estrogen Persistence and Fish Movement

Jordan Anderson [α *]
Colorado State University

Dana Winkelman, Aaron Jastrow

Estrogens are endocrine disrupting contaminants (EDCs), a large group of chemicals that can impair normal endocrine function. Our goal was to better understand the distribution of estrogenic effects downstream of wastewater treatment plants (WWTPs) in the South Platte River drainage. To do this, we estimated the downstream persistence of estrogenic exposure and evaluated differences in responses to an estrogen between wild and laboratory Fathead Minnows *Pimephales promelas*. To evaluate the persistence of estrogenic effects downstream of WWTPs, male Fathead Minnows were caged at two WWTPs at the following intervals: one cage placed upstream of the effluent, one cage placed in the effluent, and four cages placed downstream at 400 m, 800 m, 1600 m, and 3200 m downstream of the effluent. Ten male Fathead Minnows were added to each cage and left for one week, at which point the cages were removed, the fish euthanized, and livers extracted for Vitellogenin (Vtg) analysis. The results of the caging were mixed with Vtg upregulation being quickly attenuated at one WWTP, and persisting for over two miles at the other. To evaluate previously observed Vtg differences between laboratory and wild fish exposed in streams, we conducted a laboratory study. We compared the Vtg response in laboratory and wild populations of Fathead Minnows exposed to 17Î± ethinylestradiol for seven days. Laboratory and wild populations expressed similar high levels of Vtg compared to controls.

Montana Stream Permitting Guide

Bruce Anderson [α]
WGM Group

The first edition of the Montana Stream Permitting Manual was published in 2001 as a tool to promote best management practices for proposed projects under 310 permitting guidelines. For more than 15 years, the manual helped both applicants and conservation districts in reviewing applications and strategies to reach decisions that considered stream process, landowner needs, and regulatory requirements. The DNRC interagency workgroup is presently updating the guide to reflect current best practices and regulatory process changes, including more extensive local and federal permitting requirements under FEMA (County floodplain) and the Army Corps of Engineers (Clean Water Act/404). While the content will continue to serve conservation district supervisors and other permitting entities, the updates will also help inform landowners and the general public interested in stream management and restoration. The guide includes an overview of permitting considerations, an introduction to stream morphology and function, project triage and selection, and strategies to address stream management issues in a balanced and ecologically sound fashion. Pragmatic approaches to bioengineering, river function, bank stability, flooding, irrigation structures, fish passage and other topics feature prominently.

An Overview of Water Law for Fisheries Biologists

Tom Annear [α]
Wyoming Game and Fish Dept

To effectively manage rivers and lakes, resource managers must integrate their understanding of complex ecological processes within legal constructs and institutional capacities while meeting some level of public expectation. Though many western states have instream flow laws, a 2009 study by the Instream Flow Council found that most states lack adequate laws and policies. In almost all states it remains much easier to take water out of streams than it is to leave it in. Though river and lake science has improved greatly in the past 30 years state instream flow laws have changed little. Arguably, at least one of the reasons for the dearth of legal mechanisms is an imperfect or incomplete understanding by fishery managers of basic legal concepts and principles that must be addressed to craft truly effective laws. While far from a complete treatise on the nuances of western water law, this paper delves into a relatively comprehensive range of terms and concepts that are important to know and address when managing water for fisheries in rivers and lakes. The paper drills down into key areas such as a) why instream flow laws are needed, b) what legal challenges need to be addressed when crafting laws, c) what the differences are between water rights and water management, d) the characteristics of good instream flow and water volume laws, and e) what actions biologists should focus on to improve the legal ability to better manage water for fisheries.

A Video Based Electroshocking Platform to Identify Lamprey Ammocoete Habitats: Field Validation and New Discoveries in the Columbia River Basin

Evan Arntzen [α]
Pacific Northwest National Laboratory

Robert Mueller

The deep water electroshocking platform (DEP), developed to sample larval lampreys (ammocoetes) and associated habitat in depths up to 15 m, was recently tested in the field. Searches were conducted at a known rearing location (mouth of the Wind River, WA) and at locations on the Cowlitz River, WA, where ammocoetes had not previously been found. At the Wind River, video imaged ammocoetes ranged from 50 to 150 mm in water depths between 1.5 m and 4.5 m and were more common in sediments containing organic silt. Ammocoetes (n=137) were detected at 61% of search locations (summer) and 50% (winter). Following the field verification, the DEP was used on the lower 11.7 km of the Cowlitz River. Ammocoetes (n=41) were found at 26% of search locations. Cowlitz River lamprey habitat was also dominated by organic silt, often downstream of alluvial bars in water depths from 0.8 to 1.7 m. Test results indicated the DEP was successful at detecting ammocoetes. The DEP can also be used to characterize lamprey ammocoete physical habitat characteristics.

Necessity-Driven Changes to Fisheries Monitoring in a Fragile Ecosystem: From Codends to Cameras

David Ayers [α]
United States Geological Survey

Collin Smith, Darren Odom, Matt Young, Fred Feyrer

Despite many advances in fish ecology, field sampling techniques have remained largely unchanged over time. As a result, much of this work is done using prodigious amounts of expensive human labor - limiting sampling frequency and the resulting inference. Additionally, most techniques involve the physical capture and handling of fish, imparting considerable stress, mortality risks, and sometimes limiting access to sampling permits. Together, these factors can limit scientific understanding of fish populations and preclude effective management solutions for recovering imperiled species. These difficulties are particularly relevant in the Sacramento-San Joaquin Delta, a highly altered estuary that contains several endemic fish species threatened with extinction. The challenges facing native fishes are particularly complex here and require process-based ecosystem understanding to develop management solutions. Our work emphasizes these objectives and seeks to incorporate a fundamental rethinking of traditional fish sampling procedures. In particular, we have focused on non-invasive and autonomous approaches using visual and acoustic cameras. To accommodate this voluminous image data, we developed platforms for object tracking and fish identification using machine learning. Through such developments, we become increasingly capable of obviating traditional limitations, facilitating enlarged sample sizes, and extending ecological understanding.

Changes in Water Chemistry and Biological Communities Associated with Metal Mining in Streams in the North Cascades

Brooke Bannerman [α *]
Western Washington University

Leo Bodensteiner, Ruth Sofield, Ashley Rawhouser

The Ruby Creek watershed in Mount Baker Snoqualmie National Forest has the highest concentration of mining and prospecting sites in the Cascade Range along with nearly 50 km of accessible spawning and rearing habitat for resident and adfluvial Rainbow Trout *Oncorynchus mykiss* and Bull Trout *Salvelinus confluentus*. The coincidence of hard rock mining and suction dredging operations with fish habitat prompted concern about their potential effects on aquatic life. Samples of stream water and biota were collected from 13 sites located upstream and downstream of mining operations during summer, 2015. Monthly grab samples from surface water were used to assess spatial and temporal changes of several metal concentrations. Periphyton collections were evaluated to assess metal accumulation in biota. Abundance and community structure of benthic macroinvertebrate communities were examined for indications of disturbances associated with mining. Water chemistry at locations downstream of active mining differed from non-mining locations. On occasion lead and cadmium concentrations exceeded EPA Aquatic Life Criteria for chronic exposures. Metals accumulated in periphyton collected downstream of mining were distinguishable from samples collected from unmined regions. The kinds and quantities of metals detected in water and biota downstream of active hard rock mining and suction dredging may be adversely affecting native trout and other aquatic life.

Mercury, Selenium and Microbial Dynamics in Water and Sediment during High- and Low-Flow, Bighorn Lake, Bighorn National Recreation Area, MT/WY

Elliott Barnhart [α]
U.S. Geological Survey

David Naftz, Collin Eagles-Smith, Mike Ruggles, Zachary Eddy, David Krabbenhoft

Mercury (Hg) bioaccumulation is pervasive in aquatic ecosystems in the Western United States. Bighorn Lake is a highly utilized fishing reservoir in Montana and Wyoming and provides streamflow to the Bighorn River below Yellowtail dam. This section of the Bighorn River is one of the most visited sport fisheries in the U.S.; however, Hg bioaccumulation appears to currently (2016) be constrained to the reservoir. Recent (2015) fish tissue samples collected from Bighorn Lake during this study had an average Hg concentration above 1.0 Î¼g/g wet weight from 12 walleye *Sander vitreus* fillets (average fish length = 46.7 cm). An additional concern for Bighorn Lake is the input of selenium (Se) and the potential antagonistic interaction of Se and Hg with respect to toxicity modifications in fish. Changes in the loadings of Hg and Se entering Bighorn Lake from the Shoshone and Bighorn Rivers during 2015 and 2016 were determined. Two synoptic sampling events during high- (early July 2015) and low- (late August 2016) flow conditions in Bighorn Lake were conducted to document chemical, physical, and microbiological changes occurring. Near-surface sediment samples from multiple locations were analyzed for Hg total and MeHg and water samples from the same locations were analyzed for Se, Hg, MeHg, and associated chemical constituents. Microbial 16S rRNA genes were also analyzed from these samples for the identification of potential Hg methylators.

Can Short-Term Nutrient Additions Lead to Long-Term Recovery of Pacific Salmon?

Joseph Benjamin [α]
U.S. Geological Survey

Ryan Bellmore, Emily Whitney, Jason Dunham

In response to declining salmon populations, multiple restoration actions have been implemented in the tributaries where salmon spawn and rear. Among these is the addition of salmon carcasses or an analog to mimic marine derived nutrients historically provided by large spawning runs of salmon. The assumption is the increase in nutrients will 'jump start' a positive trend to population growth. Although immediate effects on aquatic ecosystems, such as increasing primary production, invertebrate biomass, and fish biomass and growth have been observed, it is unclear if nutrient additions can result in long-term population growth for salmon. To test this assumption and uncertainty, we linked a food web model with a salmon life cycle model to evaluate the short and long-term effects of carcass additions in a on a salmon population. Results confirmed increases in biomass of periphyton, invertebrates, and fish during carcass additions. In addition, the larger size of juvenile salmon improved survival and the abundance of smolts migrating to the ocean, which translated to a greater number of adults returning, further influencing the positive feedback of salmon on the food web. However, once additions ceased, biomass and abundance levels gradually returned to previous conditions, which may be due to factors outside the tributaries. For instance, if survival can be improved downstream, populations may increase and provide the benefits of marine derived nutrients over time.

The Yellowstone Concerto and the Hidden History of Film in Environmental Protection Movements

Nick Bergmann [α]
Montana State University

Historical scholars studying environmental protection in the United States have largely overlooked the critical role of documentary film in shaping political outcomes. From a crusade to designate wilderness in the North Cascades to the struggle to remove dams from the Klamath River, film has helped sway public opinion and influence key political decisions. During the 1970s the Montana Department of Fish and Game led the charge to keep major impoundments off the Yellowstone River. Responding to the threat of large-scale industrial coal development in the Northern Plains, the agency sought to capitalize on a progressive legal mechanism that allowed various government entities to reserve instream flows for the benefit of fish, wildlife, recreation, and water quality. As part of the strategy to increase support for its reservation request, Fish and Game produced a 32-minute color film entitled The Yellowstone Concerto. A moving tribute to the aesthetic, ecological, and agricultural values of the river, it argued for an understanding of the Yellowstone that transcended economic utility. Viewed by thousands of Montanans during the late 1970s, The Yellowstone Concerto helped generate enough support to secure a 5.5 million acre-feet instream water reservation. Although this fulfilled the film's original purpose, it continued to influence environmental issues outside of the Yellowstone River Basin and even today remains a tool used to protect instream flows.

Reconnecting Migratory Westslope Cutthroat Trout Populations in the Lower Clark Fork River Following Years of Blockage

Shana Bernall [α]
Avista Corporation

Jacob Johnson

Migratory Westslope Cutthroat Trout *Oncorhynchus clarkii lewisi* historically traveled the lower Clark Fork River between spawning tributaries in Montana and Lake Pend Oreille, Idaho. In the 1950s, two mainstem dams were constructed on the lower Clark Fork River that are currently owned by Avista. Avista began implementing the Native Salmonid Restoration Plan in 2001 to mitigate for impacts of the dams on native salmonid populations, including blocked migration. Avista is working closely with other stakeholder groups to develop affective fish passage including the future construction of a fish capture facility at Cabinet Gorge Dam. In the interim, connectivity for migratory adult Bull Trout *Salvelinus confluentus* has been facilitated by a capture and upstream transport program. Following genetic and pathogen surveys, this upstream passage effort was expanded in 2015 to include Westslope Cutthroat Trout. Radio transmitters were implanted in a targeted number of Westslope Cutthroat Trout visually assessed to be phenotypically pure in 2015 and 2016. These fish were transported upstream of Cabinet Gorge Dam and released into Cabinet Gorge Reservoir and fish movements were monitored. Westslope Cutthroat Trout have been transported at various times of the year in an effort to determine transport time periods that will increase the likelihood of spawning following upstream transport. The results of these monitoring efforts are being used to further define the future of this transport program.

Implementing Process-Based Restoration in Harvey Creek, Washington, USA

Eric Berntsen [α]
Kalispel Tribe Natural Resources Department

Kate Day

Native Bull Trout *Salvelinus confluentus* and Westslope Cutthroat Trout *Oncorhynchus clarki lewis*i populations have been declining on Kalispel Tribe aboriginal lands in northeastern Washington State, primarily due to the presence of Brook Trout *Salvelinus fontinalis*, which compete with native trout for food and other resources and increased road densities that can isolate populations and produce sediment yields in excess of natural background levels. These factors combined can lead to unharvestable population levels. In order to protect and restore native trout populations, it is necessary to assemble a group of invested stakeholders, identify a mutually-agreed upon restoration goal, delineate and quantify the physical and biological processes that create productive aquatic habitats and identify and prioritize projects that address root causes of impairment to habitat forming processes. This presentation describes the methodology that was used in the Harvey Creek watershed to help identify native trout habitats that are either 1) important to protect, 2) a high priority to restore, or 3) least sensitive to impacts from changes in land use and identify and prioritize projects that address root causes of impairment.

Fish Passage at Remote Natural Barriers

Shaun Bevan [α]
HDR

As fish passage projects become more difficult and expensive to implement it has become more common to look at providing fish passage at natural barriers as an economically favorable option to increase fish habitat. This presentation will discuss two projects at natural bedrock falls that were determined to be a barrier to migrating anadromous salmonids. The first is Seldovia Falls, a 10-foot high barrier on the Kenai Peninsula in Alaska. The Seldovia River is an important local resource for the Seldovia Village Tribe and providing fish passage at the falls is estimated to increase Coho Salmon *Oncorhynchus kisutch* habitat between two and four fold. The second is Big Bear Falls near Troy, Idaho, comprised of upper and lower falls with 14-foot and 6-foot drops, respectively. Currently, the natural bedrock falls is believed to block access of Snake River steelhead *O. mykiss* to high quality spawning habitat above the falls. Discussion will include the comparison of fish passage design at natural barriers in remote locations versus the typical fish passage design process, as well as the difficulties specific to working in remote areas.

Isolation, Migration, and Local Recruitment Drive Persistence of Cutthroat Trout in Tributaries near American Falls Reservoir

Daniel Bingham [α]
Rogue Biological Consulting

Preston Buckskin, Hunter Osborne

We used 67 SNPs to describe the genetics of Yellowstone Cutthroat Trout *Oncorhynchus clarkii bouvieri* in tributaries near American Falls Reservoir, Idaho. We detected Cutthroat Trout in all but one site despite massive stocking of Rainbow Trout *O. mykiss*. Sites near the reservoir contained apparent mixtures of Cutthroat Trout, hybrids, and Rainbow Trout yet contained no physical barriers to admixture. Assignment tests suggested persistence is driven by migrants from a headwater population and possibly recruitment by Cutthroat with fluvial or adfluvial life histories. In contrast, hybridization was rare or absent in headwaters and was associated with physical isolation. We also compared our samples to Yellowstone basin Cutthroat Trout and Bear River Bonneville Cutthroat Trout *O. c. utah* to examine historical gene flow during the Pleistocene. Multivariate analysis showed most genetic variation among individuals was explained by divergence of Yellowstone basin Cutthroat Trout from our samples and Bonneville Cutthroat Trout, which supports recent mtDNA studies and a possible change in taxonomic nomenclature. Results indicate that, due to isolation and downstream emigration, headwaters are critical to persistence of Cutthroat Trout and loss of such populations would likely threaten the subspecies throughout the region. Management to reduce threats from established Rainbow Trout will have to be multifaceted and may include a combination of targeted removal and physical barriers to prevent further dispersal.

Arctic Grayling and Denil Fishways: A Study to Determine How Water Depth Affects Passage Success of Arctic Grayling through Denil Fishways

Matt Blank [α]
Western Transportation Institute and Department of Civil Engineering at Montana State University
Erin Ryan, Kevin Kappenman, Owen Dudley

Arctic grayling *Thymallus arcticus* are a species of special concern in Montana and the last remaining fluvial population in the lower 48 states. Over 60 Denil fishways have been installed at irrigation diversions in the Big Hole River watershed, with more planned for the future. However, there is relatively little information to guide the operation and management of the fishways, especially during water limited periods. The objective of this study was to determine the optimum water depth, or range of depths, for upstream passage of Arctic grayling through both 6- and 12-ft Denil fishways. We performed a lab study using an open-channel flume, the ladders, and hatchery reared Arctic grayling (TL ~ 12 inches). The study targeted 18 depth treatments per ladder, a combination of three approach depths and six depths at the upstream-most baffle, and one treatment with no ladder. Fish movements were monitored during 2-hour trials using overhead video cameras and passive integrated transponder (PIT) antennae - one installed at each end of the fishway. The hydraulic environment was characterized by collecting water depths, water velocities, flow and temperature. Multiple logistic regression was used to examine relationships between passage success and hydraulic variables including water depth, velocity and flow. Key results and our best statistical models will be presented, including recommendations for design and operation of the fishways to optimize passage for Arctic grayling.

Domestication and Fitness Decline in Hatchery Steelhead: Why Does it Happen So Fast?

Michael Blouin [α]
Oregon State University

I will briefly review data showing that steelhead trout can rapidly adapt to hatcheries in ways that influence their fitness in the wild. Then I will discuss recent and ongoing experiments that are designed to elucidate what traits are under selection in hatcheries, and what aspects of hatchery culture might be changed to reduce those selection pressures.

Distinctions in Vegetation and Fish Assemblages among Wetland Types According to Dominant Features in Large, Shallow Lakes

Leo Bodensteiner [α]
Western Washington University

Anthony Gabriel

In the face of degradation of lakeshore wetlands by increasing impacts, resource managers are challenged to retain their ecological functions. Confounding this may be a lack of recognition of the implications of loss. Our goal was to characterize the biological structure of the remnant shoreline wetlands in three large lakes in central Wisconsin to address the question: do shoreline wetland types based on the dominant emergent plant or the geomorphic location translate to differences in associated aquatic vegetation and fish assemblages? We categorized the 40 remaining wetlands and selected 13 sites representing 5 types: cattail, common reed, mixed emergent, river delta, and creek delta. Aquatic vegetation and fishes differed among wetland types based on non-metric multidimensional scaling. Each site type could be uniquely characterized by the presence and abundance of three or four plants and two or three fishes although individual species and other environmental conditions did not differ among types. Conservation of the functional relationships among plants and fishes associated with lakeshore wetlands may depend on management that recognizes the diversity of habitats represented by individual wetlands.

The Influence of Rainbow Trout Hybridization on Natal Site Fidelity

Samuel L Bourret [α]
Montana Fish, Wildlife, and Parks

Ryan P Kovach, Amber Steed, Matt Boyer

Westslope Cutthroat Trout *Oncorhynchus clarki lewisi*, once the most abundant and widely distributed cutthroat trout sub-species, now occupy less than 10% of their native range. Rainbow Trout *O. mykiss* hybridization has rapidly increased throughout river drainages of the North Rocky Mountains despite the termination of stocking for almost 40 years. Native Westslope Cutthroat Trout in the North Fork of the Flathead River system show divergent genetic population structure that suggests local environmental adaption through natal homing (or philopatry), which is consistent with genetically based fine-scale local adaption found among native salmonid populations elsewhere. We sought to quantify hybrid trout philopatry by analyzing geochemical markers in spawning trout. To assess the utility of geochemical markers, we collected ambient water and juvenile fish (about 1 year old) otoliths in 3 spawning creeks in the North Fork Flathead watershed. Then, to quantify dispersal we compared the natal origin of migratory spawning adult fish from the 3 spawning creeks to the geochemical markers of the natal stream in which the fish returned. Preliminary data estimate 25% stray rate in a sample of mostly hybridized spawning adults. Our findings imply increased stray rates in the invasive taxon can contribute to the spread of hybridization and loss of local adaptions and genetic diversity in native trout populations.

Use of Local Westslope Cutthroat Trout Stocks for Genetic Conservation

Matthew C. Boyer [α]
Montana Fish, Wildlife & Parks

Scott E. Relyea, Samuel L. Bourret, Andrew R. Whiteley, Robb F. Leary

Genetic advances over the last half century have shaped the role that hatcheries play in native fish restoration programs. Increasingly, goals of these programs emphasize the importance of maintaining genetic variation within and among populations to preserve a species' evolutionary legacy. Westslope Cutthroat Trout *Oncorhynchus clarki lewisi* poses a particularly challenging set of issues for conservation since genetic divergence between populations is due to many alleles that exist in only a few populations but are common where they occur. Thus, many populations throughout this species' range will need to be preserved to achieve effective genetic conservation. Here we discuss an approach where wild fish from populations in the South Fork Flathead River drainage are captured and transported to a hatchery at Sekokini Springs, raised to maturity and spawned to produce offspring for restoration projects in this drainage. Genetic analysis of wild fish and their offspring is used to test for allele frequency divergence and compare heterozygosity and allelic diversity between parents and progeny and estimate the effective number of breeders and offspring relatedness for each year class. Applying genetic principles to hatchery practices ensures the diversity of the wild source population is reliably incorporated into the recipient population and helps achieve the restoration program goal of conserving Westslope Cutthroat Trout genetic variation at a landscape scale.

Wyoming's Powder River Sturgeon Chub: Here, Gone, and Back Again

Bill Bradshaw [α]
Wyoming Game and Fish Department

Sturgeon Chub *Macrhybopsis gelida* were recently petitioned for listing throughout the Missouri River basin, including the Powder River in Wyoming. They are considered an NSS1 Species of Greatest Conservation Need by the Wyoming Game and Fish Department. Sturgeon Chub were first reported from Wyoming's Powder River in 1893 and described as "rare in Wyoming collections" in the first edition of Fishes of Wyoming in 1946. The Powder River has only been sampled in 16 of the 140 years since Sturgeon Chub were first reported. Sampling during the period from 1964-2016 was undertaken with different objectives and sampling approaches, but most fish were collected by seining. Some sampling was unsystematic, some was stratified by habitat type, and some specifically targeted Sturgeon Chub. Temporal and spatial sampling scales included single year/multiple sites, consecutive year/multiple sites, and multiple year/single sites. Natural population variability combined with differences in sampling locations, methods, effort, and 13-15 years between some samples, confounds Sturgeon Chub catch comparisons over time. Before 1994, Sturgeon Chub were at times present in relatively "high" numbers, but rarely collected during extensive sampling from 2004-2007. Annual sampling from 2011-2016 suggests that previous "high" and "low" Sturgeon Chub catch may reflect population variation rather than a long term trend, and that Sturgeon Chub are currently as widely distributed and abundant as ever.

Quantifying the Shifting Habitat Mosaic of Pacific Salmon Using Otolith Microchemistry and Dendritic Isoscapes

Sean Brennan [α]
University of Washington, School of Aquatic and Fishery Sciences
Daniel E. Schindler

Production patterns of Pacific salmon exhibit high spatial and temporal variability across river basins. Salmon returns to any river are represented by the sum of contributions of individuals produced from different natal habitats, populations, and habitat-use strategies. Because the dynamics of these individual components of the diversity in salmon and their habitats rarely vary synchronously through time, complexity serves to spread the risk of poor production across river basins at any point in time. The overall effect of such heterogeneity is a buffering to environmental change of populations and habitats at aggregate scales of complexity -- an ecosystem service that has significant ecological, economic, and cultural value. However, assessing production patterns at multiple scales remains difficult, but critical for the effective conservation and management of Pacific salmon and their rivers. Here, we present an analytical framework to simultaneously assess production patterns at multiple spatial and temporal scales by integrating the natural spatial variation of chemical constituents throughout river networks (i.e. dendritic isoscapes) and the time-keeping properties of fish otolith microchemistry. We present results from ongoing work in the Nushagak River, Alaska, where this approach is being used to quantify how production of Chinook Salmon *Oncorhynchus tshawytscha* and Sockeye Salmon *O. nerka* changes across space and time with respect to these fundamental dimensions of salmon biology.

Malad River Rainbow Trout Passage: Past Success Informing Future Design

Steve Brink [α]
Idaho Power Company

Idaho Power Company (IPC) began implementing a fish passage program at its Malad River Project in 2006 as part of mitigation requirements under a new FERC license. The Malad River supports one of the few self-sustaining tributary populations of fluvial Rainbow Trout *Oncorhynchus mykiss* in the middle Snake River, Idaho. IPC proposed to construct fishways at 2 diversion dams to restore connectivity within the lower 4.8 km of the Malad River. The lower diversion fishway, completed in 2008, uses a 22.9 cm vertical-slot ladder to pass resident fish over a 4-m high diversion. The fishway was designed to withdraw ~ 70 cfs at its upstream end; all but 10-12 cfs is screened out of the ladder flow, providing attraction flow at the downstream end of the fishway. The additional water entering the upstream end of the fishway was intended to promote downstream passage of trout. From 2008 through 2015, more than 44,000 wild Rainbow Trout have passed either upstream or downstream through the fishway. Upstream passage has averaged over 2,200 trout annually, while downstream passage averages over 3,200 trout each year. The conceptual design for the upper diversion fishway was informed by the successful use and operation of the lower diversion fishway. The final design was supported with a computational fluid design model of the upper diversion forebay that will hopefully produce a similar result of both upstream and downstream passage through the upper diversion fishway, scheduled for construction in 2017.

An Automated Imaging System to Monitor Rainbow Trout Passage

Steve Brink [α]
Idaho Power Company

Darren Odom

Resident fish, specifically Rainbow Trout *Oncorhynchus mykiss*, pass upstream and downstream through a fishway in Idaho at all times of the year. Since 2008, monitoring requirements were accomplished using a video camera with motion detection software that produced video clips of movements past a viewing window. Processing this data has been labor intensive and prompted Idaho Power Company to look at ways to automate this imaging process. IPC contracted with Sureworks, LLC to develop an automated system that could reduce the human component required to process passage data. This automation needed to: 1) track objects, 2) determine direction, 3) differentiate objects as fish or non-fish, 4) classify fish as either rainbow trout or sucker spp., and 5) measure fish within 2 cm accuracy. This system uses several components to achieve accuracies that are approaching human-level ability. By far, the largest single contributor to classification accuracy is the deep neural network (DNN). This is composed of several layers of networks to model nonlinear relationships between object classes (in this case, two main fish and several non-fish object classes). In contrast to traditional computer vision techniques, the DNN builds models where the object is expressed as function of image components and learns which features actually define the various classes. Performance is about 96% on average (as compared to our human manual classifiers, who have their own bias and human error).

Do Reservoirs Trophic Niche Spaces Become More Crowded Under a Warmer, Drier Climate?

Phaedra Budy [α]
Utah State University

Stephen Klobucar, Lisa Winters, Deanna Strohm, Gary Thiede

In managed reservoirs, species interactions within novel fish assemblages can be difficult to predict and dependent on physical factors influenced by climatic change (e.g., temperature regimes and reservoir elevation). When numerous and novel suites of large-bodied fishes are stocked to meet angling desires, there is potential for competition among apex species. At both coarse and fine scales, we have been examining the interspecific interactions among piscivores in western reservoirs using a multifaceted approach (e.g., meta-analyses, stable isotopes, bioenergetics). We have documented an apparent mismatch between predators stocked, forage supply, and temperature regime. In many small lakes and ponds, trout species are temperature-stressed and food-limited. In larger mountain reservoirs, we have observed the decline of coveted Rainbow Trout *Oncorynchus mykiss* when significant diet overlap occurs between hybrid Tiger Trout *Salmo trutta* x *Salvelinus fontinalis* ($\alpha > 0.65$) and Cutthroat Trout *O. clarki* ($\alpha > 0.68$), and Utah Chub *Gila atraria* ($\alpha > 0.63$), the primary forage fish. As reservoirs become warmer and more variable, we predict trophic niche space will become further crowded. As such, stocking decisions, with regard to species and numbers, will be most effective if contemporary reservoir dynamics are explicitly included.

Stream Restoration on Medicine Lodge Creek, Wyoming

Laura Burckhardt [α]
Wyoming Game and Fish Department

Medicine Lodge Creek, located in northcentral Wyoming, has high fisheries, wildlife and cultural resource significance in Wyoming. A section of Medicine Lodge Creek, located on Wyoming Game and Fish Commission owned property and within the Medicine Lodge State Park, has experienced significant anthropogenic channel instabilities for at least 40 years. This section the stream channel and floodplain is laterally and horizontally confined by one bridge, by road and trail development, and development and maintenance of two irrigation diversion dams. In the 1970s, the Wyoming Game and Fish Department documented that the majority of the stream habitat damage had been caused by instream bulldozer work at the two irrigation diversions. The WGFD proposes to repair the channel degradation across 0.8 miles of stream. A new bridge will be constructed, year-round fish passage will be restored, and a stable stream channel will be constructed which allows for sediment transport, floodplain connectivity and fisheries habitat. During this presentation, the impairments of the stream, the goals, and proposed restoration approach will be discussed. The necessary planning, stakeholder coordination, and permitting required to construct a restoration project while protecting a culturally sensitive archeological site, State Park aesthetics, sage-grouse core area, and instream flow and irrigation water rights, will be discussed.

Squeezing Water from Stones: Developing an Instream Flow Program in Utah.

Paul Burnett [α]
Trout Unlimited

Restoration practitioners have a long and rich history of stream restoration work in Utah, ranging from instream habitat restoration, fish passage, and population reintroductions. Missing from this equation is a cohesive effort to secure instream flows. Securing instream flows has long been considered out-of-reach by many restoration practitioners, primarily because of the complexities surrounding water rights, a lack of adequate protections for instream flow transactions and a concern from water users that ecological interests may be trying to take water from agricultural uses. Nevertheless, the need for minimum and ecologically protective flows is well established and becoming more critical as Utah's population increases, putting more pressure on finite water supplies. In this presentation, I describe the approach that TU is proposing to take in the state of Utah to move water transactions for environmental benefits into the mainstream of restoration actions. We have begun this approach by developing a flow transaction strategy for Utah, consistent with larger scale flow transaction efforts in the Colorado and Columbia River Basins. Over the next 5 years we hope to prioritize flow transactions in ecologically and economically important watersheds and demonstrate both the ecological importance and the social legitimacy of working with water in the state.

Rufus Woods Rainbow Trout Supplementation: A Six Year Overview of Creel Monitoring and Evaluation

Jeff Caisman [α]
Colville Confederated Tribes

Benjamin Cross

Rufus Woods Lake, an 82 km long reservoir on the Columbia River, emerged as a destination triploid Rainbow Trout *Oncorhynchus mykiss* fishery over the past two decades, primarily due to supplementation by the Colville Confederated Tribes (CCT) and aquaculture net pen escapements. Since 2011, approximately 284,000 Rainbow Trout were released into Rufus Woods by CCT or escaped from aquaculture net pens. In 2015, CCT established management objectives to maintain an annual angler harvest exceeding 40,000 trout with an average length greater than 400 mm. In order to assess supplementation effectiveness, a creel survey was implemented in August 2010. During 2011-2016, the annual effort averaged 200,940 angler hours with an average annual harvest of 54,176 trout. Mean annual catch rates ranged from 0.27-0.46 fish/hr, while the majority of stocked fish were harvested within three months of release. Previous work showed entrainment of released trout was likely associated with spill rates over the downstream dam (Chief Joseph Dam), and utilization of available prey was likely insufficient to sustain growth of trout stocked below target harvest size. To meet management objectives, CCT focused supplementation efforts on periods of high angler effort prior to springtime spill and directly released trout at target size.

Adaptation to Residency in Rainbow Trout Above Barriers to Migration: Alternative Molecular Pathways Towards a Predictable Phenotype

Matthew A. Campbell [α]
University of California Santa Cruz

Eric C. Anderson, John Carlos Garza, Devon E. Pearse

How organisms maximize fitness in their current environments is a major focus of biological research. In particular, the identification of links between a phenotype increasing fitness and a heritable basis. Genetic studies of adaptation are prolific, but many questions remain. Does adaptation utilize existing variation or new mutations? Are supergenes major players in most adaptations? Does the same phenotypic change occur with the same underlying genetic basis? In the frame of these questions from RADseq data we identify genomic regions under differential selection by comparing the genomic diversity of four populations of now above-barrier and landlocked Rainbow Trout *Oncorhynchus mykiss* with the ancestral diversity present in a below-barrier steelhead population. Compared to anadromous Rainbow Trout, the landlocked populations show altered frequencies of inversions on chromosomes 5 and 20. Numerous genomic regions outside of the two inversion regions are also identified to be under differential selection, but there is little concordance among above-barrier populations in specific the genomic regions identified. Our results indicate standing variation plays a role in the ongoing adaptation of the landlocked populations and that both super genes and single genes contribute to adaptation of these populations. While selection acts on landlocked populations to favor a resident ecotype universally, the resulting genetic changes are largely distinct between landlocked populations.

No Fish Left Behind: Environmental DNA Sampling to Ensure Successful Fish Eradication

Kellie Carim [α]
National Genomics Center for Wildlife and Fish Conservation

Michael K. Young, Kevin M. McKelvey, Michael K. Schwartz

Environmental DNA (eDNA) sampling has proven highly effective at detecting animals in low abundance such as those suffering from population decline, or at the leading edge of an invasion. Another situation that requires sensitive and accurate detection of individuals is after an eradication effort to remove nonnative species. In this context, overlooking a single individual may result in significant waste of conservation resources. We used case studies to understand the strengths and limitations of eDNA sampling for assessing efficacy of eradication efforts in stream ecosystems. Environmental DNA sampling equaled or exceeded the ability of traditional sampling methods to identify single individuals persisting in treated areas. Systematic spatial sampling designs allowed managers to reduce overall cost and effort of eradication projects by narrowing the spatial scale at which additional treatments were necessary. These case studies also highlighted the difficulties in interpreting positive eDNA detections when live individuals were not observed. For example, because DNA can be easily transported and samples are highly susceptible to contamination, positive detections need to be considered in a case-specific context. We conclude that eDNA sampling is an effective tool for assessing the efficacy of eradication efforts and, with the proper sampling design, will reduce the overall costs associated with these management projects.

Spatial Positioning in a Desert Tributary Network Affect Larval Growth, Recruitment, and Community Associations of an Imperiled Migratory Catostomid

Nate Cathcart [α]
University of Alaska Fairbanks

Keith Gido, Mark McKinstry

Population dynamics of migratory fishes with natal homing behavior that partition habitats between adults and young offspring are driven partly by growth, survival and recruitment of progeny. While Pacific salmon provide models of how these behaviors affect offspring, spatial effects on early life stages of freshwater migrators like many imperiled sucker species are poorly understood. We tested how spatial position of migratory Flannelmouth Sucker *Catostomus latipinnis* spawning in a small tributary affected larval growth (quantile regression), juvenile recruitment time, and community associations (canonical correspondence analysis). Nine sites distributed >32 km from a mainstem confluence upstream to a headwater tributary confluence were sampled fortnightly with a larval seine from April-June, 2015. Larvae were identified, measured, aged to hatch date and linked to environmental conditions per site (i.e., community associations, stream morphology and temperature). Distance upstream was positively related to higher larval growth and larvae in upstream sites recruited to juvenile phase two weeks faster than downstream sites. However, upstream sites contained more potential predators and competitors, especially nonnative species like American bullfrog *Lithobates catesbeianus* and virile crayfish *Orconectes virilis*. Rapid larval growth can improve survival and enhance recruitment to maintain a robust population of Flannelmouth Sucker.

What Reporters Look For

Robert Chaney [α]
Missoulian newspaper

* And-and-but: The screenwriter's guide to scientific abstracts

* What we're not talking about: Be clear about what your research doesn't say

* Tell Mom: Don't just describe your findings in ways non-scientists can understand, convince me why I should care

Evaluating the Transferability of Flow-Ecology Relationships across Space, Time, and Trait Guilds

William Chen [α *]
University of Washington

Julian Olden

Across the hundreds of methods proposed for determining environmental flows, the large majority share the need to understand how species respond to specific facets of the flow regime. However, the mounting impacts of climate change and human activities are outpacing our ability to monitor species and evaluate river systems individually. An emerging challenge, therefore, is to develop streamflow management plans that are directly transferable across broad geographies and taxonomies. Here, we explore whether flow-ecology relationships are transferable across space, time, and within traits-based guilds, using freshwater fishes of southwestern American rivers as a case study. While there is inherent variation in flow-ecology relationships, we found that species-specific relationships were equally transferable across river systems as they were within river systems. Species temporal transferability also varied similarly to spatial transferability. Flow generalists, periodic life-history strategists, and nonnative species exhibited higher transferability. Understanding the transferability of flow-ecology relationships will guide effective environmental flow management, even in the absence of comprehensive monitoring data. Our findings suggest both cautionary notes and encouraging opportunities for transferring flow-ecology knowledge across time, geography, and guilds.

Drought May Compound Effects of Climate Warming on High Elevation Lakes

Kyle Christianson [α *]
Colorado State University

Brett Johnson, Douglas Silver

Changes in climate are expected to have the greatest effect on high elevation and high latitude systems. In the Southern Rocky Mountains, >90 percent of an estimated 2,000 natural lakes are located at high elevations (>2,700m). Analysis of historical temperature measurements from >500 of these lakes demonstrated a signal of surface warming since 1940. A mechanistic one-dimensional lake thermal model, General Lake Model (GLM, v3.1.14), was used to capture contemporary dynamics and predict the effects of lake-specific characteristics on thermal structure given future environmental change. We found that lake size, water clarity, inflow, precipitation, and water level all affected lake thermal responses. Drought scenarios demonstrated that reduced precipitation and snowpack will compound the effects of increased air temperatures on thermal structure of high elevation lakes. Stratification developed more rapidly and was more intense under drought conditions, increasing the potential for hypoxia to develop. Interactive effects of climate warming and drought have important implications for habitat suitability for coldwater stenotherms such as *Mysis diluviana* and salmonids currently inhabiting high elevation lakes in the Southern Rocky Mountains.

Estimating Behavioral Diversity of Salmonids in the Upper North Platte River Using Otolith Microchemistry

Lindsy Ciepiela [α *]
Wyoming Cooperative Fish and Wildlife Research Unit, University of Wyoming

Annika Walters

As natural and anthropogenic disturbances increase in magnitude and frequency the ability of populations to rebound from disturbance will be critical to their overall success and longevity. A growing body of evidence suggests there is a positive relationship between the amount of diversity displayed by a single population and the resiliency of that population to disturbance. By tracing natal origins, time spent in rearing streams and spawning site fidelity of individual salmonids in the Upper North Platte River, a sustainable wild trout fishery, we were able to identify the behavioral diversity displayed by Brown Trout *Salmo trutta* and Rainbow Trout *Oncorhynchus mykiss* in this system. We found 64 percent of Rainbow Trout and 59 percent of Brown Trout captured in the mainstem of the North Platte River were born in a tributary to the North Platte River and all uniquely identifiable regions within the watershed were used for spawning. As well, 43 percent of captured spawning Rainbow Trout had strayed from their natal origin for spawning. Our results indicate the North Platte River sport fishery is robust to point disturbances with the fishery's resiliency likely linked to the behavioral diversity of the population as well as continued access to a mosaic of spawning and rearing habitat. Furthermore, our research provides evidence that within-population diversity, particularly behavioral diversity related to movement and life history strategies, may be an important mechanism underlying resilient riverine fisheries.

Can Amphibians Help Conserve Native Fish?

Niall Clancy [α *]
Montana State University

Native fish populations have continued to decline worldwide despite advances in management practices. As such, new approaches are needed to complement the old. In some flowing and standing waters, larval amphibians are the dominant vertebrate taxa. This can be important to fisheries due to amphibians' ability to influence macroinvertebrate communities, alter benthic habitat, and supply nutrients in aquatic systems. These changes can, in turn, affect the ecology and fitness of other aquatic organisms such as fishes. Due to their large effects in some systems, it is suggested that fisheries managers carefully consider actions that may affect amphibian populations and actively conserve them in some cases. Preservation of riparian areas and amphibian-associated microhabitats may even be used as a tool to positively impact freshwater fisheries by conserving amphibians that help maintain aquatic systems. Therefore, knowledge of local amphibian life histories and behaviors may be important in conserving associated freshwater fisheries.

In Defense of Resident Bull Trout

Chris Clancy [α]
Montana Fish, Wildlife and Parks

Resident Bull Trout *Salvelinus confluentus*, by definition, spend their entire life in the same stream system. Typically, they don't grow larger than 300 mm and 250 g. These populations are sometimes described as remnant or "at risk" due to their limited distribution and lack of connection to river and lake habitats. However, in the context of development pressure in western landscapes, warming climate and long term persistence, some of these populations offer contrasting advantages and disadvantages to the larger migratory forms. Resident forms usually inhabit public lands at high elevations and are less threatened by development and significant angling pressure common on private lands at lower elevations. Migratory forms offer advantages of mobility and genetic diversity as well as the ability to re-found extirpated populations. Actions taken to maintain the long term viability of the resident population may require a different focus than attempting to maintain the migratory form. A case in point is the Bitterroot Valley in Western Montana, where migratory forms are present, but declining, and resident forms in some areas are stable. Assuming limited resources, where do we expend our efforts?

A Remote Sensing and Occupancy Estimation Approach to Quantify Spawning Habitat Use by Fall Chum Salmon along the Chandalar River, Alaska

Chelsea Clawson [α *]
Alaska Cooperative Fish and Wildlife Research Unit, University of Alaska Fairbanks

Jeffrey Falke, Joshua Rose, Anupma Prakash, Aaron Martin

Groundwater upwellings provide stable temperatures for overwinter salmon egg development and this process may be particularly important in cold, gravel-bed Arctic rivers. Aerial counts and remote sensing were used during 2013-2015 to estimate fall Chum Salmon *Oncorhynchus keta* spawner abundance states (low or high), classify river segments by geomorphic channel type (primary, flood, or spring), and map thermal variability along 25.4 kms of the Chandalar River in interior Alaska. We delineated 330 unique river segments (mean length=536 m) and used a multi-season multistate occupancy model to estimate detectability, occupancy, and transition probabilities. Triplicate surveys (2014) allowed us to estimate detectability and examine observer bias. Detectability did not vary by observer, channel type, or segment length, but was better for high abundance (0.717±0.06 SE) relative to low abundance (0.367±0.07 SE) aggregations. After correcting for imperfect detection, the proportion of segments occupied by spawning fall Chum Salmon was highest in 2014 (0.41±0.04 SE), relative to 2013 (0.23±0.04) and 2015 (0.23±0.04). Unoccupied segments were likely to remain so from year to year (2013-2014=0.67; 2014-2015=0.90), but low abundance spawning segments were dynamic and rarely remained in that state. One-third of high abundance sites remained so, indicating the presence of high quality spawning habitat. Mean segment temperatures ranged from -0.5 to 4.4°C, and occupancy varied positively with temperature.

Restoring Streamflow in Coastal California

Matt Clifford [α]
Trout Unlimited

For more than a decade, voluntary and regulatory efforts have been underway to reduce the impacts of water diversion on native salmon and steelhead *Oncorhynchus mykiss* in California's coastal streams. Although these efforts have benefitted from the experience of instream flow programs elsewhere in the western United States, the physical, social, and legal setting of coastal California presents challenges that differ in key ways from those faced in other regions. These challenges in turn call for a unique set of scientific and policy solutions. This presentation describes selected elements of the physical and human landscape of coastal California, including the region's Mediterranean climate, the corresponding seasonal extremes in natural streamflow, the presence of numerous and widely dispersed diversions, and California's dual riparian and appropriative water rights system. The presentation discusses how these elements contribute to widespread streamflow impairment (particularly during the summer dry season when juvenile steelhead and Coho Salmon *O. kisutch* are rearing in small headwater tributaries) and how they also impede the implementation of improved water management at scale. Finally, the presentation describes several related scientific and policy tools that are being developed to streamline the implementation of streamflow improvement projects at scale, as well as to document the resulting improvements in fish populations.

Ecological Tradeoffs between Commercial Salmon Fisheries and Foraging Opportunities for Trout

Timothy Cline [α *]
University of Washington

Daniel Schindler, Timothy Walsworth

Over the last decade there has been increasing emphasis on shifting towards ecosystem-based fisheries management. A challenge for implementing ecosystem-based fisheries management is evaluating tradeoffs between competing objectives, which is critical for buy in from multiple stakeholders and determining optimal management targets. Bristol Bay, Alaska, produces the world's largest commercial Sockeye Salmon *Oncorhynchus nerka* fishery. However, species within upstream ecosystems have evolved to take advantage of the annual pulse of marine derived energy from spawning adult salmon. This subsidy provides the majority of the annual energy intake for resident stream fishes, the target of valuable sport fisheries. The current management system limits the number of salmon allowed to reach the spawning grounds with the goal of maximizing commercial salmon harvest and minimizing oversaturation during spawning. Thus, the goals for maximizing commercial yield may be in opposition of those that support upstream resident fishes. Here, we use over a decade of empirical data in conjunction with a simulation-modeling framework to evaluate how changes in escapement shift the relative balance of realized benefits between commercial salmon fisheries and resident stream fishes. This research will contribute to a growing knowledge of the shape of tradeoffs between competing objectives in management frameworks considering multiple stakeholders.

Regulatory Considerations for New Fish Passage Technologies

Alison Colotelo [α]
Pacific Northwest National Laboratory

Brian Bellgraph

Recent innovation has led to novel approaches for moving fish around barriers. New technologies are changing the way that we think about fish passage, but are also introducing questions about the requirements for safe and effective passage. One consideration for both developers and end-users is the steps and information required to gain regulatory approval to deploy new passage technologies, particularly where Endangered Species Act (ESA) listed species may be impacted. Currently, the process is ill-defined and lacks clear acceptance criteria. Furthermore, private companies desiring to commercialize novel technologies are tasked with the burden of overcoming ambiguous, and non-scientifically supported performance criteria of conventional technologies. One such technology currently seeking approval for deployment in systems with ESA-listed fish is the Whooshh Fish Transport System (WFTS), developed by WhooshhTM Innovations. This presentation outlines a decision tree, using the WFTS as an example, that can be used by developers and end-users as a reference to better elucidate the regulatory process and factors to consider when seeking approval of new fish passage technologies. In recognition of regulatory approval process differences between and even within agencies, this decision tree should be considered an assistive tool rather than a panacea.

Stream Restoration to Improve Human Overwintering and Rearing Habitat

Warren Colyer [α]
Trout Unlimited

Sean McFall, Kurt Fesenmyer

The ecological merits of restoring stream processes to benefit fish and wildlife are well-known, but too often the value of these projects for landowners and agricultural producers is poorly communicated, or overlooked altogether. In this presentation we describe specific projects in several western states that restored some combination of habitat, passage and streamflow for fish, while at the same time improving local communities through infrastructure upgrades and restoration of hydrologic processes that increased water availability, predictability and flood and drought resiliency. We argue that in many cases the direct benefits of aquatic restoration projects for people and communities are at least as significant as those for fish, and by describing them as such restoration practitioners can more effectively recruit stakeholders as partners and advocates for stream and watershed restoration projects. Moreover, an important component of that effort should be investing in marketing, branding and outreach activities that are often an afterthought for biologists, or perceived as a drain on limited project resources. We show that modest investments in these activities can leverage significant additional resources by appealing to broader constituencies and non-traditional funding sources.

Monitoring Fisheries Responses to Restoration in the Upper Clark Fork River Basin

Nathan Cook [α]
Montana Fish, Wildlife, and Parks

The Upper Clark Fork River Basin (UCFRB) is undergoing a historic restoration effort. To evaluate and guide restoration activities, the State of Montana has been intensively studying fish populations in the Upper Clark Fork River and tributaries. An ongoing otolith microchemistry project is revealing recruitment and movement patterns for Brown Trout *Salmo trutta* in the mainstem. By integrating data from otolith microchemistry, telemetry studies, age and growth studies, and analyses of fish tissue metals concentrations, we are gaining new understanding of factors limiting trout populations in the UCFRB. These data will be critical for monitoring fishery effects of metals cleanup activities in the mainstem, as well as the myriad of restoration projects taking place in tributaries.

Using Hypolimnetic Oxygenation to Enhance a Mesotrophic Lake Coldwater Fishery

Benjamin Cross [α]
Colville Confederated Tribes

Barry Moore, Megan Skinner

The distribution, abundance, and diversity of lake biota can be impacted by the duration and extent of low dissolved oxygen levels. To enhance the trout fishery, the hypolimnion of North Twin Lake, Washington was oxygenated throughout the summers of 2009-2015, while adjacent South Twin Lake provided an un-oxygenated reference. Using Rainbow Trout *Oncorhynchus mykiss* preferred temperature (13-19°C) and dissolved oxygen (>5.0 mg/L) values, preferred habitat availability did not increase during oxygenation. Oxygenation altered trout access to prey by increasing Daphnia density in North Twin compared to South Twin, but Chaoborus water column density was lower in North Twin. Chaoborus and chironomid densities in the benthos were higher in oxygenated North Twin compared to South Twin. Increased Daphnia prey was reflected in trout diets during one sampling month, but trout growth and condition was not influenced by oxygenation. While the abundance of trout in South Twin generally remained similar or higher than North Twin during oxygenation, Rainbow Trout growth rates and relative weights were not significantly different between lakes. Hypolimnetic oxygenation may enhance a fishery if preferred habitat or hypolimnetic prey utilization increase for an extended duration, but this was not observed in North Twin Lake.

Stonecat Ecology in St. Vrain Creek

Timothy D'Amico [α *]
Colorado State University

Dana Winkelman

The ecology of Stonecat *Noturus flavus* is relatively unknown, especially at the western extent of its North American distribution. There are two Stonecat populations in Colorado, including a population of particular interest in St. Vrain Creek, a transition zone stream running through the city of Longmont. The Stonecat in the St. Vrain is the only extant population in a Colorado transition zone stream. In addition to occupying a unique transitional habitat, the population is in an urban setting that is undergoing several modifications to reduce the potential impacts of flooding. Managers are concerned that proposed changes to the stream channel could have detrimental effects on Stonecat and other native fishes. Our study seeks to evaluate habitat preferences and movement of Stonecat to better understand the potential effects of instream channel modifications on this species. We have PIT tagged Stonecats and are using a combination of static and mobile PIT tag antennae to characterize their habitat preferences and movement ecology over a 5.3 km long section of St. Vrain Creek that runs through Longmont, Colorado. Initial analyses indicate that Stonecats move long distances (up to 2.5 km) in our study reach and prefer riffle habitat. Understanding Stonecat movement patterns and habitat preferences are crucial for upcoming stream restoration and management.

Monitoring and Evaluation Programs at National Fish Hatcheries in the Columbia River Gorge

Kari Dammerman [α]
Columbia River Fish and Wildlife Conservation Office, U.S. Fish and Wildlife Service

Fish hatcheries in the Pacific Northwest play a vital role in mitigating for declines of wild salmon and steelhead populations. However, the listing of numerous species under the Endangered Species Act (ESA) has led to hatchery reformation initiatives aimed at reducing the ecological and genetic risks of programs on wild stocks. In the Columbia River basin, National Fish Hatcheries (NFHs) produce fish to mitigate for lost production due to hydropower development under the Mitchell Act and John Day/The Dalles Dam mitigation program as well as augment populations to provide tribal, sport, and commercial harvest opportunities. Collaborative Hatchery Review Teams provide recommendations and Hatchery and Genetic Management Plans are used to evaluate the impacts of the programs on ESA-listed species. Additionally, long-term data on marking, release numbers, juvenile migration and survival, sex and age structure of adult returns, and coded-wire tag recoveries have been used to develop research projects and adaptive-based, monitoring and evaluation (M&E) plans that improve hatchery performance, minimize impacts to wild fish, comply with ESA requirements, and meet tribal mandates. An overview of the M&E programs at six NFHs including ongoing research projects as well as potential impacts of hatchery-origin fish on wild stocks will be discussed.

Kootenai River Pool Ladder: Reach-Scale Habitat Restoration for Native Fish and Wildlife Species

Matt Daniels [α]
River Design Group, Inc.

Sue Ireland

Since 2011, The Kootenai Tribe of Idaho has been implementing large-scale habitat restoration projects on the Kootenai River in northern Idaho as part of the Kootenai River Habitat Restoration Program (KRHRP). The KRHRP embraces a holistic ecosystem approach to restoration for addressing the decline of Kootenai River White Sturgeon *Acipenser transmontanus* caused by Libby Dam operations and a century of land use. Restoration actions being implemented include side channel enhancement, island/floodplain creation, bank restoration and pool creation. The desired result of the combined projects is a more resilient ecosystem capable of sustaining diverse native plant and animal populations, and is tolerant of natural disturbances and altered regimes. Pool creation has been undertaken at multiple locations to improve migration and holding habitat on a five mile reach of the Kootenai River that provides suitable spawning substrate for sturgeon, but does not attract significant numbers of fish. This presentation describes the design approach, technical challenges, implementation techniques and lessons learned from constructing multiple pool creation projects on a large river system. Details related to data collection, hydraulic modeling and large wood design will also be discussed. The Kootenai Tribe of Idaho is implementing the KRHRP with funding provided by Bonneville Power Administration under the Northwest Power and Conservation Council's Fish and Wildlife Program.

Riparian Vegetation, Instream Habitat, and Aquatic Biota Differences within Riparian Grazing Exclosures

Daniel Dauwalter [α]
Trout Unlimited

Kurt A. Fesenmyer, Scott W. Miller

Improper riparian grazing can alter the amount and composition of riparian vegetation and reduce streambank stability, which in turn can result in wide and shallow stream channels with poor habitat for aquatic biota. Riparian exclosures are one grazing management tool used to reduce livestock access to streams and improve stream health. We evaluated differences in riparian and instream habitat, benthic macroinvertebrates, and fish within seven riparian exclosures in a grazing allotment managed for riparian health. The Normalized Difference Vegetation Index (NDVI) from Landsat imagery (1985 to 2015) showed significant increases in riparian vegetation productivity - often associated with increased production of woody riparian vegetation - after some but not all exclosures were constructed (1982 to 2005). Across all exclosures, woody riparian vegetation was more abundant, streambanks were less altered, and stream channels were narrower, although there were exceptions to these general patterns. Despite observing expected changes to riparian vegetation, stream channels, and juvenile trout densities inside versus outside exclosures, aquatic macroinvertebrate indices, fish species richness, and adult trout density did not differ. Exclosure size, position in the watershed, mobility of aquatic biota, and other factors likely limited strong and consistent biological differences within exclosures.

Effects of Nonnative Brown Trout on the Foraging Ecology of Rio Grande Cutthroat Trout

Quintin J. Dean [α *]
New Mexico State University

Brock M. Huntsman, Colleen A. Caldwell, Abigail J. Lynch, Bonnie J. E. Myers

Nonnative trout have displaced native trout populations across North America. One mechanism for displacement is competitive exclusion from resources. Our goal was to determine if invasive Brown Trout *Salmo trutta* (BT) affect the foraging ecology of native Rio Grande Cutthroat Trout *Oncorhynchus clarki virginalis* (RGCT). We compared benthic macroinvertebrate collections with RGCT diets collected from RGCT populations with and without BT, as well as BT diets. We hypothesized RGCT in sympatry with BT would require higher prey diversity than BT to meet energetic needs and higher prey diversity than allopatric BT. Both the Shannon diversity and an electivity index revealed greater diversity of prey items (i.e., lower selectivity) in sympatric RGCT (2.0 ± 0.7) than BT (1.6 ± 0.6; $P = 0.06$, $F_{1,31} = 3.88$). Further, sympatric RGCT consumed higher prey diversity than both allopatric RGCT populations ($P < 0.01$, $F_{2,52} = 13.54$). Mean biomass consumed by sympatric RGCT and BT were not different from one another ($P = 0.14$, $F_{1,31} = 2.27$), although consumption of terrestrial biomass by RGCT was marginally greater ($P = 0.06$, $F_{1,31} = 3.77$). Our results indicate BT have an impact on the foraging ecology of RGCT and may play a significant role in RGCT productivity.

Introgression between Native Redband Trout and Coastal Origin Hatchery Rainbow Trout in the Northern Great Basin

Patrick DeHaan [α]
US Fish and Wildlife Service

Jennifer Von Bargen, Mike Meeuwig

Redband Trout *Oncorhynchus mykiss newberrii* are a subspecies of Rainbow Trout *O. mykiss* found in inland drainages east of the Cascade Mountain Range. The endorheic drainages of Oregon's Great Basin represent unique environments where Redband Trout have persisted for thousands of years. Redband Trout have experienced population declines throughout their native range due to habitat disturbance, climate change, and stocking of non-native fish. Costal origin Rainbow Trout have been stocked extensively throughout the range of Redband Trout and introgression with hatchery origin fish is a threat to the persistence of many populations. We used 96 polymorphic SNPs to assess the level of introgression between Redband Trout and two Rainbow Trout strains that have been stocked throughout the Great Basin. We observed a high level of genetic divergence between the hatchery strains and native Redband Trout (FST = 0.387-0.415). We used Bayesian clustering methods to estimate levels of introgression at the population and individual levels. The level of introgression ranged widely among sub-basins, populations, and individuals. The proportion of introgression within each population varied from 0.0 to 0.6. Within populations, individual levels of introgression varied from 0.0 to greater than 0.9. Despite evidence of introgression, data suggest native Redband Trout persist in all of the watersheds surveyed. Additionally, we examined the relationship between landscape features and stocking intensity on the levels of introgression.

Whooshh Fish Passage - Results from 2016 Studies

Todd Deligan [α]
Whooshh Innovations

Janine Bryan

Study results in 2016 confirm that Whooshh Innovations™ fish transport system (WFTS) can transport migratory species safely, timely, efficiently, and effectively over barriers. The Yakama Nations concluded a three-year comparison study that demonstrated safe WFTS transport included an additional study arm of a 1,100 ft tube transport group (funded by USBOR). The study results indicate that adult survival and egg viability were statistically equivalent across transport methods. BOR has now requested a full prototype test over Cle Elum dam in 2017. A CRITFC Sockeye Salmon *Oncorhynchus nerka* migration study was also conducted in the Columbia River. The study directly evaluated if WFTS transport affected in-river survival and travel time. Sockeye Salmon were sampled, PIT-tagged and divided between control and WFTS. Control fish were returned the upstream ladder whereas WFTS fish were tube-transported ~100 ft and then into the ladder. A one-day feasibility test of transporting 54 WFTS Sockeye Salmon directly over the dam into the forebay bypassing the remaining ladder passage also occurred. PTAGIS tracked the Sockeye Salmon as they traveled up the Columbia into various tributaries. Study analysis showed no WFTS impact on migration or survival and control and WFTS groups that continued up the ladder tracked nearly identically. In contrast, the travel times of WFTS Sockeye Salmon transported over the dam were reduced resulting in arrival at upstream sites one or more days sooner; a statistically significant finding.

Whooshh Fish Passage - Non-Anadromous Species Reconnectivity

Todd Deligan [α]
Whooshh Innovations

Janine Bryan

With 2016 study results confirming that Whooshh Innovations™ fish transport system (WFTS) can transport migratory anadromous species safely, timely, efficiently, and effectively over barriers, the next question is can the WFTS be designed for non-anadromous fish passage? The challenge in NAF passage lays in understanding each species unique biological behavior, characteristics and attraction driver. What motivates a NAF to move upstream and how can it be used to facilitate passage? As an example, why and what influences the ability of Bull Trout *Salvelinus confluentus* to migrate? What cfs provides the proper attraction flow? Does the number or height of ladder steps impact whether Bull Trout pass upstream? What is the seasonality of migration? Does water temperature impact migration? Is there an age/size associated with Bull Trout motivation? Is there a preferred hydraulic landscape that provides the ideal passage opportunity? Because WFTSs are customizable, fish passage on a per species basis can be contemplated. A species unique characteristics can be addressed through system design that addresses flow, seasonality, and biological behavior and motivation. Development will, however, require partnership work with fisheries biologists to determine species migration motivating characteristics and enable a shift from a one-size-fits-all passage to species-centric options. Potential adaptations of the WFTS for NAF passage will be discussed.

Ecotechnology in the Age of Invasive Species

Todd Deligan [α]
Whooshh Innovations

Janine Bryan, Vince Bryan

The ecosystems of our lakes, rivers and streams are made up of complex, intricate ever-changing interactions of the species (plants and animals), the environment, climate conditions, and the seasons. There is a give and take dynamic that enables a balance. Unfortunately, opportunistic species have invaded such ecosystems disrupting the balance, threatening devastation of essential niches, and harming native species and habitats. Identifying uninvited guests such as Atlantic Lamprey *Petromyzon marinus*, Northern Pike *Esox lucius*, and common and Asian Carp *Cyprinus carpio*, is the first step in invasive management. The next step requires understanding both the native ecosystem and the behavior and characteristics of the invasive species. Innovative engineering aligned with the ecological and environmental concerns of the native species – ecotechnology – is needed to address these problems. The Whooshh Fish Transport System (WFTS) is an ecotechnology designed to assist fish past man-made and natural barriers and was developed with a scanning system to enable identification and sorting of fish. Currently the U. of Minn and Whooshh are working to determine the conditions to attract specific invasive species to enter the WFTS enabling removal. Whooshh is also working with the Great Lakes Fisheries Commission on a feasibility study to collect data and develop protocols that will identify native species and select out invasive species. These studies/tests, and other potential WFTS applications, will be discussed.

The Communications Secret the Pros Don't Want You to Know About

Tom Dickson [α]
Montana Outdoors Magazine, Montana Fish, Wildlife & Parks

Communicating effectively is much easier than it looks. In fact, most communications pros in advertising, marketing, journalism, and public relations don't want you to know how easy it is, because that would take the mystery• out of their profession. What's the secret? Following a simple five-step blueprint known as POAM-T: 1. Identify your communications PROBLEM. 2. Identify your communications OBJECTIVE. 3. Understand your AUDIENCE. 4. Figure out the two or three most important MESSAGES to deliver to that audience. 5. Figure out the most effective communications TOOL for delivering those messages. That's all there is to it.

Water Clarity, Drought and Length-Weight Relationships of the Endangered June Sucker and Sport Fishes in a Highly Eutrophic Utah Lake

Ryan Dillingham [α]
Utah State University - Ecology Center

Jereme Gaeta

Drought and eutrophication often have deleterious effects on aquatic ecosystems by degrading water clarity. Utah Lake, UT, for instance, is a highly degraded, eutrophic system caused by excessive nutrient inputs and an invasive Common Carp *Cyprinus carpio* population comprising ~90% of fish biomass. The effects of eutrophication and Common Carp on water clarity are likely exacerbated during drought conditions. We take a mixed effects approach to test whether changes in Utah Lake water clarity (in this case, Secchi depth), is associated with the length-weight relationship of the June Sucker *Chasmistes liorus*, an endemic, endangered species, and sport fishes including White Bass *Morone chrysops* and Walleye *Sander vitreum*; a species highly adapted to low clarity environments. We hypothesize that water clarity will influence fish reaction distance, their ability to obtain resources, and, therefore, manifest in altered weight at length, or fish health; a metric for reproductive potential and fishery quality. Our findings will not only inform managers and resource users about optimal water clarity levels for June Sucker reproductive potential and fishery quality but also highlight the influence of drought and eutrophication on the health of fishes.

Drought and Water Availability in Western Riverscapes

Jason Dunham [α]
US Geological Survey

Christian Torgersen, Roy Sando, Kristin Jaeger, Kyle Blasch

Many species depend on water availability in low-order, headwater streams, which constitute the majority of streams in riverscapes. Though these streams are important for a variety of reasons, we know very little about their current status (i.e., whether they are perennial or not) and potential responses to drought or other climate-related changes. To address these fundamental questions, we have initiated a series of studies ranging from deployment of instrument networks to track year-round patterns of temperature and flow permanence in focal watersheds in the Great Basin to regional assessments of flow permanence using large, crowd-sourced data sets on water availability across the northwest US. In aggregate, these studies are providing important new information that allows us to better understand water availability in space and time across broad extents. Results emerging from this series of studies should be relevant to vulnerability assessments for all aquatic and many terrestrial species in the west.

Spawning Area Residence Related to Freshet Timing in an Ocean-type Chinook Salmon Population

Roger Dunlop [α]
Uu-a-thluk Fisheries Program, Nuu-chah-nulth Tribal Council

Reliable area-under the curve (AUC) estimates of Pacific salmon spawning escapement from visual observations require costly annual radio-telemetry studies to identify residence time and detection probability parameters. An index of spawning ground residence time integrating detection probability was developed from an intensive multi-year live mark-recapture (MR) experiment and periodic visual surveys of spawning Chinook Salmon *Oncorhynchus tshawytscha* from 2009 -2014. In the MR experiment closure and the apparent survival and capture probability assumptions were evaluated. Closure tests proved the population was open in all years. The Jolly-Seber formulation POPAN of Arnason and Schwarz (1999) in Program MARK (White and Burnham 1999) was used for abundance estimation by modelling apparent survival, capture and entry probabilities and weighing competing models by AIC. Violations of assumptions demonstrated in data for several group-years were corrected with appropriate time-since-marking models. AUC integrals were divided by the MR estimate to provide the spawning area survey life (S-hat) that integrates detection probability. The number of days from September 1 to the first fall freshet stimulating migration onto the spawning grounds provided the measure of migration delay. A preliminary relationship was described between the migration delay indices and the annual estimates of S-hat. The relationship provides a simple means of estimating S-hat from knowledge of the freshet date. The relationship may be more broadly applicable in ocean-type Chinook Salmon and perhaps in other Pacific salmon with freshet driven migrations. Integrating an interaction between cumulative arrival and freshet timing will require additional work to accommodate very early timed migrations when few animals have arrived.

Using Food Webs to Guide Conservation Propagation of Pallid Sturgeon

Addie Dutton [α *]
MT Cooperative Fishery Research Unit, Montana State University
Christopher Guy, Eric Scholl, Tanner Cox, Wyatt Cross

Conservation propagation for the Pallid Sturgeon *Scaphirhynchus albus* began in the late 1990s because the species was not recruiting in the Missouri River. The propagation program has been successful and several studies have suggested that the survival of stocked Pallid Sturgeon in the upper Missouri River is relatively high. Thus, the purpose of this study was to describe the food web of the upper Missouri River to better understand interactions among prey species used by Pallid Sturgeon and predict forthcoming bottlenecks. Nineteen families of benthic macroinvertebrates were found in at least ten percent of sturgeon diets. Large Pallid Sturgeon (> 365 mm fork length) consumed five species of prey fish in proportion to their relative abundance. Most prey species in the Cyprinidae family were specialists feeding on less than five taxa; whereas, prey species in Ictaluridae and Hiodontidae families consumed fifteen taxa. Chironomidae and Hydropsychidae were common in ninety percent of all fish species. The food web of the upper Missouri River is complex, suggesting stability in the food web. Many of the prey items consumed by Pallid Sturgeon were relatively abundant in the environment, suggesting that Pallid Sturgeon may be more opportunistic than originally reported.

Everything You Wanted to Know About Rock Snot. A Brief History of *Didymosphenia geminata*

Leah Elwell [α]
Invasive Species Action Network

Didymosphenia geminata is a freshwater diatom (a type of alga, also called “didymo”) that has become a cause for concern in river systems in North America and internationally. Although historically *D. geminata* was found in the Northern Hemisphere, in more recent times this species has been noted for nuisance bloom behavior and spread to new locations. Notably, novel detections of *D. geminata* in rivers across eastern North America, New Zealand and South America have caused concern and have created the need for a management response. Researchers, managers, and anglers alike have found interest in *D. geminata* and all seek to better understand the species. Scientists have interest in gaining knowledge in *D. geminata* biology, while managers and conservation non-profits are tackling ways to protect water resources and address public concerns, and anglers want to learn how to protect their favorite fishing areas. New research improves our knowledge of the biology, control, outreach and impacts of *D. geminata*.

Invasive Species and Fisheries Management: an Examination of Current Issues

Leah Elwell [α]
Invasive Species Action Network

Bob Wiltshire

In recent years, there has been more focus on the issue of Aquatic Invasive Species (AIS) management. During this time, we have also seen an increase on impacts to the fisheries profession due to AIS. We will discuss an overview of AIS management and trends, as well as discuss vehicles for successful efforts to manage AIS. Regional partnerships have been instrumental in building consistency, and strengthening programs to protect waters of the west from AIS. While many efforts have a focus on dreissenid mussels, programs have continued to shift their focus to managing pathways of introduction and spread to address the issue of AIS. Partnerships among the Western Regional Panel on Aquatic Nuisance Species, state and federal agencies and others have continued to aid in the rapid evolution of managing the complex issue of AIS. This presentation will provide the backdrop to the symposium on "Invasive Species and Fisheries Management - an Examination of Current Issues."•

Describing Interactions between Bull Trout and Lake Trout in Priest Lake, Idaho

Derek Entz [α *]
Eastern Washington University

Paul Spruell, Jason Connor

The objective of this study was to better understand the interactions between native Bull Trout *Salvelinus confluentus* and nonnative Lake Trout *S. namaycush* in the Priest Lake system in northern Idaho. We first estimated the level of connectivity between Priest Lake (PL) and Upper Priest Lake (UPL) by placing acoustic receivers in a gate arrangement at either end of the channel connecting the lakes. Lake Trout (n=220) and Bull Trout (n=40) movements were tracked from May 2015 - October 2016. We found that 10 fish were detected by both gates, confirming movement between the lakes. Direction of movement of Lake Trout occurs at a high rate from UPL to PL (86%). Also, we investigated diets of Lake Trout in UPL which is managed for native species, including Bull Trout, by collecting 282 Lake Trout stomachs from gill nets. Fish prey items made up 98% of the diet by weight and 67% of the diet by number. Ongoing DNA analysis is being used to determine the identity of fish consumed. This analysis confirms the biological connectivity of the Priest Lake system and provides evidence that movement of Lake Trout from UPL to PL occurs more frequently than previously thought.

Climate Vulnerability and Salmonids in Alaska: Hind- and Forecasting Freshwater Growth and Phenology across Species and Habitats

Jeff Falke [α]
USGS, Alaska Coop Unit

Morgan Sparks, Eric Torvinen, Peter Westley

Freshwater ecosystems in Alaska are changing rapidly. Limited data and the remote setting create challenges for fish population vulnerability assessments to climate change in this region. Here we present a synthesis of three recent studies that hind- and forecast salmonid population responses across a broad range of climate and habitat conditions in Alaska. First, in southwest Alaska, we predicted hatching timing for a lake-beach spawning population of Sockeye Salmon *Oncorynchus nerka* using modeled daily lake temperatures given historic data (1948-2014) and future (2016-2099) climate scenarios. Extreme scenarios shifted hatching timing up to one week earlier than historical minima. Second, we used spatially-explicit flow and stream temperature models to assess how recent (1970-2015) climate variability influenced juvenile Chinook Salmon *O. tshawytscha* growth potential across an interior Alaska boreal riverscape. Juvenile salmon were up to 60 percent larger in September during warm years with lower flow relative to cool, wet years. Finally, based on a biochronology fit using mean August air temperatures, we found an increasing trend in relative growth of adult Lake Trout *Salvelinus namaycush* in Arctic Coastal Plain lakes from 1950-2014. The complexity of responses we observed to climate variability and change highlights the importance of incorporating life-stage-, species-, and habitat-specific information into broad-scale vulnerability assessments.

Using Genomic Data for Conservation: Range-Wide Demographic and Genetic Structure of Longfin Smelt

Mandi Finger [α]
UC Davis

Alyssa Benjamin, Ismail Saglam

Longfin Smelt *Spirinchus thaleichthys* (LFS) have experienced a dramatic decline within the San Francisco Estuary (SFE) - the southernmost extent of the species' range. LFS is estuarine and anadromous, with breeding populations ranging from Alaska to the SFE. Though the endemic Delta Smelt *Hypomesus transpacificus* is the more famous Osmerid cousin in California, the decline of LFS is arguably more alarming; LFS was one of the most common open water fish in the estuary. However a petition for listing LFS under the ESA was denied in 1992 due to uncertainty regarding the genetic distinctiveness of the SFE population. We evaluated the range-wide demographic and genetic structure of LFS populations using genomic data generated by RAD sequencing. Using a probabilistic framework, we estimated diversity indices for each population. Population structure was determined by PCA and admixture analysis, while genetic distances between populations were calculated using the Fst metrics. To examine population connectivity, simultaneous estimates of effective population sizes and the migration matrix of populations were determined using an approximate Bayesian approach based on the joint site frequency spectrum between populations. Analysis is ongoing, but we found that SFE population is most closely related to the Columbia and Humboldt River populations. Lake Washington, Yakutat Bay (AK), Canadian populations from Pitt and Harrison Lakes, and the Skeena River were all genetically distinct.

Restoring Streamflow in Oregon's Deschutes Basin: Tailoring Tools to Context

Kate Fitzpatrick [α]
Deschutes River Conservancy

Natasha Bellis

Fish need flows, but how do we get them? Many stream reaches in the west are over-appropriated and suffer from low streamflow at certain times of the year. Water trusts use a variety of tools to work with irrigators to secure flow back instream for fish and wildlife. These tools include instream leases, instream transfers, conserved water projects, points of diversion switches, source switches and management agreements. Approaches can be tailored to a wide variety of ecological and socio-political contexts. The Deschutes River Conservancy (DRC) will share its experience designing and implementing strategies to restore flows in Whychus Creek and McKay Creek, two streams in the Deschutes Basin where salmon and steelhead have recently been reintroduced. In Whychus Creek, the DRC has worked incrementally with irrigation partners over 15 years using a wide variety of tools. Instream targets are well on their way to being met and stream temperatures have decreased. In McKay Creek, the DRC is developing a source switch of water that will restore natural flow to the creek within a unique cultural and geographic context. Through these case studies, we will highlight the technical, legal/policy and socio-cultural considerations that drive successful flow restoration strategies.

Total Dissovled Gas Levels Below Foster Dam and Implications for Chinook Salmon and Steelhead Populations

Ryan Flaherty [α]
Pacific Northwest National Laboratory

Evan Arntzen, Alison Colotelo, Ryan Harnish, Jerry Tagestad

The construction and operation of dams in the Willamette Valley of Oregon has played a significant role in the decline of ESA-listed salmonid populations. Operational changes at several of those dams are currently being considered to reduce turbine entrainment and enhance spillway passage to bolster dam passage survival rates for juvenile Chinook Salmon *Oncorhynchus tshawytscha* and steelhead *O. mykiss*. However, those changes will likely increase the levels of total dissolved gas (TDG) below the dams, thereby increasing the risk that fish sustain gas bubble trauma. In Oregon, the criterion for TDG is 110 percent statewide and 105 percent in waters that are shallower than two feet. Here, we investigate the exposure of Chinook Salmon and steelhead to TDG downstream of Foster Dam (Foster) on the South Santiam River, Oregon from October 17 to December 31, 2016 using sensors deployed in the surface water and at egg pocket depth. Chinook Salmon eggs, fry and juveniles, as well as juvenile steelhead, were present below Foster during the study period. Our results suggest that surface water TDG exceeded 110 percent for approximately 532 hours and depth compensated TDG at egg pocket depth exceeded 105% for 273 hours. Concerning levels of TDG occurred only when spill represented at least 90 percent of the total discharge through Foster, leaving open the possibility of controlling elevated TDG by modifying dam operations in the Willamette Valley.

Western Lake Trout Woes - Revisited

Wade Fredenberg [α]
U.S. Fish and Wildlife Service

In Montana, Lake Trout *Salvelinus namaycush* are a self-sustaining introduced species established in over 20 lakes, mostly west of the Continental Divide. Only a few lakes were intentionally stocked and most of the rest were either illegally stocked or naturally invaded through interconnected waterways. Lake Trout populations are a detriment to native fish in the majority of Montana waters where they occur, including large lakes in Glacier National Park as well as Flathead, Swan, Whitefish, Lindbergh and Yellowstone (Wyoming). In lakes with threatened native Bull Trout *S. confluentus*, Lake Trout management runs headlong into the Endangered Species Act. In addition, ongoing Lake Trout expansion ranks high amongst future threats to Bull Trout in the Clearwater lakes (Salmon, Seeley, Alva, Inez, etc.), Lake Koocanusa, and others. Lake Trout are long-lived, hardy, resistant to starvation, reproduce liberally, and prey upon and compete with other native and sport fishes. In systems where abundant invertebrate food sources are added to the mix, a tipping point has often been exceeded for maintaining a diverse native ecosystem. A 2009 review of seven western states revealed that agencies were increasingly implementing strategies aimed toward reducing Lake Trout populations in an attempt to minimize their growing impact. This presentation is a Montana update, but has broader ramifications, documenting millions of dollars spent and mixed results in stemming the Lake Trout tide.

The 2015 Columbia River Salmon Migration-An Omen for the Future in a Warming World?

Jeff Fryer [α]
Columbia River Inter-Tribal Fish Commission

Low snowpack and hot weather in 2015 resulted in unprecedented Columbia River temperatures exceeding 22.2C for almost three weeks, just past the peak of the third largest Sockeye Salmon *Oncorhynchus nerka* run on record and during a period when large numbers of Chinook Salmon *O. tshawytsha* passed. For weeks, the region saw pictures and videos of dead and dying Sockeye Salmon and speculation that runs would be devastated. Tagging studies conducted at Bonneville Dam, although halted during peak temperatures, provide data on their impact. For Chinook Salmon, survival from Bonneville Dam to McNary Dam dropped from 78.9% to 36.4% in the two weeks prior to water temperatures at Bonneville Dam exceeding 22.2C. However, immediately after temperatures dropped, survival to McNary increased to 85%. For Sockeye Salmon, the survival rate from Bonneville Dam to McNary dropped from 82.4% to 31.7% but then increased to 46.2% once tagging resumed. Climate models suggest that events such as occurred in 2015 may become the norm in the future. A question of concern to the region is how well Columbia Basin salmon can adapt to climate change. Sockeye Salmon bound for the Okanagan Basin in Canada may provide insights into a stock that may be adapting to climate change. This stock is reaching the Okanagan River 12 days earlier than in the late 1970s, possibly due to a warming Columbia River as well as habitat improvements in the Okanagan Basin that have made an earlier migration more advantageous.

Playing God with Guppies: Testing Whether Genetic Rescue Works Using a Model Experimental System

W. Chris Funk [α]
Colorado State University

John Kronenberger, Sarah Fitzpatrick, E. Dale Broder, Jillian Gerberich, Lisa Angeloni

Fragmentation impedes dispersal among previously connected populations, often leading to inbreeding depression and reduced evolutionary potential. A potential solution is demographic and genetic rescue. Augmentation with immigrants that are genetically similar to the target population is an effective strategy for increasing population fitness, but when only divergent immigrant sources remain, outbreeding depression may ensue. Experimental tests of these riskier augmentation scenarios are lacking. Here, we present the results of a mesocosm experiment in which we used Trinidadian Guppies *Poecilia reticulata* to test the multigenerational demographic and genetic effects of immigration from a range of divergent sources into two populations. We found no evidence for demographic rescue, but we did observe genetic rescue in one population. Specifically, treatments that received divergent immigrants maintained greater genetic diversity, abundance, and hybrid fitness than controls that received immigrants from the source used to seed the mesocosms. In the second population, divergent immigrants had a slightly negative effect in one treatment, and the benefits of gene flow were less apparent, possibly because this population had higher genetic diversity at the start and a lower reproductive rate. Our results support a growing body of research suggesting that immigrants can increase population fitness even when they are divergent.

Resiliency and Vulnerability of Lentic Ecosystems and Communities to Multiyear Drought: What is Known and What Remains Uncertain

Jereme Gaeta [α]
Department of Watershed Sciences and the Ecology Center, Utah State University

Phaedra Budy

Water storage in lakes and reservoirs throughout the Intermountain West is highly sensitive to drought. Future droughts conditions in the region are not only projected to occur more frequently, but for longer durations. While short-term effects of drought and lake level reductions are well known, the effects of multiyear droughts on lake ecosystems and the aquatic organisms these lakes support remain understudied. Multiyear droughts may alter physical aspects of lakes and reservoirs by reducing volume, altering water quality, leaving littoral habitat stranded along shorelines, and disrupting connectivity to tributaries. These habitat changes associated with multiyear droughts are suspected of disrupting fish life cycles (e.g., reduced or failed recruitment) as well as shifting or breaking food web connections (e.g., altered, reduced, or collapsed prey communities). However, the strength of these effects varies among ecosystems, communities, and populations. What characteristics are associated with resiliency to multiyear drought and which are associated with vulnerability? Can we predict whether and how an ecosystem, community, population, or fishery will be influenced by multiyear drought? Here we synthesize what is known about multiyear drought and lentic ecosystems and propose a conceptual framework through which researchers and managers may assess lentic systems in a changing climate.

Stable Isotope Analyses on Otoliths of Pacific Salmon

Yongwen Gao [α]
Makah Fisheries Management

Pacific salmon *Oncorhynchus* spp. have distinct life histories from freshwater to marine. In this study I report examples of using stable carbon and oxygen isotope ratios of archived otoliths of chum salmon *O. keta* and Chinook salmon *O. tshawytscha* to examine the fish's stock structure and life history. Two aragonite powder samples were extracted from each otolith: one from the nucleus of otolith that represents the initial 3-6 month growth; the other from the second summer otolith zones. Among about 400 powder samples analyzed, the d13C values of chum otoliths ranged from -10.93 to -3.75° whereas $\delta^{18}O$ values of the same samples ranged from -6.39 to +1.93°. Both species have the same life history from freshwater to marine as well documented. At the freshwater stage fish from different stocks had distinct $\delta^{18}O$ values, reflecting the river habitat conditions and different timing for ocean entry. From downstream migration to adaption of the marine life, there were no significant food or trophic level shifts from $\delta^{13}C$ variations. Thus we concluded that stable isotopic records of otoliths can be used as a natural tag in Pacific salmon studies.

Instream Flow Protection in Washington State: Mitigation Challenges and Opportunities

Kiza Gates [α]
Washington Department of Fish & Wildlife

Steven Boessow, Jonathan Kohr, Robert Granger, Cole Provence

The Washington State Instream Flow Protection Program has operated for almost 50 years, backed by legislation protecting streamflows for fish and wildlife. Roughly half of the watersheds in Washington have an instream flow rule in place that functions as a water right for instream resources. These rules have priority dates placing them in line with other junior and senior water rights. In protecting instream flow rules, new applications for water rights are reviewed by the Washington Department of Fish & Wildlife to ensure that any impacts to the resource are mitigated. Past negotiated mitigation packages have included direct water replacement as a priority (in-kind), but have also included habitat improvements when water was not available (out-of-kind). Out-of-kind mitigation has focused on the impacts of development such as increased imperious surface area, encroachment on stream habitat, and flashier runoff patterns. The flexibility to combine both types of mitigation and the collaborative stakeholder driven process for developing mitigation packages helped produce habitat improvement projects with benefits to fish and wildlife. Unfortunately, not all impacts of development can be mitigated for and determining the mitigation value of out-of-kind projects is contentious. Recent State Supreme Court rulings have halted the use of out-of-kind mitigation and placed instream flow rules at odds with development.

The Effect of Multiyear Drought on Habitat Availability and Tributary Connectivity with Implications for Bear Lake Sculpin & Bonneville Cutthroat Trout

Hayley Glassic [α *]
Utah State University

Jereme Gaeta

Multiyear droughts are projected to increase in frequency and duration within arid regions across the world. In Utah, multiyear droughts have historically been associated with declines in Bear Lake, UT/ID lake elevations. Drought-driven lake elevation declines may expose littoral habitat and cause spawning tributary disconnection. Endemic Bear Lake Sculpin *Cottus extensus* (BLS), a species of concern, use littoral substrate for refuge and spawning habitat. Bonneville Cutthroat Trout *Oncorhynchus clarki utah* (BVCT), need tributary connectivity to spawn as adults and out-migrate as juveniles. We tested whether declines in lake elevation reduce the area of littoral cobble available to fishes and increase the tributary distance by creating an elevation-explicit habitat and elevation-explicit tributary map. We combined historical datasets for BLS and BVCT with the elevation-explicit habitat map and elevation-explicit tributary map to determine whether drought-driven changes in critical habitat influence species dynamics. As lake elevation decreases from full pool to the lowest historical elevation, littoral cobble decreases by 91 percent, BLS CPUE decreases by 50 percent, and sculpin year class strength declines. As tributary channel distance increases by 190 percent from full pool to the lowest historical elevation, we expect BVCT year class strength will suffer. With a projected increase in multiyear drought, the endemic fishes of Bear Lake will be under pressure to persist with impediments to critical habitat for multiple life stages.

Our Future in a Warming, Water-Stressed World

Robert Glennon [α]
University of Arizona, Rogers College of Law

As the Earth's population increases from seven to nine billion, farmers face the immense challenge of growing more food. As climate change continues to warm the Planet, farmers need more water just to grow the same amount of food. At the same time, cities and industry want some of the water farmers currently use and prime farmland is being converted to municipal and industrial uses. Our usual response to water shortages is to build more dams, increase diversions from rivers, and drill new groundwater. These options are not viable, except at a huge cost to our environment. Nor are zany schemes, such as weather modification or towing icebergs from the Arctic. We have tools available to address shortages, beginning with conservation, water reuse, and desalination. However, we need to go farther. We need to price incentives to encourage conservation and market forces to encourage reallocation. Using a market-based system, which values water as a commodity and a fundamental right, will allow us to build resiliency into water management.

Monitoring Pacific Lamprey Distribution and Re-introduction in the Wenatchee River: an eDNA Pilot Study

Ann Grote [α]
USFWS: Mid Columbia Fish and Wildlife Conservation Office

Kellie Carim, RD Nelle

Although historically abundant in the Pacific Northwest, Pacific Lamprey *Entosphenus tridentatus* have declined dramatically throughout their native range. Defining the current Pacific Lamprey distribution is central to conservation efforts, and environmental DNA (eDNA) sampling may be a time and cost effective method to assess habitat. This pilot study evaluated the capacity of eDNA sampling to detect Pacific Lamprey in the Wenatchee River, WA. The Wenatchee River is currently the subject of an adult translocation program intended to supplement the existing lamprey run, and re-establish Pacific Lamprey upstream of a passage impediment (Tumwater Dam). Initial study results are promising: Pacific Lamprey eDNA was detected at 100 percent of Lower Wenatchee River sites located within the known distribution of the species. Lamprey eDNA was also detected at seven sites in the Upper Wenatchee River, in areas accessible to only translocated fish. Pacific Lamprey eDNA concentrations from paired-transect samples were similar, suggesting that single samples at one river bank may be sufficient to document lamprey presence at a given location. Based on these results, eDNA sampling appears to be a valuable tool for evaluating Pacific Lamprey presence. However, because questions remain about detection probabilities when the target species is extremely rare, we recommend that the eDNA approach be combined with traditional sampling methods in systems where little is known about Pacific Lamprey distribution.

Competing Interests on the Yellowstone: Pallid Sturgeon and the Intake Diversion Dam

Aaron Hall [α]
Defenders of Wildlife

The Intake diversion dam, constructed in 1906, is located on the Yellowstone River about 70 miles upstream of its confluence with the Missouri River. Although built to provide irrigation water, the rock dam has had the unintended consequence of preventing Pallid Sturgeon *Scaphirhynchus albus*, a federal endangered species (listed in 1990), from passing upstream and accessing potential spawning and larval drift habitat. Thus, any plan to update the dam must also take into account the needs of Pallid Sturgeon to move upstream. This talk focuses on the role of environmental groups, the public, and science in decision-making when potentially competing interests exist.

Parentage Based Tagging Reveals Overestimation of the Proportion of Natural-origin Chinook Salmon and Steelhead in the Columbia River Basin

Daniel J. Hasselman [α]
Columbia River Inter-tribal Fish Commission

Jon E. Hess, Maureen A. Hess, Shawn R. Narum

The presence of a visual mark to discriminate natural- vs. hatchery-origin salmonids is an important component of fisheries management and conservation. Non-treaty Chinook Salmon *Oncorhynchus tshawytscha* fisheries in the Columbia River are frequently mark-selective and target hatchery-origin fish that have their adipose fins removed. Further, daily census counts of steelhead *O. mykiss* at Bonneville Dam use the presence/absence of the adipose fin (and other visual criteria) to indicate whether fish are putatively natural- or hatchery-origin. However, not all hatchery-origin fish have their adipose fins removed prior to their release as juveniles. This can overestimate the proportion of natural-origin fish returning to spawn, and can have implications for fisheries conservation and management. Parentage based tagging (PBT) provides a powerful genetic method for identifying the origin of anadromous salmonids, and does not rely on visual marks. We used PBT to examine the stock composition of Chinook Salmon and steelhead sampled at Bonneville Dam over two consecutive years (2015-2016). We detected hatchery assignments for 7 percent and 17 percent of putatively natural-origin Chinook salmon and steelhead in 2015; these values increased to 15 percent and 20 percent in 2016 and may reflect the expansion of our PBT baseline. Our results suggest the visual marks are not always a reliable indicator of the origin of anadromous salmonids, and overestimate the proportion of natural-origin Chinook Salmon and steelhead returning to the Columbia River basin.

Quantifying Individual Based Migration Strategies to Understand Selection on Juvenile Life-History for a Salmon Population in an Altered Landscape

Jens Hegg [α *]
University of Idaho

Brian Kennedy, Paul Chittaro, Rich Zabel

Fall Chinook Salmon *Oncorhynchus tshawytscha* in the Snake River are heavily impacted by anthropogenic changes to the river system, including significant decreases in available habitat, as well as changes in flow, temperature and productivity throughout their range. In recent years, the population has transitioned from an apparently ubiquitous sub-yearling (early) outmigration strategy to a mix of early out-migrants and yearling (late) out-migrants. This change is presumably related to changes in the selective pressures exerted on out-migrants, and recent research suggests that this shift has an evolutionary component rather than being an entirely plastic response. Understanding this behavioral shift requires linking individual downstream movement timing to heterogenous conditions across large spatial scales but at a fine spatial and temporal resolution. Otolith microchemistry provides a tool to understand these ecological connections, linking individual movement data to population trends across the basin. Using a ten year dataset of isotope and elemental microchemistry from otoliths of juvenile (n=376) and returning adult (n=591) fish we have determined the hatchery or wild origin, downstream movement patterns, and out-migration timing of individual fish. Our work examines changes in outmigration timing over this ten year period, correlating movement to temperature and flow within the basin during critical juvenile periods.

Distribution of and Habitat Use by the Salish Sucker, an Endemic Species West of the North Cascades

James Helfield [α]
Western Washington University

Leo Bodensteiner, Jeremy Gilman, Ashley Rawhouser, Nate Lundgren

The provisionally-named Salish Sucker *Catostomus* spp. is an endangered fish endemic to northwestern Washington and southwestern British Columbia. Not yet formally described, it is an evolutionarily significant unit, morphologically distinct from its closest relative, the Longnose Sucker *C. catostomus*. The described distribution of the Salish Sucker was lowland streams and lakes within the Fraser River Valley and Puget Sound lowlands. We sought to better characterize the distribution of this species in the region because of threats to its potential habitat. We sampled at 12 sites in five major watersheds in and near Mt. Baker-Snoqualmie National Forest. Using prescribed capture methods, we collected Salish Suckers along the Skagit and Nooksack Rivers. This expanded the potential range farther upstream and to higher elevations than previous efforts and identified preferred habitats as riverine backwaters and low gradient streams; fish were not present in areas dominated by colder groundwater or snowmelt. Because these findings have substantial implications for conservation of this species, we are currently characterizing the genetic identities among these populations.

Lolo National Forest: 15 Years of Aquatic Organism Passage

Shane Hendrickson [α]
U.S. Forest Service, Lolo National Forest

Since the 1970's, Fish Biologists on the Lolo National Forest have been concerned with culverts impacting fish passage. Data files depict surveyed culverts and hand drawn maps of culvert passage barriers, however there was no consistent definition of fish passage. Beginning in 2001, the Lolo NF, in cooperation with the Northern Region, began a systematic inventory using survey methods developed by the San Dimas Technology and Development Center (Clarkin et. al. 2003). By 2003, approximately 600 road culvert crossings across the Lolo NF had been inventoried. This data was then entered into a Microsoft Access database and filtered through a course screen fish passage definition that was developed by the Northern Region (Hendrickson et. al. 2008). This definition was based upon swimming capabilities of resident Westslope Cutthroat Trout *Oncorhynchus clarki lewis*, the most widespread fish species across the Northern Region. Arc GIS was utilized to map culverts by the type of barrier. This allowed biologists and engineers to see spatial distribution, miles of stream impassable, constriction ratio of culverts, and other parameters; which allowed for prioritization of replacement or removal. Since 2001, the Lolo NF has removed 88 and replaced 71 culverts that have opened approximately 63 and 142 miles, respectfully, of aquatic access. Results from these culvert replacements has influenced surveys, designs, and monitoring that has improved the quality of these newly simulated stream segments.

Evaluation of Potential Translocation Sites for Hornyhead Chub

Brian Hickerson [α *]
University of Wyoming, Cooperative Fish and Wildlife Research Unit
Annika Walters

Hornyhead Chub *Nocomis biguttatus* are a Species of Greatest Conservation Need in Wyoming where they are restricted to 26 kilometers of stream habitat in two rivers. Glacial relict populations of Hornyhead Chub have been extirpated from Colorado, western Nebraska and Kansas. Because of this severely restricted distribution and a history of stochastic events causing population extirpations, there is interest in establishing new Hornyhead Chub populations through translocation. We evaluated 12 potential translocation streams within the plausible historic range of Hornyhead Chub in the North Platte River drainage, Wyoming. Fish community and habitat data were collected at 24 sites on translocation streams and compared to 21 sites on the Laramie River that currently support Hornyhead Chub populations. On the basis of fish community and habitat similarity to sites with robust Hornyhead Chub populations, we were able to identify streams not likely to support translocations and streams to investigate further during our 2017 field season. We also evaluated the effect on non-native predators on existing Hornyhead Chub populations through stomach sample and stable isotope analysis.

The Use of Strontium Isotope Ratios 87Sr:86Sr in Otoliths and Fin Rays to Inform Ecology, Conservation, and Management of Fishes in California

Jim Hobbs [α]
University of California, Davis
Malte Willmes, Levi Lewis

In-situ chemical analysis (strontium isotope ratios) of calcified structures (e.g., otoliths and fin rays) is a useful tool for reconstructing movement and habitat use patterns of individual fish. Such analyses provide enhanced inference regarding critical spawning and nursery habitats, migration history, diversity in life history strategies, and discrimination between wild- versus hatchery-spawned individuals in adult populations. The California Central Valley receives runoff from the Sierra Nevada range and provides water to 35 million people and supports a multi-billion dollar agricultural industry. These freshwaters also flow into the San Francisco Estuary which is critical habitat to many native anadromous, partially anadromous, and semi-anadromous species of fishes; many of which are threatened with extinction or are commercially important. For the last decade, we have used in-situ laser ablation MC-ICP-MS to better describe the ecology of native fishes and enhance specific conservation and management efforts in California. Here I will provide an overview of our studies on osmerid smelts, Chinook Salmon *Oncorhynchus tshawytscha*, and White Sturgeon *Acipenser transmontanus*; describing our techniques, major findings, and how our work can and has informed management and conservation efforts.

The Genomics of Adaptation: Lessons from Threespine Stickleback

Paul Hohenlohe [α]
University of Idaho

Threespine Stickleback *Gasterosteus aculeatus* have long been an ecological and evolutionary model system. Stickleback exhibit remarkable patterns of parallel adaptation among populations across their range, most notably repeated colonization and adaptation in freshwater habitats from ancestral marine or anadromous forms, as well as repeated diversification into different freshwater ecotypes. The phenotypic traits involved in this parallel adaptation include physiology, behavior, life history, pigmentation, and numerous aspects of body size, shape, and morphology. With the advent of next-generation sequencing and the availability of a well-assembled reference genome for the species, numerous studies have identified genomic regions exhibiting signatures of selection in natural populations, and containing candidate genes. Laboratory-based genetic mapping has similarly identified numerous genes associated with key traits. I review these data and show that there is a high degree of parallelism in the loci associated with divergent adaptation among stickleback populations and concordance with genetic mapping studies. Much of the parallel phenotypic evolution involves re-use of similar genes and even shared allelic variation among populations. Models of the demographic scenario of serial colonization and adaptation, along with genomic features such as inversion polymorphism, provide insights into how such multi-trait, polygenic parallel adaptation can occur.

Detecting Spawning of Threatened Chum Salmon Over a Large Spatial Extent Using eDNA: Implications for Monitoring Recolonization

Kris Homel [α]
Oregon Department of Fish and Wildlife

Chum Salmon *Oncorhynchus keta* were historically abundant in the Columbia River Basin. Beginning in the 1930s, populations experienced precipitous declines and in 1999, Chum Salmon were listed as threatened under the ESA. Oregon recovery efforts began in 2011 with the creation of a conservation broodstock, experimental reintroductions, and collection of baseline data to identify current spawner distribution and abundance. However, because spawner abundance in Oregon is low and Chum spawning habitat can be difficult to survey, it appeared that spawning ground surveys were insufficient to accurately assess spawning. In 2015, we initiated a study in the recovery population between Bonneville Dam and The Dalles Dam to identify spawner distribution using environmental DNA (eDNA). To do so, eDNA was collected from all low gradient tributaries to the Columbia River, during peak spawning. Samples were also collected from four known positive• control sites and all samples were processed at the Rocky Mountain Research Station Genomics Lab in Missoula. Chum Salmon DNA was detected in all control sites, along with four other sites in the study area. Results suggest that eDNA is a cost effective and accurate tool for identifying the spawning distribution of a rare species over a large spatial extent. Future work will focus on using eDNA to monitor Chum recolonization throughout the Oregon side of the Columbia River, following reintroduction efforts.

Foraging Ecology and Production of Rio Grande Cutthroat Trout in the Face of Mounting Ecological Pressures

Brock Huntsman [α]
New Mexico State University

Colleen Caldwell, Abigail Lynch, Bonnie Myers, Quintin Dean

Rio Grande Cutthroat Trout (RGCT) *Oncorynchus clarki* have experienced substantial declines throughout their native range. Competition with invasive trout, stream drying, and rising stream temperatures are critical factors suggested responsible for the species decline. We collected seasonal mark-recapture data as well as gastric lavage diet information from seven streams in northern New Mexico in 2016 to explore how temperature, flow, and invasive trout affect RGCT food webs and secondary production. We developed a hierarchical von Bertalanffy growth model and a depletion count model within a Bayesian framework to estimate age specific RGCT growth rates, population sizes, and secondary production. Neither abundance nor growth demonstrated strong relationships with environmental factors. However, a strong quadratic relationship between production and stream temperature, and a negative exponential relationship between habitat and production was observed. Interestingly, the only stream with Brown Trout *Salmo trutta* also had the lowest rates of RGCT production. The majority of RGCT populations had greater terrestrial prey contribution to productivity than aquatic contributions, although three of the four most productive streams had stronger support via aquatic prey biomass. Our results suggest production of RGCT populations depend on a complex assemblage of environmental and biological factors, where production and food-web studies may help explain declines.

The Aquatic eDNAtlas for the American West: All Species, All Streams Through Crowd-sourcing and One Interagency Database

Dan Isaak [α]
USFS

Mike Young, Mike Schwartz, Kevin McKelvey, Taylor Wilcox, Tommy Franklin

Aquatic environmental DNA sampling is rapidly transforming our ability to describe and monitor biological communities. Adoption of this sampling technology is occurring broadly across many natural resource organizations and now results in samples being collected at thousands of sites each year across the American West. To reduce redundancy and maximize data sharing among organizations, the Aquatic eDNAtlas project will develop an interagency database, sampling template maps, and a website to ensure standardization of data collections while providing access to samples collected in association with the National Genomics Center for Wildlife and Fisheries Conservation (http://www.fs.fed.us/research/genomics-center/). Data will be provided in flexible digital formats that enable efficient use for many purposes that include species status assessments, trend monitoring, distribution modeling, detection and tracking of nonnative species invasions, and assessments of habitat restoration efforts. The eDNAtlas project will encompass all species throughout the 400,000 kilometers of perennial rivers and streams in 12 western states. The website and database will be launched in the latter half of 2017 and will be updated semi-annually with newly processed samples from those willing to share their data. The NGC database currently houses eDNA samples from ~8,000 stream sites, and >4,000 new sites are sampled each year so a wealth of data will soon become available to the aquatic community.

Climate Warming Rates of Salmon and Trout Rivers in the West: Implications for Conservation and Management

Dan Isaak [α]
USFS

Charlie Luce, Gwynne Chandler, Dona Horan, Sherry Wollrab

Large rivers in the West compose a small portion of the perennial network but are disproportionately important as salmon migratory corridors and world-class trout fisheries. Mortality events and fisheries closures have occurred in recent years and will become more frequent as climate warming continues this century. Conservation strategies require knowing where, and whether, temperatures will continue to support cold-water fishes, so here we estimate warming rates at >300 western river sites during the 40-year period of 1976–2015. Warming trends occurred in all seasons but were pronounced during the summer (0.1–0.3°C/decade) due to the combined effects of air temperature increases and flow decreases. Warming trends were used with NorWeST temperature scenarios to show how the distribution of thermal habitats for rainbow and brown trout could be affected in Montana, and how the cumulative thermal load experienced by migrating adult salmon could increase. Trout and salmon populations may adapt to thermal stress by shifting their distributions in space and time but doing so creates trade-offs during other life-stages or causes range contractions. Many western rivers, especially those that currently have relatively cold temperatures, should continue to support cold-water fishes even under extreme future climate change scenarios, but other rivers will gradually become too warm and community transitions away from cold-water fishes are likely to occur and should be acknowledged.

How Many Fish Live in that River Network? A Scalable Population Estimator that uses Spatial Stream Network Models and Nonrandom Fish Density Datasets

Dan Isaak [α]
USFS

Jay Ver Hoef, Erin Peterson, Dona Horan, Dave Nagel

Population size estimates for stream fishes are important for management but sampling costs limit the extent of most estimates to small reaches of networks that encompass thousands of linear kilometers. However, the advent of large fish density datasets, spatial-stream-network models that benefit from non-independence among samples, and geospatial database frameworks for streams enable broadly scalable approaches to population estimation. Here, we demonstrate a new approach to population estimation with an example dataset composed of trout density surveys from 108 sites in a 735 kilometer network. Universal kriging was used to predict a continuous map of densities among survey locations and block kriging (BK) was used to summarize discrete map areas and make population estimates at stream, river, and network scales. The grand population estimate for the network was 184,030 +/-27,263, of which ~80% were native Yellowstone Cutthroat *Trout Oncorhynchus clarkii bouvieri*. Population sizes for steep tributaries with short networks ranged from 612 to 7,128 trout while longer tributaries hosted populations ranging in size from 12,963 to 27,216 trout. The SSN-BK population estimator can be applied throughout much of North America using free software and nationally consistent geospatial resources to develop valuable information at low cost from many existing fisheries datasets. The paper describing this research appears in CJFAS and is available from TreeSearch here: https://www.treesearch.fs.fed.us/pubs/53350.

Egg vs. Water: Maternal and Incubation Water Contributions to Otolith 87Sr/86Sr

Jill Janak [α]
Pacific Northwest National Laboratory

Tim Linley, Holly McLellan

Otoliths are calcium carbonate structures that accrete elements present in the water and diet on a daily basis, and can serve as a permanent record of the fish's chemical environment. Numerous studies have demonstrated that the chemical record is reflected in the Strontium Isotope ratios (87Sr/86Sr) of the otoliths, and that this ratio can be used to determine natal origins and reconstruct life histories of fish. The core or maternal zone of the otolith is a composite of the maternal environment(s) during oogenesis and of the water during incubation. Because of this maternal influence, this zone is typically avoided when determining natal origins. However, for species that leave their natal site at emergence to enter a lake or ocean for rearing, such as Kokanee Salmon *Oncorhynchus nerka*, the maternal zone may represent the only chemical record of the spawning and incubation environment. We quantified the 87Sr/86Sr contribution from both egg and incubation water to the maternal zone of Kokanee otoliths, and the degree to which it varies through emergence. Further understanding of this relationship would increase the utility of the maternal zone of the otolith for reconstructing fish life histories and the range of species that would benefit from geochemical analysis of otoliths for determining natal origins.

The Dolores River Restoration Partnership; Reflecting on Seven Years of Watershed Restoration and Collaboration

Michael Jensen [α]
US Bureau of Land Management

For many miles, the Dolores River, located in southwest Colorado and eastern Utah, is choked with invasive salt ceder *Tamarix* spp., Russian knapweed *Rhaponticum repens*, and Canada thistle *Cirsium arvense.* Large portions of the river suffer from an altered flow regime due to the construction of McPhee Reservoir located near Dolores, Colorado. Constructed in 1985 to provide irrigation water to southwest Colorado farmers, the reservoir has substantially reduced spring peak flows in the Dolores River. Subsequent sediment accumulation has resulted in constriction of the river channel by invasive plant species, and reduced habitat complexity, diversity, and quality for native fish, wildlife, and riparian species. As the primary land manager within the watershed, the Bureau of Land Management (BLM) recognized the ecological impacts these invasive plant species were having on habitats within the watershed. In 2009, the Dolores River Restoration Partnership (DRRP) was founded. This diverse partnership, comprised of thirty organizations/individuals including multiple federal, state, county, non-profit, and private entities has been working to restore the riparian corridor of the Dolores River. Since inception, the DRRP has built trust and good working relationships across two states, five counties, four BLM field offices, and dozens of private land owners. We share here some of the successes of this diverse public private collaboration.

Mysis diluviana Responses to Severe Drought in Three Montane Reservoirs

Brett Johnson [α]
Colorado State University

Douglas Silver, William Pate, Kyle Christianson

Drought can alter limnological conditions in reservoirs and change the quantity and quality of habitat for limnetic organisms. Reduced inflows and increased demand during water scarcity can affect water storage, nutrient loading, water residence time, thermal stratification and water clarity. A standardized *Mysis diluviana* monitoring program at three coldwater reservoirs during 1991-2016 coincided with two severe, multi-year droughts and allowed us to examine responses of *Mysis* populations. *Mysis* density averaged 342 mysids/m^2 over the 26 years of the study. In 2003, reservoir content decreased by as much as 80% after two successive years of severe drought. *Mysis* density in 2003 (~30 mysids/m^2) was the lowest observed in the period of record at the two reservoirs with the most severe drawdowns. We hypothesized that *Mysis*, which are cold stenotherms, may be sensitive to drought-induced changes to physicochemical habitat such as temperature and dissolved oxygen conditions. In this presentation we will evaluate the evidence for this hypothesis. *Mysis* introductions have proven detrimental to host ecosystems in Colorado, and throughout western North America. The prospect of increasing drought frequency and severity may actually prove beneficial to fish populations that compete with *Mysis* in coldwater reservoirs.

Swimming Performance of Sauger in Relation to Fish Passage

Kevin Kappenman [α]
U.S. Fish and Wildlife Service - Bozeman Fish Technology Center

David Dockery, Tom McMahon, Matt Blank

A lack of information on the swimming abilities may inhibit the design of effective passage structures for Sauger *Sander canadensis*, a highly migratory species particularly sensitive to habitat fragmentation. Passage success, maximum ascent distances, and maximum sprint velocities of Sauger were estimated in an open-channel flume over a range of water velocities (51, 78, and 92 cm/s) and temperatures (10.0, 14.3, and 18.3° C) to assess swimming performance. Passage success was high (91 percent) over all test velocities, as was the maximum instantaneous burst velocity (219 cm/s). Water temperature and body size had little effect on swimming performance. Sauger transitioned from steady sustained swimming to unsteady, burst-glide or steady burst swimming at 97 cm/s. Sauger were capable of sustained sprints of 124 cm/s over 15 second duration in a swim chamber. Results suggest passage structures with water velocities less than 97 cm/s should provide high probability of successful passage of adult Sauger whereas structures with water velocities exceeding 219 cm/s may be impassable.

Sustainable Agro-based Earthen Pond Integrated Carp Fish Farming in Pakistan: Prospects of Transfer of American Fish Feed Technologies

Muhammad Naeem Khan [α]
University of the Punjab

Traditional inland carp *Cyprinus* spp. pond fish farming has opened up new avenues for sustainable animal food production, integrated agriculture and rural development, and alleviated poverty in rural communities. The environment friendly integrated carp fish farming relying on pond manuring and fertilization with occasional home-made feed supplementation helps in the local recirculation of agriculture and animal organic wastes. However, recently the soy-based extruded floating fish feed introduced in Pakistan by the American Soybean Association's World Initiative for Soy in Human Health (ASA/WISHH) with the support from the US Department of Agriculture (USDA), has given a new impetus to the development of agro-based sustainable pond fish farming in Pakistan. The prospects of the use of soy-based extruded floating fish feed for carp poly-culture in earthen ponds in the provinces of Punjab and Sindh are enormous, as the farming conditions in these provinces are suitable for introduction of these agro-based feed technologies. It is anticipated that the American fish feed technologies can be promoted on a larger commercial/industrial scale in Pakistan as these technologies are similar and suitable for the Pakistani fish farming system and the agriculture environment. This paper will explore the prospects of transfer of American fish feed technologies for promotion of sustainable green fish farming in Pakistan.

Evaluating the Size Selectivity of Mid-Water Trawls for Sampling Kokanee

Zachary Klein [α *]
University of Idaho

Michael Quist, Andrew Dux, Matthew Corsi

Kokanee Salmon *Oncorhynchus nerka* are arguably one of the most important fish in Idaho. Kokanee Salmon provide valued recreational fisheries, and also serve as an important prey resource. As such, Kokanee Salmon are a major focus of natural resource agencies throughout Idaho. Kokanee Salmon are largely monitored using hydroacoustic surveys and mid-water trawls. However, the validity of data collected using mid-water trawls has been questioned due to the potential size selectivity of the gear. Therefore, we sought to assess the length selectivity of mid-water trawls by comparing estimates obtained from gill nets to those obtained using mid-water trawls. Experimental curtain gill nets and mid-water trawls were used in conjunction to sample Kokanee Salmon in six waters throughout Idaho. The relative selectivity of gill nets was quantified using the SELECT method and was used to estimate a corrected length distribution. The corrected length distribution was then compared to mid-water trawl data to identify potential size-biases of mid-water trawls. Data from 2015 and 2016 suggest that mid-water trawls overestimate the number of small fish and underestimate the number of large fish in a population. The apparent size-selectivity of mid-water trawls could bias population demographic and dynamics data used to manage Kokanee Salmon populations. As such, managers should clearly identify the goals of a given monitoring program and choose gears that best address questions relating to the management of Kokanee Salmon in Idaho.

At the Forefront: Evidence of the Applicability of Using Environmental DNA to Quantify the Abundance of Fish Populations in Natural Lentic Waters

Stephen Klobucar [α *]
Utah State University

Torrey Rodgers, Phaedra Budy

Environmental DNA (eDNA) sampling has proven to be a valuable tool for detecting species in aquatic ecosystems. Within this rapidly evolving field, a promising application is the ability to obtain quantitative estimates of relative species abundance based on eDNA concentration rather than traditionally labor intensive methods. We investigated the relationship between eDNA concentration and Arctic Char *Salvelinus alpinus* abundance in five natural lakes, and additionally, we examined the effects of different temporal (e.g., season) and spatial (e.g., site, depth) scales on eDNA concentration. Concentrations of eDNA were linearly correlated with fish abundance (R^2 = 0.82) and exponentially correlated with density (R^2 = 0.97 by area; 0.85 by volume). Across lakes, eDNA concentrations were greater and more homogeneous in the water column during mixis; however, when stratified, eDNA concentrations were greater in the hypolimnion. Overall, our findings demonstrate that eDNA techniques can produce effective estimates of relative fish abundance in natural lakes. These findings can guide future studies to improve and expand eDNA methods to inform research and management using rapid and minimally invasive sampling.

Whitewater Parks: Implications for Fish Habitat and Fish Passage

Matt Kondratieff [α]
Colorado Parks and Wildlife

Eric Fetherman, Brian Fox, Nell Kolden, Kristoph Kinzli

Whitewater parks (WWP) have become popular recreational amenities in the United States, with Colorado being the epicenter for WWP design and development. WWPs consist of instream structures designed to create a hydraulic wave for recreational boating activities such as kayaking and tubing. Fish density, biomass, and habitat suitability scores were estimated for pools located within WWP and natural stream reaches with similar lengths and geomorphic settings over three years. Fish biomass and density were lower in WWP pools despite being deeper with larger-volumes and higher habitat suitability. Lower fish abundance may be explained by conversion of food producing riffles to short, impervious, grouted drop structures and increased hydraulic variability within WWP pools. Higher turbulence (6x), vorticity (2x), velocity (3x), surging (40x), and depth (2x) were observed in WWP pools as compared to natural pools. WWPs were also found to impair fish passage, as a year-long study using multiple PIT tag arrays and 2,500 resident fishes found that salmonid movements through a WWP reach were reduced by as much as 34% when compared to a natural reach. Taken together, results from population estimates, hydraulic, and movement studies indicate that WWPs create suboptimal habitat conditions and can limit upstream movement of resident fishes. Additionally, caution should be exercised when applying habitat suitability to estimate habitat quality in hydraulically-variable lotic environments.

Selection Against Rainbow Trout Admixture Across Populations, Environments, and the Genome

Ryan Kovach [α]
University of Montana

Clint Muhlfeld, Matt Boyer, Winsor Lowe, Fred Allendorf, Gordon Luikart

Human-induced hybridization between native Cutthroat Trout *Oncorhynchus clarkii* and invasive Rainbow Trout *O. mykiss* is a principal threat to the persistence of native Cutthroat Trout throughout western North America. Although admixture between native Cutthroat Trout and invasive Rainbow Trout is widespread, the fitness consequences of hybridization and introgression remain poorly understood. Evolutionary and ecological consequences of hybridization between native and invasive species are notoriously complicated because patterns of selection acting on non-native alleles can vary throughout the genome and across environments. We combine various forms of data (individual reproductive success, selection coefficients derived inter-cohort changes in allele frequencies, and patterns of genome wide ancestry) from multiple populations and diverse environments to describe the fitness consequences of hybridization between Westlope Cutthroat Trout *O. c. lewisi* and Rainbow Trout. Results show consistent patterns of strong selection acting against Rainbow Trout admixture at multiple scales ranging from genes to genomes, individuals to cohorts, streams to entire river basins, and across diverse abiotic gradients (e.g., water temperature). On the other hand, evidence for adaptive introgression remains elusive. Together, these data suggest that ongoing hybridization between Rainbow and Westslope Cutthroat Trout is deleterious for local adaptation, with potential consequences for contemporary and long-term persistence.

Evaluation of an Electric Fish Barrier on an Irrigation Canal on the Lower Gunnison River, Colorado

Dan Kowalski [α]
Colorado Parks and Wildlife

Eric Gardunio

An electric fish barrier was installed on the east portal of South Canal to reduce fish entrainment with the construction of two hydropower plants in 2012. The objective of this study was to monitor fish entrainment and evaluate the effectiveness of the barrier. Three groups of fish were tagged and released upstream of the barrier; fish from the canal, wild Gunnison River fish, and hatchery reared fingerlings. Mark recapture boat electrofishing was completed and population estimates were made with the Huggins Closed Capture model using fish length to model capture probabilities. The study reach contained 2,994±1,043 fish (>150 mm) in Oct-2011, 1,764±279 in Oct-2013, 1,224±239 in Jul-2014 and 1,900±379 in Oct-2014. Fish population estimates have declined after the electric barrier, but not significantly at the 95% level. A total of 288 tagged fish less than 300 mm and four fish greater than 300 mm were recovered below the barrier, 1.3% of all tagged fish. The electric barrier appears to successfully exclude larger fish from the study reach, but not smaller age 0, 1 and 2 trout. The entrainment, growth and survival of smaller fish maintains a stable population of fish in the canal, but fewer entrained mature fish is likely a benefit to the fish population of the Gunnison River. Further study is needed to evaluate if smaller trout can be successfully excluded by this electric barrier.

A Comparative Analysis of the Bristol Bay, Southeast, and Kenai River Fisheries: Tracking Stakeholder Participation over the Last 15 Years

Meagan Krupa [α]
University of Alaska

Molly McCarthy

Management decisions regarding the allocation of salmon fisheries are made by the Alaska Board of Fisheries (Board). The Board considers proposals to changes in the allocation of salmon for each region every three years. Anyone is welcome to submit proposals and testify during the public decision-making process. Using integrated data digitization and coding methods, this research project seeks to understand stakeholder participation in Alaska's fisheries management, and the regional differences affecting the implementation of the fisheries management system across the state. This specific paper investigates differences in stakeholder participation in the form of Board proposals within the regions of Bristol Bay, Southeast, and Kenai over the last 15 years. We began by digitizing Board of Fisheries meeting documents from 2000-2015. We then coded a series of relevant data (e.g., area, species, sector) within the proposals to develop a regional analysis of stakeholder proposals. We identified stark differences in user participation and success rates across the three regions during this time period.

Olympic Mudminnow, Where Art Thou?

Lauren Kuehne [α]
University of Washington

Julian Olden

Olympic Mudminnow *Novumbra hubbsiis* Washington State's only endemic species. The highly restricted range is limited to southwestern and northern coastal regions and is the smallest of the five mudminnow species worldwide. Some evidence of population decline led to listing as state "Sensitive" in 1999, but a limited understanding of habitat requirements and threats has curtailed conservation action since. Additionally, genetic analysis conducted in 2012 identified populations along the north coast of Washington as a subgroup of potential concern due to evidence of historical isolation and low occurrence. We developed a species distribution model (SDM) to predict habitat suitability across the range of Olympic Mudminnow, and used this to guide sampling to detect new occurrences along the north coast. The SDM indicated that important landscape factors in predicting occupancy were elevation (< 200 m) followed by proportion of the surrounding 1-km^2 that was emergent wetland. We sampled 15 sites encompassing Low, Medium, and High suitability; Olympic Mudminnow were newly detected in only one site, which was in the drainage with the highest overall suitability. Overall, our results indicate that north coast Olympic Mudminnow are rarer and face greater constraints on suitable habitat than elsewhere in the range.

Fish Movement Patterns in the Smith River Watershed in Central Montana.

Michael Lance [α *]
Montana Cooperative Fishery Research Unit, Montana State University

Al Zale, Jason Mullen, Robert Al-Chokhachy, Grant Grisak, Tom McMahon

Movement is an important component of life history diversity in freshwater fish populations. Movement delineates geographic and management boundaries of populations. We considered movement patterns of fish in the Smith River, a highly valued wild trout fishery in central Montana where prior studies of relatively few individuals documented fish moving throughout the watershed. We studied species-specific movement patterns in the Smith River watershed by monitoring movements of 6,751 PIT tagged fish across three distinct geomorphic reaches: a wide headwater valley, a steep canyon, and a relatively low-elevation unconfined reach typical of the Great Plains. Across species, the median travel distance of individuals monitored for at least one year was 6.8 km (range 0-559 km), and 25 percent of fish travelled more than 30 kilometers. Movement that included the Smith River and at least one tributary was more common among fish tagged in the Smith River than among fish tagged in tributaries. Of fish tagged in the Smith River, 68 percent of Rainbow Trout *Oncorynchus mykiss*, 65 percent of Brown Trout *Salmo Trutta*, and 57 percent of Mountain Whitefish *Prosopium williamsoni* moved between the Smith River and at least one tributary. Fish movement differed across geomorphic reaches, and fish tagged in the low-elevation, unconfined reach were most likely to move to another reach. Our results indicate movement of fish in the Smith River is common and links distinct habitats and sub-populations, suggesting the importance of protecting fish movements at watershed scales.

Multiyear Drought-Driven Changes in Zooplankton Community Structure with Implications for Fish Conservation in a Large Shallow Lake

Kevin Landom [α]
Utah State University

Joan M. Meiners, Jereme W. Gaeta

Multiyear droughts can severely alter aquatic ecosystems, with effects ramifying through food webs. Zooplankton provide a critical trophic link between primary producers and fish, which are often the focus of management efforts. Given the importance of zooplankton to aquatic ecosystem stability, understanding their response to environmental change is essential. Across the western United States drought conditions have intensified, yet multiyear studies of drought-driven impacts on lake dynamics are few. We assessed the zooplankton community in a large shallow lake that experienced multiyear drought. Utah Lake, UT harbors an endemic, endangered fish species, the June Sucker *Chasmistes liorus*, which preys almost exclusively on zooplankton. We used a multivariate approach and a suite of environmental variables to determine that lake elevation (inversely related to multiyear drought) was a stronger predictor of zooplankton community structure than the commonly implicated variables of temperature and salinity. In response to drought, the community shifted toward a dominance of smaller-bodied zooplankton prey, likely due to increased predation pressure by fish. Using bioenergetics modelling, we test whether these drought-driven trends have implications for June Sucker conservation. Our results enhanced our ecological understanding of drought effects on zooplankton community structure, and provided the framework to assess ensuing implications for endangered fish conservation.

Forecasting With a Mechanistic Model the Invasion and the Management of Brown Trout in the Logan River, Utah

Christophe Laplanche [α]
Université de Toulouse

Arnaud Elger, Frédéric Santoul, Gary P. Thiede, Phaedra Budy

Management actions aimed at eradicating exotic fish species from riverine ecosystems can be better informed by the forecasting abilities of mechanistic models. We illustrate this point with an example of the Logan River, Utah, originally populated with endemic Cutthroat Trout *Oncorhynchus clarkii utah*, which compete with Brown Trout *Salmo trutta*. The coexistence equilibrium was disrupted by a large scale, experimental removal of the exotic species in 2009-2011, followed by an increase in the density of the native species. Our goal was to determine the chance that this removal could result in a full reoccupation of the niche by the native species. For that purpose, we built a simple spatially-explicit, reaction-diffusion model encompassing four key processes: habitat heterogeneity, competition, dispersal, and a management action. The model was calibrated with detailed long-term monitoring data collected along the 35-km long river main channel since 2001. Our model, although simple, did a remarkable job reproducing the system steady state prior to management as well as the increase of the native species following the management action. Data processing in a Bayesian framework allowed us to conclude that the chance for suppression/eradication of the invader was 15.4 % and raised to 52.3 % and 70.2 % if 2 or 3 times as many brown trout were removed in 2009-2011, respectively.

Phased Approach for Monitoring Recolonization by Anadromous Fish of a Large, Transboundary Watershed

Matthew B. Laramie [α]
US Geological Survey

David S. Pilliod, Brian Miller

The Confederated Tribes of the Colville Reservation (CTCR) are working to reestablish spring Chinook Salmon *Oncorhynchus tshawytscha* in the Okanogan Basin of Washington, USA and southern British Columbia, Canada beginning with the release of an ESA-10j Designated Experimental Population in 2015. Spring Chinook was historically an important cultural food source for indigenous tribes in the region until the extirpation of the life-history type (stream-type Chinook) from the Okanogan in the early 1900s. This experimental population is being intensively managed and monitored to assess the success of the reintroduction efforts. Environmental DNA (eDNA) analysis provided important pre-reintroduction baseline information as well as data on the recolonization process of tributaries throughout the basin. Multiple locations throughout this large, transboundary watershed were sampled for eDNA from 2012 - 2016 and sampling is ongoing. This information is being used as part of a phased-approach to population monitoring that includes eDNA analysis, PIT tags, electro-fishing, snorkel surveys, redd surveys, and other fisheries monitoring methods. We explore the strengths and weaknesses of eDNA data for informing fisheries managers on population status and trends including whether inference based on eDNA detection are limited to occupancy, or whether eDNA concentrations might be reliably used as an index of relative abundance. This project is a joint project between the USGS and CTCR.

Understanding Multiple Impacts of Hydrologic Alteration on Native Fish Communities in the Rio Grande, Texas and Mexico

Brian Laub [α]
Utah State University

Demitra Blythe, Phaedra Budy

Hydrologic alteration impacts patterns of flood and drought, water quality, physical habitat, and can provide favorable conditions for nonnative species. Understanding how these different factors affect native fish communities is critical for river management, but separating relative effects of synergistic factors is difficult. One way to isolate impacts of stressors is to compare fish community changes in reaches that differ in the type and magnitude of hydrologic changes. We compared structural equation models linking physical and biotic changes to native fish richness in a highly altered, static, flow-losing reach (Forgotten reach) and a less impacted, dynamic, flow-gaining reach (Big Bend reach) of the Rio Grande along the international border. In the Big Bend reach, flood and drought events, along with changes in physical habitat, had the greatest impact on native fish richness. In the Forgotten reach, flood events and physical habitat were also important, but water quality was a much stronger limiting factor for native richness compared to the Big Bend reach. These results highlight the importance of maintaining water quality while improving habitat in less impacted reaches and improving water quality in highly degraded reaches. Although data limitations warrant some caution, the models help prioritize management goals, provide hypotheses to test, and provide a method for using limited data to understand multiple, interacting factors driving native fish communities.

Culture Clash and Partnership? Challenges of Implementing Watershed Restoration for Threatened and Endangered Species in Culturally-Significant Areas

Rob Lawler [α]
U.S. Forest Service

Eric Berntsen

Abstract: Episode II: The Saga Continues - Successful planning and implementation of aquatic and terrestrial watershed restoration activities in a watershed with threatened and endangered species habitat and cultural historic district components requires creativity and good working relationships with multiple partners. Threatened and endangered species within the West Branch LeClerc Creek watershed include Grizzly Bear *Ursus arctos*, Bull Trout *Salvelinus confluentus*, Woodland Caribou *Rangifer tarandus* caribou habitat and Gray Wolf *Canis lupus*. Historic cultural district includes sites from a Diamond Match Company community and logging camps. Recent and current projects completed include replacing fish barrier culverts with aquatic organism passage structures, road relocation, in-stream habitat improvements with placement of woody debris, and forest health improvements. Future and more complex projects in the planning stage include large scale wood placement in the mainstem, removal of legacy crib dams to provide fish passage to approximately 20 miles of habitat, historic channel reconstruction. Remote areas create access constraints presenting an additional challenge to implementation. Success in implementing these projects requires multiple partnerships and funding sources with federal, state, local, and tribal agencies. Implemented projects were funded by a combination of funds from Forest Service, Kalispel Tribe of Indians, Washington State Recreation and Conservation Office, and Pend O'reille Public Utility Department.

Harmony Ditch Diversion, It's Not Always Harmony

Erin Leonetti [α]
Wyoming Game and Fish Department
Nick Scribner

The Harmony ditch diversion (HDD) is located in North Central Wyoming on the Nowood River 7.5 miles upstream from its confluence with the Big Horn River near Manderson, WY. The HDD consists of an instream diversion, 3 headgates and 2 ISI cone fish screens. The instream diversion is an upstream barrier to fish movement and the canal entrains an estimated 55,000 fish annually. The rehabilitation of HDD started in 2014 with Phase I of the 2 ISI cone fish screens. After, Phase I was complete the HDD was no longer in Harmony. Unfortunately, Phase II of the project that consisted of a concrete diversion, fish ladder, and sluiceway plans were developed before issues related to Shovelnose Sturgeon *Scaphirhynchus platorynchus* passage, ice jams, and long-term maintenance of the adjacent highway were fully evaluated. After considering all the issues involved with the site and previous designs, a new approach is being pursued to move the diversion upstream, abandon the newly built headgate structure, and replace it with a similar headgate and fish screens at a new site. The new structure would incorporate 5 rock weirs in the stream channel and require moving a portion of the irrigation ditch. Finding a solution to best address entrainment, passage, and maintenance all at once has been a tumultuous task at HDD. However, the current plan provides the greatest benefit to the stream, fish populations, and landowner while favorably addressing long-term maintenance and channel stability.

Fisheries Response to Remediation and Restoration Actions in the Upper Clark Fork Basin

Jason Lindstrom [α]
Montana Fish, Wildlife & Parks

The Upper Clark Fork Basin has a long history of human impacts to the native and recreational fisheries of the area. Most notable is the mining and smelting that occurred in Butte and Anaconda that severely degraded water quality and habitat in nearby streams. Silver Bow Creek (SBC) and the Clark Fork River (CFR) were two of the most impacted waters, both of which are now listed as Superfund sites. For approximately a century most of SBC was void of aquatic life due to massive quantities of mine tailings in the stream and floodplain. The State of Montana began the clean-up of SBC in 1999, and largely completed it in 2015. Fisheries monitoring during this time period showed that at the start of the clean-up SBC remained fishless. However, after remediation work progressed fish began colonizing the creek from tributary sources. The first species to arrive were suckers and sculpin, followed several years later by trout. Presently, Silver Bow Creek supports fishable populations of native Westslope Cutthroat Trout *Oncorhynchus clarkii lewisi* as well as non-native Brook Trout *Salvelinus fontinalis*. While conditions along the upper CFR were not as severe as SBC, the fishery was only estimated to be one-fifth of what would be expected absent mining contamination. Clean-up efforts along the upper CFR began in 2012. Approximately 8 miles of the 45 mile project were completed by 2016. Since 2008, a substantial amount of baseline fishery information has been collected to help evaluate the success of clean-up and restoration actions.

Natal Origins and Migration Behavior of Kokanee Salmon in Lake Roosevelt

Tim Linley [α]
Pacific Northwest National Laboratory

Jill Janak, Megan Nims, Eirik Krogstad, Holly McLellan

Kokanee Salmon *Oncorhynchus nerka* are an important contributor to the sport and tribal fisheries in Lake Roosevelt, Washington. Genetic evidence has indicated the majority of the stock consists of a wild population that is distinct from nearby Kokanee in Canada and the U.S. However, tagging studies and escapement surveys conducted within the reservoir and adjoining tributaries have failed to identify the origin(s) of these fish. To address this question, we quantified 87Sr/86Sr and element/Ca ratios in samples of water and otoliths from tributaries to Lake Roosevelt in the upper Columbia River. Our results show that the geochemical signatures in water and otoliths vary widely across coarse and fine spatial scales. Regionally, water 87Sr/86Sr ranged from 0.707 - 0.738 and 0.705 - 0.775 in the U.S. and Canada, respectively, yet comparable ranges were found within major tributaries. Isotopic and elemental signatures in otoliths indicated that Lake Roosevelt and Canadian origin Kokanee were more similar than those from U.S. waters. The signatures suggest a substantial proportion of Lake Roosevelt Kokanee spend much of their life in waters with geochemical signatures similar to the reservoir, whereas others originate outside the watershed, potentially from the upper Columbia and Kootenay rivers in British Columbia. Future efforts to confirm natal origins and migration behavior will focus on detailed sampling of water and otoliths from Lake Roosevelt and Canadian sources.

Exploring the Isotopic Niche in Rocky Mountain-Great Plains Fish Communities

Bryan Maitland [α *]
Program in Ecology, University of Wyoming

Frank Rahel

Just as the increase in species richness from the poles to the equator is one of the most consistent biogeographical patterns of species distributions, so too is the longitudinal increase in fish species richness from headwaters to lowland rivers. In these ecosystems, we hypothesize that community expansion in fish communities occurs mainly through niche expansion rather than niche packing, whereby the expanded community occupies a large niche space, has low niche overlap among species, and high individual diet specialization. To test this hypothesis, we use stable isotope analysis (C,N) to determine isotopic niche structure, overlap, and individual specialization in fish communities found along the longitudinal gradient in the North Platte River Basin, USA. The isotopic niche provides a powerful approach for evaluating the realized niche of organisms and species within and across food webs. Here, we address: 1) how isotopic variability (niche position, breadth, and overlap) within local fish communities is structured, i.e., are species niches conserved along the longitudinal gradient? And, 2) how inter-individual diet variation (i.e. individual specialization) varies within species along the longitudinal gradient. We discuss how species additions and land use influence niche structure and overlap, and the potential management benefits of using a food web approach in fisheries management.

Do Spawning and Rearing Habitat Contribute to the Recruitment Bottleneck of Imperiled Bluehead Sucker?

Bryan Maloney [α *]
Utah State University

Phaedra Budy, Jereme Gaeta

Changes to riverine ecosystems that alter physical and thermal habitat available to freshwater species may cause recruitment bottlenecks. The genetically-distinct population of Bluehead Sucker (BHS) *Catostomus discobolus* in the anthropogenically-altered Weber River (N. UT) is likely experiencing a recruitment bottleneck. Our objectives were to determine whether spawning and rearing habitat available in the Weber R. is limiting BHS recruitment. We located and quantified spawning habitat in the Weber R. and a relatively-unaltered surrogate. We sampled backwaters for juvenile sucker and habitat characteristics and we conducted laboratory experiments to evaluate juvenile BHS growth response to different temperature and velocity treatments (12-19°C, 0.004-0.18 m/s). In the Weber R. and Ferron Creek, availability of gravels (4-64 mm), cobbles (64-256 mm), and pools (6-26 pools/km) were important components of spawning habitat. In Weber R. backwaters, juvenile sucker abundance increased significantly with maximum depth (18-378 sucker; 19-87 cm). In the laboratory, juvenile BHS growth was greatest in the cooler temperature and slower velocity treatments. Collectively these results suggest BHS recruitment may be limited by the availability of small rocky substrate, pools, and deep, slow, cool backwaters. By evaluating factors that may limit BHS recruitment, this study will provide a template for future restoration efforts directed at recovering this imperiled population.

Forecast Informed Reservoir Operations: A Tool to Manage Flows for Fisheries, Water Supply, and Flood Control in California's Russian River Watershed

David Manning [α]
Sonoma County Water Agency

Joshua Fuller, Christopher Delaney, Michael Dillabough

As climate is shifting to more extreme events like flooding and drought, understanding when water should be stored or released is critical for reservoir managers. Most precipitation in California's Russian River watershed comes from events called atmospheric rivers. Rainfall from these intense events is critical for water supply but also poses significant flood risks. Lake Mendocino, a multi-purpose reservoir constructed in 1959 is managed by the U.S. Army Corps of Engineers and Sonoma County Water Agency. Flows released from Lake Mendocino support habitat for threatened steelhead *Oncorhynchus mykiss* and Chinook Salmon *O. tshawytscha*. The operating rules for the reservoir have not been adjusted in more than 50 years. Conservative management of the reservoir's flood control pool and constraints on water storage due to endangered species act requirements have challenged the reliability of the reservoir, particularly during a recent four year drought. A multi-agency team is evaluating the viability of Forecast Informed Reservoir Operations (FIRO) in Lake Mendocino. FIRO is a management strategy that uses data from watershed monitoring and improved weather forecasting to help reservoir managers selectively retain or release water in a flexible manner. Preliminary results from the viability assessment show significant improvements in reservoir storage and cold water flows for fisheries.

Design and Construction Considerations for Remote Fish Barriers

Dan March [α]
HDR Engineering

Non-native species have encroached on Cutthroat Trout *Oncorhynchus clarkii* habitat. In the interest of maintaining Cutthroat Trout population numbers and genetics purity, it is sometimes desirable to isolate populations in small remote drainages with limited access. This presentation will discuss fish barrier site selection, design and construction considerations for remote sites.

The Northern Pike are Coming and You Should be Afraid...Be Very Afraid

Joe Maroney [α]
Kalispel Tribe of Indians

There is a serious need for concentrated focus and education throughout the Columbia Basin for the control and management of non-native invasive fish. Non-native species introductions (illegal and intentional) were a factor in 68 percent of fish extinctions in North America. The rates of these types of introductions have increased dramatically in the last 50 years impacting nearly every major watershed in the United States. The transformation of the Columbia River and its tributaries from a free-flowing system to a system dominated by reservoirs has contributed to the establishment and spread of non-native invasive fish. That transformation has also impacted native fish in terms of habitat loss and degradation. The predatory effects of non-native invasive fish species on native fish are well documented in the Columbia Basin. These issues necessitate the discussion of the ecological and biological impacts of non-native invasive fish. Northern Pike *Esox lucius* is a non-native invasive fish that is emerging as a serious threat for salmon, steelhead and other native fish throughout the Pacific Northwest. Several examples will be highlighted on the efforts to suppress and/or eradicate Northern Pike from Washington State waters.

Estimating Pallid Sturgeon Larval Drift in the Missouri River Downstream of Fort Peck Dam Using a 3D Hydro-Acoustic River Mapper, River Analyzer

Brian Marotz [α]
Montana Fish, Wildlife & Parks

Mark Lorang

Previous estimates of Pallid Sturgeon *Scaphirhynchus albus* larval drift in the Missouri River downstream of Fort Peck Dam, Montana, used a 1-D particle drift model. Results indicated that most larvae would be swept into Sakakawea Reservoir (~375 river km) in six days, indicating poor survival. Questions remained whether some larvae locate suitable river habitat and survive. In June 2016, we measured 3D river hydraulics in 338 km of the Missouri River using an array of Acoustic Doppler Profilers and GPS. River flow was 247 cms downstream of the Milk River, 287 cms above the Yellowstone River confluence, and 612 cms at Williston, North Dakota. River Analyzer meshed bathymetry, topography, water velocities, and current vectors in 10 cm depth increments, creating base maps for 400 drift simulations near the bottom (<0.5m) and mean water-column. The fastest 10 percent could drift to Sakakawea Reservoir in 6.56 days if they remained in the thalweg the entire distance. However, 90 percent flushed from the thalweg into low velocity habitats. The longest continual drift distance before stalling was 22.3 km mid-depth and 36.5 km near the bottom. Over half stalled along riverbanks, islands, and eddies, where drifters would have to become re-suspended or swim to continue downstream. The fastest drifters in the bottom boundary layer would not reach Sakakawea Reservoir for 31 days. Our results indicate that drift duration may not be the factor limiting Pallid Sturgeon recruitment downstream of Fort Peck Dam.

Remediation/Restoration of the Upper Clark Fork River Basin: Uncertainty, Challenges, and Successes

Douglas Martin [α]
Montana Natural Resource Damage Program

Joel Chavez

The Upper Clark Fork River Basin is known as one of the United States largest Superfund complexes made up of 11 operable units, more than 160 miles of stream/river miles, thousands of acres of land, tens of millions of tons of contaminated tailings, soil, and waste, and six affected communities. The 100 years of extensive mining and mineral processing are pervasive and extensive throughout the basin, resulting in many uncertainties and challenges associated with the remediation and restoration activities taking place. The Environmental Protection Agency, the State of Montana's Department of Environmental Quality, and the Potential Responsible Parties are tasked with the remediation responsibilities to protect human health and the environment. The State of Montana Natural Resource Damage Program (NRDP) is attempting to restore the natural resources injured by the release of hazardous substances. This presentation discusses some of the many uncertainties, challenges, and success stories that the Upper Clark Fork River Basin has presented over the past several decades and how collaborative efforts to integrate remediation and restoration has impacted the basin.

Partnering to Preserve Natural Diversity, Ecosystem Health, and Subsistence Fishing Opportunities Across the Yukon River Basin.

Aaron Martin [α]
U.S. Fish and Wildlife Service

The Yukon River Chinook Salmon *Oncorhynchus tshawytscha* stock complex is comprised of over 130 spawning populations in a basin larger than the state of Texas. These populations exist in an almost entirely intact ecosystem at the northernmost extent of the species' range and the transboundary river supports one of the longest migrations of Chinook Salmon in the world. Safeguarding the health of the Yukon River Chinook Salmon stock complex and providing harvest opportunities for domestic and foreign fishers requires extensive collaboration among state, federal, tribal, and international partners. Due to record low returns and the decline in age and size structure, commercial harvest has been closed and subsistence Chinook Salmon harvest practices have changed considerably over the past decade to maintain the natural diversity and meet escapement goals and border passage obligations. This presentation will focus on the challenges and knowledge gaps associated with managing this iconic fishery and preserving the natural diversity and linkages of the aquatic and terrestrial ecosystems of the Yukon River Basin.

Restoring Flow and Rehabilitating Diversion Structures in the Lostine River, Oregon: Benefits to Chinook Salmon Spawning Migration

Aaron Maxwell [α]
Nez Perce Tribe

Shane Vatland, Ryan Rumelhart, Montana Pagano, Mitch Daniel

Irrigation withdrawals and diversion structures can limit access to spawning habitat for migratory fish and, consequently, reduce individual fitness and population productivity. Historically, reaches of the Lostine River in northeastern Oregon were severely dewatered for irrigation, precluding adult Chinook Salmon *Oncorhynchus tshawytscha* from critical spawning grounds upstream of these flow-impaired reaches. Chinook Salmon were nearly extirpated from the Lostine River in northeastern Oregon during the 1990s. Fears of an impending ESA crisis similar to that witnessed on the Klamath in 2001 prompted Lostine irrigators, the Nez Perce Tribe, and The Freshwater Trust to seek a cooperative solution to instream flow and fish passage issues. For the last 13 years, restoration partners and irrigators have successfully maintained minimum flows and improved fish passage during critical migratory periods. These restoration efforts were coupled with radio-telemetry monitoring of adult Chinook migration at specific diversions and through low-discharge reaches. These empirical movement data, combined with evolving economic and cultural realities within the agricultural community, continue to provide a foundation for evaluating restoration efforts, identifying problem areas, and prioritizing future efforts.

Evaluation of Fin Rays and Scales as Nonlethal Alternatives to Otoliths for Assessing Natal Origins in Salmonids

Jaclyn McGuire [α *]
Montana State University

Thomas McMahon, Brian Marotz

Microchemistry analysis of fish otoliths has been a useful tool in elucidating natal origin and acting as a natural tag to record environmental life history. However, the removal of otoliths is lethal and not ideal for species of special concern. We compared otoliths, fin rays, and scales of Westslope Cutthroat Trout *Oncorhynchus clarki lewisi* and their ability to record water chemistry in a controlled environment and their ability to retain chemical signature marks over time. Fish from two different hatcheries with known life histories were stocked in three high mountain lakes and sampled between one and four years after stocking. Strontium isotope ratios in otoliths and fin rays from the stocked fish were significantly correlated to strontium isotope ratios of the lakes, after correcting for dietary influences. Scale strontium isotope ratios were not significantly correlated to water strontium isotope ratios for Westslope Cutthroat Trout due to low strontium amounts in the scales. Natal origins (hatchery water chemistries) were still identifiable in otoliths and fin rays up to four years after stocking, suggesting that fin rays can be an effective nonlethal alternative to otoliths in microchemistry analysis.

Patterns of Rainbow Trout/Westslope Cutthroat Trout Hybridization in Montana and Northern Idaho

Kevin McKelvey [α]
U. S. Forest Service, Rocky Mountain Research Station

Michael Young, Daniel Isaak, David Nagel, Michael Schwartz

Headwater streams in Montana and northern Idaho contain many pure or minimally hybridized populations of Westslope Cutthroat Trout *Oncorhynchus clarki lewisi* (WCT), despite stocking hundreds of millions of hatchery Rainbow Trout *O. mykiss* (RBT) and the formation of naturalized populations throughout this region. Recent work using a large panel of diagnostic markers, which permitted estimates of introgression at the scale of individual fish, showed that nonintrogressed WCT and RBT co-occur in many streams, yet progeny exhibiting high levels of introgression are rare. This suggested the possibility of environmental constraints on introgression. We analyzed hybridization using data from 12 studies on over 15,000 fish located in over 500 sites within the range of WCT in Montana and northern Idaho. We hypothesized that hybridization would be sensitive to temperature, stream flow, distance to RBT source populations and/or stocking sites, and whether a site was within the native range of RBT. Models were strong and consistent: the likelihood of introgression was lower in small, cold streams far from RBT sources and in areas where RBT trout were non-native. Model results were consistent with recent genetic analyses indicating that most streams on federally managed lands in the area were expected to exhibit low levels of hybridization. Because of the influence of temperature on hybrid zone position, any future stream warming is likely to lead to smaller and more isolated populations of nonintrogressed WCT.

Duplicate Loci and Gene Mapping in Fisheries Genetics: Allozymes to Next-Generation Sequencing

Garrett McKinney [α]
University of Washington

James Seeb, Lisa Seeb

Genetics has undergone several technological revolutions beginning with the use of allozymes in the 1970s. Microsatellites, SNPs, and next-generation sequencing (NGS) have each substantially increased the scope of fisheries genetics, from basic population structure to identifying gene variants underlying variation in ecologically important traits. We detail how two aspects of fisheries genetics in particular have changed with technological advances: genotyping of duplicate loci and gene mapping. Duplicate loci are particularly prevalent in species with ancestral whole genome duplications such as salmonids and catostomids. Duplicate loci were particularly useful for discriminating populations using allozymes; however, their use declined with microsatellite, SNP, and NGS markers due to difficulties in genotyping. We summarize the evolutionary importance of duplicates, the limitations associated with genotyping duplicates, and new advances in NGS analysis that now allow us to identify and genotype duplicates. Gene mapping has evolved from identifying the relative chromosomal location of a few allozymes to creating linkage groups with hundreds of microsatellite markers and now to creating dense genome maps with thousands to tens of thousands of NGS markers. These new genetic maps have been used to enhance marker selection for genetic stock identification, identify genes associated with important traits, and improve selective breeding programs.

Evaluating Minijack Rates in Spring Chinook: Comparing Minijack Rates Based on Spring Plasma 11-ketotestosterone Levels with Rates Based on Fall GSI

Lea Medeiros [α]
University of Idaho

Andrew Pierce, Curt Knudsen, Chad Stockton, Peter Galbreath

High rates of precocious male maturation of spring Chinook Salmon *Oncorhynchus tshawytscha* as two-year old minijacks have been observed in Columbia River Basin hatchery programs. To our knowledge no studies have confirmed that individual males with elevated spring plasma 11-KT levels complete maturation the next fall. Thus, we utilized both lethal and non-lethal sampling methods to determine if elevated spring plasma 11-KT levels accurately predict precocious male maturation. In April of 2016, 1254 phenotypically male juvenile Chinook were lethally sampled. In addition, 459 fish were non-lethally sampled, PIT tagged, returned to the tanks, and lethally sampled the following September. Analysis of the April plasma 11-KT values revealed a strongly bimodal distribution with approximately 55% of all male fish falling into the higher mode. The gonadosomatic index data obtained from the non-lethally sampled fish confirmed that high plasma 11-KT in April correlated with maturation in the fall. Growth analysis indicated that the early stages of precocious maturation are associated with elevated growth and increased energy stores, whereas the later stages are associated with reproductive growth. In summary, our findings support the use of spring plasma 11-KT level as an indicator of minijack status, and provide new insight into the effect of precocious maturation on development and growth.

Temporal Variability in the Distribution and Abundance of a Desert Trout Associated with Stream Drying

Mike Meeuwig [α]
Oregon Department of Fish and Wildlife

Desert fishes occupy habitats that can experience a large degree of inter- and intra-annual variation in environmental conditions. For example, drought conditions may substantially reduce the quantity of water available to stream fishes. As streams dry, habitat availability decreases and fish may respond by redistributing into wetted areas or they may become stranded and die. We examined the distribution and abundance of Redband Trout *Oncorhynchus mykiss newberri* in Rock Creek, Oregon, in relation to patterns of stream drying. Wetted habitat in Rock Creek decreased from about 30 km on June 3 to about 8 km on September 2, 2015. We did not detect Redband Trout within the lower 13.1 km of Rock Creek; despite the fact that Redband Trout have been detected in this area in previous years. We estimated that Redband Trout abundance decreased from 1,375 individuals (lower-upper 95% CL; 701-2,044) to 665 individual (124-908) during this study. These estimates represent about a 90% decrease in abundance compared to surveys conducted in previous years. Results from this study and previous surveys in Rock Creek suggest that successive years of drought or near-drought conditions, and not just the magnitude of drought in any one year, may contribute to the ability of Redband Trout to re-colonize previously dry habitats and may greatly influence the abundance of Redband Trout. Additionally, understanding patterns of stream drying may aid in identifying drought-resistant refuge habitats that warrant special protection.

Examining the Drivers of Cold-Water Refuges in a Large Impounded River

Francine Mejia [α]
USGS, Forest and Rangeland Ecosystem Science Center, Cascadia Field Station

Christian Torgersen, Eric Berntsen, Joseph Maroney

We used a combination of airborne thermal infrared (TIR) data from August 2002 and satellite remote sensing data of ice-free areas from January 2017 to identify cold-water refuges for native trout species and to examine potential drivers influencing longitudinal, lateral and vertical thermal heterogeneity in the Pend Oreille River in eastern Washington and northern Idaho. Summer surface water temperature was not representative of the entire water column because there was thermal stratification in deep, slow-moving sections of the river. In situ measurements of water temperature during winter revealed areas of groundwater influence that were not observed in the summer. Preliminary results indicate that longitudinal peaks and troughs observed in the TIR remote sensing data were correlated with ice-free areas observed in the satellite imagery. In situ temperature measurements also provided data at reach and habitat unit scales and provided information on the degree of stratification at selected locations. Generalized additive models (GAM) with probability of occurrence and number of ice-free areas as response variables revealed that geomorphic setting (valley width), water depth and flow velocity explained most of the variability of these models. Our preliminary results demonstrate that the complexity of thermal patterns in these systems will require new approaches to assessment and modeling in order to understand the implications of these patterns for cold-water fishes.

Drawn to Science: Communicating Visually for Diverse Purposes and Audiences

Bethann Garramon Merkle [α]
Wyoming Migration Initiatitve

Humans think in images. Our brains actually understand images faster, and remember images longer, than words. And approximately 70% of the receptors in our brain respond to visual stimuli. As a result, your images choices are fundamental to communicating such things as the significance of your research or the information you want your students to understand. Too often, however, incorporating images isn't part of our initial project planning, if it is ever part of the planning at all. Author, illustrator, and science communicator Bethann Garramon Merkle will share tips and hands-on techniques for enhancing your approach to visuals: by using illustrations and custom photographs in publications and presentations. Specifically, you'll learn about choosing images, some tips about addressing copyrights and licenses, and the history synergy between art and science. And, you'll enjoy hands-on practice with a couple of illustration shortcuts used by pros. Don't worry! No previous drawing experience is necessary. See www.commnatural.com/portfolio/images/ for more details about using images in science communication.

What's the Deal with Invasive Crayfish in the West? A Case Study of Rusty Crayfish

Mathis Messager [α *]
School of Aquatic and Fishery Sciences, University of Washington

Julian D. Olden

Crayfish are among the most widely introduced freshwater taxa worldwide, yet still have a recent history in parts of western North America. Following their introduction, invasive crayfish can impart ecological impacts across entire ecosystems due to their omnivory and potential to spread rapidly and reach extremely high abundances. However, despite continued invasion and mounting impacts, effective management of nonnative crayfish is still challenged by limited funding and inadequate forecasting tools. We review our current knowledge of nonnative crayfish distributions and impacts in the West, and describe known and emergent approaches for monitoring, forecasting, and managing their spread. To illustrate the challenges and opportunities involved in managing invasive crayfish, we highlight one notable case: the invasion of rusty crayfish *Orconectes rusticus* in the John Day River, a major tributary of the Columbia River. First discovered in 2005, rusty crayfish has since spread throughout the watershed and is heading towards the Columbia River with increasing speed. There is considerable concern regarding its interactions with native species, including spring Chinook Salmon *Oncorhynchus tshawytscha*, and a highly-valued nonnative Smallmouth Bass *Micropterus dolomieu* fishery. We demonstrate the use of an individual-based model to simulate the past and future spread of rusty crayfish in the watershed and show how more rapid responses to the initial invasion would have resulted in an opportunity to slow the invasion spread.

Growth and Foraging Patterns of Juvenile Chinook and Coho Salmon in Three Geomorphically Distinct Sub-Basins of the Kenai River

Benjamin Meyer [α *]
University of Alaska Fairbanks

Mark Wipfli, Daniel Rinella, Erik Schoen, Jeff Falke

Changes in air temperature and precipitation from climate warming in south-central Alaska affects juvenile salmon freshwater rearing habitat differently, dependent on local watershed properties. Many south-central Alaskan salmon streams already experience water temperatures above Alaska Department of Environmental Conservation's maximum thermal criteria of 15°C during summer months. Water temperature and food resources are key controls on juvenile salmon growth; however, the influence of temporal and spatial patterns in these variables is not well characterized. We surveyed (2015-2016) a lowland-to-montane spectrum of catchment types within the Kenai River watershed with differing potential vulnerabilities to warming air temperatures. Temperature, diet, and growth data are being incorporated into bioenergetics models that will allow us to determine the degree to which growth rates of juvenile salmon are limited by consumption rates and water temperature. Preliminary results indicate that low-elevation tributaries appear more influenced by air temperature, and rearing salmon in these environments are expected to be exposed to future temperatures outside physiological optimum more frequently than montane habitats. Our work underscores a growing consensus that conservation of habitat features that buffer thermal sensitivity and a diverse portfolio of intact, interconnected habitats best ensures the adaptive capacity of wild salmon populations in the face of climate change.

Deer Creek Floodplain Enhancement Project: A Modern Approach to Process Based Ecosystem Restoration

Kate Meyer [α]
U.S. Forest Service

Deer Creek exemplifies the classic story of degradation for Western Cascades mid-order streams. Historic riparian logging, stream clean-out, and berm construction increased transport capacity and channelized the stream creating a single-thread, incised, transport channel through a once depositional alluvial valley. Major limiting factors for ESA-Threatened spring Chinook Salmon *Oncorhynchus tshawytscha* and Bull Trout *Salvelinus confluentus* and other native fishes include: lack of spawning gravel, off-channel habitat, high flow refuge, deep pools, large wood, complex cover, and high summer stream temperatures. While the story of degradation is a classic one, the restoration approach and design are considered modern and fearless. We employed a process-based approach to improve ecological function by resetting• channel and floodplain elevations for full floodplain connectivity through redistribution of berm material into the incised mainstem channel. We then placed large wood accumulations throughout the floodplain to create hydraulic complexity and to dissipate energy wherever channels may migrate. This approach does not dictate channel form or construct channels. Rather, it allows natural processes to create dynamic channels, islands, bars, and complex habitat. Although the implementation techniques (i.e. re-grading of channel and floodplain surfaces) are relatively bold, the benefits are immediate, dramatic, and sustainable. This project has set the stage for an upcoming project an order of magnitude larger.

Legacy Introductions and Climatic Variation Explain Spatiotemporal Patterns of Invasive Hybridization in a Native Trout

Clint Muhlfeld [α]
U.S. Geological Survey, Northern Rocky Mountain Science Center

Ryan Kovach, Robert Al-Chokhachy, Fred Allendorf

Hybridization between invasive and native species is predicted to increase due to climate-induced expansions of invasive species. Using a large, multi-decade genetics dataset with high-resolution climate predictions and extensive stocking records, we evaluate the spatiotemporal dynamics of hybridization between native cutthroat trout *Oncorhynchus clarkii* and invasive rainbow trout *O. mykiss* across the northern Rocky Mountains of the United States. Historical effects of stocking and contemporary patterns of climatic variation were strongly related to the spread of hybridization across space and time. The probability of occurrence, extent of, and temporal changes in hybridization increased at sites in close proximity to historical stocking locations with greater rainbow trout propagule pressure, warmer water temperatures, and lower spring precipitation. Although locations with warmer water temperatures were more prone to hybridization, cold sites were not protected from invasion; 58% of hybridized sites had cold mean summer water temperatures (<11°C). Despite cessation of stocking over 40 years ago, hybridization increased over time at half (50%) of the locations with long-term data, the vast majority of which (74%) were initially non-hybridized, emphasizing the chronic, negative impacts of human-mediated hybridization. These results show that effects of climate change on biodiversity must be analyzed in the context of historical human impacts that set ecological and evolutionary trajectories.

O'Dell Springs Creek and Wetland Restoration: 13 Years of Successful Partnerships and Collaboration

John Muhlfeld [α]
River Design Group, Inc.

Steven Leathe, Jeff Laszlo, Jim Wellington

Since 2004, resource agencies, industry, and landowners have developed and implemented comprehensive stream and wetland restoration strategies in the O'Dell Spring Creek wetland complex near Ennis, Montana. During the 1950s, over ten miles of drainage ditches were constructed and miles of stream channel straightened to make the area more suitable for cattle and hay production. Channel straightening resulted in highly incised stream channels, greatly diminished riparian wetland habitat, accelerated bank erosion and elevated levels of fine sediment throughout the spring creek system. Eleven phases of stream and wetland restoration have been implemented on private land owned by the Granger and Longhorn Ranches. These working cattle ranches have been owned and operated by the same families for generations and are both protected by perpetual conservation easements that preclude future development and ensure the continuation of excellent land stewardship practices and open space in the Madison River Valley. Motivated by a changing management philosophy, both ranches entered into a visionary cooperative partnership with private industry, government agencies, and land trusts to tackle the job of restoring high quality fish and wildlife habitat in the O'Dell Spring Creek watershed. Projects have restored 12 miles of O'Dell Spring Creek and improved the functions and values of approximately 600 acres of riparian wetland habitat in the project area.

Riverscape Genomics of Speckled Dace Differ by Basin in Western North America

Steven Mussmann [α *]
University of Arkansas

Marlis Douglas, Michael Douglas

The ubiquitous distribution of Speckled Dace *Rhinichthys osculus* throughout all major drainage basins of the western United States is a direct result of an ever-changing riverscape. Hydrological processes have altered the distribution and diversity of Speckled Dace across its range, resulting in narrow endemism for many unique subspecies, and permitting secondary contact of previously isolated lineages. We conducted a population-level assessment of Speckled Dace by contrasting genetic diversity among drainages within the exorheic Colorado River Basin (CRB) and the many endorheic basins of the Great Basin (GB). We employed next generation DNA sequencing techniques – specifically double digest restriction associated DNA (ddRAD) sequencing – and recovered approximately 9,000 loci for population genomic analyses. Assessment of 1,000 samples collected from 100 populations detected varying levels of population structure among different drainage systems. The CRB contained 10 unique lineages (five within the Virgin River and its tributaries), whereas 14 were found in the GB. Also, lineages in the GB displayed greater among-group differentiation than did those in the CRB. Streamtree analysis and isolation-by-distance were used in the CRB to identify unique properties of and to infer drivers of Speckled Dace evolution.

Migration Patterns of Adult Chinook Salmon in Two Southeast Alaska Transboundary Rivers

Kristin Neuneker [α *]
University of Alaska Fairbanks

Jeff Falke, Jeff Nichols, Phil Richards

Chinook Salmon *Oncorhynchus tshawytscha* undertake extensive migrations between their ocean and freshwater habitats, requiring them to adopt behavioral and physiological traits that will allow them to reach spawning locations at the optimal time. Adaptations may be shaped by factors such as flow regime, distance to spawning location, sex, and body condition. The Stikine and Taku Rivers in Southeast Alaska are two of the largest producers of Chinook Salmon in the state, and have been designated as indicator stocks by the Alaska Department of Fish and Game. Adult Chinook salmon returning to the Stikine (N=270) and Taku (N=403) rivers were sampled using drift gillnets from May-June 2015 and 2016 and outfitted with a uniquely coded radio tag. Using tagging date to represent migration timing, we assessed how timing varied as a function of sex, length, spawning site distance, and discharge using linear models. We found that distance to spawning location was influential on migration timing, where fish tagged earlier traveled further. Taku River fish were also found to migrate earlier than Stikine River fish. This information will be useful for fisheries managers to help better understand why many Alaska Chinook Salmon populations are currently declining, and provide information for future management strategies.

Genome Wide Association and Fst-Outlier Tests Reveal Candidate Adaptive Loci in a Unique Lacustrine Life History of a Threatened Trout

Helen Neville [α]
Trout Unlimited

Stephen Amish, Mary Peacock, Michael Miller, Gordon Luikart

The evolutionary history of Lahontan cutthroat trout *Oncorhynchus clarkii henshawi* (LCT) was shaped by Mid- to late-Pleistocene glacial cycles most notably by dynamics of the massive pluvial Lake Lahontan, whose contraction ~8000 years ago created several large desert terminal lakes in the NW Great Basin Desert. Here, migratory lacustrine LCT grew to world-record sizes and assumedly evolved tolerance to the warm temperatures, high salinity and alkalinity of this environment. Though extirpated from the largest historic lakes in the 1940s, a broodstock developed from a previously-transplanted population has demonstrated heritability in temperature tolerance and body condition, and a correlation between body condition and temperature tolerance in thermal challenges of known siblings. Family-based association testing of these same full-siblings, genotyped at 4,644 newly-discovered single-nucleotide-polymorphisms (SNPS), uncovered 53 loci correlated to these same phenotypic traits. Biological functions associated with annotated SNPS include immune function, metabolic pathways or processes, ATP processing, growth and redox homeostasis. Several of these loci were also significant in FST outlier tests between the only two remaining natural lake populations of LCT, which reside in contrasting montane-desert habitats. These results provide further evidence for some of the assumed unique genetic characteristics of the conservation hatchery broodstock currently being used for ESA recovery of lacustrine LCT.

The Salmonid Population Viability Project: Modelling Trout Viability in a Desert Landscape

Helen Neville [α]
University of Georgia

Doug Leasure, Seth Wenger, Dan Dauwalter, Jason Dunham

Many species of conservation interest exist solely or largely in isolated populations, where management priorities ideally would be guided by quantitative estimates of extinction risk. However, conventional methods of demographic population viability analysis (PVA) generally model each population separately and require temporally extensive datasets that are rarely available. We developed a new spatiotemporal population viability analysis (STPVA) that combines fish sampling data with remotely-sensed and other environmental data to deliver estimates of carrying capacity, inter-annual variability, and viability for all populations simultaneously. Remotely-sensed spatial covariates describe habitat size and quality, while temporal variability is a function of temperature and flow. A hierarchical approach includes an observation model which calculates site- and pass-specific probabilities of detection and informs a sampling model, which feeds into a process (population dynamics) model. STPVA can leverage information from well-sampled populations to extrapolate to poorly sampled or even un-sampled areas; it also allows for evaluation of different management scenarios (e.g., barrier or non-native trout removal). We applied STPVA to Lahontan Cutthroat Trout *Oncorhynchus clarkii henshawii*, a federally threatened trout native to the Great Basin Desert, to generate simultaneous estimates of extinction probability and evaluate management actions across the sub-species' range.

Parentage Based Tagging of a Natural Coho Salmon Population to Assess Hatchery Influence

Hayley Nuetzel [α *]
University of California, Santa Cruz
Elizabeth Gilbert-Horvath, Carlos Garza

Coho Salmon *Oncorhynchus kisutch* in the Shasta River (Klamath River basin) are considered a functionally independent population whose stability is critical to species recovery throughout the basin. However, this stability is threatened by consistently low population size and slow recovery rates. Supplementation using excess Coho Salmon returning to the nearby Iron Gate Hatchery (IGH) has been suggested as a mitigation strategy to counter low population abundance. To evaluate the efficacy of this strategy, we quantified the current contribution of IGH fish to productivity in the Shasta using SNP-based parentage analysis. Genotype data at 88 SNP loci was generated for juveniles collected in the Shasta from 2013-2015, and adults that passed through IGH from 2010-2015. Identification of parent-offspring trios and single parent-offspring pairs via likelihood-based pedigree reconstruction methods indicated a minimum of 8.67%, 1.72% and 1.22% of juveniles caught in 2013, 2014 and 2015, respectively, were offspring of IGH fish. Given fairly complete sampling at the IGH weir since 2010, our results suggest a significant proportion of productivity in the Shasta River may therefore be attributed to some combination of natural origin and hatchery-raised fish straying to the Shasta. Given the low observed contribution by IGH fish, management efforts that prioritize native habitat restoration may be the best means of conserving this population and its unique life history strategies.

Drought Effects on Lake and Reservoir Levels in the American West

Sarah Null [α]
Utah State Univeristy
Katelyn Boyer

Climate change is anticipated to warm air temperatures by approximately 2°C to 6°C in the western USA by the end of the 21st century. Precipitation change is uncertain, although increasing variability is expected. Climate change will affect hydrology by shifting snowfall to rainfall, causing earlier runoff timing, generally wetter, flashier winters, and drier summers that are prone to drought. Climate variability also means that the frequency of very wet or very dry years increases, while the frequency of average, or normal years, decreases. Drought reduces reservoir and lake levels, and thus affects lake and river ecosystems and habitats, streamflows, and water supply reliability. Similarly, we rely on built and natural infrastructure in extremely wet years to reduce the magnitude and duration of flooding. Select reservoir and lake levels are analyzed by water year type (wet, normal, and dry compared to the historical average) to illustrate how climate change and increasing climate variability may affect lakes, reservoirs, aquatic ecosystems, and water resources management in the American West.

Transport-to-Adult Return Rates among Adfluvial Bull Trout Transported as Juveniles Downstream of Hydroelectric Dams in the Lower Clark Fork River

Eric Oldenburg [α]
Avista

Paul Kusnierz, Ernest Keeley, Wade Fredenberg

Avista owns and operates two dams on the Clark Fork River immediately upstream of Lake Pend Oreille: Noxon Rapids and Cabinet Gorge. Historically, adfluvial Bull Trout *Salvelinus confluentus* in the lower Clark Fork River system utilized Montana tributaries for spawning and early rearing before returning to Lake Pend Oreille. In 2000, Avista initiated a two-way transport program to reestablish connectivity for adfluvial Bull Trout between Lake Pend Oreille and tributaries. Since this time, juvenile Bull Trout have been trapped while outmigrating from Montana streams and transported around the dams to Lake Pend Oreille. Night electrofishing downstream of Cabinet Gorge Dam has been used to capture returning adults to transport to their natal streams. One goal of this research was to develop an understanding of variables associated with the likelihood that juvenile transports would subsequently be recaptured as adults. Multiple logistic regression was used to evaluate the relationships among numerous independent variables and the binary response variable (i.e., recaptured as an adult or not). The overall transport-to-adult return rate was 0.055 (i.e., 5.5%). The best-fit reduced model included fish length, month of transport, and year of transport. Results from this study were used to modify length criteria for juvenile transports and to eliminate trapping and transport during July and August when the likelihood of transport-to-adult return approached zero.

Genetic Monitoring of Reintroduced Spring Chinook Salmon

Kathleen O'Malley [α]
Oregon State University

Andrew Black, Dave Jacobson

Dams, utilized for hydroelectric or flood control purposes, obstruct organism dispersal and have contributed to the decline of many migratory fish populations. For threatened Chinook Salmon *Oncorhynchus tshawytscha* from the Willamette River Basin in Oregon, human-assisted reintroductions are being used to facilitate dispersal to historical habitats located above dams. However, little is known about the reproductive outcomes of reintroduced individuals or the efficacy of reintroductions towards the goal of population demographic viability. Here, we use genetic parentage assignments of 3-, 4-, and 5-year-old adult recruits to estimate the fitness of Chinook Salmon reintroduced above high-head dams located on the South Santiam and North Santiam rivers. Our parentage assignments indicate that fitness of reintroduced salmon was highly variable, with individuals producing a range of 0-40 adult offspring. Furthermore, for three brood years, adult offspring recruitment achieved or exceeded population replacement in the South Santiam but not the North Santiam River. We will compare and contrast findings from these two systems and discuss ongoing research efforts to examine if individual fitness is associated with genetic and/or environmental variation within each reintroduced population. Overall, our findings demonstrate how genetic parentage analysis can address questions that are directly relevant to conservation and management.

Mountain Whitefish Kill and Proliferative Kidney Disease in the Yellowstone River, Montana

Scott Opitz [α]
Montana Fish, Wildlife & Parks

Travis Horton

In August 2016, a significant Mountain Whitefish *Prosopium williamsoni* kill took place on the upper Yellowstone River. Histology and PCR were used to identify proliferative kidney disease (PKD) as the cause. The introduction of the PKX parasite, the causative agent of PKD, in the Yellowstone appears to be recent based on the naive reaction of the fish. Because of the large number of dying Mountain Whitefish and the diagnosis of PKD. Montana Fish Wildlife and Parks implemented a 183-mile closure of the Yellowstone River to reduce stress on the fishery and limit the spread of the parasite to other waters. Monitoring was done to track progress of mortality and identify species that were affected. With decline in mortality of whitefish the river closure was reduced through time with the entire river being open on September 23, 2016. While the fish predominantly affected were whitefish, extremely low numbers of mortalities were noted in Rainbow Trout *Oncorhynchus mykiss* and brown trout *Salmo trutta*, Yellowstone Cutthroat Trout *O. clarki bouvieri*, Longnose Suckers *Catastomus catostomus* and Longnose Dace *Rhinichthys cataractae*. The PKX parasite has not been confirmed in Longnose Suckers and Longnose Dace to date. Monitoring will be conducted in spring 2017 to fully evaluate the impact of the disease on fish populations in the Yellowstone River.

How to Talk about Science so that People Want to Listen and Get Involved

Patrick Ortmeyer [α]
Clark Fork Coalition

Karen Knudsen

Science is at the center of the Clark Fork Coalition's work to protect and restore the Clark Fork River basin. It drives our discussions, decisions, and strategies. It helps us understand what's happening in our watershed, what's causing changes, what the implications are for people, fish, and wildlife, and what the likely outcomes of various strategies and policies might be. There is no debate at the Clark Fork Coalition: decisions about how we interact with, manage, and care for our rivers, lakes, and streams should be informed by science. However, science is complex and usually has some degree of uncertainty. These realities make science difficult to communicate simply to nonscientific decision-makers, stakeholders, and the public. Furthermore, issues involving water - whether it's climate change, streamflows, or dams - can be highly controversial, making the communications task more challenging. This presentation will focus on how the Clark Fork Coalition gets science across to the public in its advocacy, restoration, and outreach work, including examples of stumbles and successes.

Linking Spatial and Food Web Complexity: Perspectives from a River-Floodplain and Implications for Restoration and Salmonid Conservation

James Paris [α *]
Idaho State University

Colden Baxter, Ryan Bellmore, Joe Benjamin

Food web studies have shifted from a focus on the dominant trophic pathways supporting consumers to considerations of diversity and complexity in feeding relationships. Moreover, theoretical studies show that complexity within food webs not only sustains the size of consumer populations, but also may promote longer term persistence. Such ideas are relevant in the management and conservation of fishes, and based on mounting evidence, may be tied to spatial complexity across riverine landscapes. For example, recent studies have illustrated that spatial heterogeneity in river-floodplains creates a mosaic of food webs important to the carrying capacity of anadromous salmonids and may mediate patterns associated with theoretically stable food webs, such as shifting the distribution of predator-prey interaction strengths toward weaker interactions. Here, we discuss the relationship between spatial and food web complexity, the ecological importance of this relationship, and how it pertains to the conservation of anadromous salmonids, specifically highlighting an ongoing study that uses quantitative flow food webs to evaluate the efficacy of restoration on the Methow River floodplain in sustaining and stabilizing salmonid populations. Our ultimate goal is to stimulate thought in, and investigation of, complexity in landscapes and food webs as they relate to the management of riverine fishes.

Ecological Restoration along the Kootenai River: Linking Food Web, Wildlife Habitat, and Aquatic Habitat

Thomas Parker [α]
Geum Environmental Consulting, Inc.

Susan Ireland

Since 2011, the Kootenai Tribe of Idaho has restored 67 acres of floodplain habitat in the Kootenai River above Bonners Ferry, Idaho. This work supports a whole ecosystem restoration vision to save Kootenai River white sturgeon from extinction and replace habitat lost to Libby Dam operations and a century of land use. Libby Dam, which became operational in 1975, has impacted the nutrient and sediment supply and reduced annual peak flows in Idaho by half. This has affected the foundation of the food web, greatly reduced sediment available to build new floodplains, and disconnected the historical floodplain from current hydrology. In response to these changes, the Kootenai Tribe of Idaho is building new floodplains that are connected to post-Libby Dam hydrology, and restoring riparian forests to support both aquatic and terrestrial habitat. Designing floodplains in this dam-controlled system has required an interdisciplinary approach that incorporates plant ecology, hydrologic and hydraulic analyses, and wildlife management, in addition to aquatic ecology, fish biology and an understanding of food web interactions. An applied adaptive management program produces annual report cards that guide maintenance actions, and monitoring is targeted to provide information that informs management. The growing data set will continue to support this project, and will also support other projects in the region with similar ecosystem-scale objectives.

Ash Meadows Amargosa Pupfish: Genetic Effectiveness Monitoring

Mary Peacock [α]
University of Nevada, Reno

The Ash Meadows Amargosa Pupfish *Cyprinodon mevadensis mionectesis* listed as endangered under the US Endangered Species Act. Historically, this pupfish occurred within 10 spring systems throughout the Ash Meadows area of the Amargosa Valley, Nye County, Nevada. It currently occurs on the Ash Meadows National Wildlife Refuge and most of the major spring systems within this Refuge are designated Critical Habitat. The USFWS has undertaken habitat restoration in order to re-establish the natural hydrologic connectivity between the Five Springs complex and outflow habitats downstream in order to address direct threats of small population size and genetic isolation. Genetic effectiveness monitoring will track the efficacy of restoration activities in reconnecting currently isolated habitats promoting gene flow among populations. Fin clips were collected in June of 2016 from 109 fish in six locations in the Five Springs system. DNA was isolated from these samples and genotypes were generated for 11 microsatellite loci. Here I report on genetic diversity (allelic richness, heterozygosities) within populations, extent of population genetic structure (Fst and Bayesian genotype clustering analysis) and estimates of effective population size (Ne) for Ash Meadows Amargosa Pupfish prior to restoration activities. These data will be compared to samples taken this spring and summer after completion of habitat restoration and rainfall levels which have provided dispersal corridors.

Saving the Spandrels? Adaptive Genomic Variation in Conservation and Fisheries Management

Devon Pearse [α]
NOAA/NMFS

As highlighted by many of the talks in this symposium, research on the genomic basis of adaptation in natural populations has made spectacular progress in the past few years, largely due to the advances in sequencing technology and analysis. Without question, the resulting genomic data have improved our understanding of regions of the genome under selection. What is far less clear, but has been the focus of active discussion, is how marker-specific approaches can or should transfer into conservation practice, complimenting more typical uses of genetic data in conservation. Before this occurs, consideration must be given to the implications of using specific targets of selection to set conservation priorities. Here I discuss the key issues for the incorporation of adaptive genomic variation in conservation and management, using examples associated with specific phenotypes in salmonids and other taxa to illustrate scenarios in which adaptive genomic data could be used to inform conservation or restoration, the practical considerations and potential pitfalls of such efforts, and the importance of validating inferences drawn from new genomic data before applying them in conservation practice. Finally, I argue that an excessive focus on preserving the adaptive variation we can measure, while ignoring the vast unknown majority that we cannot, is a modern twist on the adaptationist programme that Gould and Lewontin critiqued almost 40 years ago.

Environmental Streamflow Restoration in the Eastern Cascades through Large Scale Irrigation Improvements and Improved Water Management

Aaron Penvose [α]
Trout Unlimited

In an era of increasing competition for water, Trout Unlimited is working hard to protect and improve environmental flows in Washington State. Washington and the Upper Columbia River are home to three ESA listed salmonids, Spring Chinook, steelhead and bull trout. In an effort to aid recovery and create future resilience, TU is working in numerous basins on the flanks of the eastern Cascades to improve instream flows. Protecting environmental flows in Washington is possible through what's known as the states Trust Water Right Program. The Trust Water Right Program provides a legal pathway for protecting water rights instream as a beneficial use of the water. In the instream flow session we will discuss how this program enables them to dedicate water rights from their projects for environmental purposes and protection. We will also discuss the various ways TU is increasing instream flows across the state with particular focus on large scale irrigation infrastructure improvements and water management.

Conservation of Bull Trout in the Lower Clark Fork River: Evaluating the Effects of Passage, Nonnative Trout Suppression, and Habitat Restoration

Douglas Peterson [α]
U.S. Fish and Wildlife Service

Shana Bernall, Wade Fredenberg, Sean Moran, David Schmetterling

Populations of Bull Trout *Salvelinus confluentus* in the lower Clark Fork River, MT, are impaired from a variety of reasons. Hydroelectric dam mitigation funds have been spent on projects to improve their survival, but until now there has been no means to rank the relative efficacy of management alternatives. Using a decade of data, we developed a probabilistic model to evaluate management alternatives for ten local populations (i.e., patches) of Bull Trout. Under current environmental conditions and management, the model predicted there were: three patches with a high likelihood (>85%) of a stable or increasing Bull Trout population (λ of 0.9-1.1 or greater); four with moderate likelihood (>59 to 76%); and three where the likelihood (48-54%) did not strongly indicate stability. An aggregate model for the eight Bull Trout patches upstream of Cabinet Gorge Dam predicted only a moderate (59%) likelihood that the metapopulation was stable or increasing. Management actions that reduced abundance of nonnative trout had the largest effect on population growth in individual patches and the metapopulation, and upstream transport of adults captured downstream of Cabinet Gorge Dam was also important. Habitat restoration had little effect unless coupled with other interventions. The model and its outputs are best described as testable hypotheses, but results suggest a greater intensity and more targeted interventions may be needed to achieve management objectives.

Dreissenid Prevention Across the Pacific Northwest

Stephen Phillips [α]
Pacific States Marine Fisheries Commission
Lisa DeBruyckere

Zebra mussels *Dreissena polymorpha* and quagga mussels *D. bugensis* have been the most costly aquatic invaders in U.S. history as tens of millions of dollars are spent each year in managing zebra mussel infestations in the Great Lakes, Mississippi, and Colorado River Basins drainages. Veliger finds in Tiber and Canyon Ferry Reservoirs, MT in 2016 are particularly alarming. The introduction of zebra and quagga mussels into the Columbia River Basin could not only threaten native species, but also industrial, agricultural, recreational, navigation, and subsistence use of the infested waters. Dreissenid mussel transfer between basins in the western United States is most likely to occur through the movement of trailered watercraft. Government agencies and organizations in the western US have implemented watercraft interception programs designed to prevent contaminated watercraft from being launched in unaffected waterways. Hundreds of thousands of boats are inspected each year in the western US. An overview will be provided of western watercraft inspection programs, data on number of boats inspected and source waters of infested boats. This talk will also highlight challenges and successes of watercraft interception programs and future direction of interjurisdictional cooperative planning, WRDA, prevention and management amongst state, federal and provincial agencies.

Columbia River Basin Steelhead Kelt Reconditioning Research

Andrew Pierce [α]
Columbia River Inter-Tribal Fish Commission and University of Idaho
Douglas Hatch, Dave Fast, Scott Everett, Matt Abrahamse, James Nagler

Every spring, large numbers of post-spawning steelhead *Oncorynchus mykiss* kelts migrate downstream throughout the Columbia River Basin (CRB), but few return as repeat spawners. Reconditioning of female kelts is being implemented as a recovery measure for ESA-listed CRB steelhead stocks. Downstream migrating kelts are captured, held in tanks and fed, and then released in the fall to migrate upstream and spawn again. Kelt reconditioning research has shown that fish divide into consecutive and skip spawners (1 and 2 year spawning interval). Fish can be screened for maturation status using plasma estradiol level by mid-August, enabling separate management of consecutive and skip spawners. Consecutive maturation rates range widely, with typical rates near 60 percent. Maturation decisions appear to be made early, as significant differences in growth are found within 10 weeks after spawning. Rematuring consecutive spawners are larger and have greater energy reserves compared with maiden spawners in the fall, and have similar or higher plasma estradiol and vitellogenin levels. Studies using a hatchery kelt model have shown that reconditioned consecutive spawners are more fecund and produce larger eggs than maidens, with an additional increase for skip spawners, and that spawn timing is not substantially altered by reconditioning. Steelhead kelt reconditioning has the potential to contribute to recovery by increasing the stability, diversity, and productivity of listed populations.

Multi-Scale Response of Migratory Native Trout to Irrigation-Based Restoration in the Blackfoot Valley, Montana

Ron Pierce [α]
Montana Fish, Wildlife and Parks

Irrigation diversions and dewatering are pervasive problems afflicting many migratory native trout across western North America. In the Blackfoot basin of western Montana, the recovery of migratory Westslope Cutthroat Trout *Oncorhynchus clarkii lewisi* and migratory Bull Trout *Salvelinus confluentus* requires landscape connectivity, restoration of critical spawning tributaries and protection of migratory fish using basin-scale protective angling regulations. This presentation emphasizes three long-term (>10 years) case studies that highlight the important role of irrigation-based restoration (fish ladders, fish screening and instream flows) in the recovery of migratory native trout. Each case study involves a spawning tributary used by migratory native trout of the Blackfoot River, as well as site-specific techniques tailored to resolving fundamental conflicts between water use and migratory native stocks. To evaluate project effectiveness, each of the three cases was monitored over the long-term (>10 years) using multi-scale techniques, which included electrofishing, radio telemetry, genetic assignment and redd counts. These monitoring efforts connect the three cases studies to multi-scale increases in the abundance and distribution of native trout, as well as the improved status of migratory native trout in the mainstem Blackfoot River.

Reach-Scale Restoration on Nevada Creek: Balancing Habitat Improvements with Traditional Agriculture in the Blackfoot Valley Montana

Ron Pierce [α]
Montana Fish, Wildlife and Parks
Ryen Neudecker, Dave Rosgen

During the last century, many natural rivers across western North America have been highly altered from traditional agricultural practices resulting in extensive ecological damage. Restoration practitioners in western Montana are attempting to balance agricultural conflicts with the recovery of wild trout fisheries. This presentation describes the restoration of a 4,400' reach of Nevada Creek that was damaged by decades of intensive agricultural practices. This project converted an unstable, over-widened, entrenched and overgrazed channel to a deeper, narrower and elevated channel to improve aquatic habitat and riparian/floodplain function. Within the new channel, toe wood• was used to improve trout habitat and to stabilize eroding streambanks. The project also used soil lifts and sod mats for revegetation with soil lifts showing the greatest short-term response. Upon project completion, the treatment area was fenced to prevent livestock damage. Additionally, a flood estimated at six times the bankfull flow occurred soon after project implementation, resulting in various channel adjustments and reducing the survival of certain shrub plantings. Nevertheless, the project withstood high flows and fish population monitoring before-after restoration shows a positive seven-year trend in the abundance and biomass for all trout within the treatment area.

Spatio-temporal Distributions of Bull Trout and Rainbow Trout in the Bruneau-Jarbidge Rivers Wilderness

David Pilliod [α]
US Geological Survey

Matthew Laramie, Dorene MacCoy, Scott Maclean, Janelle Alleman

Environmental DNA (eDNA) analysis has allowed for detection of aquatic species that are elusive or occur at low densities, but few studies have examined its utility to document spatial and temporal patterns of species distributions in free-flowing rivers. eDNA was used to assess the spatio-temporal distributions of Bull Trout *Salvelinus confluentus* and Rainbow Trout *O. mykiss* in the Jarbidge and Bruneau Rivers that are within a protected desert wilderness area in southwest Idaho. Samples were collected at 5 locations monthly from October 2015 through September 2016. Samples were also collected during three longitudinal surveys of the Jarbidge and Bruneau Rivers at winter base-flow, spring peak flow, and summer base-flow conditions. Preliminary data suggest that Bull Trout are limited to the headwater regions of the watershed and rarely move downstream even when water temperatures are suitable and connectivity is high. Rainbow Trout were widely distributed in the watershed throughout the year indicating their tolerance for warmer waters. However, Rainbow Trout eDNA concentrations were lower during summer base-flow conditions indicating that the population may also be stressed during the summer months. This study demonstrates how eDNA sampling can provide information on seasonal distribution patterns for aquatic species of concern in river habitats, especially where traditional sampling techniques are impractical or not permitted.

When Tiny Bubbles Cause Big Problems: A Systematic-Type Review of Gas Bubble Trauma in Freshwater Fishes

Naomi Pleizier [α *]
Department of Zoology, University of British Columbia

Steven J. Cooke, Colin J. Brauner

One of the impacts of hydroelectric dams on fish is gas bubble trauma caused by total dissolved gas supersaturation. Despite a large body of research on the topic, uncertainty remains over safe levels of total dissolved gas for fish. This uncertainty is a result, in part, of the variation in experimental conditions among studies of gas bubble trauma, as well as unsystematic approaches to summarizing the data that do not account for differences in the quality of the data. We undertook a systematic-type review of laboratory studies to assess the effects of total dissolved gas supersaturation on freshwater fish and to identify knowledge gaps. As part of the review we modeled time to gas bubble trauma and mortality based on extrinsic factors such as total dissolved gas supersaturation, oxygen and nitrogen ratios, depth, temperature, and the quality of experimental design, as well as intrinsic factors such as species, fish stock, and fish size. Based on our systematic search of the literature and interpretation of that data, we also summarize the scope of the existing research on gas bubble trauma in freshwater fish. We report the important factors affecting gas bubble trauma and include recommendations to improve the quality of future studies on this phenomenon. We also identify gaps in our understanding of gas bubble trauma, including sublethal effects on fish and additional factors that could affect the progression of the condition.

Flowering Rush Facilitation of Northern Pike

Peter Rice [α]
University of Montana

Virgil Dupuis

Our investigations of flowering rush since 1997 indicate that flowering rush is inducing an invasional meltdown. Of particular relevance are the negative impacts of flowering rush on the maintenance and restoration of native salmonids. Expanding stands of flowering rush provide habitat for structurally orientated introduced fish that are obligate vegetation spawners. Some are ambush predators of Cutthroat Trout *Oncorhynchus clarki*, Bull Trout *Salvelinus confluentus*, and juvenile salmon. These vegetation-adapted piscivorous species include bass, perch, and Northern Pike *Esox lucius*. The negative impact of structurally orientated introduced fish on open water salmonids in the western states is well documented. Northern Pike are having serious impacts on Cutthroat and Bull Trout. Sloughs that are heavily infested with flowering rush are being utilized by adult Northern Pike. Vegetation and plant litter are key factors in pike habitat selection. Vegetation is mandatory for spawning, rearing juveniles, and used for ambush predation. Northern Pike are utilizing mats of senesced flowering rush leaves from the previous year as spawning beds. Juvenile pike are strongly associated with vegetated habitat, where they can feed on small prey but also be sheltered from their predators which include cohorts of slightly larger cannibalistic juvenile pike. We believe that as new flowering rush leaves emerge in May, the larval pike are attaching to these new leaves; then the juvenile stage shelters from cannibalistic predation in the thickening new growth.

Fisheries Habitat Conservation... Montana Fish, Wildlife & Parks' Aquatic Habitat Protection, Mitigation and Restoration/Enhancement Programs and Legacy

Bruce Rich [α]
Montana Fish, Wildlife and Parks

Montana Fish, Wildlife & Parks is responsible for the stewardship of Montana's fishery and aquatic habitat resources, and has developed a legacy of effectively conserving them through a program utilizing protection, restoration and mitigation. Among the many tools used in this important effort are: state stream protection laws requiring permits for projects that affect stream beds or banks; a state environmental protection act (MEPA); field biologists and technicians who do the bulk of our stream permitting and restoration work, as well as dedicated state-wide positions in water pollution, stream permitting, water conservation and habitat restoration; instream flow water rights and leases, and an active voice in state water rights processes; state funded fishery habitat restoration and community pond grant programs; conservation of key riparian and other watershed lands; major mitigation programs with private and Federal hydropower producers; partnerships with federal, state and local government agencies, as well as with NGO's, private industry and the public in general. Finally, it is postulated that a major reason for the public, executive and legislative support for our habitat conservation efforts in Montana, is that our healthy habitats support vital ecological services and productive, quality fisheries which, very importantly, the public has access to.

Create, Visualize, and Share 3D Models Using UAS Technology for River Restoration

Ryan Richardson [α]
River Design Group

Andrew Belski, John Muhlfeld, Matt Daniels

The combination of advances in photogrammetry and UAS technology has revolutionized field data collection efforts in the field of fluvial geomorphology and river restoration. High resolution 3D point clouds offer users the ability to assess, model, and design river restoration projects with greater precision and for a fraction of the cost of LiDAR. The ability to share and visualize these data sets have been difficult due to the large file size and specialized software associated with such data. Cloud computing offers a simple and robust answer to this problem through the utilization of SketchFab, a free online 3D model viewing platform originally designed for animators and 3D graphic designers. These communities use overlapping file types to the 3D models that can be created using photogrammetry and required fast 3D visualization engines with an easy to use interface. 3D models of existing conditions, post construction, and restoration designs projects can be uploaded and shared with project stakeholders quickly and with minimal computing knowledge requirements for the end user. The ability to view detailed models of a restoration site with a stakeholder increases the level of communication that can be had and helps drive discussions throughout the restoration process. Overall, this technology is a great asset to the river restoration community and will enhance our ability to communicate effectively with stakeholders regardless of their background in river science.

Experimental Test of Genetic Rescue in Isolated Populations of Brook Trout

Zachary Robinson [α *]
University of Montana

Jason Coombs, Mark Hudy, Kieth Nislow, Benjamin Letcher, Andrew Whiteley

Genetic rescue is an increasingly considered conservation measure to address genetic erosion and inbreeding associated with habitat loss and fragmentation. Here, we conducted a test of genetic rescue by translocating ten (five of each sex) Brook Trout *Salvelinus fontinalis* from a single source to four isolated (above dam) stream populations in Virginia, USA. Prior to the introduction of translocated individuals, the two smallest above-barrier populations had substantially lower genetic diversity, and all populations had reduced effective number of breeders relative to adjacent below-barrier population. In the first reproductive bout following translocation, 31 out of 40 (78%) of translocated individuals reproduced successfully. Translocated individuals contributed to more families than expected under neutral introgression, and hybridization consistently resulted in larger full-sibling family sizes. We observed relatively high (>20%) introgression in three of the four recipient sites. On average the translocations increased genetic diversity of recipient populations by 45% in allelic richness, and 25% in expected heterozygosity. Additionally, strong evidence of hybrid vigor was observed through significantly larger body sizes of hybrid offspring relative to residents in all recipient populations. These results provide much-needed replicated experimental data that inform the potential effectiveness of genetic-rescue-motivated translocations in fisheries conservation.

An Introduction to the Yellowstone River

Leanne Roulson [α]
HydroSolutions Inc

The Yellowstone is often touted as the longest "free-flowing" river in the lower 48 states. It is also distinct among North America's larger rivers in that it is almost wholly contained in one state, Montana. The Yellowstone has a rich cultural presence that tracks periods before written history, western expansion, development, and all the changes and issues that increased human presence have brought. It flows from an elevation of over 12,000 feet in its headwaters to just under 2,000 feet near its confluence with the Missouri, encompassing several large tributaries as it crosses Montana. Its fishery, management, ecological roles, and usage all evolve substantially over its 700-mile (give or take) length. This introduction will cover the path of the river, provide some historical information, and set the stage for the symposium.

Range Boundary Dynamics Reveal Drivers and Limits of Smallmouth Bass Distribution in Pacific Northwest Streams

Erika Rubenson [α *]
University of Washington

Julian Olden

Human-caused changes in stream temperature are facilitating range expansion of nonnative warm-water fishes. For instance, in the Columbia River Basin, Smallmouth Bass *Micropterus dolomieu* has appreciably expanded its distribution into headwater habitats where subyearling salmonids rear. Integral to understanding the upstream range expansion potential of bass is to examine its population dynamics at range boundaries. We explore this at the upstream edge of smallmouth bass distribution in the headwaters of the John Day River, Oregon. Reporting on a multi-year, spatially extensive riverscape survey, our results show a dramatic ebb and flow of seasonal occupancy and spawning success at the range boundary. We demonstrate how mean July water temperature drives the leading edge of seasonal occupancy, but juvenile growth potential drives colonization success and ultimate establishment. Using our enhanced understanding, we present a model of bass distribution throughout the Columbia River Basin, with results verified using eDNA and snorkel surveys. We highlight how understanding stage specific sensitivities to stream temperature can help predict current and future distributions of nonnative smallmouth bass to guide management practices.

A Baseline Swimming Assessment for Arctic Grayling: Characterizing the Volitional Swimming Performance of Arctic Grayling to Inform Passage Studies

Erin Ryan [α]
U.S. Fish and Wildlife Service

Matt Blank, Kevin Kappenman

Swimming performance studies provide information necessary for the effective design, implementation, and monitoring of fishways. The swimming ability of Arctic Grayling *Thymallus arcticus* has been assessed in swim chamber studies. However, a more complete characterization is obtained when both forced (swim chamber) and volitional (open-channel flume) swimming are quantified. This study characterized the swimming performance of Arctic Grayling in an open-channel flume by analyzing their volitional ascent through four hydraulic challenges. Hatchery reared Arctic Grayling (TL 212 ± 20 mm) were exposed to average velocities ranging from 0.49 - 2.17 m/s. Passive integrated transponder (PIT) antennae were used to determine participation rates and identify individual attempts. An array of overhead video cameras captured behavior and incremental time and distance in order to calculate velocities. The hydraulic environment was described using water temperature, depth, velocity, and flow rate. Multiple logistic regression and mixed linear effect models were used to examine passage success, maximum ascent distance, and maximum burst velocities. The test fish, which were held in recirculating flow to build and maintain fitness, exhibited wild swimming characteristics and appeared to represent the swimming abilities found in their wild counter parts. Key results and our best statistical models will be presented, along with examples of application.

Floodplain Remediation and Restoration in the Upper Clark Fork River Basin, Montana

Amy Sacry [α]
Geum Environmental Consulting

Doug Martin, Cara Nelson, Bill Bucher, Matt Daniels, Tom Parker

The Clark Fork River is located in western Montana. Widespread contamination of its floodplain led to designation of the upper 120 miles as a federal Superfund site. Clean up of the site led by the EPA and Montana DEQ has been closely coordinated with restoration work led by the Montana Natural Resource Damage Program (NRDP). To date, remediation and restoration of the site has been completed at the Milltown Dam site near Missoula and four reaches of the upper Clark Fork River near Warm Springs. At the Milltown Dam site, an interdisciplinary team of restoration professionals collaboratively developed designs for reconstructing the pre-dam landscape. Restoration of the site, including reconstruction of 17,000 feet of channel and over 300 acres of floodplain occurred between 2009 and 2012. Monitoring of the Milltown Dam site began in 2010 and is planned to continue for 15 years. Work on the upper Clark Fork began in 2013 and the most recent phase was completed in fall 2016. This talk provides a synopsis of the interdisciplinary design and implementation effort for the Clark Fork River including discussion of design criteria, monitoring, and treatment performance. After five years of monitoring at the Milltown Dam site, the river channel remains connected to the floodplain despite some morphological adjustment and plant communities are establishing from both active plantings and natural processes.

Montana's Response to Invasive Mussel Detections

Patrick Saffel [α]
Montana Fish, Wildlife & Parks

Greg Lemon

For more than a decade, Montana Fish, Wildlife & Parks (FWP) and others have monitored waters and conducted boat inspections around the state looking for aquatic invasive species. In 2016, boat inspection stations checked 37,000 watercraft, aided by it being illegal to bypass an inspection station if you have a watercraft. FWP has also developed an outreach and education program focusing on a Clean, Drain, Dry message. Despite these efforts, Montana had its first positive detection of invasive mussels at Tiber Reservoir in the Missouri River watershed east of the Continental Divide in the fall of 2016. A suspect sample was also found upstream at Canyon Ferry Reservoir. As a result, Montana Governor Steve Bullock issued an executive order declaring a natural resource emergency. Montana's Mussel Response Team was formed to develop a response plan and strategy to reduce future contamination risks and mitigate economic and ecological damage. Legislative proposals and administrative rules were developed to enhance funding, monitoring, inspections and education. Enhanced efforts include mandatory inspection for out-of-state boats prior to launch, mandatory inspection for boats coming into the Columbia River Basin, doubling the inspection stations, requiring decontamination of boats leaving Canyon Ferry and Tiber Reservoirs, and doubling the monitoring effort. The latest information will be provided, as well as the state's long-term strategy for managing invasive mussels.

2017 State of the Salmonids: Fish in Hot Water

Patrick Samuel [α]
California Trout

Peter Moyle, Rob Lusardi

In 2008, California Trout and the University of California, Davis authored a report summarizing the status of each of California's 32 native salmonids. The authors drew upon scientific literature and input from scientists and fishery managers to estimate that 65% of California's salmonid taxa faced extirpation from California in the next century.

New genetic information, more extensive monitoring, and a better understanding of climatic impacts on fish have come to light since 2008. Significant conservation and recovery actions have largely been stymied by historic drought (2012-2016), climate change, and increasing demand for limited water across the state. In 2016, California Trout and UC Davis again reviewed the scientific evidence to assess current salmonid status statewide to raise public, manager, agency, and legislator awareness of declining salmonid populations across California, identify actions to reverse their decline, and advocate for implementation of specific actions to help restore populations. Here, I discuss the original 2008 report, research methods, analysis, and scoring rubrics to assess the status of each taxon, and highlight efforts to share the finding that species status has declined for over three quarters of native salmonid taxa across in an updated, printed report and interactive multimedia platforms.

An Evaluation of Variables Influencing Cutthroat Trout Colonization and Abundance in Newly Accessible Habitats Above Previously Blocking Road Culverts

Travis Schill [α]
Weyerhaeuser

Jason Walter, Renata Tarosky, Brian Fransen, Jack Giovanini

Forestlands in Washington contain extensive road networks. In accordance with the Washington Forest Practices Road Maintenance and Abandonment Plan (RMAP), road crossings on fish bearing streams must meet certain criteria to allow for upstream fish passage. Crossings that do not meet these criteria must be upgraded or removed. Coastal Cutthroat Trout *Oncorhynchus clarkii* are often the sole salmonid species in headwater stream habitats impacted by anthropogenic blockages such as non-fish passable culverts. We assessed the variables influencing Cutthroat Trout colonization and abundance in stream reaches upstream from previously blocking culverts. From 2013-2016, twenty-nine study streams were selected with blocking culverts that prevented upstream fish passage. At each location, we verified that 1) Cutthroat Trout were present in the stream segment below the blockage, 2) fish were absent upstream from the blockage, and 3) suitable fish habitat existed upstream from the blockage. After the replacement or removal of blockages, we monitored upstream fish colonization and abundance using spatially continuous, single-pass electrofishing and physical stream habitat surveys. This study is ongoing, but preliminary results indicate that temporary natural blockages to upstream fish passage (e.g. debris steps) often limit and/or delay the colonization of these habitats, and that stream size, gradient, and fine-scale channel morphology influence cutthroat trout abundance where habitat is accessible.

Scale and Permanence: Fish Response to the Removal of Milltown Dam, MT

David Schmetterling [α]
Montana Fish, Wildlife & Parks

Rob Clark, Tracy Elam

The removal of Milltown Dam commenced in 2006, after a century of impacts to the watershed. The last vestiges of the dam were extracted from the confluence of the Blackfoot and Clark Fork rivers in 2009. The dam that once annually blocked the migrations of 10s of thousands of fish, limited downstream fish movements, created a reservoir that fostered illegally introduced Northern Pike *Esox lucius* and was a source of heavy metal inputs to the river below is gone and over 2 million cubic yards of sediments removed. The removal of the dam reversed many of its effects immediately. Connectivity was restored for all fish species and the benefits to other wildlife occurred in months. Many of the changes in the coming years will be subtle, like offering populations more resilience, and promoting the expression of life history tactics that were formerly selected against. However, we have documented drastic local changes in species composition, fish densities, and unimpeded fish passage. Monitoring these changes has occurred on a watershed scale and the activities range form in situ bioassays to population and community monitoring. Dam removal may not ameliorate all the challenges to native fish conservation; however, it may ultimately be the only way to guarantee success. The effects of dam removal are permanent and at a scale which could not be afforded by engineering solutions.

Future of Alaskan Salmon in the Face of Change: Bringing a Food-Web Perspective to Management and Conservation

Erik Schoen [α]
University of Alaska Fairbanks

Mark Wipfli, Benjamin Meyer, Kristin Rine, Kristen Sellmer

Wild Pacific salmon *Oncorhynchus* spp. populations in Alaska are currently at record high overall abundance levels, but they face an uncertain future. Rapid changes in climate and landscape are transforming salmon habitats, and statewide declines in the abundance and body size of Chinook Salmon *O. tshawytscha* have raised concerns about the resilience of salmon ecosystems and fisheries. The changing physical environment affects salmon directly through physiology and demographics, and also indirectly by influencing food-web interactions with their prey, predators, and competitors. Here, we present 1) highlights from a synthesis of environmental changes affecting Alaskan salmon ecosystems, and 2) case studies illustrating how food-web interactions can be key to understanding the effects of these changes on salmon. We explore a curious case of juvenile Chinook Salmon growing faster in a glacially turbid river with low food densities than in adjacent clear-water habitats with more food. We examine why predation may be key to understanding how increasing stream flows and warming temperatures affect juvenile Chinook Salmon in a sub-Arctic river. We argue that, in addition to physiology and population dynamics, food-web interactions are an essential consideration for designing effective management and conservation strategies to allow salmon to continue to thrive in a changing world.

Taxonomic Revisions for Cutthroat Trout: What Can This Charismatic Sportfish Teach Us to Address Taxonomic Uncertainty in Other Fishes?

Luke Schultz [α]
WY Game & Fish, Western Native Fishes

Patrick Trotter, Pete Bisson, Brett Roper

At the 2015 AFS meeting in Portland, a group of taxonomists, biologists, and managers convened to discuss revisions to the taxonomic classification of Cutthroat Trout *Oncorhynchus clarkii* across western North America. This process examined Cutthroat Trout evolutionary biology using the latest advancements in morphometric and genetic techniques to resolve taxonomic uncertainty within the multiple described subspecies of Cutthroat Trout. There was general consensus for 4 major clades consisting of ~20-22 unique lineages that originated from a basal *O. clarkii clarkii* group. These findings led the group to propose a revised taxonomy for the Cutthroat Trout lineage. We use insights from this process to guide this process for other groups. In particular, we emphasize that the selection of a species concept is a critical first step to maintaining transparency in the process. Secondly, any revisions should be supported by multiple lines of evidence (e.g, morphometrics, geologic history, genetics). It is also important to understand that a proposed taxonomic hypothesis can (and should) be revised as new evidence becomes available. Conservation of several western taxa is currently challenged by taxonomic uncertainty, and this approach can provide a framework to guide taxonomic revisions for other western native fishes.

Turning Genomic Data into eDNA Assays for Detection of a Cryptic Invasion Front

Travis Seaborn [α]
Washington State University

Caren Goldberg

The Sonoran tiger salamander *Ambystoma mavortium stebbinsi* is an endangered subspecies in the San Rafael Valley of Arizona. Along the eastern edge of the range, barred tiger salamanders *A. m. mavortium* have been introduced and may be hybridizing with this subspecies. Differentiating hybrids is difficult because the two species are linked ancestrally and only display morphological differences in post-metamorphic juveniles. We used double-digest RAD-seq methods to survey the genome for SNPs that could be used as diagnostic markers to distinguish these subspecies in eDNA assays. We analyzed genomic samples from 68 Sonoran tiger salamanders, collected from the areas furthest from the putative invasion front, and 27 Barred tiger salamanders, collected from the closest known populations to the Sonoran tiger salamander range. Principal component analysis found complete clustering of the two species along the primary axis. Bayesian clustering methods indicated support for two distinct groups, with some evidence of shared genetic variation. To identify diagnostic SNPs, we filtered for those found in loci observed in 80 percent of individuals and within both species. We removed SNPs that were likely homologues by filtering those with excessive heterozygosity (Hobs>0.5). We will use these diagnostic SNPs to test for evidence of a cryptic invasion front across the range of this subspecies in previously-collected environmental DNA samples.

Two Million Genotyped Fish and Counting: What We've Learned About Genetic Stock Identification in Salmon

Lisa Seeb [α]
University of Washington

Genetic stock identification (GSI) as applied to Pacific salmon traces its origin back to the 1970's and 1980's and to the colleagues and students of Fred Utter at NMFS, Seattle. Early applications were based on allozymes, a labor intensive technique requiring lethal sampling. Despite its limitations, the major genetic lineages of Pacific salmon were accurately characterized, and large collaborative databases emerged. Although meeting with considerable skepticism from the majority of fisheries managers, several forward-looking managers became advocates, and GSI applications gradually expanded to high-profile and contentious fisheries. In the 1990's, the advent of DNA based markers, dominated by microsatellites, introduced non-lethal sampling, automation, and, eventually, standardized databases. SNPs emerged around 2005 and gradually eclipsed microsatellites due to highly automated chip-based techniques and low error rate. Laboratories were able to routinely process 100,000 samples in a year. Recently, genomic techniques have been incorporated into SNP discovery for fine-scale applications, and amplicon sequencing techniques have been refined to allow the analyses of hundreds of SNPs for thousands of individuals. However, the lessons from the early years endure. As genetic data continues to reduce uncertainty in conservation and fisheries management, fisheries managers and stakeholders will increasingly rely on and support GSI applications.

Symposium Endnote: Why Has Genome Science Had Such a Profound Effect on the Conservation of Pacific Salmonids?

Jim Seeb [α]
University of Washington

The organizers asked me to provide a symposium wrap by backgrounding and highlighting the important contributions of the participants. This was not a salmonid symposium, yet 19 of the 21 topics explored salmonid genetics or genomics. I will explore reasons for these profound studies beyond the local importance of salmonids in the Western Division of AFS. And, of course, many of these studies build upon advances made possible in model organisms (as presented for guppies and sticklebacks).

Introduced American Bullfrog Spread in the Yellowstone River

Adam Sepulveda [α]
USGS, NOROCK

I used explicit dynamics occupancy models to gain insight about conditions that may facilitate or impede the establishment of self-sustaining American bullfrog *Lithobates catesbeianus*; (hereafter, bullfrog) populations in the Yellowstone River floodplain of Montana. Specifically, I used five years of annual bullfrog monitoring data at 92 sites to test if the probabilities of colonization and extinction for breeding bullfrog life stages (i.e., eggs, larvae and metamorphs) were related to covariates that describe habitat suitability, propagule pressure and environmental stochasticity. I found that the realized distribution of bullfrogs is less than the maximum distribution in our study area, as many suitable sites have yet to be colonized. However, many colonized sites went extinct so are not suitable for long-term establishment. Habitats most likely to be colonized and least likely to go extinct were those close to artificial ponds and lakes and those with emergent vegetation. Identifying factors associated with invasion dynamics is critical for prevention and early detection, developing effective mitigation strategies to suppress, eradicate or arrest further spread, and identifying habitats that are vulnerable to future bullfrog spread.

Using Environmental DNA to Evaluate Invasive Species Eradication Efforts

Adam Sepulveda [α]
USGS, NOROCK

Kristine Dunker, Robert Massengill, Jeffrey Olsen, Ora Russ, John Wenburg

Environmental DNA (eDNA) sampling is a powerful tool for detecting rare taxa; but detectable DNA fragments can persist over time despite absence of the targeted taxa. This complication is a concern for fish eradication efforts in lakes since killed fish can sink to the bottom, slowly decay, and remain detectable for long periods. We evaluated the efficacy of eDNA sampling to detect invasive Northern Pike *Esox lucius* following piscicide treatments in southcentral Alaskan lakes. We used field observations and experiments to test the sensitivity of our pike eDNA assay and to evaluate the persistence of detectable DNA emitted from pike carcasses. Our assay detected an abundant, free-roaming population of pike and low-densities of pike held in cages. We then stocked three lakes with pike carcasses and collected eDNA samples post-stocking. We detected DNA at 7 and 35 days, but not at 70 days. Finally, we collected eDNA samples ~ 230 days after four lakes were subjected to piscicide-treatments and detected pike DNA in 3 of 179 samples, with a single detection at each of three lakes, though we did not catch any pike in gillnets. Taken together, we found that eDNA can help to inform eradication efforts if used in conjunction with multiple lines of inquiry and sampling is delayed long enough to allow full degradation of DNA in the water.

Shifting Fish Distributions in the Yellowstone River with a Focus on Introduced Smallmouth Bass

Adam Sepulveda [α]
U.S. Geological Survey, NOROCK

Robert Al-Chokhachy, Al Zale, Jason Rhoten, Mike Ruggles

As the largest contiguous river in the lower 48 states, the Yellowstone River changes dramatically in species composition along the continuum. Recently, introduced Smallmouth Bass *Micropterus dolomieu* have demonstrated considerable expansion from their initial introduction sites downstream of Billings, MT. With such changes, there remains uncertainty as to what factors may be controlling Smallmouth Bass expansion and the potential impacts of these changes to extant communities. It is also unclear how the expansion of Smallmouth Bass differs from recent upstream shifts in native coolwater fishes. To understand such patterns, we initiated a study in 2016 to quantify the distribution, growth, and habitat use of juvenile Smallmouth Bass in side channels on the Yellowstone River. Using a variety of sampling methods, we found successful recruitment of juvenile Smallmouth Sass in portions of the Yellowstone River adjacent to Big Timber, MT. A substantial portion of these fish observed significant over-summer growth exceeding the minimum size for likely overwinter survival (100 mm). The distribution results also signify that juvenile Smallmouth Bass are likely to have extensive overlap with juvenile, coolwater native fishes. Our habitat surveys indicated that sidechannel habitat may be particularly suitable to the thermal demands for Smallmouth Bass growth. We present these results in the context of overall species assemblage shifts within the Yellowstone River.

Non-Native Trout as Invasive Species Affecting Native Fish Species

Bradley Shepard [α]
B. B. Shepard & Associates

Rainbow *Oncorhynchus mykiss*, Brown *Salmo trutta*, and Brook Trout *Salvelinus fontinalis* have been extensively trans-located outside their native ranges to provide important sport fisheries. In most cases, these species were released directly into waters that supported populations of native fishes, including native trout species. Dispersal of non-native trout from original release locations, either via natural or angler-assisted movements, have resulted in wide-spread invasions of these non-native trout species. Non-native trout species have been implicated in the decline and even extinction of some populations of native fish due to direct effects such as competitive exclusion, niche displacement, genetic introgression, and predation, or through indirect effects such as introduction of diseases or parasites. These impacts have occurred throughout the world. Fish managers are beginning to address the impacts of non-native trout on native fishes. Allocation of local and regional waters for preservation of native fish or to support non-native trout sport fisheries is occurring. Managers are beginning to control the spread of non-native trout and some efforts have begun to remove non-native trout from selected waters to conserve native fish species.

The Efficacy of Using Electrical Waveforms to Kill the Embryos of Invasive Common Carp at Malheur Lake

Will Simpson [α]
Abernathy Fish Technology Center, U.S. Fish and Wildlife Service

Doug Peterson, Kurt Steinke, Linda Beck

Common Carp *Cyprinus carpio* are devastating invaders due to their tolerance to a variety of environmental conditions and because they can act as ecosystem engineers. Habitat degradation by invasive carp at Malheur Wildlife Refuge, a major stop for waterfowl on the pacific flyway, has triggered population control efforts that focus on removing adult carp. Solely removing adult carp has not successfully controlled the population, and as a result the refuge is considering control efforts that include the electroshocking of young carp because vulnerable spawning areas are often localized in shallow, vegetated areas. Very little is known about what voltage gradients and waveform types are the most deadly to fish embryos and larva, so we exposed the embryos of Common Carp to two waveforms types commonly emitted by boat electrofishers (AC, PDC). Fish were shocked at five developmental stages (Blastula, Gastrula, Organogenesis, Active Movement, and Pigmentation) and under four different voltage gradients (10, 15, 20, and 25 V/cm); but the shock frequency and duration were held constant among treatments. Results from both shocking Common Carp and a pilot study that shocked steelhead embryos indicate that the vulnerability of embryos and larvae to electricity differs among developmental stages, voltage gradients, and waveform types. The study results are being used to project at what lake conductivities commercially-available electrofishing equipment can kill carp embryos.

Life History Flexibility May Facilitate Colonization of Diverse Habitats by Invasive Brook Stickleback

Paul Spruell [α]
Eastern Washington University

Samuel Gunselman

Successful invasive species are often able to tolerate a variety of habitat conditions. For aquatic species in temperate regions, the timing and number of reproductive events may be one of the most crucial aspects of life history. This is especially true when suitable spawning conditions and prey availability are highly variable and unpredictable. Brook Stickleback (BSB) *Culaea inconstans* were first detected in eastern Washington in wetlands of Turnbull National Wildlife Refuge in 1999 and have subsequently dispersed to numerous streams and wetlands. There is substantial variation among these locations with respect to the stability of the habitat. We hypothesized that BSB in unstable habitats may be functionally semelparous due to the unpredictability of future habitat conditions and competition with rapidly growing young of the year. To test this hypothesis, we extracted otoliths to determine the age of 561 BSB from 18 water bodies in the Palouse River drainage. The average age of BSB collected in stable habitats was significantly higher than the average age of BSB collected in ephemeral habitats (ephemeral = 0.76, stable = 1.24, $p < 0.001$). In addition, while BSB up to age class III were collected in several wetlands, 90.4 percent of BSB collected in less stable habitats were age class 0+ or I. These data suggest that BSB in unstable habitats with potentially limited food availability are reproductively active for a single season and perhaps a single reproductive event.

Aquatic Ecological Diversity Shifts along the Yellowstone River Continuum from Trout to Sturgeon

David Stagliano [α]
Montana Biological Survey

The Yellowstone River is the longest, undammed tributary of the Missouri River. Unlike regulated rivers, the Yellowstone does not have long reservoir sections that disrupt the ecological succession of aquatic communities, thus removing it from the serial discontinuity concept. The Yellowstone reveals a natural river's progression from a cold-water salmonid section in the upper 300 miles to a warm-water fishery in the lower 300 miles with a 100 mile transitional cool-water section. This transitional section results in fish species shifts to a native sucker and minnow assemblage. However, as warmer water temperatures and fluctuating hydrographs affect the river, communities may shift upstream or downstream in response. Introduced species such as Smallmouth Bass *Micropterus dolomieu* and Walleye *Sander vitreusor* and species such as the virile crayfish *Orconectes virilisor* and fatmucket mussel *Lampsilis siliquoidea* may use these shifts to expand ranges upstream while salmonid ranges contract. Likewise, invertebrate communities follow the natural river continuum shifting downstream in relation to differing food sources and tributary streams. The lower Yellowstone is a vulnerable ecosystem, containing the endangered Pallid Sturgeon *Scaphirhynchus albus* and species of concern: Sturgeon Chub *Macrhybopsis gelida*, Sicklefin Chub *Macrhybopsis meeki*, Paddlefish *Polyodon* spp., Sauger *Sander canadensis* and Blue Sucker *Cycleptus elongatus*. This lower reach also contains the globally rare, sand-dwelling mayflies, which are currently ranked imperiled in Montana. This presentation will explain the aquatic ecological changes from Yellowstone National Park to the Missouri River.

Yellowstone River: A Tale of Two Spills

Alicia Stickney [α]
Montana Natural Resource Damage Program

The Yellowstone River has recently suffered two oil spills: the Exxonmobil Pipeline Company July 1, 2011 and the Bridger Pipeline Company January 17, 2015. Under the Oil Pollution Act of 1990, the State of Montana and the U.S. Department of the Interior are Trustees for the restoration of natural resources and public use services that were exposed and/or injured by the oil spills. The Trustees used the natural resource damage assessment process to study the effects of these incidents on fish, wildlife, aquatic and terrestrial habitats, and public use of the resources. The July 1, 2011 oil spill occurred close to Laurel, Montana, near the peak of a 35-year flood event. Injured natural resources on the river included terrestrial/riparian habitat, large woody debris piles, riverine aquatic habitat and supported biota, birds, and human services losses. The January 17, 2015 oil spill near Glendive, Montana, occurred during extreme winter conditions when the river was iced over and temperatures were in the single digits. The release of oil in an aquatic system with limited atmospheric interaction made the 2015 spill much different than the 2011 spill. Due to winter conditions on the river, there were two distinct phases of oil release: first when the pipeline broke and second during ice-out. The Trustees are now assessing injuries to natural resources.

Wanted: Dead or Alive. Determining Fish Status from Mobile PIT Antenna Detection Data

Ben Stout [α *]
Utah State University

Phaedra Budy, Mary Conner, Peter MacKinnon, Mark McKinstry

Accurate estimates of vital rates are essential for tracking and understanding the successful recovery of endangered species such as the Razorback Sucker *Xyrauchen texanus* and the Colorado Pikeminnow *Ptychocheilus lucius*. Mobile Passive Integrated Transponder (PIT) tag antenna systems (e.g., on a floating raft) have recently been developed to increase resight rates; however, mobile systems present new challenges. Tags, not fish, are detected thus increasing the chance that shed tags or dead fish with tags are being detected which could lead to over-estimation of survival. Our goal is to address this limitation and determine if the addition of mobile detections can improve vital rate estimates. Our field study was performed on 273 kilometers of San Juan River designated critical habitat. PIT tags were seeded in the river to quantify dead/shed tag movement. Live fish movements were identified by matching tag detections with live capture data. Preliminary results have already changed our perspective on potential PIT tag movement in river systems. We found that high flows increased the mean distance moved of seeded tags from 30.8m (σ=37.5m) to 206m (σ=396.6m). Despite low susceptibility to high flows, live fish movements are highly variable ranging from 41m to 37km. This method may be useful in censoring data and increasing fish resighting numbers, which will improve the accuracy and precision of estimates of vital rates, while also providing new information about post stocking location and habitat associations.

Genotype-Environment Interactions Increase Summer Growth of Hybrid Rainbow x Cutthroat Trout in Three Wild Populations

Jeffrey Strait [α *]
The University of Montana

Lisa Eby, Ryan Kovach, Seth Smith, Gordon Luikart

Human induced hybridization of Rainbow Trout *Oncorhynchus mykiss* is a major conservation problem threatening numerous subspecies of Cutthroat Trout *Oncorhynchus clarkii*. Landscape-level patterns of introgression suggest an interaction between the site-specific environmental characteristics and physiological differences between Cutthroat and Rainbow Trout might mediate the occurrence and spread of Rainbow Trout alleles. Growth in fish is known to be under both genomic and environmental control and can influence key vital rates such as survival and fecundity. Thus, individual growth rates might act as a mechanism promoting or inhibiting introgression across the landscape. We investigated the effects of Rainbow Trout admixture on individual summertime somatic growth rates (July-October) in three populations of Westslope Cutthroat Trout *Oncorhynchus clarkii lewisi* that experienced different environmental conditions. Within each creek, we individually genotyped, marked, and recaptured *Oncorhynchus* spp. for three years (n=518). Individuals with greater Rainbow Trout admixture had a slight, but significant increase in growth rates. Furthermore, individual genotypes positively interacted with both summertime temperature and date of spring peak discharge such that years with warmer temperatures or earlier runoff resulted in a greater increase in summertime growth rates for hybrids over pure Cutthroat Trout. These results suggest that introgression with Rainbow Trout provides a growth advantage over Westslope Cutthroat Trout growth for year 1+ fish.

Invasive Northern Pike are Associated with Range Contractions of Three Native Cyprinids

Allison Stringer [α *]
Montana Cooperative Fishery Research Unit, Montana State University

Robert Bramblett, Alexander Zale

Pearl Dace *Margariscus margarita*, Northern Redbelly Dace *Chrosomus eos*, and Northern Redbelly Dace *C. eos* X Finescale Dace *C. neogaeus* have undergone range contractions in Montana. Nonnative Northern Pike *Esox lucius* have expanded from stocked reservoirs to prairie streams that are inhabited by native cyprinids. Our objectives were to: (1) establish the current distributions of Pearl Dace and *Chrosomus* spp., and (2) evaluate the extent to which their current distributions may have been influenced by the expansion of Northern Pike. We captured Pearl Dace at only 8 of 85 sites in their historic range and found that they may have been extirpated from 11 of 13 streams. Northern Pike were captured in 9 of the 11 streams where Pearl Dace were not captured. Of 141 sites in the historic range of *Chrosomus* spp., we captured *Chrosomus* spp. at 43 sites, and Northern Pike at 20 sites. *Chrosomus* spp. and Northern Pike co-occurred at only one site. Expansion of Northern Pike may lead to the extirpation of Pearl Dace from Montana and substantial declines in *Chrosomus* spp.

Colorado's Water Plan: Stream Management Planning and Watershed Health

Chris Sturm [α]
Colorado Water Conservation Board

Colorado's Water Plan (CWP) was submitted to the Governor in December 2015. It leveraged and integrated the work accomplished by Colorado's nine Basin Roundtables, the Colorado Water Conservation Board (CWCB), and stakeholders statewide to determine how to implement water supply planning solutions that meet Colorado's future water needs while supporting healthy watersheds; robust recreation and tourism economies; vibrant and sustainable cities; and viable and productive agriculture. CWP sets a measurable objective to cover 80 percent of prioritized streams with stream management plans by 2030. Well-developed stream management plans should be grounded in the complex interplay of biology, hydrology, channel morphology, and alternative water use management strategies. They should consider the flow, restoration priorities, and management strategies needed to support both recreational uses and ecosystem function. A stream management plan should: (1) Involve stakeholders to ensure their acceptance of the plan; (2) assess existing biological, hydrological, and geomorphological conditions at a reach scale; (3) identify flows and other physical conditions needed to support environmental and recreational water uses; (4) incorporate environmental and recreational values and goals; and (5) identify and prioritize alternative management actions to achieve measurable progress toward maintaining or improving flow regimes and other physical conditions.

Perspectives on Restoring Connectivity and Anadromy Upstream of Impassable Dams in the Elwha and Skokomish Systems, Washington

Kathryn Sutton [α]
National Park Service

Sam Brenkman, Pat Crain, Josh Geffre

The Olympic Peninsula, Washington contains two rivers with dams that were constructed without fish passage, the Elwha River and North Fork Skokomish River (NFSR). Two recent management actions to restore fish passage, dam removal versus trap and haul operations, present differing challenges for managing anadromous fish. Our goal was to establish baseline conditions before recolonization or reintroduction of anadromous fish and to evaluate the relative success of fish passage in the Elwha and NFSR. In the Elwha River, we assessed relative abundance, migration timing, and spatial extent of recolonizers. Chinook Salmon *Oncorhunchus tshawytscha*, Sockeye Salmon *Oncorhynchus nerka*, steelhead, and Bull Trout *Salvenlinus confluentus* were observed above the former dam sites after removal. Bull Trout populations that were formerly isolated between and above Elwha River dams now have full access to sea, and a re-awakening of anadromy has been observed based on stable isotope analysis. In the NFSR, trap and haul operations for adult salmonids will begin in 2018. In addition, hatchery-bred spring Chinook and Sockeye salmon will be reintroduced. With snorkel and spawning ground surveys, we have found that the upper NFSR is a stronghold for one of the last thriving populations of Bull Trout in the Puget Sound region and also contains a unique population of landlocked Chinook Salmon. Reintroduction programs raise important management questions in regard to the impact to these threatened, resident species from competition with re-introduced wild and hatchery-bred fish.

Steep Grade Ahead – Developing Fishway Design Criteria for Small-bodied Great Plains Fishes

Tyler Swarr [α *]
Colorado State University

Ryan Fitzpatrick, Chris Myrick

There is growing global recognition of the need to improve the longitudinal connectivity of lotic systems, frequently through the use of fish passage structures (fishways). When designing fishways in the past, biologists and engineers focused primarily on strong swimming species such as salmonids. However, the majority of riverine species in the interior of the United States are not salmonids and may not be as effective swimmers. When fishways are designed based on salmonid criteria, it increases the likelihood that non-salmonid species could be excluded by fishways, whereas biologists realize that it is important to exclude as few species within an assemblage as possible. This study measured the effects of grade (slopes of 2 – 10%, in 2% increments) on the passage success of three Great Plains fish species: Arkansas Darter *Etheostoma cragini*, Stonecat *Noturus flavus*, and Flathead Chub *Platygobio gracilis* in a 6.1-m long rock ramp research fishway fitted with multiple PIT tag antennas to detect full or partial passage success. Passage success over the full 6.1-m fishway for all species increased as slope decreased; Stonecat and Flathead Chub passage success was 100% at slopes of 2 and 4%. Arkansas Darter success was much lower than the other two species, but approached 40% at 2% slope. The results of this study provide valuable design criteria by identifying fishway slope and length combinations that allow passage of these representative small-bodied Great Plains fishes.

Montane Meadow Restoration in the Sierra Nevada: Understanding the Potential Impacts to Native Fish Communities

Lora Tennant [α]
US Geological Survey

Collin Eagles-Smith, James Johnson, James Willacker

Montane meadows associated with perennial or intermittent streams provide many important ecosystem services. However, past and current land use practices have degraded 40-60 percent of montane meadows in the Sierra Nevada. Efforts to restore function to these habitats have increasingly relied on pond-and-plug techniques that use excavated alluvial material from the stream channel and adjacent floodplain (forming ponds) to plug the incised stream channel and then excavate shallower stream channels that may or may not provide connectivity among the created ponds. Little has been documented on the impact of pond-and-plug treatments on fish communities; therefore, we studied the fish community at a recently implemented pond-and-plug project in the Red Clover Valley, California. Preliminary results indicate that variability in CPUE of Mountain Sucker *Catostomus platyrhynchus* and Speckled Dace *Rhinichthys osculus* was best explained by sample season and pond connectivity index. Documented fish movement during the study was minimal, with a single Mountain Sucker being recaptured in a different pond than it was originally marked. However, several fish that were recaptured in the pond from which they were marked suggests successful survival during summer and/or winter when conditions are often less suitable. Stable isotope data suggest that ponds have similar food web structures with some variability of among pond carbon source. Understanding how pond-and-plug treatments can impact fish communities will help inform future projects.

Fine Tuning the Relationship between Shovelnose Sturgeon Spawning and Discharge in a Tributary to the Missouri River, Montana

Anne Tews [α]
Montana Fish, Wildlife and Parks

Researchers have collaborated with the Bureau of Reclamation for several years to evaluate Shovelnose Sturgeon *Scaphirhynchus platorynchus* response to discharge in the Lower Marias River, Montana. The Lower Marias River is the largest tributary in the 400 km reach of the Missouri River between Morony Dam and Fort Peck. It is completely regulated by Tiber Dam. Past studies found that Shovelnose Sturgeon spawning occurred in the Marias River at 28 m^3/s when peak June flows were at least 85 m^3/s. In this study, controlled flow releases of 28 m^3/s in 2012 and 56 m^3/s cfs in 2013 further clarified minimum flow needs for Shovelnose Sturgeon spawning. Shovelnose sturgeon spawning was not documented at 28 m^3/s, but sturgeon embryos and larvae were sampled once discharged reached 56 m^3/s. In addition, radio tagged adult Shovelnose Sturgeon use in the Marias River was 2-3 times higher when peak June flows were at least 56 m^3/s. This work indicates Shovelnose Sturgeon spawning may be tied to a trigger flow for migration coupled with a minimum spawning flow and relatively small changes in discharge can influence fish behavior. It has implications for flow management and for Pallid Sturgeon *S. albus* recovery.

The Effect of Lake Level on Forage and Lahonton Cutthroat Trout in Pyramid Lake, Nevada

Gary Thiede [α]
Utah State University

Brian Laub, Nick Heredia, Phaedra Budy

Pyramid Lake, Nevada is one of the last remaining strongholds for lacustrine Lahontan Cutthroat Trout *Oncorhynchus clarkii henshawi* (LCT); almost all other large lake populations have undergone population declines or extirpation due to invasive species interactions and habitat degradation. In addition, lake levels have declined significantly and consistently since 1999. Although the vertical distribution and temperature preferences of LCT and Tui Chub Gila bicolor appear to vary by season, Tui Chub remain the primary diet item of LCT throughout the year, allowing this native piscivore to maintain the top trophic position. Our analyses indicate that large LCT distribution was best explained by water transparency, lake location, and depth; suggesting abiotic and not biotic factors generally have more effect on the LCT distribution. Tui Chub abundance has been highly variable over time and has shown a significant decreasing trend since the mid-1980s. As lake level drops, total dissolved solids (TDS) increase and both zooplankton and Tui Chub abundance decrease, with important potential implications on the food web and LCT. TDS concentrations, which are directly linked to lake elevation, may play a role in regulating Tui Chub abundance, and could become an important predictor of Tui Chub abundance, if lake levels continue to decline and TDS continue to increase.

Evaluation of Suppression Methods Targeting Non-native Lake Trout Embryos in Yellowstone Lake

Nathan Thomas [α *]
Montana State University

Christopher Guy, Todd Koel, Alexander Zale

Non-native Lake Trout *Salvelinus namaycush* threaten to extirpate native Yellowstone Cutthroat Trout *Oncorhynchus clarkii bouvieri* in Yellowstone Lake, Yellowstone National Park. Suppression of Lake Trout in Yellowstone Lake has been ongoing since 1995, primarily by extensive gillnetting. Bycatch of Yellowstone Cutthroat Trout is associated with this removal method, which targets adult and subadult Lake Trout. Alternative methods effective at causing mortality in early Lake Trout life stage(s) could be used simultaneously with gillnetting to improve suppression effectiveness. Thus, the goal of this study was to evaluate the efficacy of methods to induce mortality in Lake Trout embryos. In situ experiments tested the effect of electroshocking, dredging, tarping, and covering spawning substrate with Lake Trout carcasses on embryo mortality. Tarping had no effect, and dredging caused 27 percent (4.0 SE) mortality. Electroshocking caused 99 percent (0.6 SE) mortality of embryos at the substrate surface but only 51 percent (20.8 SE) at 20 cm depth in the substrate. Lake Trout carcasses placed on the spawning substrate caused 99 percent (0.01 SE) mortality of embryos both at the surface and at 20 cm in the substrate. Lake Trout carcasses placed on Lake Trout spawning substrate may therefore be an effective alternative suppression method if implemented on a large scale.

Development of a Fully-Integrated Field eDNA Sampling and Detection System

Austen Thomas [α]
Smith-Root

Jesse Howard, Mieke Sinnesael, Jesse VanWestrienen

Environmental DNA (eDNA) sampling is being rapidly adopted by government agencies as a low-impact means of species detection in aquatic environments. Until recently, eDNA sampling technology has consisted of tools designed for other scientific fields such as well-water monitoring and bacteriology. In addition, species detection from eDNA has been confined to the laboratory and requires large benchtop equipment, often delaying sample results for weeks or even months. Here we present recent technological developments that greatly improve the sterility and efficiency of eDNA sampling in the form of a purpose-built eDNA sampling system. Furthermore, we discuss the availability of field-based DNA detection technologies, such as a handheld qPCR device with on site DNA-extraction, that enables species detection in less than one hour. Such technologies will likely become common tools in the future of aquatic species management, as they are further developed and refined by the eDNA user community.

The Promise and Pitfalls of Fish Enumeration Using eDNA: Spatiotemporal Dynamics of Salmon DNA in a Spawning Stream

Michael Tillotson [α *]
University of Washington

Ryan Kelly, Jeff Duda, Marshall Hoy, Thomas Quinn

Estimates of abundance at various stages of the salmon life cycle provide valuable data on survival, movement and population productivity. Traditional counting methods are typically expensive and/or labor intensive; severely limiting the spatial and temporal extent of monitoring. Advances in the collection and analysis of eDNA may offer a relatively low cost alternative to traditional salmon counting. However, uncertainties remain regarding the correlation between abundance and the amount of DNA ultimately detected. The sources, fates and collection location of DNA in dynamic stream environments all have the potential to influence this relationship. In this study we paired visual counts of salmon in a small stream with daily eDNA sampling and environmental monitoring to explore factors that influence the quantitative relationship between abundance and DNA. Over time, DNA followed the general pattern of salmon abundance; starting near zero, increasing after first fish entry and then falling as in-stream abundance declined. Surprisingly, the carcass count was far more predictive of DNA concentration than the live or total count. These initial findings suggest that there is indeed a quantitative relationship between fish abundance and DNA in the environment, but that it is sensitive to both environmental and biological conditions. Further analysis will explore the relative influence of these factors and compare the predictive power of eDNA with established enumeration methods.

Sound Passages in Migration of Semipelagic Icefish

Ryszard Traczyk [α]
University of Gdansk

The large expanse of fast flowing West Wind Drift and deep waters separating the islands of Scotia Arc are responsible for restriction of icefish distribution to islands shelves. Shag Rock is separated from South Georgia by distance of 250 km and the waters deeper than 1000 m. Further South Orkney Islands are more isolated by 1040 km to south. In 1980 there was discovered that semipelagic *Pseudochaenichthys georgianus* do not migrate between South Georgia and South Orkney. The probability such a large scale migration was assumed extremely small also for pelagic *Champsocephalus gunnari*. Generally low genetic differentiation for many Antarctic fish species including strictly benthic suggest high connectivity between populations in the South Scotia Arc (Damerau et al. 2012). Sagitta of Antarctic fish show different morphologic patterns related to environment and may have acoustic features. Perception of sounds fish evolved to learn about their environment. Sound provides information that is not hindered by currents, light and objects. Mechanism of otolith crystal formation and maintenance is not clear and understood (Lundberg et al. 2015). The objection of this work is to show the connection between fish swimming in different conditions and formation of otolith.

Saving Genetic Material in Growth of the Otolith

Ryszard Traczyk [α]
University of Gdansk

Mechanism of crystal formation and maintenance in otolith is not clear and understood (Lundberg et al., 2015). The creation of otolith (statolith) occurs both in fish embryos and in phylogeny when in animal start blood circulation that supports drainage of urea, which dissolve calcium carbonate. Shark having a lot of urea in the tissues have a different construction of the labyrinth. This suggests that creating otoliths is in self-organization and will depend on the concentration of components in the lymph. Growth of otolith is in self-organization in intercellular space and under physical and chemical law. Knowledge of chemical components of otoliths: aragonite, collagen like proteins and water give large possibilities to discover the spatial microstructure of otolith. Component molecules are modeled, knowing the chemical structure (type and sequence of individual links in the chains) conformation angles, bond lengths of the main and side chains and the structure of subunits (Scientific Committee, 1983). Their conformation determines mechanisms of their action. Otoliths have the spherical surfaces, indicating that the crystallization of the main component aragonite to mixed crystal using its plastic futures initiate fixed network of the second component: fish sclerite-protein and energy pressure. Presentation shows the space microstructure of otolith.

Illegal Fish Introductions in Montana

Jim Vashro [α]
Montana Fish, Wildlife and Parks (retired)

Despite increasing interest in Aquatic Invasive Species, little or no attention is given to illegal fish introductions by resource agencies and the angling public. Illegal fish introductions can cause great damage to native and sport fisheries, decrease fishing opportunity and divert scarce agency resources, and cause dissension within the angling community. A unique database has been assembled for Montana to document nearly 600 illegal fish introductions in more than 250 waters. The characteristics of the illegal introductions are detailed along with several case histories. The motivations behind illegal introductions are explored along with possible prevention strategies.

The Upper Clark Fork River: A History of Use, Abuse and Reuse

Matt Vincent [α]
Rampart Solutions

Dating back to prehistoric times, from the age of Glacial Lake Missoula, to its early use by the region's original peoples, on to its more recent history through the years of exploration, westward expansion, agriculture, mining and industry, on up to today, as we restore and attempt to chart its future course, the Upper Clark Fork River has undergone a myriad of changes. The diversity of its nomenclature over time tells a story in itself. Names like "shining waters," "place of the big bull trout," "s@$t creek" and "river of rebirth" all concoct strikingly different images. This broad overview of the Upper Clark Fork River from prehistory through the present will give listeners an interesting and engaging look at a river that has been a key part of its inhabitants lives and livelihoods for going on over 15,000 years – and an ability to appreciate and better understand the impressive transformation the watershed has undergone in a relatively short amount of time.

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

Katie Vivian [α]
Montana Fish, Wildlife and Parks

Frank Wilhelm

In phosphorus (P) stressed environmental conditions, the diatom *Didymosphenia geminata* excessively produces mucopolysaccharide stalks, forming nuisance mats along the benthos of lotic systems. This P limitation has been linked to nitrogen pollution which may be driving the seemingly invasive• proliferation of this native species. Since the early 2000s, nuisance mats of *D. geminata* have occurred in the Kootenai River near Libby, Montana. As part of a follow-up study to phosphorus enrichment mesocosm experiments below the Libby Dam, an in-river dissolved P enrichment was completed in the spring of 2015 to test the addition of P at the river scale. The addition of 108.41 kg of struvite (CrystalGreenTM) over 18 days increased available phosphorus by approximately 0.8 µg/L above ambient river concentrations. After 14 days, P enrichment significantly suppressed mat depth and coverage for ~300 m downstream and resulted in nuisance mat detachment in several areas. The cost-benefit analysis of this strategy to fish growth and survival is still being evaluated by Montana Fish, Wildlife and Parks. However, these results suggest that P enrichment is a potential management strategy for nuisance mats and warrants further evaluation as no suppression techniques currently exist for nuisance mats in river systems with important fisheries.

A Potential Success Story of a Conservation Hatchery

Jennifer Von Bargen [α]
U.S. Fish and Wildlife Service

Christian Smith

Anthropogenic activities and natural environmental events have impacted many species throughout the world. The winter run Chinook Salmon *Oncorhynchus tshawytscha* found in the Sacramento River, California is one of these impacted species. Two of the dams built on the Sacramento River effectively eliminated a large portion of the spawning habitat for the winter run Chinook Salmon, Shasta Dam (1945) and Keswick Dam (1950). The winter run Chinook Salmon were listed as threatened under the U.S. Endangered Species Act in 1989 and upgraded to endangered in 1994. The United States Fish and Wildlife Service in 1997 built Livingston Stone National Fish Hatchery at the base of Shasta Dam to help propagate winter run Chinook Salmon with conservation as its main goal. Conservation of genetic resources and the use of genetic tools to monitor this species played important roles in shaping the program. Genetic analysis using pairwise estimates of relatedness has helped hatchery staff reduce the chance of spawning related individuals. Over time the hatchery managers have continued to make adjustments in their culture practices to compensate for changes in the environment outside the hatchery. Genetic data continues to inform hatchery managers and play a key role in recovery actions for this endangered species.

Accounting for Adaptive Capacity and Uncertainty in Assessments of Species' Climate Change Vulnerability: Applications to Threatened Salmonids

Alisa Wade [α]
University of Montana

Brian Hand, Ryan Kovach, Gordon Luikart, Clint Muhlfeld

Climate-change vulnerability assessments (CCVAs) are valuable tools for assessing species' vulnerability to climatic changes, yet failure to include measures of adaptive capacity and to account for sources of uncertainty may limit their effectiveness. We took a more comprehensive approach that incorporates exposure, sensitivity, and capacity to adapt to climate change. We applied our approach to anadromous steelhead trout *Oncorhynchus mykiss* and nonanadromous Bull Trout *Salvelinus confluentus*, threatened salmonids within the Columbia River Basin. We quantified exposure on the basis of scenarios of future stream temperature and flow, and we represented sensitivity and capacity to adapt to climate change with metrics of habitat quality, demographic condition, and genetic diversity. Both species were found to be highly vulnerable to climate change at low elevations and in their southernmost habitats. However, vulnerability rankings varied widely depending on the factors (climate, habitat, demographic, and genetic) included in the CCVA and often differed for the two species at locations where they were sympatric. Our findings illustrate that CCVA results are highly sensitive to data inputs and that spatial differences can complicate multispecies conservation. Based on our results, we suggest that CCVAs be considered within a broader conceptual and computational framework and be used to refine hypotheses, guide research, and compare plausible scenarios of species' vulnerability to climate change.

Finding a Way to Create Robust Fisheries in a Changing Environment

Craig Walker [α]
Utah Division of Wildlife Resources

Historically, reservoir water storage has mitigated the variability in annual precipitation; providing for economic stability, development and growth of societies in the semiarid areas of Utah and the western U. S. Unprecedented drought and continued human population expansion has lead to drastic and prolonged drawdowns of western reservoirs. Although multipurpose, aging western reservoirs are primarily operated for municipal water supply, irrigation, power production and flood control. Recreational angling is rarely viewed by reservoir operators as more than an incidental use and fisheries are often sacrificed seasonally during periods of drought in order to provide for primary water uses. Although fisheries are among the first of the beneficial uses impacted in western reservoirs, recent developments have caused other water users to recognize that even primary uses of reservoirs may now jeopardized during prolonged periods of drought. The Utah Division of Wildlife Resources (UDWR) is beginning to explore unique partnerships and solutions to prevent the loss of recreational reservoir fishing opportunities. By using habitat enhancement, using alternate species for fisheries management, becoming involved in the creation and construction of new reservoirs, and paying for a say in the timing and magnitude of water withdrawals, UDWR is finding a way to create more robust reservoir fisheries in a changing environment.

Otolith Microchemistry Reveals Inter-Annual Shifts in the Quality of Juvenile Sockeye Salmon Habitats in a Remote Alaskan Watershed

Timothy Walsworth [α]
University of Washington

Jeffrey Baldock, Daniel Schindler, Christian Zimmerman

Aquatic organisms exist within a mosaic of habitat types, which provide a range of growth and survival opportunities across the landscape. However, the quality of these diverse habitats will vary through time due to changes in geomorphology, climate, and other ecosystem properties (e.g. competition). For migratory species with high fecundity and low survival to reproduction, determining the ultimate fitness of juveniles that exploit the habitat mosaic differently is nearly impossible using conventional methods. Otolith microchemistry provides a means for examining juvenile habitat-use of individuals captured during the adult life-phase, enabling quantification of the relative contribution of different habitats to the spawning population. Here, we examine inter-annual variation in juvenile Sockeye Salmon *Oncorhynchus nerka* habitat-use for those fish that contributed to a single spawning population with access to a set of rearing lakes of varying quality. The distribution of growth accumulated in each habitat varied substantially among years. In some years, a majority of freshwater growth was accumulated within the apparent 'optimal' habitat, while very little growth was accumulated there in other years. This result suggests non-stationarity of growth and survival opportunities across space and time, and underscores the importance of habitat connectivity for animal populations needing to cope with highly variable environments.

Recovery of Fish Populations and Physical Channel Characteristics in Streams Impacted by Catastrophic Debris Flows

Jason Walter [α]
Weyerhaeuser

Brian Fransen, Renata Tarosky, Travis Schill, Jack Giovanini

In 2007, an extreme magnitude storm event impacted southwest Washington. The heaviest recorded rainfall associated with the storm fell within the upper Chehalis River basin, resulting in an estimated 500-year flood event. As a result of the storm many streams in the area experienced record high flows, as well as channelized landslides that developed into catastrophic debris flows. Coincidently, the area of the most intense storm impact occurred where comprehensive data on stream habitat and fish populations had been collected by Weyerhaeuser Company since the mid-1970s. This forty years of previous aquatic research and survey work provided the opportunity to assess the impact of the storm on fish distribution and habitat conditions, and to monitor post-storm recovery. The re-colonization of fish populations and recovery of habitat conditions in streams impacted by catastrophic debris flows is currently being monitored in over 29 kilometers of stream channel within 19 individual sub-basins using spatially continuous, single-pass electrofishing and physical stream habitat surveys. As of 2016, fish have recolonized habitats up to or beyond the upper extent of their pre-storm distribution in 12 of the 19 sub-basins. This study is ongoing, but preliminary results indicate fine-scale physical habitat characteristics including stream gradient, size, and the presence of natural blockages significantly influence the rate and extent of fish re-colonization in these systems.

Quantifying Hypoxia Exposure in Fishes Using Redox-Sensitive Chemical Markers in Otoliths

Benjamin Walther [α]
Texas A&M University - Corpus Christi

Matthew Altenritter

Reconstructing patterns of hypoxia exposure in mobile fishes is essential to estimate population responses to this widespread environmental stressor in freshwater, estuarine and coastal habitats. Otolith chemistry offers a unique opportunity to identify sublethal hypoxia exposure using redox-sensitive chemical markers, such as manganese (Mn), that record lifetime exposure histories for individual fish. We applied this approach to quantify the proportion of Atlantic Croaker *Micropognias undulatus* exposed to hypoxia in the northern Gulf of Mexico, which experiences widespread summertime hypoxia every year. We found the proportion of fish with sublethal hypoxia exposure during their first year of life varied among sampled geographic regions (18-25%), indicating that exposure was common enough to have important consequences for reproductive sustainability. In contrast, we found limited evidence for exposure effects on growth or condition factor for Atlantic croaker, suggesting some life history parameters in this species are relatively resilient to hypoxia. Finally, we coupled tissue stable isotope measurements with otolith chemistry to assess whether hypoxia displaces demersal foragers to pelagic food webs, and found limited evidence for food web displacement. The effects of hypoxia are thus complex, and otolith chemistry offers a novel way to unravel the dynamics of this growing environmental stressor.

Some Neat Stuff in Fishery Genetics I Have Stumbled Across Over the Years

Robin Waples [α]
University of Washington

Any scientific career is defined in part by serendipitous events that lead to novel results, research directions, or collaborations. Events of this type that have helped shape my career in fishery genetics include: An evaluation of how temporal changes in allele frequency in baseline populations affect mixed-stock fishery analysis of Chinook Salmon *Oncorhynchus tshawytscha* leads to startling conclusions about hatchery practices; A simulation study of the ability of linkage-disequilibrium (LD) analysis to detect mixtures of salmon populations unexpectedly reveals that LD can be a powerful tool to estimate effective population size (Ne); A question posed by Mike Gilpin, and seemingly contradictory simulation results for salmon and annual plants with seedbanks, lead to new insights about factors that determine the Ne/N ratio in semelparous species with variable age at maturity; Attempts to extract key information from terse output of a computer program leads to discovery of a new and simple way to calculate inbreeding Ne; Forward-thinking action by a colleague saves a large, empirical genetic study of Snake River salmon from a near disaster.

Collaborating to Develop a Watershed Action Plan

David Ward [α]
HDR, Inc.

Terry Luecker

The mission of the Partnership for the Umpqua Rivers (PUR) is to maintain and improve water quality and fish populations in the streams of the Umpqua River Basin in Southwest Oregon. In 2016, PUR worked with partners to develop a watershed action plan for the West Fork Cow Creek Watershed, a small remote, watershed in southwestern Oregon. The focus of the Plan is to direct restoration project funding to recover or restore native fish populations. In addition to West Fork Cow Creek, the watershed includes a number of fish-bearing streams, many of which support anadromous salmonids. Steps for developing the Plan included (1) holding a workshop with partners in spring 2016 to construct a framework for scoring and ranking potential restoration projects, (2) collecting information on current habitat and fish presence throughout the watershed to inform the scoring, (3) working with partners to develop a list of potential restoration projects throughout the watershed, and (4) holding workshops with partners in fall 2016 to utilize all available information to score potential projects. Participants then placed each project into one of three tiers based on the distribution of final scores. This project serves as an example of how a collaborative effort among public and private entities can lead to restoration of habitat for native fish species.

Monitoring Natural-Origin Adult Chinook Salmon Escapement using Dual-frequency Identification Sonar in the Secesh River, Idaho

Clark Watry [α]
Nez Perce Tribe - Dept. of Fisheries Resource Management

John Robbins

We used dual-frequency identification sonar (DIDSON) in the Secesh River since 2004 to monitor adult natural-origin spring/summer Chinook salmon escapement relative to population viability (delisting) thresholds. The Secesh River is the only stream in the Snake River basin where natural-origin Chinook salmon escapement is directly monitored absent a hatchery supplementation program. DIDSON technology provides a passive monitoring method that avoids incidental trapping, handling mortality, and/or impedance-related concerns for this threatened population. The DIDSON unit ensonified the entire water column, continuously sampling passages during the salmon migration period, typically between June and mid-September. We used the convolved samples over threshold (CSOT) file-processing feature to identify motion-only periods for manageable viewing. We adjusted raw daily directional passage counts for reader and CSOT file-processing errors, and accounted for periods of DIDSON down-time, while the degree of precision for escapement estimates was represented by the coefficient of variation. Validation monitoring used underwater optical video cameras to assess the accuracy of fish passage counts. The Secesh River Chinook salmon population is not considered viable for delisting at this time based on the viability threshold established by the Interior Columbia Basin Technical Recovery Team (2006) which uses a 10-year geometric mean spawner abundance of 750 fish to measure recovery success.

Changes in Climate, Flows and Algae Levels in the Clark Fork River

Vicki Watson [α]
University of Montana

Sylvia Doyle

Efforts to reduce nutrient loads to the Clark Fork River appear to have reduced nuisance algae levels below the city of Missoula; however, the upper river has shown increasing algae levels in recent years. Since climate change can impact the frequency and severity of ice scour and scouring flows and these can impact algae levels, the relationship between algal levels and flows was examined. Summer attached algal chlorophyll a and ash free dry weight sampled at Missoula and an upper river site from 1995 to 2016 were compared to peak flows over those years. Both algal biomass measures were strongly correlated with peak stream flows. Research is continuing in relating summer algal biomass to timing of spring high flows, since earlier peaks allow attached algae more time to grow during the long days of late spring and early summer.

Yellowstone River Channel Migration Easement Program

Wendy Weaver [α]
Montana Aquatic Resources Services

Montana Aquatic Resources Services (MARS) Channel Migration Easement (CME) Program is an innovative, community-based approach to conserving Montana's iconic Yellowstone River. MARS uses funds from mitigation and non-mitigation sources to fund CMEs which are the first of their kind in the U.S. CMEs at their core prohibit landowners along the Yellowstone from stabilizing river banks or preventing the river channel to move or flow out onto the floodplain. According to the Yellowstone River Cumulative Effects Analysis published by the Army Corps of Engineers in late 2015, bank armoring has a cumulative impact on river processes by disconnecting the river from its floodplain. CMEs maintain this connection, providing many ecological and hydrologic benefits. CMEs help ensure a reliable supply of clean water to Yellowstone River Valley including its agricultural producers, municipalities, other water users, and the fish and wildlife populations of the river and floodplain. This program is ever so important, given the recent whitefish die-off, which caused tens of thousands of fish to die unexpectedly from proliferative kidney disease parasite that completely closed a major stretch of the river to any kind of public access for over a month. This closure, MARS believes, stems from water quality issues that have developed as a result of channelization of the river, losses in floodplain connectivity, and dewatering.

A Collaborative Approach to Restoration and Flood Recovery on the Big Thompson River

Tracy Wendt [α]
Big Thompson Watershed Coalition

Catastrophic floods ravaged the Colorado Front Range in 2013 destroying homes, roads, and infrastructure; taking lives; and reconfiguring rivers and streams. To deal with the destruction, many watersheds founded river restoration coalitions. This presentation showcases one such organization: the Big Thompson Watershed Coalition (BTWC). The Big Thompson Watershed includes a major highway, private residences, businesses, agricultural land, and, of course, the Big Thompson River, all vying for space in a narrow, bedrock canyon. BTWC is tasked with restoring the post-flood river to protect lives, property and infrastructure, create a resilient system that can respond more naturally to future disasters, enhance habitat for fish and wildlife, and ensure community values are considered, including recreation, clean and abundant water, and economic interests. These resulting projects must be coordinated with projects by multiple other entities, which are also taking place in and around the river. The effort to accomplish all of this includes dozens of projects, millions of dollars, and an endless number of partners all collaborating to carry out the work and meet a multitude of objectives.

Demography and Genetics of a Salmonid Metapopulation

Andrew Whiteley [α]
University of Montana

Benjamin Letcher, Evan Childress, Ronald Bassar, Matthew O'Donnell, Keith Nislow

We conducted a tagging study (2002-2015) in a small stream network (West Brook, MA) with the goal of understanding how environmental variation influences population dynamics and connectivity within a Brook Trout *Salvelinus fontinalis* metapopulation. Using a combination of population modeling, population genetics, and pedigree analysis, we found that 1) population dynamics were largely driven by environmental effects acting on the youngest fish, 2) size-based vital rates and responses to environmental variation were quite different among network components, 3) local-scale estimates of the effective number of breeders were not correlated, 4) genetic differentiation of a large tributary was substantial despite evidence for high gene flow, 5) year-to-year variation in stream flow in the fall drove successful reproduction in a small tributary, 6) life histories were shifted towards early maturation and low adult survival in a naturally-isolated tributary (waterfall), and 7) blocking access to a small tributary could lead to local extinction in just a few generations. Overall, stream network structure, even on the scale of 1 km, produces adjacent habitats with remarkably different demographic rates and responses. This portfolio of responses will help buffer the connected system from environmental changes, but the dominating effects of environmental variation indicate that future populations are at high risk.

Environmental Flow Restoration: Perspective from the Trenches

Jedediah Whiteley [α]
Clark Fork Coalition

Andrew Fischer

Bolstering environmental flows in Montana takes innovation, generous funding and perseverance. The Clark Fork Coalition has been working on protecting instream flows in Montana for over 10 years and we're still learning how to "get 'er done" This talk reviews our experience on three different instream flow projects on Tin Cup and Lost Horse Creek in the Upper Bitterroot watershed. Both these streams have suffered from chronic dewatering that has impaired spawning, habitat and cold water refugia for native salmonids. Each project has its own unique set of challenges and lessons learned including funding, agencies, legal, construction, stakeholders and ongoing management of these water rights. The lessons learned from these projects can be used to restore environmental flows in Montana and across the West.

Environmental DNA 2.0: What is eDNA Doing for Fisheries Today?

Taylor Wilcox [α]
National Genomics Center for Wildlife and Fish Conservation

Michael Schwartz, Kevin McKelvey, Michael Young, Kellie Carim, Thomas Franklin

Environmental DNA (eDNA) sampling uses genetic material in water samples to infer species presence. This method has been touted as a powerful new tool for fisheries promising sensitive species detection, non-invasive abundance estimates, and low-cost whole community data. These are lofty expectations for a new technology. In this symposium we explore how eDNA sampling is actually being used to understand the ecology of aquatic systems and inform the management of fisheries today. The field of eDNA sampling has matured to move beyond methods development and is now a part of the toolbox available to researchers and managers across the globe. In this symposium we draw from recent examples that highlight the many ways that eDNA sampling is currently being applied to answer pressing questions in fisheries science and management.

Examining Distribution and Habitat Preferences of Native Fishes in a Coastal Basin of Washington State

Marie Winkowski [α]
Washington Department of Fish and Wildlife

Neala Kendall, Hal Beecher

Due to major flooding in the Chehalis River in recent years, flood reduction strategies are being considered, including construction of a dam in the upper watershed. Efforts are underway to examine the potential impacts. We surveyed the proposed dam footprint to identify fish presence and distribution. We then investigated habitat use in the inundation footprint and developed habitat suitability criteria (HSC) for depth and velocity for select native fishes, including spawning and rearing Pacific lamprey and speckled dace and rearing largescale sucker. Our HSCs reflect individual species' habitat preferences specific to the Chehalis River Basin. For Pacific Lamprey *Entosphenus tridentatus*, most preferred habitats were depths of 1 ft and velocities of 1.6 ft/sec for spawning and 2.4 ft and 0 ft/sec for rearing. For Speckled Dace *Rhynichthys osculus*, most preferred habitats were depths greater than 0.9 ft and velocities greater than 1.9 ft/sec for spawning and depths of 1.8 ft and velocities of 0 ft/sec for rearing. Largescale Sucker *Catostomus macrocheilus* most preferred habitat for rearing occurred at depths greater than 2.5 ft and velocities of 0.6 ft/sec. Moving forward, we plan to use these HSCs with the Chehalis River's previously developed Physical Habitat Simulation (PHABSIM) model to interpret how flow changes downstream of the dam could impact available habitat of native fishes. These results will inform future dam-construction decisions, playing a part in cost-benefit analyses and informing impacts to native freshwater fishes.

Can We Manage Resource Subsidies and Food Webs to Benefit Fishes and Fisheries?

Mark Wipfli [α]
U.S. Geological Survey

Erik Schoen, Ben Meyer, Jess Grunblatt, Sarah Laske, Phil Joy

Stream fishes in Alaska and western U.S. are often food-limited, and evidence shows that processes that affect food web productivity and prey abundance can dramatically affect fish populations. Prey and nutrient subsidies in riverine systems that enter from neighboring ecosystems are a key component of the food base for fishes, at certain times comprising the bulk of their nutritional intake. For example, terrestrial invertebrates are important for stream fishes early summer through fall. Plant community composition (e.g., deciduous vs coniferous forest) affects terrestrial invertebrate inputs into streams, and riparian vegetation can be managed accordingly to influence the quality and quantity of terrestrial prey inputs entering streams. Additionally, marine subsidies from runs of anadromous fishes are also critically important to stream fishes, with inputs spanning from summer to early winter, depending on region. Salmon are a key species providing marine subsidies, and their returns regulated through management affect the extent to which food webs are subsidized and stream fishes are benefited. Ultimately, tradeoffs between socio-economic and ecological costs and benefits dictate how food webs can be managed to benefit fish and fisheries.

Restoration of a Legacy Fish Passage Barrier in the Upper Salmon River Drainage, Idaho

Chad Wiseman [α]
HDR, Inc.

Gene Bosley

A legacy open pit mine on the East Fork of the South Fork of the Salmon River, Idaho has been a barrier to upstream passage of threatened Chinook salmon *Oncorhynchus tshawytscha*, steelhead *O. mykiss*, and bull trout *Salvelinus confluentus* since 1938. The large spatial scale and scope of this fish passage barrier and other upstream legacy impacts preclude typical public funding mechanisms for correction. New mining in the district provides an opportunity to correct the fish passage barrier and other legacy impacts. Midas Gold Idaho, Inc. proposes to provide temporary fish passage around the open pit barrier during new mining operations and restore permanent fish passage along the approximate historical channel alignment after mining operations are complete. Temporary fish passage would be accomplished in this confined river valley with a tunnel that bypasses the open pit. Permanent fish passage would be accomplished by backfilling the open pit with development rock and constructing a fish passable river channel at the approximate pre-mining historical grade. These proposed fish passage barrier corrections demonstrate the potential benefits of coupling new mining operations with restoration of legacy impacts.

Results from Acoustic Tracking of Redband Trout Tagged in Lake Roosevelt Tributaries

Bryan Witte [α *]
Eastern Washington University

Allan Scholz, Paul Spruell

Lake Roosevelt is a 240km reservoir of the Columbia River that harbors a natural population of Columbia River Redband Trout *Oncorhynchus mykiss gairdneri* that use tributaries of the reservoir for spawning and rearing. Understanding how Redband Trout utilize the reservoir after leaving their spawning stream is necessary to manage this population. Here I present results from tagging and acoustically tracking Redband Trout from March 2015-July 2016. In total 81 Redband Trout from seven tributaries were implanted with VEMCO acoustic transmitters and passively tracked on a reservoir wide acoustic array. Redband Trout tagged in five tributaries in the lower 100 km of the reservoir rarely moved out of this zone, and those tagged in two tributaries of the upper most 40 km of the reservoir rarely moved into the lower most 100 km of the reservoir. However, some individuals made extraordinary movements such as one fish tagged in the lower reservoir that moved into the upper 50 km of the reservoir and subsequently moved 170 km down the reservoir in 10 days. Ten fish were confirmed to home back to their tagging stream on PIT tag arrays. Use of the reservoir appeared to be distinct between fish tagged in upper and lower regions.

Fish Out of Water - Regulating and Restoring Floodplain Function

Marjorie Wolfe [α]
Wolf Water Resources

Until recently, habitat protection regulations have been limited to impacts below ordinary high water ignoring the importance of floodplains. Oregon is facing increasing surface water regulations related to the recent FEMA NMFS BiOP which will require stricter regulations for floodplain development including stormwater management, buffers, and setbacks. Meeting surface water regulations requirements on a piecemeal basis is increasingly complex, expensive, and has a high risk of failure. This is because ecosystem services operate as interdependent processes that cannot be parced out and accounted for in isolation. The need to integrate watershed context and function is broadly applicable to habitat, species, and water quality management planning.

This presentation describes the relationships between floodplain storage to habitat and water quality using modeling scenarios and resurveyed stream reaches 10 year after restoration. The results demonstrate improvements in stream stability due to riparian vegetation and beavers. Understanding ecosystems as a network of interdependent systems that support diverse services such as water quality, habitat, and flood control enables us to focus on restoring the overall network. This approach is more cost effective, self-sustaining, and resilient while meeting multiple compliance goals as opposed to adding more layers local code and regulations.

The Range-wide, eDNA-Based Inventory of Bull Trout: Early Results and an Ongoing Invitation

Michael Young [α]
Rocky Mountain Research Station

Dan Isaak, Kevin McKelvey, Tommy Franklin, Dave Nagel, Michael Schwartz

We describe recent developments in the eDNA-based inventory of Bull Trout *Salvelinus confluentus* in natal habitats across their historical U.S. range. The project arose from the need to validate predictions from the Climate Shield model about the occupancy of thousands of cold-water habitats by Bull Trout. We coupled an efficient, reliable eDNA sampling method (https://www.treesearch.fs.fed.us/pubs/52466) with a probabilistic/systematic sampling design that provides reach-specific and range-wide descriptions about the presence of Bull Trout and sympatric species. The method has better detection efficiency, costs less, and takes less time than electrofishing; one person can sample a 6th-code watershed in one day. Initial studies precisely delineated the distribution of Bull Trout within select watersheds (https://www.treesearch.fs.fed.us/pubs/50137), as well as discovering previously unknown populations. We are now targeting the entire U.S. range of Bull Trout, expect completion by the end of 2018, and are sharing the results in an open-access ArcGIS Online environment. Early results have largely confirmed the accuracy of the Climate Shield model predictions including a few surprises, demonstrated seasonal occupancy by Bull Trout in thermal refugia, and answered long-standing questions about the presence of Bull Trout in potential natal areas. We invite those interested in participating to learn more at our website: https://www.fs.fed.us/rm/boise/AWAE/projects/BullTrout_eDNA.html.

The Shape of a River

Ocean Media Institute [α]

Carving its way from Badland to Paradise, the Yellowstone River is a shape-shifter. Both provider and partner, this river courses through the landscape as the very lifeblood of Montana, ever-shaping the land and lives of those along its path. We at the Ocean Media Institute welcome you to join us for this screening of our short film, The Shape of a River, produced for Montana Aquatic Resources Services (MARS). It has been selected as part of the 2017 Wild Rivers Film Tour.

Reproductive Strategies of White Sands Pupfish Inhabiting Stable and Variable Habitats

Adam Baca [α *]
New Mexico State University

Damon Peterson, Colleen Caldwell

Reproductive signals such as bright coloration, body size, and agonistic behavior influence mate selection by females; however, these signals may not be an accurate means of judging the relative fitness of an individual. When such signals fail, animals may adopt a bet-hedging strategy where reproductive investment isn't based on the reliability of a given cue to compensate for variation in reproductive success across generations. The White Sands Pupfish *Cyprinodon tularosa* was used as a model organism to test the hypothesis that mate choice strategies are influenced by environmental stability. Wild fish were collected from two genetically distinct populations characterized by either highly variable flows marked by stream drying and extreme temperatures or stable flows with consistent diel water temperature patterns. A laboratory experiment assessed female reproductive output and distribution eggs from fish of variable vs. stable environments. An experimental manipulation of male and female origin was conducted to characterize the role of female choice. Significant differences were observed in total reproductive effort between variable and stable populations. Additionally the distribution of eggs among nest-holding males suggested either local adaptation or phenotypic plasticity to variable environmental conditions can impact patterns of reproductive effort.

French and Moose Creek Restoration Project Case Study

Matt Barnes [α]
Morrison Maierle, Inc.

This presentation will present the implementation of restoration on French and Moose Creek in the Mount Haggin WMA. This area of French Creek was mined extensively starting in 1864 resulting in large remnant tailings piles in the floodplain resulting in a confined French Creek with minimal sinuosity and lack of complex aquatic habitat. Sinuosity of the impaired reaches was near 1.0 and the average flood prone width was less than 22', much less than functioning reference conditions.

Reaches were identified for reference conditions and levels of restoration based on the degree of impacts. A combination of LiDAR, topographic survey, hydraulic analysis, and geomorphic bioengineering were employed to design and permit this project. Over 100 cross sections of the stream channel were analyzed to determine low flow channel dimensions. Average bankfull flows were between 12 and 14 cfs and restoration reaches mimic reference conditions for planform, pool/riffle complexes, and woody features.

Due to the large and dispersed nature of the project located in a remote area, quantities of work were broken down into detailed bid items. This allowed flexibility to vary earthwork, woody debris, bioengineering, and revegetation quantities of the project during construction. Construction was completed in fall 2016 ahead of schedule and under budget. This habitat restoration project is one step in a watershed scale plan by FWP to exclude non-native fish and restore native Cutthroat Trout *Oncorhynchus clarkii*.

The Merced River S.A.F.E Plan - Riverine and Riparian Restoration

Jarvis Caldwell [α]
HDR

As part of the Merced Irrigation District's S.A.F.E Plan (Salmon, Agriculture, Flows and Environment) MeID would restore approximately 5.5 miles of riparian and riverine habitat on the Merced River that was drastically altered by historic, mechanical dredge mining. The S.A.F.E. Plan would provide targeted flows at various times of the year intended to maximize the benefit to salmon and other wildlife. Based on the restoration design, we can greatly increase backwater, side channel and bar habitats for rearing salmonids while reducing the amount of slow velocity pool habitat which in turn may reduce predation. To support the design, we conducted a 5.5 mile topographic and bathymetric survey and developed a 2-dimensional instream flow model using HEC-RAS 2D and performed habitat modeling using multiple post-processing applications.

Trophic Plasticity of a Renowned Piscivore: Dietary Patterns of Northern Pike in its Native and Invasive Ranges of Alaska

Nate Cathcart [α]
University of Alaska Fairbanks

Peter Westley

While native to large parts of Alaska, introductions of Northern Pike *Esox lucius* to the Southcentral region have resulted in variable effects on native fish communities with extreme cases being extirpation or severe declines of native stickleback and Pacific salmon populations. The ability of Northern Pike to broadly impact aquatic communities relates to its dietary capacity that can include various invertebrate and vertebrate prey sources. However, the trophic ecology of Northern Pike in its native or invaded range of Alaska is not well known. We tested Northern Pike diets from native (3 lakes) and nonnative (25 waterbodies) ranges for differences in diet composition based on Northern Pike size, location, Northern Pike origins, taxa consumed, and presence of cannibalism. We analyzed diets by measuring prey-specific abundance, frequency of occurrence, and then used Canonical Correspondence Analysis to visualize trophic orientation (i.e., generalist, specialist) among diet types (i.e., invertivorous, piscivorous, cannibalistic) across different size classes of predators (small, medium, and large). Common gradients among populations of all size classes involved 1) diet compositions that ranged from piscivory to macroinvertebrate-dominated omnivory and 2) trophic orientation toward specialization or generalization of prey taxa. The trophic plasticity of Northern Pike populations potentially enable them to act as key predators, especially in novel environments.

PIT Tag Retention in a Native Catfish

Timothy D'Amico [α *]
Colorado State University

Dana Winkelman, Tyler Swarr, Chris Myrick

Members of the freshwater catfish family Ictaluridae are capable of trans-intestinal expulsion of foreign bodies through three steps: adhesion, migration and passage. Studies have shown that internally implanted tags used for marking catfish can be shed through this expulsion process. We are currently implanting PIT tags to examine movement and survival in wild Stonecat populations *Noturus flavus*. We were concerned that trans-intestinal expulsion and subsequent tag loss would bias movement and survival estimates in the field. Therefore, we evaluated retention rates in a laboratory setting to assess potential tag loss. We surgically implanted PIT tags in 52 Stonecats in May 2015 and have been continuously monitoring tag loss. Tag retention was approximately 85% at ten months and has remained constant since. We also used ultrasound images to inform our analysis and help understand expulsion mechanisms and to allow visualization of tag movement in the body cavity.

Columbia River Northern Pike - Investigating the Movement and Life History of an Invasive Freshwater Predator in British Columbia, Canada

Dan Doutaz [α *]
Thompson Rivers University

Brian Heise

Northern Pike *Esox lucious* is a highly piscivorous invasive fish species in the Columbia River watershed, posing a major threat to native fish communities through predation, competition and the introduction of a variety of diseases. Pike have recently established a significant population downstream of the Hugh L. Keenleyside Dam near Castlegar, British Columbia, prompting the provincial government and industrial partners to implement an ongoing suppression program in 2014 that has seen the removal of 331 confirmed Northern Pike to date. Our research aims to assist the province's management effort by investigating the behaviour, movements, and geographic life history of Northern Pike in B.C.'s Kootenay region. We performed microchemical analysis of otoliths from individual Northern Pike captured in the B.C. portion of the Columbia, providing the first scientific evidence that pike originating in the Pend d'Oreille River have moved (or have been moved) into the Columbia River. Acoustic tagging of Northern Pike has also led us to the location of crucial spawning habitat within the Castlegar area, in addition to providing movement data throughout the Spring, Fall, and Winter seasons of 2016/2017.

Using Otoliths to Describe Brown Trout Growth Patterns in the Upper Clark Fork River

Martin Etchemendy [α *]
University of Montana

Nathan Cook, Lisa Eby, Tracy Elam, Craig Stafford

We used otoliths to age fish and better describe growth patterns in Brown Trout *Salmo trutta* along the Upper Clark Fork River (UCFR). Montana Fish, Wildlife and Parks (MFWP) have previously developed size at age estimates for Brown Trout on UCFR using fin rays, but comparisons between methods and among years is useful to better understand the system. We chose brown trout because they are common and help sustain an important fishery. Brown Trout were collected from seven different sites along the UCFR from Rock Creek to Warm Springs Creek. For this question, total length was measured and otoliths were extracted from more than 70 individual fish (111 mm -476mm) along the river. We sanded, photographed, and measured each otolith. Von Bertalanffy growth equations were fit to the size at age data. Differences between otolith and fin ray estimates of size at age are being investigated by comparing differences in aging techniques and controlling for key environmental conditions, such as temperature and flow for the years of growth. Finally, to describe growth patterns across the fish collection sites, we will compare variation in growth trajectories among individuals and river sections (upper, mid, and lower) to explore the scale of variation and identify areas of high growth.

Jeep in a Creek: Evaluating Riparian OHV Roads, Effects to Aquatic Fauna, and Restoration Efficacy in a Central Rocky Mountain Headwater Stream

Matthew Fairchild [α]
U.S. Forest Service

Christopher Carroll, Benjamin Swigle

Off-highway vehicle (OHV) use is a primary threat to aquatic ecosystems in the western United States. Few studies have empirically quantified the impacts of OHV roads and the efficacy of OHV-related restoration on aquatic habitats and biota. Using a controlled design, we quantified OHV road impacts in a Rocky Mountain stream, and evaluated the effects of restoration treatments by examining aquatic biota and physical habitat, before and after stream restoration treatments. We compared stream reaches with OHV road encroachment to similar, nearby reaches without roads (controls). Aquatic communities (invertebrates and fish), physical stream attributes, and riparian widths were measured and compared among reach type (i.e., control and OHV-affected/restored). Prior to restoration, abundance, biomass, and diversity of fish and invertebrate communities were reduced or altered in OHV-affected reaches when compared to control reaches, and physical habitat structure was simplified, which correlated well with biological shifts (e.g., loss of trout with absence of pools). Restoration included obliteration of riparian OHV roads and manipulation of stream features, including additions of large wood. Following restoration, many metrics of aquatic biota and physical habitat had recovered to levels similar to control reaches. Results provide insights that may aid in effective prevention approaches and restoration of similar sites.

Environmental DNA (eDNA) Sampling for Aquatic Species

Thomas Franklin [α]
USFS

Kevin McKelvey, Mike Young, Dan Isaak, Mike Schwartz

Environmental DNA (eDNA) is DNA collected from environmental samples such as water, soil, or air. Organisms that exist in these environments sluff DNA which can be collected and analyzed. In this poster, we show how filtering water from streams is used to detect the presence of Bull Trout *Salvelinus confluentus* in the Rocky Mountains. Single molecules of eDNA can be reliably detected, making the method extremely sensitive. Further, collecting filtrate only requires a single individual and about 10 minutes so sample collection is quick and inexpensive. The ease of sampling coupled with extreme sensitivity provides a revolutionary technology enabling detection and range mapping for many species. eDNA markers already exist for many aquatic organisms, or can be developed inexpensively for those currently lacking them to enable species-specific monitoring.

Reconstructing Temperature-Mediated Growth in Juvenile Chinook Using Otolith $\delta^{18}O$

Katherine Gillies-Rector [α *]
University of Idaho

Brian Kennedy

Ambient water temperature greatly impacts development, growth, and migration of juvenile salmonids. A major limitation in most early life history studies is the inability to reconstruct a temperature history for individual fish, given that most temperature-sensing telemetry tags are too large to implant in juvenile fish. Several recent projects have addressed this limitation by developing relationships between otolith oxygen isotope signatures and ambient water temperature. Oxygen isotopes are incorporated into otoliths in equilibrium with ambient water and previous studies have developed taxa-specific fractionation relationships to estimate ambient water temperature histories for individual fish. We believe this method holds promise for application in migratory fish research, specifically to examine the temperature history experienced by individuals where within species variation in migration strategy may be related to temperature-mediated growth. We will use otoliths from known-origin juvenile Chinook sampled as sub yearling and yearling individuals to validate an oxygen isotope fractionation relationship previously developed for *Salvelinus* spp. Additionally, we hope to link individual growth to temperature history by performing growth increment analysis and oxygen isotope thermometry for each sampled fish. Ultimately, we will apply a spatially-explicit bioenergetics analysis to individual temperature and growth data with the goal of determining growth potential variation between several rearing locations.

Alternatives to Mechanically Deflating Swim Bladders: Potential Physiological Method in Recreational and Commercial Fisheries

Joshua Goff [α *]
Montana State University

The swim bladder is an essential part of a fish that allows it to move throughout the water column. Inflation and deflation of the bladder is self-regulated through physiological means by creating concentration gradients between it and the capillaries that surround it. This balance can be disrupted if the fish is quickly moved from deep water to shallow water without giving the fish a chance to regulate itself. This is due to rapid changes in the pressure of the water. When this happens, the swim bladder can expand greatly to the extent the swim bladder protrudes from the mouth, causing bulging eyes and damage to internal organs. Swim bladder over inflation is a serious effect of angling fish at depths in both marine and freshwater environments. At the moment, the only way to cause swim bladder deflation is to return the fish to capture depth or, more commonly, to relieve the pressure by 'fizzing'. This can be unsafe for the fish if used by inexperienced hands. This study will assess the feasibility of using a fish's own physiological mechanisms to induce a more rapid, natural deflation in angled fish with over inflated bladders. This study consists of two parts. The first is an extensive literature review on physiological mechanisms of swim bladder deflation. The second is a series of possible experiments that could test possible deflation mechanisms.

Instream Structures Increase Pool Habitat for Cutthroat Trout in Simplified Headwater Streams

Tyson Hallbert [α *]
Idaho State University

Ernest Keeley

Habitat alteration in the riparian zones of streams often results in a decrease and a loss of fish habitat complexity, quality, and abundance. In this study, we tested the effectiveness of an instream restoration effort, designed to increase the availability of suitable habitat for native Cutthroat Trout *Oncorhynchus clarkii* populations in headwater streams. We conducted a field experiment in four study streams treated with instream structures designed to increase the availability of pool habitat for Cutthroat Trout, and compared the effect to control sections of the streams that did not receive any habitat improvement structures. To increase pool area nine wooden instream structures were installed in three 100-meter sections in each of the four streams. The structures were created by driving wooden posts vertically into the substrate across the stream using a gas powered post driver, and then placing woody debris collected locally upstream of the posts and perpendicular to the stream flow. Fish populations in each stream were sampled before and after structure installation. We compare differences in fish growth rates, differences in biomass, percent change in fish density, percent change in reach area, and percent change in mean depth. This study will provide insight into how Cutthroat Trout populations respond to small scale instream habitat improvements in simplified streams in the presence of other stressors such as continued grazing activity.

Upper Snake River Climate Change Vulnerability Assessment

Scott Hauser [α]
Upper Snake River Tribes Foundation

Sascha Petersen, Jake Bell

The climate around the Upper Snake River Watershed (USRW) of Idaho, Nevada, Oregon, and Wyoming is changing. To better understand these changes, the Upper Snake River Tribes (USRT) Foundation and the Burns Paiute Tribe, Fort McDermitt Paiute-Shoshone Tribe, Shoshone-Bannock Tribes, and Shoshone-Paiute Tribes collaborated with Adaptation International, University of Washington (UW), and Oregon State University (OSU) to complete a climate change vulnerability assessment. The collaborative assessment expressly considered the species, habitats, and resources that are important and valuable to USRT member tribes. Climate change impacts to these resources has the potential to affect tribal members' culture, spirituality, and lifeways. OSU developed temperature and precipitation projections for the USRW using two representative concentration pathway (RCP) trajectories: RCP 4.5 and 8.5. Projections indicate that under RCP 8.5, temperatures will increase throughout the 21st century in the USRW by as much 10.9° F. Precipitation projections are less certain, but it is likely that increases will be seen in the Snake River Plain, with decreases in the mountainous regions of the USRW. A set of shared tribal concerns were identified and analyzed by UW to develop a climate change vulnerability index (CCVI). The CCVI results suggest that certain shared tribal concerns, such as bull trout Salvelinus confluentus, Chinook salmon *Oncorhynchus tshawytscha*, Redband Trout *O. mykiss gaidneri*, and steelhead, *O. mykiss* are extremely vulnerable to climate change.

Kootenai River Habitat Restoration Program

Susan Ireland [α]
Kootenai Tribe of Idaho

Matt Daniels, Tom Parker, Alison Squier

The Kootenai River Habitat Restoration Program (KRHRP) is a multi-year, ecosystem-based habitat restoration program to restore habitat conditions that will support all life stages of endangered Kootenai River White Sturgeon *Acipenser transmontanus*, Burbot *Lota lota* and other native fish. Under this program, the Kootenai Tribe of Idaho is building multiple habitat restoration projects in a 55-mile-long reach of the Idaho portion of the Kootenai River. In 2009, the Tribe completed the Kootenai River Habitat Restoration Program Master Plan. The Master Plan identified reach-specific habitat conditions that limited the success of Kootenai sturgeon, Burbot and other native fish, and provided restoration strategies and treatments to address those limiting factors. From 2011 through 2016 the Kootenai Tribe has constructed nine individual projects under the KRHRP. Additional projects are planned for construction in 2017 and beyond. Project actions include in-river treatments such as construction of a ladder• or deep pools, construction of pool-forming structures, creation and enhancement of floodplain surfaces, bank restoration, riparian planting and riparian fencing. Projects are identified, prioritized and designed via an iterative process in collaboration with multiple agency partners and a multi-disciplinary team of independent experts.

Big Biology Meets Microclimatology: Defining Thermal Niches of Trout and other Species for Conservation Planning using Large Interagency Databases

Dan Isaak [α]
USFS

Seth Wenger, Mike Young, Dona Horan

Temperature strongly affects the ecology of ectotherms like trout and other stream species and is an environmental characteristic subject to change from global warming and habitat alteration. Information about the realized thermal niches of species and where temperatures are most constraining is needed for conservation planning this century. We developed a large species occurrence database (>23,000 electrofishing surveys) from USFS, IDFG, MTGFP, WYGF, and ID-DEQ and linked the information to NorWeST stream microclimate scenarios for a 149,000-km network in Idaho and Montana to describe thermal niches of 14 fish and amphibian species. Thermal response curves showed that species occurrence peaked across a wide range of temperatures (7–19°C) and that all species had distinct warm- or cold-edge distribution boundaries. Bull Trout *Salvenlinus confluentus*, Cutthroat Trout *Oncorhynchus clarkii*, Brook Trout *S. fontinalis*, and tailed frogs *Ascaphus montanus* had especially cold thermal niches and showed warm-edge boundaries; whereas rainbow and brown trout had warmer niches with cold-edge boundaries that indicated some streams were unsuitably cold. Remaining species (Longnose Dace *Rhinichthys cataractae*, Speckled Dace *R. osculus*, Redside Shiner *Richardsonius balteatus*, Longnose Sucker *Catostomus catostomus*, Mountain Whitefish *Prosopium williamsoni*, Chinook Salmon *O. tshawytscha*, Slimy Sculpin *Cottus cognatus*, and Columbia spotted frog *Rana luteiventris*) also had warm niches showing cold temperature constraints. Thermally-mediated boundaries are where populations may be most sensitive to thermal changes and habitat protection or restoration efforts could be targeted at these areas to protect local populations.

The Crowd-sourced NorWeST Temperature Database and Massive Microclimate Scenarios for Streams and Rivers of the American West

Dan Isaak [α]
USFS

Seth Wenger, Erin Peterson, Jay Ver Hoef, Dave Nagel, Steve Hostetler

Climate change is warming streams across the West and threatens investments made to conserve valuable cold-water fishes. Efficient threat response requires prioritization of limited conservation resources and investments guided by accurate information about climate at scales relevant to species distributions within landscapes. We aggregated and organized most of the stream temperature data collected by >100 natural resource agencies throughout the West during 1993–2015 to create the NorWeST database that hosts >200,000,000 temperature recordings from >20,000 unique stream sites. A subset of those data were extracted from the database and used with a geostatistical spatial-stream-network (SSN) model (r^2 ~ 0.90; RMSPE ~ 1.1°C) to predict mean August temperatures and map predictions at 1-km resolution for 36 historical and future scenarios in all streams. This poster shows a historical scenario for 1993–2011 of perennial streams mapped to 400,000 km the NHDPlus 1:100,000-scale stream layer. Temperature data summaries and scenarios are available in user-friendly formats through the NorWeST website (http://www.fs.fed.us/rm/boise/AWAE/projects/NorWeST.shtml) to facilitate inter-agency coordination of monitoring, climate vulnerability assessments, and research on stream thermal ecology. NorWeST information has been rapidly adopted by the management community because of its accuracy, convenient use, and development from data collected by the people working in local landscapes.

Life History Diversity in Post-Spawn Female Steelhead Trout Assessed Using Plasma Estradiol-17B: Relationship with Growth and Energy Reserves

Laura Jenkins [α *]
University of Idaho

Andrew Pierce, Neil Graham, Scott Everett, Douglas Hatch, James Nagler

Anadromous steelhead trout *Oncorhynchus mykiss* are known for their life history diversity. This study used plasma estradiol-17B (E2) to determine post-spawning life history trajectory, and assessed changes in growth and energy reserves over time in post-spawn females (kelts) reconditioned in captivity. Returning hatchery-origin females were spawned, placed in tanks, fed, and sampled every 10 weeks at Dworshak National Fish Hatchery (Clearwater R., ID) in 2015 and 2016. Plasma E2 was bimodally distributed with no overlap after 30 weeks, with the high mode indicating consecutive spawning (30% in 2015, 40% in 2016) and the low mode indicating skip spawning. Fish were then assigned to consecutive and skip spawning trajectories dating back to initial spawning for tracking of the following factors. Plasma E2 was elevated 20 weeks after spawning in consecutive versus skip spawners. Mass specific growth rate was elevated in consecutive versus skip spawners over the first 10 weeks after spawning in both years. Muscle lipid levels and condition (K) were elevated 10 weeks after spawning in 2016 and at 20 weeks in 2015. This study shows that two distinct post-spawning life history trajectories exist in Clearwater River kelts, with increased growth and energy reserves evident soon after maiden spawning in consecutive spawners. Appropriate management of both types in wild kelt reconditioning programs in the Snake R. Basin will maximize the contribution of reconditioned fish to recovery.

Improving Reservoir Fish Habitat: A Story on Building Relationships and Saving Money

Amberle Jones [α]
Arizona Game and Fish Department

Bass anglers in Arizona have been actively concerned at the lack of work conducted by Arizona Game and Fish to improve warm-water fisheries especially at Roosevelt Lake. With funds decreasing, hiring freezes, larger workloads, and longer compliance processes, we found we had fewer people but triple the amount of work. Management realized that large-scale habitat improvement projects were not being pursued as often and we needed to make a change. The first step was to begin repairing relationships with our warm water anglers. We held multiple meetings and began an intensive volunteer program to engage anglers in building fish habitat. We worked with angler clubs and utilized Facebook to its fullest and in a little over 2 years, we have had over 100 volunteers and over 600 volunteer hours. We have been able to build 173 Reef Balls and 100 Georgia Cubes. Despite the environmental compliance process taking almost two years to complete, there has been a noticeable change in angler's attitude towards the Department's work with warm-water fisheries. We have improved our relationships with the angler community and volunteers have saved the Department over $20,000 in labor and donated materials to build fish habitat.

Population Characteristics and the Influence of Discharge on Bluehead Suckers and Flannelmouth Suckers

Zachary Klein [α *]
University of Idaho

Matthew Breen, Michael Quist

Of the 35 fishes native to the Colorado River basin (CRB), seven are considered either endangered, threatened, or species of special concern. Thus, the conservation of fishes native to the CRB is a primary interest for management agencies. One of the major factors limiting the conservation of fishes endemic to the CRB is the lack of basic information on their population characteristics. As such, we sought to describe the population dynamics and demographics of three populations of Bluehead Suckers *Catostomus discobolus* and Flannelmouth Suckers *Catostomus latipinnis* in Utah. Additionally, we evaluated the potential influence of altered flow regimes on the recruitment and growth of both species. Mortality of Bluehead Suckers and Flannelmouth Suckers from the Green, Strawberry, and White rivers was comparable to other populations. Growth of Bluehead Suckers and Flannelmouth Suckers was higher in the Green, Strawberry, and White rivers when compared to other populations in the CRB. Similarly, recruitment indices suggested that Bluehead Suckers and Flannelmouth Suckers in the study rivers had more stable recruitment than other populations in the CRB. Models relating growth and recruitment to hydrological indices provided little explanatory power. Notwithstanding, our results indicate that Bluehead Suckers and Flannelmouth Suckers in the Green, Strawberry, and White rivers represent fairly stable populations and provide baseline information that will be valuable for the management and conservation of the species.

Using USGS StreamStats to Evaluate Relationships between Fish Populations and Flow Regime

Larissa Lee [α *]
University of Arizona

Scott Bonar

Conserving the natural flow regime of streams is critical to safeguarding the diversity of native fish species throughout river systems. To understand the relationship between fish species and flow regime, scientists have used stream flow statistics based on USGS gage stations to characterize streams and compared these statistics to the relative abundance of species in these streams. In Arizona streams, fish populations and flow can vary significantly throughout a single river, and these statistics may not represent the diversity of flows and fish populations found throughout each stream. The USGS program StreamStats uses regional regression models to create flow-related statistics for a precise location in a stream based on drainage area. This research uses these statistics and relative abundance of fish species at precise locations to examine relationships between StreamStats statistics and fish populations within the Verde River, AZ. StreamStats statistics analyzed included peak 2-year flow, peak 10-year flow, the magnitude of maximum 7-day duration flow, and bankfull velocities. This information can provide critical information to managers on how flow dynamics interact with different fish species in arid-land rivers. Future research will expand these analyses to include four more mid-size Arizona streams.

Deer Creek Floodplain Enhancement Project: A modern Approach to Process-Based Ecosystem Restoration

Kate Meyer [α]
U.S. Forest Service

Deer Creek exemplifies the classic story of degradation for Western Cascades mid-order streams. Historic riparian logging and stream clean-out reduced channel roughness and increased transport capacity. Constructed berms further channelized the stream creating a single-thread, incised, transport channel through a once depositional alluvial valley. Major limiting factors for ESA-Threatened spring Chinook Salmon *Oncorhynchus tshawytscha* and Bull Trout *Salvelinus confluentus* and other native fishes include: lack of spawning gravel, off-channel habitat, high flow refuge, deep pools, large wood, complex cover, and high summer stream temperatures. While the story of degradation is a classic one, the restoration approach and design are considered modern and fearless. We employed a process-based approach to improve ecological function and biological productivity by resetting• channel and floodplain elevations for full floodplain connectivity through redistribution of berm material into the incised mainstem channel. We then placed large wood accumulations throughout the floodplain to create hydraulic complexity and to dissipate energy wherever channels may migrate. This approach does not dictate channel form or construct channels. Rather, it allows natural processes to create dynamic channels, islands, bars, and complex habitat. Although the implementation techniques (i.e. re-grading of channel and floodplain surfaces) are relatively bold, the benefits are immediate, dramatic, and sustainable.

Suppression of Nonnative Salmonids to Benefit Migratory Bull Trout in an Open System: An Update of the Effort on the East Fork Bull River, Montana

Sean Moran [α]
Avista

Josh Storaasli

During relicensing of its two Clark Fork River hydroelectric dams, Avista cooperatively developed the Native Salmonid Restoration Plan (NSRP). The NSRP recommended, in part, addressing impacts that nonnative fishes have on native trout. Due to Brown Trout *Salmo trutta* redd superimposition on Bull Trout *Salvelinus confluentus* redds and Brook Trout *Salvelinus fontinalis* x Bull Trout hybridization, a nonnative fish suppression effort was authorized for the lower East Fork Bull River (EFBR). This effort used electrofishing, selective passage at fish traps, and Brown Trout redd excavation to create a more favorable condition for native species in the lower EFBR. During the intensive suppression period (2007 to 2009), nearly 5,500 nonnative trout were removed from the EFBR. Abundance estimates from 2007 to 2009 showed that nonnatives were reduced by greater than 70%, while juvenile Bull Trout density increased over 200%. Suppression efforts were reduced to trapping and Brown Trout redd excavation in 2010, and monitoring through 2014 showed a marked decrease in juvenile Bull Trout following the high abundance of 2010. Difficulty in maintaining closure of the stream using fish traps allowed a degree of nonnative recolonization, although abundance of nonnatives remained well below 2007 levels through 2014. Results from 2016 depicted an increase in abundance of both juvenile Bull Trout and nonnative species. Based on results observed through 2018, managers will decide whether to revisit non-native suppression efforts in this drainage.

Investigation of the Suitability of Insect Meals as Protein Sources for Rainbow Trout

Cheyenne Owens [α]
U.S. Fish & Wildlife Service Bozeman Fish Technology Center

T. Gibson Gaylord, Zachariah Conley, Hayden Nelson, Wendy Sealey

In recent years, interest has grown among fish culturists for cost effective and sustainable alternative protein sources to fish meal. A digestibility trial was conducted to determine the available nutrient values of insect meals for Rainbow Trout *Oncorhynchus mykiss*. Fish were fed either a reference diet or one of five test diets created by blending the reference diet with each of the test ingredients (Menhaden fishmeal (MFM), two cricket meals (Griopro and Entomo), waxworm meal, and mealworm meal) in a 70:30 ratio (dry-weight basis). Twenty-five, 370-g Rainbow Trout were stocked per 140-L fiberglass tanks (N= 3/diet), maintained at 15°C, and hand-fed twice daily to satiation one week prior to collection of fecal samples. Griopro and Entomo cricket meals contained similar protein (CP) and lipid (CL) levels (68 and 69% CP and 17.1 and 16.6 CL%, respectively). Mealworm meal contained 56.5% CP and 27.7% CL and waxworm meal contained 32.5% CP and 54.2% CL. The percent of the analyzed protein available (ADCs) to rainbow trout for cricket meals were 81.6% for Groprio and 79.5% for Entomo. The protein ADCs for mealworm meal and waxworm meal were 83.5% and 82.8%, respectively. These values are slightly lower but comparable to MFM (87%). The results suggest that insects can be used as dietary protein sources for Rainbow Trout. Further research will be conducted to evaluate the effects of extended feeding of insect meal-containing diets on growth and disease resistance of Rainbow Trout.

Using Standard Benthic Macroinvertebrate Sampling to Derive Food Web Metrics in Salmon-bearing Streams

Sean Sullivan [α]
Rhithron Associates, Inc.

Seth White

Benthic macroinvertebrates are at the base of aquatic food webs and play an integral role in the health and sustainability of salmonid populations. Benthic macroinvertebrates are routinely collected as part of watershed and stream health surveys; however, varying methods are usually employed to determine links and associations to fish abundances (i.e. benthic kick samples vs. diet or drift sampling). States, Tribes, and municipalities are required to monitor biological communities as part of Clean Water Act requirements, and often use benthic sampling as a means to satisfy this requirement; thus creating a large dataset of benthic invertebrate community composition. The large benthic sampling effort is rarely accompanied by additional sampling that focuses on fish prey and fish abundance. This study aims to establish linkages between routine benthic sampling and fish community abundances in the upper Columbia River basin. The methods employed to synthesize new metrics derived from benthic sampling and the relationships to fish abundances are discussed.

An Alternative Approach to Designing Fish Passage Structures: Design, Construction, and Operation of a Full-scale Indoor Research Fishway

Tyler Swarr [α *]
Colorado State University

Ryan Fitzpatrick, Chris Myrick

Fish passage structures are expensive to construct and the designs of proposed structures are commonly based on knowledge gained from existing structures, assuming that structures which allow passage of the species of interest exist. Developing an apparatus that allows rigorous testing of fish passage structure designs prior to the construction of structures in the field could reduce the reliance on a “build it, monitor it, does it work?” approach, thus saving limited resources. Such an apparatus would also allow testing of the response of target fish species to design parameters (e.g., slope, roughness elements, water depth, etc.). To meet this need, we designed and built a full-scale indoor research flume at the Colorado State University Foothills Fisheries Laboratory and installed an experimental rock-ramp fishway within the flume. The slope of the flume can be adjusted (0 – 10%) and integrates a set of four full duplex/half duplex dual mode PIT tag antennas to track the individual progress of fish as they ascend the flume. Flows up to 0.10 m^3/s (3 cfs) are recirculated through the flume with a 15-hp pump and temperature is controlled by a heater and chiller. Lessons learned during the design, construction, and operation of the flume are presented here.

Using Juvenile Fish Composition to Examine Adult Walleye Use of the Missouri River Upstream of Canyon Ferry Reservoir

Tanner Traxler [α *]
University of Montana

Lisa Eby, Adam Strainer

Over the last decade, Walleye Sander vitreus have been increasingly using the Missouri River upstream of Canyon Ferry Reservoir to Toston Dam. To understand if this expansion could be associated with spawning and/or foraging, we examined the composition and distribution of juvenile fish in the area. Specifically, the presence of juvenile Walleye would indicate that adult Walleye are using the river to spawn and availability of abundant prey fish could indicate adults are using the river to feed. We divided the 23-mile-long stretch of river into three sampling sections. In each section, juvenile fish were sampled using beach seines and mini fyke nets across pool, riffle, run, and backwater habitats. Each section was sampled once in late July/early August and again in mid-August in 2016. We captured 26,510 fish; the most common species captured were Yellow Perch *Perca flavescens*, White Sucker *Catostomus catostomus* and Longnose Dace *Rhinichthys cataractae*. Only 16 of these fish were juvenile Walleye, all coming from sampling locations at the interface of the river and the reservoir. No juvenile Walleye were found in the river upstream of this interface. Based on these results, it appears that Walleye did not use the river to spawn in 2016. However, high densities of juvenile fish species in the river, including one of the walleye's favorite prey items, the yellow perch, would suggest that adult Walleye are likely using this stretch of river to feed.

Physiological Responses of Fishes to Stressors Assocated with Oil and Natural Gas Development

Richard Walker [α *]
Wyoming Cooperative Fish and Wildlife Research Unit, University of Wyoming

Geoffrey Smith, Annika Walters

With the human population growth rising, one challenge facing managers is to develop a balance between resource extraction and wildlife conservation efforts. Yet the ecological consequences of these activities are still not fully understood. Water quality data from our study streams in the Wyoming Range indicate salinity and temperatures are greater and more variable in drainages with higher levels of oil and natural gas (ONG) development. Little is known on the stress physiology of non-game fishes that dominate most North American freshwater assemblages. The objective of this study is to measure changes in physiological responses of Mottled Sculpin *Cottus bairdii* and Mountain Sucker *Catostomus platyrhynchus* to stressors associated with ONG development. Specifically, we are measuring hormonal responses across a gradient of ONG stressors (e.g., temperature and salinity) to examine how fishes experiencing increased stress respond physiologically using: 1) baseline glucose, 2) baseline cortisol, 3) stress reactivity, and 4) immunocompetence. Our preliminary results suggest ONG development stressors differentially affect fish physiological responses. Understanding how fishes respond to chronic stressors associated with human activities will help improve conservation practices, and allow us to better understand species' adaptability in changing environments.

A Map and Database of Westslope Cutthroat Trout Hybridization Zones Throughout Idaho and Montana Streams

Mike Young [α]
USFS

Dan Isaak, Kevin McKelvey, Mike Schwartz, Dona Horan

Hybridization zones are common between Cutthroat *Oncorhynchus clarkii* and Rainbow *O. mykiss* trout where environmental conditions allow species overlap. To describe where those zones occur, we developed a database of 13,315 genotyped fish from 558 sites across Idaho and Montana that encompassed locations where these species have naturally co-occurred for thousands of years and where Rainbow Trout are non-native. Logistic regression models accurately predicted (AUC, 0.78-0.86; classification success, 72-82%) whether hybridization would exceed three conservation-relevant thresholds (1%, 10%, 20%) as a function of water temperature, stream size, proximity to rainbow trout propagules, and presence within the native range of rainbow trout. This poster depicts an interpolated probability map of 10% Westslope Cutthroat Trout *O. c. lewisi* introgression throughout the subspecies' 55,234-km habitat network in Idaho and Montana during a scenario that represents present climate conditions and Rainbow Trout distributions. The database, as well as high-resolution digital maps and ArcGIS shapefiles showing hybridization probabilities for the three thresholds under six climate change and Rainbow Trout invasion scenarios are available at the Cutthroat Trout-Rainbow Trout hybridization website (http://www.fs.fed.us/rm/boise/AWAE/projects/CutthroatRainbowTrout.html to assist managers in conservation planning. The manuscript describing this research appears is available from TreeSearch: http://www.treesearch.fs.fed.us/pubs/53197.