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Approved Abstracts

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Presentation Type: Oral

Trammel nets for the assessment of burbot stocks in lentic systems: Do they provide a reasonable tool?

Trammel nets have been found to be a sampling gear that is selective for burbot in lakes and reservoirs. Burbot were sampled in water bodies of the Wind River drainage, Wyoming, during fall 2007 and spring 2008 using a standard sampling protocol. A crew of 2 people in a single boat could retrieve, process fish, and re-set three trammel nets during a work day enabling 12 net-nights of effort during a single week. Twelve net-nights of effort were expended on each of nine water bodies during both fall and spring. Estimates of catch per unit effort (C/f) and proportional distribution (PSD) were computed from these data. In this presentation we describe the precision of the C/f and PSD estimates and assess the sufficiency of the sampling effort. We found that when a $\log^{10}$-transformation was applied to the C/f data, 12 net-nights of effort were sufficient to estimate the mean within 10% at $\alpha = 0.10$ among all of the water bodies during both seasons. However, the numbers of fish sampled with 12 net-nights of effort were not sufficient to obtain very precise estimates of PSD for most of the water bodies. We conclude that 12 net-nights of effort were sufficient to assess relative abundance of burbot in lakes and reservoirs, but more effort would be needed to obtain sufficient samples of fish to assess length structure using PSD as an index.

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Presentation Type: Oral

Student Award Candidate

Larval collection and observed movements of telemetered bigmouth sleeper *Gobiomorus dormitor* in Puerto Rico

In general, there is little published information about tropical freshwater larval fishes. However, there is a

growing interest in conserving and enhancing native freshwater fisheries in tropical regions worldwide. Effective management and culture for stock enhancement requires a thorough understanding of life history. In Puerto Rico, the bigmouth sleeper *Gobiomorus dormitor* is found in rivers and reservoirs, targeted by anglers, and is a candidate for culture and management. The life history requirements of bigmouth sleeper are uncertain, so conditions for culture are unknown. This study examined spawning location and migration using larval sampling and radio telemetry. Larval sampling was conducted during the presumed spawning season in 2007 for 24-hour periods in two river mouths. In summer 2008, larvae were sampled for 12-hour periods in one river at four locations (river mouth, 3 km, 6 km, and 9 km upstream). Radio tagged bigmouth sleepers were monitored in 2008 from January to November. Bigmouth sleeper larvae were caught at the surface and bottom in drift nets and light traps. Bigmouth sleeper larvae appeared only in river mouth samples, and no fish larvae were caught upstream of the river mouth. Observed movement of adult bigmouth sleeper suggested that some fish migrated to the river mouth, and tagged fish were significantly closer to the river mouth from June-September when compared with the rest of the year ($t=4.12$, $df=19$, $p=0.0005$). It is unclear whether these movements were directly related to spawning activity, but it was apparent that larval bigmouth sleeper likely spend some period in high salinity water to complete its life cycle.

Al-Chokhachy, Robert. USDA Forest Service, USFS Rocky Mountain Research Station, 960 N. 1200 E, Logan, UT 84321; Brett Roper, USDA Forest Service, Logan, UT 84321; Eric Archer, USDA Forest Service, Logan, UT 84321

Presentation Type: Oral

Assessing stream habitat trends: Lessons from repeat sampling in 700 Columbia River Basin treams

The listing of bull trout (*Salvelinus confluentus*) and steelhead (*Oncorhynchus mykiss*) in the Columbia River Basin prompted the need to evaluate the effects of land-management activities on the quality and quantity of instream habitat. To meet this need, PIBO Effectiveness Monitoring Project has been monitoring instream habitat at over 700 sites within the Interior Columbia River Basin since 2001. Here, we evaluate changes in stream habitat collected at sentinel sites ($n = 50$), which are sampled annually, and at sites repeat-sampled after 5-year intervals. We evaluate the temporal variability of instream habitat using sentinel sites to quantify potential differences in this variability between reference and managed sites. Using the 5-year repeated sites we evaluate changes in stream habitat at reference and managed sites using a spatially-broad dataset of over 700 repeat-visit sites. Furthermore, we integrate landscape, disturbance, and climate data into our analyses to identify which characteristics result in different levels of temporal variability and change in habitat quality through time. Across all sites we found considerably higher annual variability in habitat attributes in reference sites than in managed sites; the average coefficients of variability (CVs) of all attributes at reference sites was 48% higher than observed in managed sites. We found the greatest differences in CVs between reference and managed sites for residual pool depth and fine sediment levels, and attribute these differences to the effects of management activities and difference disturbance levels. The results from the 5-year repeat-visit sites indicate most habitat attributes at managed sites improved over this time period; percent fine sediment and percent pool habitat however, illustrated negative changes during this period. Our results suggest land-management

activities may be reducing annual variability instream habitat and hypothesize that this may have significant effects on the diversity of biota in these systems.

Al-Chokhachy, Robert. USDA Forest Service, USFS Rocky Mountain Research Station, 960 N. 1200 E., Logan, UT 84321; Brett Roper, USDA Forest Service, Logan, UT 84321

Presentation Type: Poster

Using patch occupancy modeling to monitor changes in the distribution of non-native riparian vegetation species

The spread of non-native vegetation species throughout the west has resulted in altered foodwebs, changed disturbance regimes, and restructured communities. Monitoring the spread of these noxious weeds has become a priority to numerous state and federal agencies to better understand changes in distribution and factors associated with these changes. Here, we illustrate the use of patch-occupancy models (robust-design) to estimate occupancy rates, colonization rates, and trends in occupancy through time for two non-native species, reed canary grass (*Phalaris arundinacea*) and oxeye daisy (*Leucanthemum vulgare*). We used riparian vegetation monitoring data collected at over 1,800 sites (2003-2008) in the Interior Columbia River Basin as part of the Pacfish/Infish Effectiveness monitoring project. We explored differences in distribution and changes in distribution through time (λ) in managed sites, which are exposed to different land-management activities, and in reference sites. Our results indicate reed canary grass has significantly higher occupancy of managed sites (11.5%, SE = 1.4)) than observed in reference sites (2.9%, SE = 1.7). Both species appear to be increasing in distribution (i.e., λ >1); however, we found significantly higher expansion rates in reference sites than in managed sites. We found very low occupancy rates of oxeye daisy in reference sites (<1%) and estimate that 9.94% of managed sites are currently occupied; there does not appear to be increasing trends in the number of sites occupied by oxeye daisy in either reference or managed sites (λ = 1). Our results indicate occupancy models, which are commonly used to monitor fish and wildlife species, provide a robust means to quantify changes in distribution of non-native riparian vegetation species.

Andersen, Eric, Student, Oregon State University, 858 SW Madison Ave, Corvallis, OR 97333

Presentation Type: Poster

Student Award Candidate

A Bayesian belief network for prioritizing restoration of aquatic connectivity in the Santiam River Basin, OR

There are numerous anthropogenic barriers, specifically culverts, to steelhead trout (*Oncorhynchus mykiss*) in the Pacific Northwest, USA. Deciding which barriers to repair first is an enormous undertaking

and the associated cost of repair is tremendous. Prioritizing restoration efforts is necessary to effectively use limited resources while reconnecting stream habitat. To assist in deciding which barrier culverts should be repaired first within the Santiam River Basin, OR, a Bayesian belief network (BBN) was created using Netica software. During summer 2008, 38 road stream crossings were surveyed using the USFS's Fish Xing software to determine passage status for returning adult winter steelhead. Barrier culverts were then assessed for repair. The BBN combines empirical evidence and expert opinion, depicting relationships between factors affecting the decision to repair a barrier. Measures of habitat quality consist of the potential of a stream to support juvenile steelhead, underlying geology and stream temperature. Habitat quality, the local population of steelhead and the existing knowledgebase of culverts within the basin all combine to influence the decision to repair a barrier. The decision tool can be exported for use in additional basins.

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Presentation Type: Oral

Student Award Candidate

Spatiotemporal variability in movement as a function of biotic and abiotic factors, and land-use practices of brown trout in the Valles Caldera National Preserve, New Mexico

Movement behavior among stream resident salmonids was evaluated in Valles Caldera National Preserve, New Mexico from November 2006 through November 2008. 1446 brown trout, *Salmo trutta*, (94-371 mm TL) were marked with PIT tags and recaptured on six week intervals between April and November to evaluate variability in displacement among ungrazed exclosures and grazed sites. Recapture rates were high, with 80% of the total marked population encountered on one occasion. 55% of the trout exhibited total movement <50 m, which in combination with short displacement distances and low turnover suggest that movement is limited in this population. Displacement distance between successive recaptures was low with median displacement of 0 m observed among all age classes. Restricted movement was most common among individuals in middle and upper Rio San Antonio stream reaches, with 70% of recaptures occurring within the same 50 m stream reach where fish had previously been located. Mobility was most common among brown trout marked in lower stream reaches of Rio San Antonio, as 57% of the total recaptures in this area were ≥50 m from the previous location. Movement was significantly greater in cattle grazing exclosures, when compared to grazed reference sites and ungulate exclosures (χ^2=7.448, df=2, p=0.0241). Regression analysis showed that individual total length, season, and stream width increased the probability of movement, while brown trout density, high stream temperature, improved condition, and increased growth rate decreased the probability of movement. Resident fish exhibited significantly higher condition and growth rates than did mobile individuals. These findings suggest high site fidelity among brown trout in Rio San Antonio. Individual trout appear to be responding to variable biotic and abiotic factors through exploratory behavior at decreased population density which may be a function of competition.

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Presentation Type: Oral

Comparison of two methods for implanting passive integrated transponders in Rio Grande silvery minnow

Uniquely-tagged animals provide an opportunity to study changes in population demographics and movement. Passive integrated transponder (PIT) tags are used to monitor growth, movement, and survival of fishes. Laboratory studies of tag retention and fish mortality following insertion of PIT tags in small-bodied, warmwater cyprinids, are rare. Mortality induced by two PIT tag implantation methods was compared, and tag retention after implantation was assessed. The relation between standard length and tag retention, and standard length and fish survival in Rio Grande silvery minnow (*Hybognathus amarus*) was examined. Fish were randomly selected and PIT-tagged with 12.5 mm tags via surgical incision or needle injection and held in laboratory aquaria for 32 d. Mean survival (±SE) on day 32 was 99 (±0.01) for control fish, 87 (±0.06) for fish implanted by incision, and 50% (±0.05) for fish implanted by injection. We also tagged 280 fish by incision and held them in aquaria for 49 days. On day 49, survival and tag retention were both 90%. Longer fish had higher survival, but tag retention was not related to fish length. PIT tags are a reliable method to tag Rio Grande silvery minnow, if fish are greater than 60 mm standard length. Treatment with antibiotics and holding fish in captivity for a minimum of 6 days before release is recommended.

Archdeacon, Thomas, U.S. Fish and Wildlife Service, New Mexico Fish and Wildlife Conservation Office, Albuquerque, NM 87109; Stephen Davenport, U.S. Fish and Wildlife Service, Albuquerque, NM 87109

Presentation Type: Oral

Estimation of detection probabilities of small-bodied fishes in the Pecos River, New Mexico

Abundance, distribution, changes in distribution, and habitat associations for a species are important criteria for determining conservation actions. Population, distribution, and habitat studies can be biased by imperfect detection probability. Occupancy estimation is an extension of closed-population capture-recapture models that estimate proportion of area occupied and probability of detecting a species if it is present at a given site, and allows modeling covariates with detection probability and occupancy. In July 2008, we made a minimum of three visits to nine sites (33 total visits) to determine the feasibility of implementing occupancy monitoring for small-bodied fishes in the Pecos River. Of 31 species encountered, detection probability ranged from 0.34 to 1.0 (mean 0.73, SE 0.23). We were able to accurately estimate detection probability for 19 species (SE < 25% of estimate). We present estimates for selected species, and discuss 2009 sampling.

Atkins, Arnold, Truchas Chapter, Trout Unlimited, 12 Vista Grande Drive, Santa Fe, NM 87508; Juan Martinez, Carson National Forest, Taos, NM 87557; Kirk Patten, New Mexico Department of Game and Fish, Santa Fe, NM 87507

Presentation Type: Oral

The Alamitos Creek Barrier Project: An example of multi-agency and organization collaboration to identify and develop a project, with an innovative funding approach

The Rio Grande Cutthroat Trout Working Group was formed in 2005 to facilitate interaction between the various governmental entities and conservation organizations involved in conservation of New Mexico's state fish, and to coordinate conservation and restoration efforts. Through work done by the agencies, a population of genetically pure Rio Grande Cutthroat Trout at risk of being compromised by failure of an existing irrigation diversion structure which had serendipitously protected this population from invasion by exotic species was identified. With funding for a better barrier lacking, a non-governmental organization (NGO) led an innovative fundraising campaign which eventually led to participation of two other NGO's, and which was accompanied by an unusually broad coalition of agencies from the state, federal, and local levels to complete funding and accomplish this project, scheduled for completion in 2009.

Beauchamp, David, USGS Washington Cooperative Fish and Wildlife Research Unit, USGS Arizona Cooperative Fish and Wildlife Research, 104 Biological Sciences East, University of Arizona, Tucson, AZ 85721; Donna Parrish, USGS Vermont Cooperative Fish and Wildlife Research Unit, Burlington, VT 05405; Roy Whaley, Wyoming Game and Fish Department (Retired), Casper, WY 82604

Presentation Type: Poster

Sampling coldwater fish in large lakes

We describe the standard techniques for sampling fish in large coldwater lakes as documented in Chapter 7 of Standard Methods for Sampling North American Freshwater Fishes (S. Bonar, W. Hubert, and D. Willis, eds). Large coldwater lakes are defined here as standing freshwater bodies with surface area > 200 ha that support coldwater fishes such as salmonids, coregonids, burbot, and associated species that are 200 mm or more FL (220 mm TL) and prey fishes of 50 mm FL or more (55 mm TL). These targeted fishes and lengths were selected to approximate the lengths that sport fishes recruit to fisheries and to the sampling methods used in the monitoring program and to reflect an index of nongame fishes that supply the prey base for piscivores. There are four standard gears identified for sampling coldwater fishes in large standing waters: (1) benthic gill nets, (2) hydroacoustic techniques, (3) midwater trawls, and (4) suspended horizontal gill nets. The use of a particular gear depends on the portion of the standing water that is to be sampled and the targeted fishes. For each of the four standard gears, we list specifications, operation, timing of sampling, and reporting of effort.

Benson, Reed, UNM School of Law, UNM School of Law, MSC 11 6070, 1 University of New Mexico, Albuquerque, NM 87131

Presentation Type: Oral

Clearing the way for restoring streamflows: Developments in other Western States

In most of the western U.S., water withdrawals for consumptive uses have seriously depleted streamflows to the detriment of aquatic and riparian ecosystems. Restoring flows typically requires cutting existing water uses, but this approach is controversial, especially where it involves permanently drying up irrigated lands. Even after many western states authorized new instream flow appropriations, they maintained legal barriers that tended to discourage movement of water from existing uses to instream flows. Developments in recent years, however, have improved the prospects in several western states for water rights transfers to restore flows. This presentation examines some of these developments in the western states, focusing on legal changes that have reduced the barriers to instream flow transfers, and on the rise of institutions and funding sources that promote such transfers.

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Presentation Type: Oral

Thermal issues in the here and now

Issues relating temperature and its effects on aquatic life have become an increasingly important issue for both the private and public sector. In Colorado, spurred by the development of temperature criteria by the state, a number of stakeholders (including municipal waste-water treatment plants, power plants, hard-rock mining interests, and others) who discharge into Colorado waterways have grappled with determining what temperature standard is appropriate for them. We provide several examples of the difficulties encountered in determining the effects of temperature on aquatic biota from both a scientific and regulatory standpoint. In one case, a small stream in the foothills west of Denver was listed as impaired for temperature despite data indicating consistently healthy salmonid populations except during extreme drought conditions. In a second case, for the highly regulated and modified South Platte River running through the metropolitan Denver area, one city discharges into a reach designated as a “cold water” segment, while the city on “the other side of the bridge” discharges into a reach designated as a “warm water” segment. Meanwhile, the segments have the same basic fish assemblage. Additionally, discharges in transition zones between cold and warm water segments are tasked with meeting cold water standards based on seasonal use of these waters by salmonid species. In Idaho, we ponder if the presence and continued persistence of the threatened bull trout is imperiled by possible large-scale

climate changes, while South Dakota is beginning to wrestle with the development of temperature criteria that may be geared towards introduced, but recreationally important, species. Through all this, one question that remains to be answered in most of these cases is: “are the people responsible for meeting temperature standards having a detrimental effect on the aquatic biota as the result of thermal modification of their operations in the first place?”

Billman, Hilary, Idaho State University, P.O. Box 882, Gardiner, MT 59030; Sophie St. Hilaire, Idaho State University, Pocatello, ID 83209; Charles Peterson, Idaho State University, Pocatello, ID 83209; Carter Kruse, Turner Enterprises, Inc., Bozeman, MT 59718

Presentation Type: Oral

Student Award Candidate

Toxicity of rotenone to larval amphibians

Piscicide use in fisheries management is becoming increasingly common. These chemicals provide effective means by which to manage diseased populations and remove non-native fish species. Rotenone, specifically, is being used more frequently in fish removal projects. While the effects on fish are well-studied, the impacts of rotenone on non-target species, specifically amphibians, are not well known. This study sought to determine the toxicity of rotenone to tadpoles of two species native to Montana – *Rana luteiventris* and *Bufo boreas* – in a laboratory setting. Tadpoles at three developmental stage ranges (Early, Middle, Late) were exposed in the lab to either a control or CFT Legumine (5% active rotenone) at one of four doses (0.1 mg/L, 0.5 mg/L, 1 mg/L, 2 mg/L). Total exposure time was 96 hours. In addition to assessing mortality, the sub-lethal effects – weight, Snout-Urostyle Length, time to metamorphosis – of rotenone exposure on survivors were also measured. Though rotenone exposure was found to be lethal to tadpoles of both species at all three developmental stages, mortality was not uniform across dosages.

Blasius, Heidi, Bureau of Land Management, 711 South 14th Avenue, Safford, AZ 85546; Codey Carter, Arizona Game and Fish Department, Phoenix, AZ 85086; Robert Clarkson, Bureau of Reclamation, Glendale, AZ 85306-4001; Glen Knowles, U.S. Fish and Wildlife Service, Phoenix, AZ 85021-4951; Ross Timmons, Arizona Game and Fish Department, Phoenix, AZ 85086; David Ward, Arizona Game and Fish, Phoenix, AZ 85086

Presentation Type: Poster

Bonita Creek native fish restoration: A lesson in partnerships

Native fishes historically found in the Gila River basin have suffered significant declines in abundance and distribution due to nonnative fishes and habitat loss and degradation. Bonita Creek, Graham County, AZ,

is considered a high priority for native fish recovery in the basin due to its assemblage of five native fishes (Gila chub, longfin dace, speckled dace, Sonora sucker, and desert sucker) uncontaminated by nonnative fishes and other nonnative aquatic organisms in upper stream reaches, habitats appropriate for introduction of additional federally-listed fishes, and its potential to be protected against invasions of nonnative fishes by constructing a fish barrier and chemically removing the nonnatives. A 160-foot wide, concrete-reinforced fish barrier was constructed across lower Bonita Creek in 2008. Following barrier construction, native fishes and Sonora mud turtles were salvaged alive and held in flow-through holding tanks. Approximately 46 beaver ponds were temporarily breached to facilitate fish salvage and chemical treatment. Rotenone (CFT Legumine) was applied based on calculations of stream discharge using constant-flow drip stations while roving crews treated backwaters and shorelines with backpack sprayers. Approximately 2.6 miles of stream was chemically treated twice. Post-treatment sampling appeared to verify a complete kill of all fishes. Sentinel native fish assured the stream had detoxified before the salvaged fish and turtles were repatriated back to the stream. Federally-listed loach minnow, spikedace, desert pupfish, and Gila topminnow were also introduced following detoxification. Restoration of native fishes in Bonita Creek is just one of several recent and intended efforts to reverse the decline of Gila River basin fishes. This project was a collaborative effort among Arizona Game and Fish Department, Bureau of Land Management, Bureau of Reclamation, City of Safford, U. S. Fish and Wildlife Service, universities, and others.

Blasius, Heidi, Desert Fishes Council, 711 South 14th Avenue, Safford, AZ 85546; Executive Committee, Desert Fishes Council

Presentation Type: Poster

Desert Fishes Council: Dedicated to the preservation of America's desert fishes

The mission of the Desert Fishes Council (DFC) is to preserve the biological integrity of desert aquatic ecosystems and their associated life forms. The history of DFC began in the late 1960’s, when groundwater pumping for agricultural development in Ash Meadows, Nevada, began to impact habitats of the endemic fishes of Ash Meadows and nearby Death Valley, specifically the Devils Hole pupfish (*Cyprinodon diabolis*). Concerned biologists and management agency officials convened a symposium to address the threats to and preservation of this unique fauna. It was at this symposium, in November 1969, that the Desert Fishes Council was born. Desert Fishes Council has grown and is now an international organization with over 164 active members, and has expanded its mission to include arid aquatic ecosystems throughout western North America from Oregon south through México. The membership includes academics, management agency biologists, aquarists and other interested individuals from many walks of life, all unified by the common thread of commitment to the conservation of desert fishes. The primary role of DFC is to hold symposia to report research/management activities and to effect rapid dissemination of information concerning activities of the Council and relevant conservation issues. The Council also maintains a network of Area Coordinators to track and report on progress and trends of species and their habitats throughout the North American deserts. On the ground, DFC supports a research station in Cuatrociénagas, México, and a small grants program has recently been added to support education and conservation projects in the U.S. and México. Annual gatherings of members from

all over western North America, including many Mexican members, serves to expand and reinforce professional relationships through the exchange of information during formal presentations and informal conversations. The Council just celebrated its 40th annual gathering in Cuatrociénagas, México.

Bonar, Scott, USGS Arizona Cooperative Fish and Wildlife Research Unit, 104 Biological Sciences East, University of Arizona, Tucson, AZ 85721; Wayne Hubert, USGS Wyoming Cooperative Fish and Wildlife Research Unit, Laramie, WY 82071; David Willis, South Dakota State University, Brookings, SD 57007

Presentation Type: Poster

Standard methods for sampling North American freshwater fishes

Standardization in industry, medicine and science has led to great advances. However, despite its benefits, freshwater fish sampling is generally unstandardized, or at most standardized locally. Standardization across large regions would allow for measurement of large-scale effects of climate or geography on fish populations; larger sample s to evaluate management techniques; reliable means to document rare species; easier communication; and simpler data sharing. With increased interaction among fisheries professionals worldwide, reasons for wide-scale standardization are more compelling than ever. The Fish Management Section of the American Fisheries Society in collaboration with the U.S. Fish and Wildlife Service, U.S. Bureau of Reclamation, U.S. Bureau of Land Management, National Park Service, USGS Cooperative Research Units and NBII Programs, National Fish and Wildlife Foundation, AFS Education and Computer User's Sections, and Arizona Game and Fish Department is developing a book of standard sampling methods for North America. Almost 50 United States, Canadian and Mexican fish sampling experts are authors. Standard Methods for Sampling North American Freshwater Fishes describes standard methods to sample fish in specific environments so population indices can be more easily compared across regions and time. Environments include ponds, reservoirs, natural lakes, streams and rivers containing cold and warmwater fishes. This book provides rangewide and regional averages; calculated from over 4000 data sets from 43 states and provinces; of structure, CPUE, growth, and condition for common fishes collected using methods discussed. Biologists can use these data to compare fish from their waterbody to index averages. These methods were reviewed by 54 representatives from 33 North American agencies and by biologists from six European and one African countries. Final drafts were reviewed by an additional 36 sampling experts. Here we give an introduction to the AFS freshwater fish standard sampling program.

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Presentation Type: Oral

An overview of captive breeding methods for five imperiled desert chub and topminnow species

Knowledge of captive breeding methods is important for conservation of highly imperiled species. Here we provide an overview of methods developed to successfully propagate five desert fishes: headwater chub (*Gila nigra*); Gila chub (*Gila intermedia*); Mohave tui chub (*Gila bicolor mohavensis*); Yaqui chub (*Gila purpurea*) and Yaqui topminnow (*Poeciliopsis occidentalis sonorensis*). Propagation was conducted in tanks and aquaria. Temperature and physical habitat manipulations were important for triggering reproduction in many of the species. Ceramic tiles covered with grating on the bottom of tanks served as chub spawning substrate, and protected recently-spawned eggs from parental predation. Chub eggs were then hatched in nearby rearing tanks. Refuges were used to successfully protect young topminnow from predation. The effects of feed types, fish density and optimal rearing temperatures on survival and growth were also investigated for larvae and juveniles of some of the chub species.

Bovee, Ken, USGS, 2150 Centre Ave, Blg C, Fort Collins, CO 80526

Presentation Type: Oral

The role of the biologist in water management decision making

Environmental flow issues are commonly resolved in water management decisions through a process of negotiation and compromise among the various stakeholders. In this setting, the primary role of the biologist is commonly one of influencing those decisions. Good science is critical to fulfill this role, but the technical information and language of the science may be unfamiliar to many of the parties to the negotiation. Technical clarity is essential in order to maximize influential potential and can be enhanced if the information addresses the basic needs of relevance, effectiveness, feasibility, risk, transparency, and accessibility. The need for decisionmakers to process a wide array of information with many dynamic and countervailing state variables has lead to the advent of the “Environmental Flows Decision Support System (EFDSS).” Attributes of a useful EFDSS include: incorporation of all state variables considered relevant to stakeholders and decisionmakers, capability to generate water management scenarios, quantification of changes to state variables relative to a pre-established baseline, tabulation and summarization of results in a variety of formats, and capability to organize, archive, and document results. An EFDSS may be designed to operate in one of two modes, hindcasting or forecasting. Most recent applications for water management have featured the hindcasting mode, where different operating rules are applied to historical hydrological and meteorological data to generate scenarios. Long range planning for global climate change, demographic shifts, and changes in land use or agricultural practices will necessitate the development of forecasting models. The Yakima River DSS is presented as an example of a hindcasting model and the Columbia River Climate Change Model as a prototype for a forecasting EFDSS.

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Presentation Type: Poster

Targeting native desert fish recovery and conservation in the West: The Desert Fish Habitat Partnership

Approximately half of U.S. threatened and endangered fishes occur in the arid western United States. State Wildlife Action Plans identify habitat loss as a primary factor threatening aquatic species in desert ecosystems. Conservation of aquatic resources is a fundamental and pervasive challenge facing people and fish sharing increasingly limited waters of the arid west. The Desert Fish Habitat Partnership (DFHP) has emerged to address this issue. As of March 2009, the DFHP has the full recognition and support of the National Fish Habitat Action Plan and governing Board, and as such is pursuing ambitious aquatic habitat restoration strategies. In light of global climate change and enormous population growth in our western states, the challenges facing desert fishes are daunting. Yet our goals are clear: no species will go extinct and no species will be added to the threatened and endangered species list. Our objectives include protecting intact habitats by addressing imminent threats and prioritizing actions based on likelihood of success. Our approach to prioritizing projects will be presented, along with details of our recently finalized *Framework for Strategic Conservation of Desert Fishes*. With the completion of these extensive planning efforts, the DFHP works across jurisdictions to focus dollars, expertise, and collaborative energy on protecting intact desert fish habitats and restoring degraded ones. This presentation will highlight one of the 3 most recently recognized National Fish Habitat Partnerships and offer WDAFS participants an opportunity to contribute ideas, expertise, and resources to our efforts to protect and conserve desert fishes and their habitats.

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Presentation Type: Oral

South Fork Flathead River drainage westslope cutthroat trout conservation program

The South Fork Flathead River drainage comprises over half of the remaining interconnected habitat for westslope cutthroat trout within the state of Montana. Despite the fact that much of this drainage lies within the Bob Marshall Wilderness Complex and is protected from anthropogenic habitat degradation, introduced rainbow and Yellowstone cutthroat trout pose a persistent threat to the remaining nonhybridized populations of westslope cutthroat trout. To address these threats, a conservation program was initiated to remove sources of hybridization and restore populations of westslope cutthroat trout in 21 high mountain lakes and their associated stream networks. Since the start of implementation in 2007, three lakes and approximately 15km of stream have been treated with rotenone to remove hybrid trout.

Continued success of this program necessitates the use of adaptive management to address a variety of complex logistical issues. Some of the future challenges include conservation of genetic variation in aboriginal westslope cutthroat trout populations, establishing a statistically rigorous baseline to test for piscicide effects on insect, amphibian, and plankton communities, and conducting these projects in a manner most consistent with traditional wilderness values.

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Presentation Type: Oral

Improved methods for assessing thermal discharge responses and behavior in fishes

Numerous regulatory considerations have required electric power generators to re-focus their attention on thermal discharge effects. In response to this re-emerging issue, the Electric Power Research Institute (EPRI) has supported research to evaluate current methods for assessing site-specific thermal impacts on components of the affected fisheries community and attempt to develop conceptual field methods that better evaluate site-specific discharge conditions affecting representative species of concern. Despite the wide range of approaches currently used in thermal discharge evaluations, little is still known about the actual thermal experiences of fishes in these environments. The extensive laboratory research on the biological responses to thermal extremes provide a mechanistic basis for isolating thermal effects on individual aquatic species but cannot account for complexities of natural conditions or independently identify the lack of conformity between lab-derived preferences and local field observations of the potentially affected community. Further, field approaches contain inherent uncertainties, making neither method a single best assessor of effect and response. The application of multiple lines of evidence is considered a robust approach for improving the stressor-effect weight of evidence in thermal evaluations, but there remains a need to move towards generally accepted field methods for evidentiary support in site-specific conditions. The availability of new technologies, combined with standard sample methods should move us closer to developing a set of protocols for more precise thermal impact assessments in the field. We examined the range of field-applied and field-derived support techniques to develop a set of generic conceptual plans that may be applied to conduct thermal impact studies across a range of waterbodies. Information derived from standardized approaches and applied to site-specific field studies could be used to better inform decision making related to setting regulatory limits and designing power generation facilities.

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Presentation Type: Oral

Student Award Candidate

Optimizing survival and growth of first-feeding Colorado River cutthroat trout – diet, temperature, and density implications

Cutthroat trout formerly occupied an expansive area of western North America. However, due to habitat loss, over-fishing, and introduction of non-native trout they have experienced population declines. Propagation programs are now necessary for recovery or restoration of these subspecies. Optimal culture conditions for cutthroat trout are largely unknown, so these fish are often reared using rainbow trout diets and culture techniques leading to poor hatchery performance. This study was designed to identify diets, temperatures, and rearing densities that produce optimal growth, condition, and survival of Colorado River cutthroat trout (CRCT; *Oncorhynchus clarkii pleuriticus*), which may be applicable to other inland cutthroat trout. We separately determined the effects of diet, temperature, and rearing density on CRCT performance. Colorado River cutthroat trout were reared at 10.3ºC and fed one of eight diets in a blinded feeding trial. Fish fed an Artemia-supplemented diet were 24% heavier, and had 7% higher survival than fish fed a non-supplemented diet. Soft-moist diets yielded significantly lower performance, and, high protein, low moisture diets produced larger fish. Skretting nutra-plus (SNP) produced the highest growth. There were significant differences in survival (68-86%) amongst diets. The top-two performing diets (SNP and Rangen regular trout, both supplemented with Artemia) from the diet experiment were used in conjunction with temperatures of 12.6-19.9ºC in a temperature experiment. The optimal diet-temperature combination for growth was SNP-16.4°C. Survival was inversely related to temperature and was higher for fish fed SNP. The optimal diet-temperature combination was used in a rearing density experiment (150-600 fish/tank). Generally, growth was inversely related to density; however, fish in the 150 fish/tank treatment were the same as fish in the 300 fish/tank treatment. Lower growth in the lowest density treatment may be attributed to a lack of learned feeding behavior. There were no statistically significant differences in survival amongst densities.

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Presentation Type: Oral

Hallowat Creek large wood project – channel morphology and bull trout habitat effectiveness monitoring

River Design Group, Inc. (RDG) partnered with Montana Fish, Wildlife and Parks (MFWP) and the U.S. Forest Service (USFS) in 2005 to evaluate stream corridor conditions on Hallowat Creek, a fluvial bull trout (Salvelinus confluentus) spawning and rearing tributary to the North Fork Flathead River in northwestern Montana. Adjacent to Glacier National Park, Hallowat Creek was used as a fire break during the 2001 Moose Creek Fire. Fire crews cut stable large woody debris jams to reduce riparian fire potential. Floods in the years following the fire consolidated the formerly distributed large wood into a few extensive jams that formed partial fish passage barriers and affected channel stability. Bull trout redd counts suggested simplified bull trout habitat and depressed spawning use in the affected reach. RDG prepared a large wood enhancement project to restore complex habitats for spawning and juvenile rearing. Salvaged trees were helicoptered from adjacent uplands and green trees were incorporated from

the riparian zone. An as-built survey was completed to document post-project conditions. Each aggregation was photographed, measured, and located using a hand-held GPS. Channel cross-sections, profiles, and pebble counts were also completed at select aggregations to evaluate channel response. Channel and large wood monitoring was also completed 1-year and 3-years following project implementation. MFWP has completed additional bull trout redd counts to assess spawning response to the structures. Results highlight large wood effects on channel morphology and bull trout spawning in Hallowat Creek. Structure , location, and composition influence stability. Knowledge gathered from the Hallowat Creek monitoring was used on a similar large wood project completed by RDG and MFWP on a neighboring watershed in 2008.

Britton, David, U.S. Fish & Wildlife Service, UT Arlington Box 19498, Arlington, TX 76019

Presentation Type: Oral

Coordinating a response to the Dreissenid invasion of Western North America

Zebra and Quagga mussels (family Dreissenidae) began their invasion of North America approximately two decades ago. Attempts to prevent further invasion have been largely unsuccessful. Stopping downstream progression and translocation via interconnected waterways has been practically impossible. The midwestern and eastern United States, where navigable waterways are common, were rapidly invaded by mussels attached to barges, boats, and other traffic. Most uninfested waters connected to already invaded systems will most assuredly also become invaded. In the West, complex water diversion systems will convey Dreissenid mussels to new habitats, sometimes across watersheds. There currently are no effective technologies that can prevent further invasions by interconnected waters. Nevertheless, isolated water systems can be protected. Adaptive management approaches have highlighted prevention efforts as our best strategy to protect isolated systems not yet invaded. Such systems typically transcend jurisdictional boundaries. Thus, a coordinated effort between federal, state, and other jurisdictions is required. Overland (trailered) boat traffic is likely the primary vector for a western invasion that has already begun. Currently, a Western action plan is under development by the Western Regional Advisory Panel to the Aquatic Nuisance Species Task Force. This plan will call for coordination between states, water districts, federal agencies and other partners to increase public outreach and education, research, boat inspections, regulations, law enforcement, detection and monitoring programs, and communication between agencies. Most of the West has not yet been invaded by zebra or quagga mussels. With a better coordination and understanding, we may be able to prevent future invasions long enough to allow researchers to develop effective mitigation strategies to help control and eradicate these nuisance species. For now, however, reactive strategies are practically useless in preventing further invasion. A coordinated, proactive strategy focused on preventing overland transport is our best hope.

Brouder, Mark, US Fish and Wildlife Service, Ashland WI, USGS Arizona Cooperative Fish and Wildlife Research, 104 Biological Sciences East, University of Arizona, Tucson, AZ 85721; Alison Iles, USGS Arizona Cooperative Fish and Wildlife Research Unit, Tucson, AZ 85721; Scott Bonar, USGS Arizona

Cooperative Fish and Wildlife Research Unit, Tucson, AZ 85721

Presentation Type: Poster

Length frequency, condition, growth, and catch per effort indices of common North American fishes

Until now, summaries of freshwater fisheries data collected in a standard manner across North America have not been available. In this chapter, we provide Ecoregional and North American averages and distributions of several commonly used fishery indices for 15 common freshwater fish species found in North America. These summaries were developed from data collected using the standard sampling techniques described in this book. For each species * water body * sampling technique combination (e.g., largemouth bass * large standing waters * spring boat electrofishing) and when a sufficient number of datasets (N > 5) were available, we calculated the following summary data: (1) mean CPUE (> stock : Gablehouse 1984), standard error (SE), and 5th, 25th, 50th, 75th, and 95th percentiles, (2) mean relative weight (Wr), SE, and 5th, 25th, 50th, 75th, and 95th percentiles for each stock density group (Gablehouse 1984), (3) length frequency as mean percentage and SE of each stock density group, and (4) mean back-calculated length at age, SE, and 5th, 25th, 50th, 75th, and 95th percentiles for each species * waterbody combination. The data presented in the tables represent a starting point for standard sampling comparison with regional and range-wide data. As standard sampling becomes more common in the future, more comprehensive data tables with larger datasets can be developed and thus, information regarding the efficiency of a particular sampling technique under a wide variety of situations will become available.

Brown, Elizabeth, State ANS Coordinator, Colorado Division of Wildlife, Colorado Division of Wildlife, 6060 Broadway, Denver, CO 80216

Presentation Type: Oral

State of Colorado ANS Program - focus on zebra and quagga Mussels

Zebra and quagga mussels are a highly invasive aquatic species that first came to the US in 1988 via ballast water of ships. Since then, they have rapid spread through the eastern states. In January 2007, the first confirmation of quagga mussels appeared west of the 100th Meridian line in Nevada. In January 2008, the first confirmation of zebra mussels was identified at Lake Pueblo State Park by the Division of Wildlife. Through an intense sampling program, mussels were found in Lake Granby, Grand Lake, Shadow Mountain Lake, Terryall Reservoir and Jumbo Reservoir over the course of summer 2008. The presentation will give an overview of zebra and quagga mussel biology. Impacts will be discussed including those to natural resources, recreation, water storage and transport, water quality and agricultural. The State ANS Program will be outlined, including early detection sampling and monitoring activities, public education program, and watercraft inspection and decontamination protocols. A brief synopsis of the ANS Act and Regulations, State ANS Management Plan and State Zebra and Quagga Mussel Rapid Response Plan will be given. Most importantly, Elizabeth will cover how to stop the spread of mussels overland through fisheries activities and on recreational watercraft.

Bryce, Sandra, Dynamac Corporation, c/o EPA Lab, 200SW 35th St., Corvallis, OR 97333; Philip Kaufmann, US Environmental Protection Agency, Corvallis, OR 97333; Gregg Lomnicky, Dynamac Corporation, Corvallis, OR 97333

Presentation Type: Poster

Using macroinvertebrate response to inform sediment criteria development in mountain streams

The phrase *biologically-based* sediment criterion indicates that biological data is used to develop regional sediment criteria that will protect and maintain self-sustaining populations of native sediment-sensitive biota. To develop biologically-based sediment criteria we must quantitatively link a gradient of sediment effects with biotic response. In this study we related an index of biotic integrity (IBI) for aquatic macroinvertebrates to reachwide measures of areal percent streambed surficial fines (≤ 0.06 mm) and sand and fines (≤ 2 mm) for 525 mountain streams in the western U. S. Quantile regression predicted declines in potential macroinvertebrate IBI of 4.6% for each 10% increase in areal percent fines (≤0.06 mm) and 3.5% for each 10% increase in areal percent sand and fines (≤ 2 mm). To collect evidence for minimum-effect sediment thresholds, we recorded the range of fine sediment values at 169 least-disturbed reference sites in our sample and calculated sediment tolerance values for eight sediment-intolerant macroinvertebrate species for both particle classes. We also gathered evidence from a literature review of studies that quantitatively linked macroinvertebrate response to the pertinent classes of streambed accumulated sediment. The body of evidence suggested that sediment thresholds that would sustain sediment-intolerant macroinvertebrates were 3% for silt-d fines and 10% for sand and fines. We found the sediment-intolerant macroinvertebrate species selected for our study to be more sensitive to fine sediment accumulation than four sediment-sensitive salmonid species that had minimum-effect sediment thresholds of 5% for fines and 13% for sand and fines. Documenting the varying sensitivities and responses of different taxa to the effects of fine sediment accumulation in streams helps to inform the criteria-setting process.

Budy, Phaedra, Utah Coop F & W Research Unit, Utah State University, 5210 Old Main Hill, Dept of Watershed Sciences, Logan, UT 84322-5210; Gary Thiede, Utah State University, Logan, UT; Chris Luecke, Utah State University, Logan, UT; Roger Schneidervin, Utah Division of Wildlife Resources, Vernal, UT

Presentation Type: Poster

Standard methods for sampling North American Freshwater Fishes: Chapter 10 --warmwater and coldwater fish in two-story standing waters

Two-story fisheries occur in lakes or reservoirs characterized by two distinct spatial strata, warmwater and coldwater. Due to both physiochemical differences between the two strata and the morphological,

behavioral, and physiological differences between the fish species that occupy each stratum, a two-story system is complex in terms of sampling. The first step in designing a sampling regime is to identify the target species and sampling goals. The second step is to understand key physical and biological characteristics of the system that may influence the distribution of fishes (e.g., lake morphology, thermal stratification, gradients in primary and secondary productivity). The upper stratum should be partitioned into (1) nearshore and slope zones, and (2) a pelagic zone. Sample the upper stratum using the standard methods for warmwater fishes in large standing waters using a minimum combination of gill netting and electrofishing. The lower stratum should be partitioned into the littoral and nearshore, slope, and the pelagic zone. Sample the lower stratum using standard methods for cold water fishes large standing waters using a combination of: (1) gill nets, (2) hydroacoustics, and (3) midwater trawls. To effectively sample both strata and to integrate CPUE across gear types, additional considerations may be warranted.

Carleton, Scott, University of Wyoming, University of Wyoming, Dept. Zoology & Physiology, 1000 E University Ave, Laramie, WY 82071; Mark Smith, Wyoming Game and Fish Department, Cody, WY 82414

Presentation Type: Oral

Student Award Candidate

Differentiating hatchery from wild origin rainbow trout in a Wyoming fishery using stable isotope analyses

To evaluate stocking, fisheries managers often employ marking techniques followed by sampling to determine persistence in a fishery and/or the proportion of stocked to wild fish. Marking is labor intensive, difficult on fish, and retention is variable. Recently, a new technique, stable isotope analysis, has been proven to work in the determination of natal origins in fish populations without manual marking of fish in hatcheries. Stable isotope analysis techniques utilize the incorporation of naturally occurring elements (C, N, S) into tissues of individual fishes during early developmental stages, enabling differentiation of fish origin. Our study objective was to determine if stable isotopes could differentiate hatchery-origin from wild-origin rainbow trout at a high elevation reservoir in northern Wyoming. We hypothed that brown and brook trout (species not stocked) would represent isotope signatures of wild fish and marked hatchery-reared rainbow and cutthroat trout would yield a hatchery isotope signature. We obtained rainbow and cutthroat trout from the Tensleep Fish Hatchery (Tensleep, Wyoming) in addition to wild brook and brown trout, stocked rainbow trout (fin-clipped), and rainbow trout of unknown origin from the reservoir during annual gill net sampling. We analyzed the δ13C, δ15N, and δ34S of muscle and bone collagen as well as δ18O of otolith tissue from hatchery and wild trout. We found that δ15N, δ13C, δ34S, and δ18O were good markers for differentiating natal dietary history for hatchery and wild trout from the reservoir. Our data indicate that rainbow trout in the reservoir are successfully reproducing and wild origin rainbow trout make up a larger than expected proportion of the population. Stable isotope analysis techniques appear to be a successful tool to determine natal origin using naturally occurring elements in fish tissues derived from dietary and environmental conditions during early development.

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Presentation Type: Oral

The New Mexico Wildlife Conservation Act: Cooperative action for native species recovery

The Wildlife Conservation Act [17-2-27 through 17-2-46 NMSA] is the New Mexico law guiding endangered species management by the state. In addition to defining what and how species are listed as endangered, the Wildlife Conservation Act directs the process and actions for recovery. As defined, recovery planning is inclusive and collaborative and implementation is voluntary and cooperative; that is, the state cannot force conservation actions upon other parties. The strengths and shortcomings to this approach are magnified in the aquatic species recovery realm, where the habitat, water, can greatly increase number of stakeholders and issues involved, especially in an arid land. The cooperative spirit of the Wildlife Conservation Act has often led to success, particularly when parties are wary of endangered species management, encouraging local partnerships and voluntary conservation efforts. However, when parties necessary for implementing recovery actions, be they landowners or resource managers, are unwilling to participate and cooperate, the voluntary, collaborative process falls short of what is needed to achieve recovery for New Mexico's endangered species. Partnering efforts under the Wildlife Conservation Act with other federal and state programs dedicated to restoring and preserving habitat, such as Outstanding National Resource Water designation, Candidate Conservation Agreements with Assurances and Landowner Incentive Programs, greatly assists in alleviating the limitations of the act.

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Presentation Type: Poster

Student Award Candidate

Brook trout electrofishing removal and Eagle Lake rainbow trout restoration

Eagle lake rainbow trout (ELRT, *Oncorhynchus mykiss aquilarum*) is a subspecies of rainbow trout endemic to the Eagle Lake Basin (Lassen County), and provides a trophy fishery in Eagle Lake. Historically ELRT migrated from the alkaline lake to cool, well-oxygenated headwater streams (mainly

Pine Creek and tributaries) to spawn, with their young rearing in the streams for two years. ELRT were on the verge of extinction in the 1950s when the last adults were rescued by the Department of Fish and Game and their offspring reared in hatcheries for planting back in the lake. In 1940, brook trout (BK, Salvelinus fontinalis) were introduced into Pine Creek and they are now present in high densities. Over the past 100 years, the distribution and abundance of ELRT has been reduced because of habitat degradation, passage barriers and competition by BK. Thus, there have been two petitions for ESA listing in 1994 and 2003; restoring natural spawning of ELRT requires eliminating or reducing book trout populations. In this study we assess the effectiveness of two years of electrofishing removal of BK, as well as on ELRT recruitment success. We selectively removed approximately 5000 and 2000 BK in 2007 and 2008 from three kilometers of stream. We are currently analyzing fish growth, condition factor, fecundity, maturity, density of different age classes of fish, electrofishing efficiency, and other parameters. We will also examine the compensatory responses of the fish left in the creek and determine whether brook trout removal by electrofishing is likely to be an effective management strategy for ELRT restoration.

Caudill, Christopher, University of Idaho, Department of Fish and Wildlife Resources, College of Natural Resources, University of Idaho, Moscow, ID 83844; Tami Clabough, University of Idaho, Moscow, ID 83844; Eric Johnson, University of Idaho, Moscow, ID 83844; Daniel Joosten, University of Idaho, Moscow, ID 83844; Christopher Peery, U.S. Fish and Wildlife Service, Ahsahkah, ID 83520

Presentation Type: Oral

Use of video to quantify adult lamprey passage at night at Bonneville and the Dalles dams on the Columbia River

The number of adult Pacific lampreys (*Lampetra tridentata*) returning to the Columbia River as estimated by daytime counts at dams has declined in recent years. However, lampreys are most active at night, suggesting daytime counts substantially underestimate total population . We recorded the nighttime movements of lampreys at count windows on all four fishways at Bonneville and the Dalles dams during the 2007 & 2008 migrations to provide more accurate estimates of population and to evaluate daytime counts as an index of abundance. We estimated lamprey escapement at each dam by summing the daytime count and the night video count; Bonneville Dam estimates also included Lamprey Passage Structure (LPS) counts. Including night counts increased the total escapement estimate by 165% over the day + LPS estimate to 45,104. As expected, more lampreys passed the Bonneville Dam Bradford Island count window at night (18,352) compared to the day (8,430). The Bradford Island LPS count was 6,817 for a total Bradford Island escapement estimate of 33,599. Surprisingly, lampreys at the Bonneville Dam Washington Shore count window exhibited high rates of up- and downstream movement and a negative net nighttime count (-439). The Washington Shore daytime count was 9,931, and the LPS count was 2,013 for a total Washington Shore escapement of 11,505. Night counts were net positive at both ladders at the Dalles Dam in 2007 (North=3,137; East =1,010), but were lower than daytime counts (North=3,246; East=2,545). Night counts increased the total escapement estimate by 171.6% over daytime counts (total estimate = 9,938). Review of the 2008 data is on-going and preliminary analyses suggest consistent patterns at each ladder in both years. Future analyses will evaluate the accuracy of the day counts as an index of total passage and identify potential causes of the observed differences among ladders.

Cavallo, Bradley, Cramer Fish Sciences, 126 East Street, Auburn, CA 95603

Presentation Type: Oral

Assessing the distribution, density, and potential impacts of New Zealand mudsnail on resident aquatic invertebrates in the Mokelumne River, California

The recent invasion of the New Zealand mudsnail (*Potamopyrgus antipodarum*) in the lower Mokelumne River, California, provides a unique opportunity to examine effects of an invasive species on resident macroinvertebrates with pre and post invasion comparisons. We examined potential impacts of the New Zealand mudsnail (NZMS) population on resident macroinvertebrates by assessment of 1) the distribution and density of NZMS and associated resident macroinvertebrate assemblages; 2) relationships between instream environmental parameters (ie. depth, velocity, substrate etc.), NZMS and associated resident macroinvertebrate assemblages; and 3) relationships between NZMS density and resident macroinvertebrate density and diversity over spatial and temporal ranges. We sampled the benthos at 11 sites (gravel bars) along a 10-kilometer stretch of the lower Mokelumne River between July and December 2006 to make spatial comparisons. The 2006 post-invasion data was also compared to pre-invasion data collected between 1996 and 2002 (baseline data). Densities of NZMS and native macroinvertebrate assemblages varied seasonally. NZMS density significantly correlated with season, location, and water depth. NZMS densities were also significantly related to whether or not there was a major flow change within the four weeks prior to each sampling. Macroinvertebrate diversity significantly decreased in four of the six sample sites after the invasion. These statistically significant relationships involving NZMS densities are consistent with previous studies and suggest important management implications.

Chaudoin, Ambre, USGS Arizona Cooperative Fish and Wildlife Research Unit, University of Arizona, Tucson, AZ 85712; Olin Feuerbacher, USGS Arizona Cooperative Fish and Wildlife Research Unit, University of Arizona, Tucson, AZ 85721; Scott Bonar, USGS Arizona Cooperative Fish and Wildlife Research Unit, University of Arizona, Tucson, AZ 85721; Kevin Wilson, National Park Service, Death Valley National Park, Pahrump, NV 89048; Paul Barrett, U.S. FIsh and Wildlife Service, Devils Hole Pupfish Recovery Coordinator, Las Vegas, NV 89310

Presentation Type: Oral

Using stand-alone videography and water quality sensing to assess relationships between environmental conditions and reproductive behavior in Devils Hole Pupfish

The endangered Devils Hole pupfish, *Cyprinodon diabolis*, is a small, silvery-blue killifish confined to a single hot spring within Death Valley National Park, California/Nevada. This hot spring, Devil's Hole, is connected to an aquifer that extends widely across the region. In the past three years, population counts

have reached record lows, which has spurred interest in renewed recovery efforts and research. Devils Hole pupfish have been the focus of considerable study over the past few decades. However, much is yet unknown about pupfish reproductive behavior and factors that influence spawning within Devil's Hole. This information is critically important for designing captive breeding programs for pupfish, and for helping to identify factors contributing to the population decline. Here we describe how current video surveillance technologies and water quality monitoring equipment is being deployed in a remote location to observe pupfish spawning behavior and measure water quality parameters. A surveillance system consisting of three video cameras provides continuous monitoring and recording of pupfish activities on a shallow spawning shelf within Devil's Hole. Meters deployed across the shelf simultaneously record dissolved oxygen, temperature, and pH. These stand-alone datalogging systems are being used to capture of pupfish spawning behavior and associated conditions over a time-continuum in the field, as uninfluenced by human interaction. This data provides a tool for investigating temporal, spatial, and behavioral aspects of spawning activity as related to ambient environmental conditions. Spawning behavior may be an important factor in regulating population dynamics, particularly in species occupying areas with extreme conditions that may promote specific behavioral and physiological adaptations.

Clancey, Pat, Montana Fish, Wildlife & Parks, Ennis, MT 59729; Rebecca Jakes-Dockter, Montana Fish, Wildlife & Parks, Helena, MT 59620

Presentation Type: Oral

Challenges to the implementation of the Cherry Creek, Montana, Native Fish Introduction Project

Numerous administrative and legal challenges resulted in a five-year delay in the Cherry Creek Native Fish Introduction Project, which relied on the use of piscicides to eradicate non-native fish. Challenges focused on state and federal permits and alleged violations of Montana's water quality statutes and the federal Clean Water Act. All challenges, including litigation in both Montana and Federal courts, were denied. Overcoming the challenges in Montana and the Federal Ninth Circuit Court of Appeals strengthened the legal standing to implement piscicide projects.

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Presentation Type: Oral

Westslope cutthroat trout conservation and restoration efforts in the Madison River drainage, Montana

Two on-going programs are working in concert in the Madison River Drainage, Montana, to conserve and restore westslope cutthroat trout populations. The Cherry Creek Native Fish Introduction Project is a

cooperative effort between Montana Fish, Wildlife, & Parks, the Gallatin National Forest, and Turner Enterprises Biodiversity Fund to remove non-native fish from over 60 stream miles and a 105 acre-foot lake, followed by introduction of native westslope cutthroat trout. The removal of the non-natives cannot be accomplished without the use of piscicides. The Sun Ranch Program is a cooperative effort between MFWP and the Sun Ranch that provides facilities to aid in the replication of existing WCT populations and to develop a regional genetically mixed brood.

Collyer, Michael, Stephen F. Austin State University, Department of Biology, Stephen F. Austin State University, PO Box 13003, Nacogdoches, TX 75962-3003

Presentation Type: Oral

Ecological explanations for body shape variation in the Pecos pupfish (*Cyprinodon pecosensis*) and other pupfishes

Euryhaline fish that occur in diverse habitats typically display morphological variation associated with greater streamlining in saline environments. This pattern has been observed in recent studies of *Cyprinodon* morphology for species that occur in environments of different salinities. These studies focused on the ecological morphology of specific taxa and no consideration was given to whether instraspecific morphological variation was substantial relative to interspecific morphological variation. In the current study, I performed a broad-scale morphological survey from museum collections of six species of *Cyrinodon*, mostly represented by populations of Pecos pupfish (*C. pecosensis*) with wide-ranging ecologies. I considered whether (1) species differences or ecological variation was more important for explaining shape variation and (2) how recent morphological divergence compares to deeper phylogenetic variation in body shape. Results indicated that salinity is an important factor for explaining shape variation associated with streamlining both within and among species, but other ecological factors are also important. Regardless of ecological reason, intraspecific body shape variation in Pecos pupfish was much more pronounced than the overall interspecific variation of *Cyprinodon* in this study, indicating that local environments rather than phylogeny predominantly influence body shape. These results suggest that divergent ecological conditions may have been important for the rapid diversification of *Cyprinodon* in North American deserts.

Connolly, Patrick, USGS-WFRC-Columbia River Research Laboratory, 5501A Cook-Underwood Road, Cook, WA 98605; Kyle Martens, USGS-WFRC-CRRL, Cook, WA 98605; Ian Jezorek, USGS-WFRC-CRRL, Cook, WA 98605

Presentation Type: Oral

Contribution to steelhead smolt production from differing life history strategies: downstream movement as parr versus staying until time of smolting

We tracked the fate of individual juvenile steelhead that expressed differing life history strategies. In both Trout Creek (Wind River watershed, southcentral Washington) and Beaver Creek (Methow River watershed, northcentral Washington), we were able to identify two distinct portions of fish, “movers” and “stayers”, that contributed to the total smolt production. The movers were those fish that left their natal area tributary system and spent time elsewhere in the system prior to smolting. The stayers were those fish that remained in their natal stream until the time of smolting. Movements of fish were monitored through the use of PIT tagging and a system of downstream traps and PIT tag interrogation systems. We compared the initial at age of movers and stayers, and we asked if a differential fate was met by these two groups of fish. Rearing environments for these movers and stayers were much different in terms of stream temperature and potential predators, which combined with the effect of initial for a decided influence on age-at-smolting. Based on these findings, a major restoration effort has been designed to enhance rearing conditions for juvenile steelhead, and other species such as juvenile spring Chinook, that move from natal areas to reaches downstream. Modeling efforts have helped illustrate the potentially large increase in smolt production that could be gained from a concerted effort to reconnect the river with its floodplain in hopes to provide better rearing opportunities for those juvenile fish that do move a year or more prior to smolting.

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Presentation Type: Poster

Effectiveness of rock type diversion structures for restoring upstream passage of juvenile and adult salmonids in Beaver Creek of the Methow River watershed

In fall 2004, the last remaining water diversion dam in Beaver Creek at river kilometer (rkm) 2 was modified to improve fish passage and reconnect the system to the Methow River in hopes of allowing enhanced production of anadromous and fluvial salmonids. An overriding goal was to enhance populations of endangered steelhead and spring Chinook and a threatened population of bull trout. Just previous to the modification, but after other passage modifications upstream, we installed a two-way fish trapping weir below the diversion. In addition, we installed four PIT-tag interrogation systems at rkm 1.3, 3.9, 4.0 and 12.0. We conducted annual population estimates at three index sites located between rkm 5 and17. By the end of 2008, we inserted 9,795 PIT tags in mostly juvenile steelhead/rainbow trout (82 %), brook trout (8 %), and juvenile Chinook (7 %), but also adult steelhead, juvenile coho, bull trout, and cutthroat trout. Since the passage modification, we have detected successful upstream passage of adult and juvenile fish over two modified water diversions in lower Beaver Creek at both high and low flows. The PIT-tagged fish have been detected at several dams in the Columbia River, which has provided valuable information on success and rate of reestablishing connectivity of Beaver Creek to the mainstem Methow and Columbia rivers and to the Pacific Ocean.

Cranney, Mike, Weber State University, 2881 S 1000 W, Syracuse, UT 84075; Christopher Hoagstrom, Weber State University, Ogden, UT 84408

Presentation Type: Poster

Morphological variation among humpback whitefish in three Alaskan creeks

Morphology is a major component of an organism's phenotype. It affects important traits such as locomotion, feeding, and reproduction. The success of an organism is directly linked to its morphology. Between 22 June and 3 July 2008 we sampled humpback whitefish, *Coregonus pidschian*, from Scottie, Desper, and Gardiner creeks on Tetlin Nation Wildlife Refuge, Alaska to quantify morphological variation within and among populations. We captured whitefish with monofilament gill nets placed in major pool areas. To get geometric-morphometric data, we captured a left-lateral image of each fish and digitized 12 landmarks on each image using the program software tpsDig. Geometric-morphometric analysis was done with tpsRelw. Overall, morphology varied in body depth, hump prominence, and fin positioning. All morphotypes were found in Scottie Creek (n = 33), whereas only relatively shallow-bodied morphotypes were found in Desper (n = 12) and Gardiner (n = 2) creeks. Lower morphological diversity in Desper and Gardiner creeks may be due to lower sample or morphology-related niche partitioning. Niche partitioning is supported by substantial differences among creeks. For example, deeper-bodied morphotypes in Scottie Creek may use more extensive pelagic habitat present in large pools. Such habitat was rare or absent in Desper and Gardiner creeks.

Cunningham, Kenneth, New Mexico Department of Game and Fish, Fisheries Management Division, 1 Wildlife Way, Santa Fe, NM 87507; Christopher Wethington, New Mexico Department of Game and Fish, Navajo Dam, NM 87419

Presentation Type: Poster

Staus of the San Juan River tailwater trout fishery: Is the sky really falling?

Anglers from around the world travel to northwestern New Mexico specifically to fish the Special Trout Water (STW) of the San Juan River (SJR) downstream of Navajo Dam. The abundance of large rainbow trout in the fishery attracts thousands of anglers who spend an average of 45,000 days per year on the 4-mile section of river and generate over 12 million dollars annually to the local economy. With its international reputation and angler success, the SJR is without a doubt the finest trout fishery in New Mexico. Despite this reputation, New Mexico Department of Game and Fish (NMDGF) has recently been receiving complaints from the angling public concerning a perceived decline in the quality of the fishery. This spurred NMDGF to summarize past angler and fish survey data to determine the status of the SJR. The San Juan River Management Plan specifies four criteria for gauging the health of the fishery; 1) an average angler catch rate of not less than 1.0 fish per hour, 2) five percent of the trout population exceeds 20", 3) fish appear vigorous, healthy, and provide a memorable angling experience, and 4) maintain a 75% or higher angler satisfaction rating for the STW. Angler catch rates from 1995-2008 averaged about 1.2 trout per angling hour annually. Results of electrofishing surveys indicated just over 5% of trout netted

in the tailwater were 20” or larger. Furthermore, condition (K) factors for these trout averaged 1.2, indicating fish were healthy. Finally, 92% of anglers indicated they were satisfied with their angling experience. Despite intense angling pressure, NMDGF is able to maintain a healthy fishery in the San Juan River through a rigorous management regimen of stocking, regulations, and habitat improvement projects.

Dahm, Cliff, CALFED Science Program, CALFED Bay-Delta Program, 650 Capitol Mall, Fifth Floor, Sacramento, CA 95814

Presentation Type: Oral

Thermal Issues in the California Bay-Delta.

The collapse of multiple pelagic fishes in the California Delta has focused much attention on the causes of the precipitous declines. Research in recent years has concentrated on the decline of several open water fishes (Delta smelt – *Hypomesus transpacificus*, longfin smelt – *Spirinchus thaleichthys*, juvenile striped bass – *Morone saxatilis*, and threadfin shad – *Dorosoma pretense*). This decline is called the pelagic organism decline (POD). Temperature has been hypothed as a potential causal factor in the POD, specifically in the case of the decline of Delta smelt. Temperatures above about 24ºC appear to be highly stressful to Delta smelt, and climate change scenarios for the Delta predict increasing occurrences of temperatures above this apparent threshold in the coming decades. Similar concerns exist for the Chinook salmon (*Oncorhynchus tshawytscha*) and Central Valley steelhead (*Oncorhynchus mykiss*) of the California Delta. Warming temperatures place stresses on these populations, and water management often tries to provide cold-water releases at times in the fall when cold water refugia are critical. Drought conditions create the potential for conflict in meeting flow requirements for Delta smelt in the spring versus storing water in upstream reservoirs to meet cold water release requirements in the fall. Mercury rising presents difficult decisions for both water managers and fisheries biologists in California.

Dahm, Clifford, CALFED Science Program, 650 Capitol Mall, Fifth Floor, Sacramento, CA 95814

Presentation Type: Oral

Thoughts on the legal, political, economic, and scientific challenges of fish protection in the California Delta

This symposium focuses on the legal, political, and economic challenges for fish protection in New Mexico. As a New Mexico aquatic ecologist presently on loan to the US Geological Survey to serve as lead scientist to the CALFED Science Program, I will share some of the legal, political, economic, and scientific challenges for fish protection in the California Delta. The recent precipitous decline of pelagic fishes in the upper San Francisco Estuary (including the California Delta) has produced substantive legal, political, and economic challenges and a major scientific program to decipher the multiple causes for this

decline. The Interagency Ecological Program (IEP) has been monitoring long-term fish populations in the upper Estuary, and an excellent long-term data base exists for pelagic fish populations. Populations of two native species (delta smelt – *Hypomesus transpacificus* and longfin smelt – *Spirinchus thaleichthys*) and two non-native species (striped bass – *Morone saxatilis* and threadfin shad – *Dorosoma petenense*) have collapsed in recent years. Recent legal rulings have restricted the pumping of water from the California Delta that supplies waters for cities in Southern California and farms in the Central Valley to protect the endangered delta smelt. These restrictions have produced significant economic impacts and generated much political scrutiny, particularly in a period of regional drought. I will highlight some of the complex interactions between science, law, economics, and politics in this ecosystem with the goal of informing some of the similar complex relationships for fish in New Mexico.

Dauwalter, Daniel, Trout Unlimited, 910 Main Street, Suite 342, Boise, ID 83702; Jack Williams, Trout Unlimited, Medford, OR 97504; John Sanderson, The Nature Conservancy, Ft. Collins, CO 80524; James Sedell, National Fish and Wildlife Foundation, Portland, OR 97205

Presentation Type: Oral

Opportunities for establishing Native Fish Conservation Areas in the Upper Green River

Fishes native to the upper Colorado River Basin are in decline. Although the Colorado River cutthroat trout *Oncorhynchus clarkii pleuriticus* has been the focus of many conservation efforts, recent efforts have also been directed towards three declining native warmwater species – the flannelmouth sucker *Catostomus latipinnis*, the bluehead sucker *Catostomus discobolus*, and the roundtail chub *Gila robusta*. Native Fish Conservation Areas (NFCAs) are watersheds that are managed primarily for native fish and aquatic ecosystem conservation. We identified a network of NFCAs in the upper Green River Basin where conservation actions will benefit both Colorado River cutthroat trout and the three declining native warmwater stream fishes. NFCAs were identified by locating strongholds of native cold- and warmwater species where they occur in relatively close proximity. Presence of non-native species, habitat conditions, and risks due to climate change and energy development were used to indentify existing threats and conservation opportunities in each NFCA and to prioritize each NFCA across the network. By focusing at the scale of watersheds, conservation and restoration activities in NFCAs will facilitate interconnected populations of native fishes and increase their likelihood of persistence. The NFCAs we identified also align with the conservation priorities of local state and federal agencies, which will synergize conservation efforts. Since the NFCAs focus on multiple cold- and warmwater species, the benefit of each conservation dollar spent will also be maximized when compared to approaches that focus on single species. We plan to extend this network and identify NFCAs throughout the upper Colorado River Basin.

Davenport, Stephen, U.S. Fish and Wildlife Service, 3800 Commons NE, Albuquerque, NM 87109; Christopher Hoagstrom, Weber State University, Ogden, Ut 84408-2505; Thomas Archdeacon, U.S. Fish and Wildlife Service, Albuquerque, NM 87109

Presentation Type: Oral

Response of Pecos River fish community to surface flow intermittence

The Pecos River was historically a perennial flow-through river, and supported the greatest diversity of fish in New Mexico. Modern impacts to the Pecos River fish community include river fragmentation, habitat degradation, seasonal dewatering, increased salinity and competition and predation from non-native fish. Long-term dewatering of the Pecos River has occurred twice in recent decades, in the years 1989-1991 and 2001-2004. We began long-term systematic monitoring of the Pecos River fish community in 1992. We present catch rates of 10 common Pecos River fishes between 1992 and 2008. We identified 10 common species, and divided them into three reproductive groups. Three native pelagic-spawning fish: *Macrohybopsis aestivalis, Notropis jemezanus*, and *N. simus pecosensis*, two non-native pelagic-spawning fish, Hybognathus placitus and N. girardi, and five native non-pelagic fish: *Cyprinella lutrensis*, *N. stramineus*, *Pimephales promelas*, *Fundulus zebrinus* and *Gambusia affinis*. Response of the 10 common species to multiple years of surface flow intermittence differed among reproductive groups: native pelagic minnow's catch rates declined, but non-native pelagic minnows and native non-pelagic minnows did not. Increase in catch rates of the three native pelagic minnows was dissimilar after surface flow intermittence ended in 2005, with N. simus pecosensis recovering after other native pelagic minnows.

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Presentation Type: Oral

Kinetic hydropower: Baseline monitoring for fish distribution and behavior at the proposed site of the Eagle Turbine Project, Yukon River, Alaska.

Kinetic hydropower (in-stream, wave, and tidal) holds great promise as an alternative electrical energy source in many locations, including those which have no access to traditional grid power. Eagle, Alaska currently relies on expensive, diesel generation of electricity, year round. Alaska Power & Telephone (AP&T) intends to incorporate in-stream generated kinetic hydropower by deploying three turbines in the Yukon River during the ice-free portion of the year and eliminate the need to operate the diesel generators during this period. Important in the project development and permitting process is the collection and analysis of baseline data, to establish current conditions and resources at the proposed site. Historical data is unlikely to provide the temporal or spatial resolution adequate to address the concerns associated with continuous operation of a power generation facility and will need to be augmented with high-resolution data collected from the proposed site. Because kinetic hydropower relies on a dynamic environment (constantly moving water), the biological resources of the proposed site will also be dynamic and vary with flow, time of day, and season. At the Eagle Turbine Project, AP&T has implemented a long-term baseline study of the site which is based on continuous hydroacoustic monitoring, with specific interest in migrating salmon (both adult and juveniles) and resident species at the proposed turbine location. The planning, installation, operation and preliminary observations from the 5-month study, using the automated, remotely accessed hydroacoustic system, are presented.

Deacon Williams, Cindy, National Center for Conservation Science and Policy, 84 Fourth Street, Ashland, OR 97520; Brian Barr, National Center for Conservation Science and Policy, Ashland, OR 97520; Marni Koopman, National Center for Conservation Science and Policy, Ashland, OR 97520; Richard Nauman, National Center for Conservation Science and Policy, Ashland, OR 97520; Bob Doppelt, Institute for Sustainable Environment - University of Oregon, Eugene, OR 97403; Roger Hamilton, Institute for Sustainable Environment - University of Oregon, Eugene, OR 97520

Presentation Type: Oral

Integrating pacific northwest aquatic ecosystem climate change preparation efforts into regional planning: Coordination in a multi-sector world

Three global climate models operated under the 'high emission' scenario assumptions developed by the Intergovernmental Panel on Climate Change were applied and downscaled to project future conditions specific to the Rogue and Upper Willamette River basins in Oregon. The results for a number of variables, including temperature, precipitation, and fire were mapped to show projected shifts in spatial patterns for two time periods, 2035-2045 and 2075-2085.. Time series graphs were plotted through 2100 for some variables, such as temperature and precipitation, to show how conditions are likely to change both annually and seasonally. The three downscaled global climate models also were used to run a dynamic vegetation model to project the dominant types of vegetation that future growing conditions in the basins would best support. These climate future projections were used as the basis for stakeholder assessments of likely consequences of climate change on natural (ecosystems and biodiversity), built (buildings, road, energy and water systems, and other critical infrastructure), human (public health, emergency management, and social services), and economic sectors in the Rogue and Upper Willamette River basins. Based on the projections, recommendations were made to increase the capacity of all four sectors to withstand and adapt to climate induced stressors. These assessments are part of an initiative aimed at establishing a common method for developing integrated climate-preparation plans and policies. This work is intended to jump-start preparation efforts in the pilot basins, and identify strategies and policies for collaborative efforts that could be used to increase the resistance and resilience of natural, built, human, and economic sectors to climate change across Oregon and, eventually, the United States.

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Presentation Type: Oral

Status update of toxic golden alga in New Mexico

Since 2002 golden alga (*Prymnesium parvum*) has caused significant fish kills in New Mexico and particularly on the lower Pecos River. Golden alga is a microalga and a common member of the marine phytoplankton. Golden alga has been described as a photosynthetic microalga with possible heterotrophic

growth (phagotrophy). It is a euryhaline and eurythermal organism tolerating a broad range of salinity and temperatures. Golden alga is a particular problem in the Pecos River from Brantley Reservoir down stream. Since 2006 and estimated 1.5 million fish have been killed including sport, native, and state listed species. Current distribution and trends for golden alga in New Mexico will be discussed including information on basic golden alga biology and criteria to help identify golden alga caused fish kills.

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Presentation Type: Oral

Genetic structure of the undescribed Mexican native trout: An assessment with microsatellite loci

High elevation rivers of the Sierra Madre Occidental (SMO), Mexico, contain a high diversity of native salmonids, commonly recognized as Mexican trout and members of the genus *Oncorhynchus*. In Mexico there are two species formally described: *O. mykiss nelsoni* in Baja California, and *O. chrysogaster* from the rivers Fuerte, Culiacan and Sinaloa in the SMO. However, most of the trout diversity discovered by the binational group Truchas Mexicanas over the past decade remain undescribed. Until only recently there have been limited data synthed regarding their delimitation. We analyze 748 individuals of Mexican trout for 12 microsatellite loci from the rivers in the states of Baja California, Durango, Chihuahua and Sinaloa, Mexico, to aid in the elucidation of both taxonomic and conservation units that contribute to the species delimitation. The genetic biodiversity parameters average 24 alleles per locus, allelic richness values between 1.707 and 4.8, observed heterozygosity ranging from 0.085 to 0.7234, and 70 alleles exclusively distributed in the different basins.
Neighbor-joining analysis using Cavalli-Sforza and Edward´s genetic distance identified the genetically similar groups within Mexico: Guzmán/Yaqui-Bavispe, Yaqui-Sirupa/Mayo, Conchos, San Lorenzo/ Piaxtla, Acaponeta/Baluarte/Presidio, one unique group in La Sidra of the San Lorenzo basin, and a group from Arroyo Aparique of the Rio Fuerte. All of these groupings were genetically distinct from the formally described trout (*O. mykiss nelsoni* and *O. chrysogaster*) and the exotic rainbow trout. These groupings were corroborated by the Bayesian assignation analysis, gene flow estimation, and analysis of

molecular variance (AMOVA). The latter analysis revealed the highest variance between groups (63.94%), with 31.76% corresponding to populations between groups and 4.40% of variance between populations inside of groups. The results of the different analyses of microsatellite variation support the existence of at least 7 taxonomic units corresponding to the groups identified above.

Dolloff, Andrew, U.S. Forerest Service Southern Research Station, Dept. of Fisheries & Wildlife, Virginia Tech, Blacksburg, VA 24060; Jason Dunham, USGS Forest and Rangeland Ecosystem Science Center, Corvallis, OR; Amanda Rosenberger, School of Fisheries and Ocean Sciences, University of Alaska Fairbanks, Fairbanks, AK; Russell Thurow, U.S. Forest Service, Rocky Mountain Research Station, Boise, ID; Philip Howell, U.S. Forest Service, Forestry and Range Sciences Laboratory

Presentation Type: Poster

Sampling coldwater fish in wadeable streams

Small, wadeable (maximum depths less than 1 m) streams comprise the majority of habitats available to fishes in coldwater (mean 7-day summer maximum water temperatures < 20^{O}C) fluvial networks. As documented in Chapter 8 of Standard Methods for Sampling North American Freshwater Fishes (S. Bonar, W. Hubert, and D. Willis, eds) we attempt to capture the major elements of a standardized sampling program based on three of the most common methods for quantitatively sampling fishes in wadeable streams: (1) electrofishing, (2) underwater observation by snorkeling, and (3) nest or redd counts. Most of our recommendations are based on experience sampling salmonids although coldwater streams may also include, cottids, cyprinids, gasterosteids, catostomids, or petromyzontids. Electrofishing typically is accomplished with specialized equipment including a pulsed, direct current (DC) backpack electrofisher. Snorkeling is conceptually simple, with relatively modest personnel and gear requirements well suited for sampling remote locations and for avoiding the risks of more potentially destructive methods when sampling rare species or species of special concern. Redd counts are a common method for monitoring reproduction of stream-dwelling salmonid fishes. We provide guidance on gear selection and configuration, deployment, data collection, safety, and training. We also address selection of sampling sites because estimates of abundance, presence, or other characteristics of fishes within a sampling site, no matter how accurate, are of limited (e.g. site-specific) value in the absence of an appropriate question and spatial context. Although use of a common method is an important step in standardization, adherence to a method without validation will not produce standardized or comparable results. We argue that investments in validation of sampling methods are essential to ensure trust and confidence in the ability of biologists to manage public fisheries.

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Presentation Type: Oral

Restoring habitat for the endangered Moapa dace, *Moapa coriacea*, in the Warm Springs system, Muddy River, Nevada.

The Moapa dace, *Moapa coriacea*, is a thermophilic minnow endemic to the warm headwater springs, tributaries and mainstem river of the Upper Muddy River system located in Clark County, Nevada. The Moapa dace has been federally endangered since 1967. The U.S. Fish and Wildlife Service assigned the Moapa dace with a Recovery Priority of 1 due to: the fish being the only one in the genus Moapa; the high degree of threat to its continued existence; and the potential for recovery of the population. Several positive conservation actions have been taken to ensure the continued existence of the Moapa dace. In September 2007, the Southern Nevada Water Authority purchased 1,218 acres of private property formerly known as the Warm Springs Ranch, which contains historical Moapa dace habitat. Upon purchase, the property was renamed the Warm Springs Natural Area (WSNA) with the primary purpose of protecting the Moapa dace and its remaining habitat. Due to the historical uses of the property, much of the spring and river systems had been altered by recreational and agricultural development. The first of several restoration activities identified by the Muddy River Biological Advisory Committee, a subcommittee of the Muddy River Recovery Implementation Program, was recently undertaken on the WSNA to enhance thermal properties in connecting streams. In turn, this will create more suitable habitat for the different life stages of the Moapa dace, and control invasive, aquatic and riparian species such as the shortfin molly (*Poecilia mexicana*), eel grass (*Vallisneria americana*), and palm trees (*Washingtonia filifera*).

Drill, Sabrina, UC Cooperative Extension, UC Cooperative Extension, 4800 E. Cesar Chavez Ave., Los Angeles, CA 90022; Rosi Dagit, Resource Conservation District of the Santa Monica Mountains, Agoura Hills, CA 91376; Stevie Adams, Resource Conservation District of the Santa Monica Mountains, Agoura Hills, CA 91376

Presentation Type: Oral

A temperature related die-off of southern steelhead trout (*Oncorhynchus mykiss*) near the southern extent of their range: Malibu Creek, Los Angeles County, California

A die-off of native and exotic fish and invertebrate species, including the endangered southern steelhead trout (*Oncorhynchus mykiss*) was observed in Malibu Creek, Los Angeles County, during the summer and fall of 2006. Death was preceded by a period of illness during which trout in particular exhibited a noticeable yellow coloration. Physical, chemical and biological variables, including temperature, dissolved oxygen, a variety of chemical contaminants, presence of toxin producing algae, and direct pathology, were examined, but results remain inconclusive. The first day of a 12-day high temperature event occurred on the same date yellow trout were first observed. This sustained event is different from shorter term temperature spikes recorded in other years. Recovery monitoring documented re-colonization by all exotic fish species and crayfish, but limited numbers of southern steelhead trout in 2007. Surveys in summer 2008 documented a record number of anadromous adults (five silvery fish over 50cm total length) and young of the year (over 2,200 under 10 cm).

Fetherman, Eric, Colorado Cooperative Fish and Wildlife Research Unit/Colorado State University, 201 JVK Wagar Buildling, Colorado State University, Fort Collins, CO 80523; Dana Winkelman, Colorado Cooperative Fish and Wildlife Reasearch Unit/Colorado State University, Fort Collins, CO 80523; George Schisler, Colorado Division of Wildlife, Red Feather Lakes, CO 80545

Presentation Type: Oral

Student Award Candidate

Heritability of myxospore count and genetic correlations in whirling disease resistant and susceptible strains of rainbow trout

The mechanisms for resistance to *Myxobolus cerebralis* seen in the German Rainbow (GR) strain of rainbow trout are suspected to be polygenic and at least partly additive. However, the genes involved in *M. cerebralis* resistance are relatively unknown. We used a quantitative genetics approach and estimated heritability to evaluate how resistance to *M. cerebralis* is acquired in different strains of rainbow trout. Heritability was evaluated using a random single pair mating design. For the *M. cerebralis* exposure experiment, pairs of individuals were spawned from the brood stock populations of GR, F1 (GR x CRR) and Colorado River Rainbow (CRR) individuals to create unique families containing full sibling offspring for each of five strains, the GR, CRR, F1, F2 (F1 x F1) and B2 (F1 x CRR) strains. All five strains were exposed to the whirling disease parasite and reared for five months to ensure the full development of myxospores. Myxospore count was used to quantify severity of infection and variability in the count was used to estimate heritability. Our estimates of heritability of myxospore count include both additive and dominance variance components and measures the extent to which phenotypic variation is determined by genotypic variation. Myxospore counts were log transformed prior to analysis. Heritability of myxospore count was lowest in the GR, F1, and F2 strains (0.34, 0.41 and 0.32, respectively). The B2 strain showed the highest heritability of myxospore count (0.93). The CRR strain also showed a high heritability (0.65) but was lower than the B2 strain. Genetic correlations between heritability of myxospore count and mean survival characteristics, including deformities, growth, and critical swimming velocity were also estimated. Our data suggest that hatchery breeding programs can select for rainbow trout strains with decreased myxospore levels and management efforts to reintroduce rainbow trout into infected Colorado rivers may be successful.

Feuerbacher, Olin, University of Arizona, University of Arizona, Biological Sciences East Room 325, Tucson, AZ 85721; Scott Bonar, USGS Arizona Cooperative Fish and Wildlife Research Unit, Tucson, AZ 85711; Paul Barrett, USFWS, Las Vegas, NV 89101

Presentation Type: Oral

Application of prophylactic disease treatments in laboratory rearing of hybrid Devils Hole pupfish

Laboratory cultivation of Devils Hole pupfish, *Cyprinodon diabolis*, has proved to be problematic for many years. Although various attempts have been made, long term maintenance and cultivation of this species over multiple generations have thus far been unsuccessful under laboratory conditions. The University of Arizona Desert Fishes Propagation Laboratory is attempting to elucidate the mechanisms behind these difficulties, utilizing hybrid Devils Hole pupfish as a model. Work is underway to reproduce these hybrids by utilizing biotic and abiotic conditions similar to those found in Devils Hole. Microbiological and histological analyses are being performed to understand potential pathogens that may affect the physiology of these fishes, as well as to maximize hatch yield. Because many of the bottlenecks previously identified in the captive breeding of Devils Hole pupfish have been during larval rearing, particular effort has been placed on maximizing larval survival. Several prophylactic antibiotic treatments are being compared as they relate to egg hatch rate, and larval survival. Treatments of moderate and broad-spectrum antimicrobials, and a mycobacterium-specific antibiotic, are being applied to eggs or larvae to improve hatch rates and larval survival, and may have potential for creating specific-pathogen-free lines of these fishes. These lines could allow for investigation of the intricacies of larval developmental physiology and functional genomics without the confounding effects of chronic disease burdens.

Finger, Amanda, University of California Davis, Genomic Variation Lab, Department of Animal Science, Davis, CA 95616; Eric Anderson, NOAA Fisheries, Santa Cruz, CA; Bernie May, University of California Davis, Davis, CA 95616

Presentation Type: Oral

Student Award Candidate

Joint estimation of admixture proportions and effective population in a hybrid trout population in Silver King Creek, California

Understanding the history of a managed population is crucial for management into the future. In Silver King Creek, California, the native range of the threatened Paiute cutthroat trout, over 70 years rainbow trout, golden trout, lahontan cutthroat trout and paiute cutthroat trout were stocked, effectively extirpating the Paiute cutthroat trout. To genetically characterize this population before fish removal and restoration, we have used 10 diagnostic single nucleotide polymorphisms. Using this data, we determined that the majority of the genetic contribution in this population comes from rainbow trout, followed by golden trout. Paiute and Lahontan cutthroat trout had very little genetic signature remaining. To further understand the history of this population, we used a coalescent-based likelihood method to jointly estimate the proportion of rainbow trout ancestry in the population founders as well as the effective population (Ne) since 1977, the time of the last non-cutthroat stocking. The maximum likelihood estimate of the proportion of rainbow trout ancestry was 0.8, 0.2 for golden trout, and 50 for total Ne. This study has practical use for the restoration of Paiute cutthroat trout, as well as broader implications for other systems. The genetic characterization will provide a baseline for genetic monitoring efforts which will undoubtedly be required into the future. In addition, it sheds light (and prompts questions) regarding the species interactions

between closely related species, the effects of long-term stocking, effective population over time, and other pertinent topics.

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Presentation Type: Poster

Rotenone reregistration and standard operations procedures manual

Rotenone has been an important tool for decades in fish management and more recently, to specifically implement native fish restoration. American Fisheries Society Fish Management Chemicals Subcommittee (FMCS), rotenone registrants and U.S. Environmental Protection Agency (EPA) have been working on the reregistration process for rotenone for several years. In March 2007, EPA issued a reregistration eligibility decision (RED) for rotenone predicated on mitigation measures to reduce impacts to public health and environment and development of a Standard Operations Procedures (SOP) Manual for use. Between 2005 and 2009, FMCS and rotenone registrants worked with EPA to develop changes in use that provided the required mitigation while conserving the continued safe and effective use of rotenone. FMCS began development of the Rotenone SOP Manual in late 2008 and completion is expected by late 2009. Changes in rotenone use that are reflected in the Rotenone SOP Manual include (1) public notification, (2) project supervision training, (3) effective treatment rates and strategies, (4) chemically induced neutralization, (5) operating semi-closed probe systems for application of liquid and powder, (6) applying small quantities of liquid, (7) operating drip cans and sprayers, (8) use of bioassays, (9) monitoring rotenone concentrations in water, and (10) using powder-gelatin-sand mix. The Rotenone SOP Manual will be instrumental in the AFS training class Planning and Executing Successful Rotenone and Antimycin Projects.

Fort, Denise, University of New Mexico School of Law, 2610 Caminito Carlitos, Santa Fe, NM 87505

Presentation Type: Oral

Protecting our natural systems - how we can protect NM's fishes

New Mexico has neglected the health of its rivers, while aggressively developing water resources throughout the state. This talk describes how we can restore balance in water management in the state: the key actors, the political landscape, legal theories, and sources of funding. While there are many opportunities, I argue that there are also dead ends that we should not pursue. The most fruitful

opportunities come from new sources of funding. The multiyear developments on the middle Rio Grande illustrate how advocacy, agency motivation, and Congressional politics can result in new initiatives.

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Presentation Type: Oral

The use of 8.5 and 12.5 mm PIT tags on both a juvenile and adult salmon tagging study in the Columbia Basin.

In 2007 and 2008, in addition to standard 12.5mm PIT tags (model TX1411SST); 8.5mm (TXP148511B) PIT tags were used in a juvenile tagging program with wild Hanford Reach fall Chinook salmon to allow tagging of smaller fish. Among the juveniles tagged in 2007, 50.1% of those tagged with 8.5mm tags were under 60mm in length compared to 8.1% of 12.5mm tagged fish. Fish tagged with 8.5mm tags had lower mortality rates (0.9% vs. 1.2%) and lower tag shed rates (0.1% vs. 0.2%), although neither relationship was significant ($p=0.07$ and $p=0.13$ respectively). In 2008 mortality rates were similar (4.1%) as were shed tag rates (<0.1%). The detection rate for 12.5mm PIT tagged juvenile fall Chinook for 2007 and 2008 ranged between 95.7% and 100.0% at juvenile bypass systems at McNary, John Day, and Bonneville dams compared to 84.6% to 99.5% for 8.5 mm tagged fish. In both years, survival to downstream detection sites was similar among fish of similar length.
In 2008, we also tagged adult salmonids with both tag types at Bonneville Dam to compare detection rates at upstream detection sites. Of the over 2000 adult Chinook and sockeye salmon sampled between April and early July, we PIT tagged approximately one third with 8.5mm tags and the remainder with 12.5mm tags and monitored detections at upstream dam fish ladders. Although the percentage of fish detected at Bonneville, McNary, Ice Harbor, and Lower Granite dams was comparable for fish tagged with the two tag types, 12.6% to 64.3% of the 8.5mm tagged fish were missed at Priest Rapids, Rock Island, and Rocky Reach dam fish ladders compared to 0.0% to 6.9% for the 12.5mm tagged fish.

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Presentation Type:

Adventures in estimating Columbia Basin lamprey escapement

Pacific lamprey abundance in the Columbia Basin has dramatically declined since white settlement of the region and this decline is likely continuing. The extent and rate of this decline is unknown due to difficulties in counting lamprey. Lamprey are currently counted with adult salmon at mainstem dam fish ladder viewing windows. However, counting at most locations is not conducted at night when most lamprey passage is believed to occur. In addition, lamprey can pass fish ladder viewing windows

uncounted as alternative routes, unavailable to salmon, can be used by lamprey. Since lamprey abundance is believed to decline dramatically with distance from the ocean, accurate counts are most desired at the lowermost dam in the Columbia Basin, Bonneville Dam. However, night counting at this site is hampered by high nighttime shad passage during the lamprey migration and the tendency of lamprey to hang in the viewing window for hours on end. Review of video tapes of peak night time passage in 2007 and 2008 commonly found that it took more than an hour of review time to count an hour of video. Furthermore, downstream passage of lamprey exceeded upstream passage. In 2008 we counted lamprey from a sample of night time video at McNary Dam during peak periods and found that 45% of passage occurred during these hours. In 2009, we will use video to estimate escapement of lamprey at the John Day Dam fish viewing window. Underwater cameras will also be used to count lamprey that do not pass in front of the viewing window. We hope to calculate the proportion of lamprey passing the fish viewing window; if successful it may then be possible to use a lamprey tagging program to estimate escapement at other dams.

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Presentation Type: Oral

Survival and growth of juvenile fall Chinook salmon exposed to constant and fluctuating temperatures

The purpose of this laboratory study was to determine if temperature guidelines proposed by management agencies protect sub-yearling fall Chinook salmon (*Oncorhynchus tshawytscha*) that become entrapped in shoreline pools downstream of Hells Canyon Dam in the Snake River when flows are fluctuated to meet electric power demand. To determine upper thermal tolerance, water temperatures were increased 1.5°C/h from 10, 12, and 14°C until fish lost equilibrium and died. An additional test increased temperatures up to 25°C and held them there for 70 h. Finally, survival and growth were monitored for 30 d for fish exposed to one of 9 constant (14 to 22°C) or 11 fluctuating (daily fluctuations from 10-14°C to 22-27.5°C) thermal regimes. The thermal tolerance test with steady temperature rise showed that half the fish died when temperatures reached 27.4 to 27.9°C. The thermal tolerance test with temperature rise and hold showed that survival at 25°C was highly variable with the average time to first death 9.1 h (range 1.7 to 22.5 h). Survival in the constant temperature regimes was 99.8% over the 30-d exposure period. In the fluctuating temperature regimes, short-term exposure to temperatures equal to or greater than 27°C in the daily cycle resulted in significant mortality, however, if the daily maximum temperature did not go above 26°C and was followed by a rapid decline in temperature (3°C/h), then the survival rates were nearly 100%. The optimum growth of juvenile salmon when fed to satiation for 30 d occurred at a constant 20°C (19.7 to 20.7°C). Growth in the constant thermal regimes was nearly twice as high as in the fluctuating regimes, even when daily average temperatures were similar. The results of this study suggest that temperature guidelines could be revised to be protective of juvenile fall Chinook salmon while providing flexibility to dam operations.

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Presentation Type: Oral

Student Award Candidate

Identification and characterization of inconnu spawning habitat in the Sulukna River, Alaska

Inconnu *Stenodus leucichthys* are present throughout much of the Yukon River drainage in Alaska, but, only five spawning areas have been identified. Radio telemetry studies indicate that nearly all inconnu in the drainage originate in one of these five spawning areas. Spawning habitat requirements are therefore thought to be very specific, however, the physical qualities of these habitats have not been characterized. The Sulukna River is one of five identified inconnu spawning areas within the Yukon River drainage. We used a systematic sampling design in September and October of 2007-2008 to further define spawning locations. Presence of inconnu was identified using a hook/line sampling and spawning was verified by catching broadcast eggs in plankton nets. We sampled a suite of habitat features at transects located every 1.8rkm, these features included small-scale, large-scale, and chemical habitat variables. We used multiple logistic regression to develop a predictive model for occurrence of spawning inconnu. Results indicate that spawning habitat is confined to a narrow reach, approximately 22rkm and occurred significantly more often in sites characterized with substrate between 6 – 12 cm, mean thalweg velocity of 0.378 m/s, mean thalweg depth of 1.4 m, and a sinuosity index of 2.45. Measures of alkalinity and conductivity were also significantly different between spawning and non-spawning sites. Our findings indicate that inconnu spawning site selection is very specific. While our understanding of the physical qualities of inconnu spawning habitats have been greatly enhanced by this work, similar studies on other known spawning habitats would reveal whether they are common qualities to all inconnu spawning populations or unique to the Sulukna River.

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Presentation Type: Poster

Standard Weight: It’s not about the third quartile

Relative weight has become the most commonly-used index of body condition among fisheries scientists working with freshwater fishes in North America. In order to compute meaningful relative-weight indices, species-specific standard weight equations that are free of length-related bias are needed. The regression-line-percentile (RLP) method became the standard method for computation of standard weight equations, but has been found to generate equations with length-related bias. A new empirically-based (EmP) for computation of standard weight equations has been proposed and is being adopted by fisheries

scientists. Both the RLP and EmP methods compute standard weight equations using third-quartile mean weights. I demonstrate that management-relevant issues arise when using third-quartile mean weights to compute standard weight equations. An alternative that has growing appeal among fisheries scientists is to compute standard weight equations using median weights. However, standard weight equations computed by the EmP method using median weights have many of the same flaws as those based on third-quartile weights. I describe a conceptually-simple, quartile-regression approach that eliminates the flaws. I also compare and contrast aspects of RLP and EmP methods as they pertain to this new approach to computation of standard weight equations.

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Presentation Type: Poster

Student Award Candidate

Conservation status of freshwater fish communities in West-Central Mexico: diagnosis and causes

Water bodies in the West-Central portion of Mexico, the most densely populated area in the country, have been affected by dewatering, pollution and species introductions, resulting in a decline in the general health of aquatic habitats. To diagnose the problem and explore the relative importance of the causes behind it, in 2005 we visited 83 selected localities in the area, sampled the fish communities and measured water quality. Localities were visited once and encompass the spectrum of water body and community types found within the area. The native ichthyofauna is not particularly diverse but contains two speciose and endemic groups: splitfins of the subfamily Goodeinae and silversides of the genus *Menidia* (*Chirostoma*), among others. We found only 65% of the expected native species. The most frequently found exotics were species of tilapia (genus *Oreochromis*), swordtails (*Xiphophorus hellerii*), and common carp (*Cyprinus carpio*). The three main sources of exotics within the area are stocking for human consumption, pet trade, and stocking for angling. In addition to those mentioned above, we found 21 other introduced species, including traslocations. Springs showed a better conservation status than other water bodies, and due to this and their small , they stand out as potential key localities for conservation or restoration efforts. Several factors can result in a decline in the numbers of native populations, and separation of their effects is not straightforward. Preliminary results indicate a correlation between conservation status and degree of invasion.

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Presentation Type: Oral

Exploring the range of potential climate change impacts on western rivers: Case studies from the upper Yellowstone

Models indicate that average temperatures in the western United States will increase by 1-2 °C or more over the next 50 years, but the outlook for precipitation remains relatively uncertain. In this study, the potential hydrologic effects of warming are explored for the Upper Yellowstone River in Wyoming and Montana. The combined effects of warming and a broad range of scenarios for future precipitation (e.g. wetter, drier or the same as today) are also explored. A water balance model that estimates runoff from precipitation and temperature inputs was calibrated against historical observations (r = 0.92 vs. measured). The model was then used to simulate runoff under three temperature scenarios: (1) observed temperatures 1896-1995; (2) reconstructed temperatures since 1177; (3) IPCC temperature projections for 2025 and 2050. Precipitation inputs included both observed values from 1896-1995 and tree-ring estimates spanning 1177-1895. When combined with either of the precipitation scenarios, projected temperatures for 2025 and 2050 produced mean runoff at 9-12% and 14-17% below the 20th century baseline, respectively. Combining historical average temperatures with tree-ring precipitation created numerous multidecadal periods with mean runoff < 85% of baseline, and runoff during these same droughts declined an additional 5-15% under 2025/2050 temperatures. All combinations of temperature and pre-1896 precipitation resulted in mean runoff below the 20th century baseline, suggesting that flows during the gage period were unusually high. Additional exercises pairing climate-runoff scenarios with changes in the timing of spring onset and peak discharge indicate that late-summer base flows are likely to be well below historical observations in coming decades. As in previous studies from the southwestern US, these results show that 1-2°C warming could have major negative effects on Upper Yellowstone flows, and climate change impacts would be especially pronounced in late summer and during times of drought.

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Presentation Type: Oral

Using fish barriers in restoration: insights from studies headwater populations of cutthroat trout

When making decisions regarding the use of fish barriers in fish restoration projects, the importance of identifying habitat requirements for the species of concern is broadly recognized. Although information about fish-habitat relationships abounds at the site scale, researchers and managers are just beginning to appreciate the need for watershed-scale assessment of persistence in headwater streams. Our work in western Oregon and the headwaters of the Colorado River has provided new insights into the large-scale variation of geologic, geomorphic, and climatic factors across regions using individual watersheds as analytical units. Spatially continuous data collection has allowed us to investigate distribution patterns of cutthroat trout throughout headwater stream networks. By incorporating movement assessments at the watershed scale, it has been possible to evaluate changes in habitat use in stream networks occurring

among seasons and years and gain further understanding concerning population-level growth and survival. Genetic data collected intensively in a single watershed and extensively for 27 watersheds across two ecoregions in Oregon yielded novel insights into the role of physical landscape features and disturbance in shaping genetic patterns of populations isolated from short-term immigration. Synthesis of these studies of salmonid distribution and persistence in headwater streams underscores the importance of incorporating disturbance (e.g., climate change and wildfire) into predictions concerning the efficacy of isolating native fish populations above barriers.

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Presentation Type: Poster

Hood River salmonid forecasting: Cohort models versus environmental models

Forecast models can be useful tools for setting harvest quotas and planning brood stock removals in salmon and steelhead fisheries. Models which relate total returns to earlier cohorts and environmental variables are commonly used, as these have the potential to shed light on the underlying causes of year to year variation. We developed and statistically compared models for forecast accuracy and precision. Models and model selection tools are programmed in an EXCEL macro for the Confederated Tribes of the Warm Springs Reservation in order to better serve Hood River spring Chinook and steelhead management needs. The Hood River Powerdale Dam will be decommissioned in 2010. Since the removal of the dam will result in the loss of the fish trap facility located at the dam, it will be necessary to forecast returning numbers of Spring Chinook and steelhead with alternative data and to insure enough precision in these estimates and predictions to provide the basis for prudent management decisions regarding levels of harvest and brood stock take. The models developed are one season ahead forecast models applying least squares multiple regression. The aim is to develop regression forecast models with as few parameters as possible but which will allow fairly high accuracy and precision of predictions of the following year’s total return of spring Chinook and steelhead adults and juveniles. Models which use cohort data plus environmental data and models incorporating solely environmental independent variables were found to be competitive based on several model selection and performance measures including AICc, Vuong tests, likelihood ratio tests, mean squared error, adjusted R2, prediction R2 and bootstrap prediction intervals. An EXCEL macro was developed to compare models, compute point estimates, non-parametric confidence intervals, prediction intervals and provide plots. We also discuss variable selection as related to salmonid spatial and temporal life stanza.

Guy, Christopher, USGS Montana Cooperative Fishery Research Unit, 301 Lewis Hall, Montana State University, Bozeman, MT 59715; Patrick Braaten; David Herzog; John Pitlo; R. Scott Rogers

Presentation Type: Poster

Warmwater fish in rivers

This poster describes standard techniques for sampling warmwater fish in rivers, as documented in

Chapter 5 of Standard Methods for Sampling North American Freshwater Fishes (S. Bonar, W. Hubert, and D. Willis, eds). Large warmwater rivers are complex ecosystems and often contain numerous species and habitats. We loosely define a large river as having a drainage area greater than 50,000 km2 and a stream order great than six. Further, these rivers typically have mean discharges greater than 1,500 m3/s. We define warmwater rivers as rivers that were naturally void of coldwater fish, such as salmonids and coregonids. Seven sampling gears (the bottom trawl and hoop net are divided into subcategories) were identified to provide the best representation of warmwater fish assemblages in large warmwater rivers based on numerous discussions among the authors and with fisheries biologists throughout North America: (1) bag seine, (2) large-mesh bottom trawl, (3) small-mesh bottom trawl, (4) boat electrofisher, (5) drifting trammel net, (6) "catfish" hoop net, and (7) "buffalo" hoop net. These sampling gears may not sample all species or work in all riverine habitats, but they provide a basis for standardization for sampling a wide array of fishes in large warmwater rivers.

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Presentation Type: Oral

Using physical and biological conditions to evaluate stream barriers used for native trout recovery in Arizona

As an ongoing effort to recover multiple metapopulations of Apache trout, (*Onchorhynchus apache*) the Arizona Game and Fish Department, in cooperation with Trout Unlimited is assessing the effectiveness and stability of existing barriers in the recovery program. Often these barrier structures include a combination of gabions, culverts, and/or natural drops modified to prevent fish passage. A systematic approach to examining the barrier geometry, structural integrity, stream hydrology, and morphologic stability was developed to assess the functionality of ten barriers critical to the recovery effort. The analysis assesses hydrology, hydraulics, and channel morphology against the physical abilities of the target fish species. The ability of fish to pass through the barrier is dependent on 1) a burst swimming velocity greater than current velocities and/or 2) a jump height greater than the vertical barrier over a wide range of flows. Problems encountered included: Small fish passing through leaking gabions, lack of a hardened apron at the base of the barrier that prevents pool formation, low barrier tops and barrier screens which are quickly overwhelmed by flows and debris. The level tops of many of the structures has reduced the ability to transport sediments and contributed to structural failure along the stream banks. System wide barrier evaluation has proved a valuable tool for planning conservation strategy. The evaluation process identifies and addresses weak links in the barrier systems. Lessons learned in the modification of existing barriers can be applied to the design and construction of new structures. Improving the effectiveness of these structures is a difficult challenge because modifications need to be tailored to the existing design or construction of individual structures. Many barriers are constructed in combination with existing culverts. In these cases the ability to successfully modify barriers is constrained by existing culvert and/or channel bed elevations.

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Presentation Type: Oral

Habitat restoration in the Middle Rio Grande, New Mexico, for the endangered Rio Grande silvery minnow (*Hybognathus amarus*)

Providing habitat for all life stages of the Rio Grande silvery minnow (*Hybognathus amarus*) is critical for survival and recovery but is also a great challenge. This endangered species only occurs in about 5% of its historic range within the Rio Grande system. Adapted to a desert river environment, the silvery minnow generally prefers warmer, slow moving, shallow water. Loss of habitat is a major reason cited for the fish's decline. For instance, Cochiti reservoir created significant degradation of the channel bed, which effectively disconnected the floodplain from the river even at high spring runoff levels. Therefore, while the Middle Rio Grande from Cochiti to Isleta diversion dam flows throughout the year, this section of the river has limited habitat, particularly for spawning and recruitment.

As a collaborative effort, the New Mexico Interstate Stream Commission (NMISC) has implemented habitat restoration to increase availability of effective floodplain habitat at varying river stages for inundation even in years of below average runoff. In 2006 and 2007, NMISC constructed a total of over 80 acres of habitat, incorporating both active and passive restoration techniques. Many heavily vegetated and elevated islands and bank-attached bars have been root plowed and lowered with constructed features that promote habitat diversity. Where allowed, bankline jetty jacks and/or bank-stabilizing vegetation have been removed in sections of the river to allow lateral movement and widening of the channel. Side channels and backwaters have been reconnected with the main channel. Monitoring of the habitat restoration sites has provided insights on fish behavior as well as preliminary indications of how the various restoration techniques are working. Since construction, monitoring of fish community, vegetation, geomorphology and hydrology was performed. Additional monitoring will provide further information on the effectiveness and longevity of the various restoration techniques employed by the NMISC.

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Presentation Type: Oral

Comparative effects of rotenone and antimycin on benthic macroinvertebrate diversity in two streams in Great Basin National Park

We used antimycin in Strawberry Creek and rotenone in Snake Creek to eradicate non-native trout as

part of a Bonneville cutthroat trout reintroduction program. These treatments followed standard piscicide application protocols and resulted in a unique opportunity to compare the effects of the two piscicides on macroinvertebrate community richness, density, and evenness over a short spatial and temporal window. Richness, density, and evenness of untreated sites were relatively constant over the study. Antimycin had minimal effects on macroinvertebrate diversity relative to rotenone. Rotenone significantly reduced richness, density and evenness. Maximum declines from pretreatment levels with rotenone were 86, 82, and 79% respectively. For rotenone treated sites, richness had not recovered at 1 year posttreatment, while density and evenness recovered between 1 and 9 months post treatment. Antimycin had no effect on richness or evenness and density increased at 9 months post treatment. Antimycin treated communities more closely tracked untreated reference sites than rotenone treated communities, further indicating greater effects of rotenone. We suggest that antimycin should be preferred over rotenone if minimizing impacts to macroinvertebrates is important. Recovery was relatively rapid with rotenone however and if short term impacts on macroinvertebrates are not a concern, rotenone use may be appropriate.

Hansen, Richard, New Mexico Department of Game and Fish, Fisheries Management Division, Box 25112, Santa Fe, NM 87504

Presentation Type: Poster

Mark retention of fin clipped tiger muskie

Fin clipping is a common and easy means of batch marking fish. Most researchers recognize that in many cases fins are regenerated to one degree or another. Numerous studies exist regarding fin regeneration in salmonids, percids, and centrachids. Fewer studies exist regarding fin regeneration of esocids, and more specifically tiger muskies (*Esox lucius* x *E. masquinongy*). As part of an ongoing study of biologic control of rough fish using tiger muskies, we conducted a mark retention assessment of fingerling tiger muskie at Rock Lake Hatchery, Santa Rosa, New Mexico. We fin clipped 66 4-month old tiger muskie and held them for 5 months in captivity to assess survival, growth, and mark retention. Fish with pectoral fin clips experienced decreased survival and growth when compared to pelvic marked fish. Pectoral fins regenerated rapidly with no scaring, and in most cases were indistinguishable from unclipped fins by the end of the study. Pelvic fins regenerated slowly and generally had observable scaring. Field observations at Quemado Lake, Catron County, New Mexico, appear to support these observations. During 4 years of conducting fin clipping of fingerling tiger muskie at this lake we have not recaptured one fish with a pectoral fin clip while pelvic fin clips have been detectable for up to 3 years post stocking.

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Presentation Type: Oral

Student Award Candidate

Crayfish, competition, and coexistence: Exploring interactions between native and invasive crayfish in Oregon's southern Willamette Valley

The Red Swamp Crayfish (*Procambarus clarkii*) is one of the IUCN's 100 Worst Invasive Species. It is present in Oregon's Willamette Valley along with the indigenous Signal Crayfish (*Pacifastacus leniusculus*). Both native and nonnative species of crayfish are aggressive habitat and dietary generalists, and are successful invasive species outside of their native range. Crayfish are largely dependent on shelter: they are prey items for many aquatic and terrestrial predators. We hypothesized that interactive effects between habitat, shelter availability, and interspecific competition could explain the mechanisms of this biological invasion. We performed 2x2x2 factorial, one-on-one behavioral trials for sex, and species of crayfish to determine the interspecific competitive relationship. We found that intraspecific behavioral patterns were similar for both species, however the invasive *P. clarkii* were superior competitors in matched, interspecific fights. We found that larger individuals were more successful in mismatched fights, regardless of species. To test the hypothesis that shelter availability and species composition affects shelter occupancy, we performed a 2x3 factorial mesocosm experiment with treatments for shelter density (high and low shelter density) and species composition. We discovered that there are significant differences in occupancy patterns for both species between conspecific only and conspecific + heterospecific(C+H) treatments, and that shelter availability alters these patterns in C+H treatments. Due to the paucity of knowledge on *P. clarkii* distribution, we employed an epileft design for our field survey that focused on areas of coexistence between both species of crayfish. We sampled water bodies at points (n=26) intersecting concentric circles with radii of 500m, 1km, and 1.5km at two regional field sites: Cox Creek (n=15 sub-sites) in Albany, OR and Amazon Creek (n=11 sub-sites) in Eugene, OR. Across both field sites, invasive *P. clarkii* were the dominate species, and they were substantially larger than the native crayfish.

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Presentation Type: Oral

The pragmatics of allocating water for stream flows

The perceived gulf between water as a property right and flowing water as a fundamental determinant of riverine ecosystems is wide. “Fish vs. Farmers” is a powerful, but counterproductive, mythology that must be set aside if the American Southwest is to transition to an accomodation of ecological water needs. This paper suggests that reality of this seeming conflict may be much smaller than generally perceived. Legal systems for allocating water were devised in an era when development of irrigation agriculture was a policy imperative. More recently, water policy makers and administrators have become aware of the need to make explicit legal protection for the natural water system, in order to avoid ecological catastrophe and the struggles over endangered aquatic species that precede it. The discourse has been difficult and charged with the sort of defensive posturing that often accompanies talk among parties with much at stake. Though progress has occurred, it has been painfully slow. Like rivers, irrigation agriculturalists are threatened by growing demand for municipal water supply and changing patterns of precipitation that accompany anthropogenic alteration of the planetary atmosphere. This coincidence of interest has created a political condition that offers potential avenues for cooperation to preserve both fish and farms.

This paper will examine the political and policy struggles surrounding passage of an environmental flow study through the New Mexico Legislature in March, 2009 and conclude that new forums for broadening the involvement of biologists, agriculturalists and public interest groups in making appropriate water policy changes are not only desirable but possible.

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Presentation Type: Oral

Fish assemblages of the Middle Rio Grande New Mexico and their relevance to restoration ecology

Humans have modified the hydrology of the Middle Rio Grande (MRG) for at least 400 years in attempts to overcome the limitations of drought and other problems associated with variations in water supply. Hydrologic manipulations designed to moderate the variability of flow in the Rio Grande have been extensive with profound consequences to the region's native fish populations. Over the course of history, 13 native fish taxa have been extirpated from the Rio Grande of New Mexico or have become extinct. Although extant in the MRG, the Rio Grande silvery minnow (*Hybognathus amarus*; silvery minnow) is listed as endangered by state and federal governments. Historic and contemporary fish collection records are reviewed to reveal limiting factors that may underlie silvery minnow populations and co-occurring assemblages of fish species in the MRG of New Mexico. Distributional and environmental data are combined with life history traits to assess how contemporary fish communities differ from random expectations to reveal ecological relatedness over a range of temporal, ecological, and geographic scales. Dispersal and environmental constraints contribute to distinct faunal patterns that vary along longitudinal and lateral axes. Information deficits presently preclude credible inferences about the determinative role of habitat in limiting silvery minnow population growth based on accurate information on the quantity and distribution of different habitats available to the species along with direct measures of the consequences of occupying different habitat types. To be effective, habitat improvement planning for species conservation must be based on information about factors that limit membership of the species community at various spatial scales and thereby point to specific intervention measures needed to achieve desired management objectives.

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Presentation Type: Oral

Trinity River restoration: Lessons learned

Construction projects to facilitate salmon restoration on the Trinity River, in Northern California, have changed greatly in form and function since the inception of the Trinity River Restoration Program more than 25 years ago. These changes have been driven by an evolving understanding of the workings of the river and failure of salmonid populations. Projects in the 1980's focused on building small spawning beds, side channels, and "pools". Over time, these projects failed; demonstrating that mechanical alteration

alone cannot create sufficient sustainable habitat. Populations of salmonids declined sharply around 1990 despite these earlier efforts. Pilot projects in the 1990's combined mechanical alteration (vegetation removal and sloping back banks) with modest flow releases in an effort to have the river build the needed salmon habitat. In 2000, a Record of Decision was signed establishing a more natural flood regime. 2004 saw the first bank rehabilitation constructed under the new restoration approach; major earthwork to create low, wide, flat floodplains with riparian re-vegetation on upper floodplain surfaces, but not near the bank. There was little geomorphic response to flood events and low utilization by juvenile or adult salmon. Construction projects in 2005 included large wood placements that were immediately used as cover for juveniles. Projects since 2006 have created greater diversity by adding micro-topography and high flow scour channels to floodplain surfaces and leaving large trees in place. Fry use these newly constructed flood plains during high flows and adjacent side channels as flows lower. Large wood and gravel placement encourages bank erosion, increases sinuosity, and transports gravel downstream. Salmon have spawned in these areas when fresh gravel and cover coincide. A new vision is emerging on how to design these various features, both individually and collectively, to integrate their function to best support geomorphic processes, riparian regeneration, and salmon recovery.

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Presentation Type: Oral

Biogeography and long-term conservation of fishes and aquatic habitats of the Pecos River drainage

The Pecos River is a major drainage basin of the Rio Grande region, where fish species endemism is relatively high. The unique regional fauna is due to a relatively high level of geographical isolation, habitat diversity, and temporal stability, particularly of spring-fed waters. At least 136 fishes are native to the Rio Grande region with at least 52 inhabiting the Pecos River drainage. The large majority either originated in situ or invaded from other portions of the Gulf of Mexico basin to the southeast. A few species invaded from the northeast, most likely from the Canadian River drainage (Mississippi River drainage, Gulf of Mexico basin). A few others invaded from the northwest (Colorado River drainage, Gulf of California basin). At least four species (*Gambusia nobilis*, *Cyprinodon bovinus*, *Cyprinodon elegans*, *Cyprinodon pecosensis*) are endemic to the Pecos River drainage. Given its , diversity, and relatively small human population, the Pecos River drainage is significant for conservation of fish diversity in the Rio Grande region. Nevertheless, portions of the drainage are heavily degraded. Humans have increasingly fragmented and diminished waters of the Pecos River drainage. At least 36 of the 52 native fishes (69%) are declining or extinct, not only from the Pecos River drainage, but from the entire Rio Grande region. In the Pecos River drainage, declining fishes are largely distributed among 9 strongholds varying from mountain to riverine to spring-fed habitats. Long-term viability of stronghold faunas will be critical for conservation of fish diversity in the Pecos River drainage. Unfortunately, humans have reduced if not eliminated presumed long-term refugia and remaining conservation strongholds either represent diminished relicts of refugia or are at best ad-hoc, short-term refugia. Efforts to secure and improve

remaining strongholds or restore degraded refugia will be paramount for long-term conservation of Pecos River fishes.

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Presentation Type: Oral

Removal of convict cichlids from Fairbanks Spring, Ash Meadows, Nevada using CFT legumine

Fairbanks Spring is a thermal spring on the Ash Meadows National Wildlife Refuge (Refuge) in southern Nevada. The spring discharges at four cubic feet per second, the water temperature at the main spring orifice is 27°C and the pH is around 7.9. Fairbanks Spring is home to the federally endangered Ash Meadows Amargosa pupfish (*Cyprinodon nevadensis mionectes*). Convict cichlids (*Amatitlania nigrofasciata*) were first observed on the Refuge at Fairbanks Spring in 2001. Although the pupfish were coping well with reproducing populations of other illegally introduced, nonnative species it was decided that the cichlids should be removed before they became established in other springs on the Refuge. After several years of unsuccessful trapping, the Ash Meadows Recovery Team initiated an eradication project using CFT Legumine. The springhead was treated at four parts per million (ppm) CFT Legumine with four booster stations along the outflow at a maximum of 1 ppm each. The springhead was also treated with pulses directly into the orifice every hour during each treatment. After three treatments, two cichlids were found alive, probably because they were able to find refuge near a series of small springs and had to be removed using traps. Surprisingly, however, we killed 100% of the mosquitofish (*Gambusia affinis*) in the spring and outflow with CFT Legumine. We had not achieved this using other rotenone formulations for treatments of similar springs elsewhere on the Refuge because mosquitofish were able to avoid contact with the chemical and gulp air during the treatment. Violent avoidance behaviors seen when using older formulations of rotenone were not triggered by CFT in any of the species treated at Fairbanks Spring. This could be a promising find considering the widespread and unwanted distribution of nonnative fishes.

Holmes, Nathan, 1742 west 1900 north, Farr West, Ut 84404; Christopher Hoagstrom, Ogden, Ut 84408

Presentation Type: Oral

Ecomorphological relations between *Cottus* species and their environment in northeastern Utah.

Factors inducing phenotypic plasticity of fishes are poorly understood. A recent study in middle North America revealed a relation between sculpin (*Cottus*) morphology and stream bottom velocity. We investigated this relation in 16 streams of northeastern Utah, but included 16 additional environmental variables, representing three spatial scales (mesohabitat, stream reach, watershed). We took 21 morphometric and two meristic measurements on all sculpin over 71 mm standard length, measuring a total of 373 individuals from 12 streams and 36 mesohabitats. Fifty-eight of these were mottled sculpin (*Cottus bairdii*) and 315 were Paiute sculpin (*Cottus beldingii*). Sculpin morphology varied substantially.

One principle component (PC; explaining 29% of variation) revealed disparity in robustness, mouth , and number of prickles among individuals and between species. Mottled sculpin were more robust with a larger mouth and more prickles. Another PC (explaining 11% of variation) revealed disparity in fin length, fin height, and head width among individuals but not between species. Environmental variables significantly explained morphological variation suggesting substantial phenotypic plasticity. Variation associated with the first PC was partly explained (r2 = 0.64) by brown trout (*Salmo trutta*) abundance, fish species richness, mottled sculpin abundance, and stream bottom velocity. Variation associated with the second PC was partly explained (r2 = 0.41) by Paiute sculpin abundance, mottled sculpin abundance, watershed area, brown trout abundance, water depth, stream bottom velocity, and substrate type. Overall, our results support the earlier study because stream bottom velocity influenced morphology. However, inclusion of additional variables substantially improved the explanatory model. In particular, biotic interactions (competition, predation) were important. Notably, nonnative brown trout were a substantial influence on sculpin morphology.

Hostetler, Steve, USGS, Department of Geosciences, Oregon State University, Corvallis, OR 97331; Jay Alder, Oregon State University, Corvallis, OR 97331; Andrea Schutez, Oregon State University, Corvallis, OR 97331

Presentation Type: Oral

Regional climate simulations for North America: Changes in the mean state and its variability under a doubling of CO^2

We are producing high-resolution simulations of the atmosphere and land surface under a doubling of atmospheric CO^2 ($2XCO^2$) using the RegCM3 regional climate model. Over North America, we are running the model on the 50 km grid adopted by the North American Regional Climate Change Assessment Program (http://www.narccap.ucar.edu/). Our model includes 23 vertical atmospheric levels, and a fully coupled land surface scheme (Biosphere-Atmosphere Transfer Scheme, BATS). Simulations for present and $2XCO^2$ are being run out for 50 years using boundary conditions derived from our coupled atmosphere-ocean general circulation model (GENESIS-MOM, A/OGCM) in an attempt to capture changes in the mean state, “normal” climate variability, and responses related to ENSO. We are also running shorter (10 yr), parallel simulations at 15 km resolution over the Pacific Northwest and Northern Rocky Mountains region. The modeling project is ongoing at this time. Our A/OGCM simulations, conducted at T31 resolution (about 3.75^o latitude by longitude grid), indicate substantial change in ENSO variability under differing levels of atmospheric CO^2: relative to the control, there is a 55% increase in the variability of sea surface temperatures in the Nino 3.4 region in our $2XCO^2$ simulations. The A/OGCM produces a Pacific decadal oscillation (PDO) and the results suggest slight changes in the statistics under $2XCO^2$. The regional model simulations reflect the climatic effects of their respective topographic resolutions. Results analyzed so far indicate general warming and drying over the West, but the changes are not uniform spatially and there is substantial variability of the direction of change within the seasonal cycle. Statistical tests on the first 20 years of the simulations indicate that significant changes in the mean states are somewhat limited over the West both spatially and temporally.

Hostetter, Nathan, Oregon State University, Department of Fisheries and Wildlife, 104 Nash Hall, Corvallis, OR 97331; Allen Evans, Real Time Research, Bend, OR 97702; Daniel Roby, USGS-Oregon Cooperative Fish & Wildlife Research Unit, Oregon State University, Corvallis, OR 97331; Ken Collis, Real Time Research, Bend, OR 97702; Mike Hawbecker, Real Time Research, Bend, OR 97702; Ben Sandford, National Marine Fisheries Service, Seattle, WA 98112

Presentation Type: Oral

Student Award Candidate

Relative vulnerability of threatened Snake River steelhead smolts to fish-eating birds nesting on the Columbia River

Piscivorous colonial waterbirds nesting along the Columbia River consume millions of juvenile Pacific salmonids (*Oncorhynchus* spp.) annually. To estimate predation rates by various bird colonies, we PIT-tagged, condition-scored, and released 16,268 steelhead (*O. mykiss*) smolts at two dams on the lower Snake River during smolt out-migration in 2007 and 2008. Of the 7,088 PIT-tagged steelhead released in 2007, surveys detected 13.5% on islands in the Columbia River with piscivorous waterbird colonies and 14.3% of the 9,180 steelhead released in 2008. When corrected for colony-specific PIT tag detection efficiency, we estimated at least 17.9% and 18.8% of PIT-tagged steelhead were consumed by piscivorous waterbirds in 2007 and 2008, respectively. After adjusting 2008 predation rates for smolt survival to the vicinity of bird colonies, Caspian Terns (*Hydroprogne caspia*) and Double-crested Cormorants (*Phalacrocorax auritus*) nesting near the mouth of the Columbia River consumed the largest proportion of available PIT-tagged steelhead smolts (16.0% and 6.4%, respectively), followed by Caspian Terns and Double-crested Cormorants nesting on islands in the mid-Columbia River (5.2% and 2.5%, respectively). In both 2007 and 2008, smolts exhibiting severe external damage or disease were more likely to be consumed by avian predators than undamaged smolts. For instance, in 2007, smolts exhibiting severe external damage or disease (n = 1,036) were 1.8 times more likely to be consumed by birds nesting along the mid-Columbia, compared to moderately or undamaged smolts (n = 6,052). In addition to condition-dependent selection, differences in smolt susceptibility to avian predators based on run-timing, rear-type (hatchery, wild), and fish length were also observed. These results indicate that impacts of avian predation on salmonid smolt survival differ by bird species and location, along with smolt condition and morphology. This condition-dependent vulnerability of smolts to avian predation may influence the efficacy of bird management to enhance smolt survival.

Hubert, Wayne, Wyoming Cooperative Fish and Wildlife Research Unit, Dept. 3166, 1000 E. University Ave., Laramie, WY 82071; David Banks, Wyoming Cooperative Fish and Wildlife Research Unit, Laramie, WY 820721; Robert Compton, Wyoming Game and Fish Department, Green River, WY 82414; Diana Sweet, Wyoming Game and Fish Department, Jackson, WY 83001

Presentation Type: Poster

Management problems to be confronted in preservation of bluehead suckers and flannelmouth suckers in small, headwater streams in Wyoming

Three small headwater streams in Wyoming with sympatric populations of bluehead suckers *Catostomus discobolus* and flannelmouth suckers *C. latipinnis* have been identified as waters where these species may be preserved within their native ranges. The streams are Muddy Creek in the Little Snake River watershed and Little Sandy Creek and the Big Sandy River in the Green River watershed. Recent research projects conducted at the University of Wyoming have identified management problems that need to be confronted for the continued persistence of native catostomids in the studied streams. The problems include genetic integration of the native catostomids with introduced white suckers *C. commersoni* and longnose suckers *C. catostomus*; competition between the native and the introduced catostomids; occurrence of small, isolated populations of the native catostomids; and predation by introduced burbot *Lota lota* affecting recruitment of native catostomids. The severity of the management problems will be discussed along with management alternatives for both the near term and the long term.

Hughes, Robert, Oregon State University, USGS Arizona Cooperative Fish and Wildlife Research Unit, 104 Biological Sciences East, University of Arizona, Tucson, AZ 85721; R. Curry, University of New Brunswick, Fredericton, NB ; Mark McMaster, Environment Canada, Burlington, ON ; David Zafft, Wyoming Game and Fish Department, Laramie, WY 82070

Presentation Type: Poster

Sampling coldwater fish in rivers

We established standard sampling methods for fishes in large, coldwater rivers, most effectively and safely sampled from a boat or raft. Such rivers have wadeable riffles, bars, and shorelines, but are generally unwadeable, 10-100 mean wetted channel widths wide, with average summer temperatures < 20C. Waters are oligotrophic, but can vary in color from clear to highly stained and low to high turbidity. Our methods focus on salmonids, cottids, and catostomids, but there are many other species that will be encountered in coldwater rivers. Effective sampling of fishes in coldwater rivers often requires the use of multiple gears or extensive sampling effort with a single gear. There are four standard methods to consider when establishing a standardized sampling protocol: (1) electrofishing by boat or raft, (2) seining, (3) gill netting, and (4) snorkeling. Electrofishing by boat or raft effectively captures fishes with minimal mortality or injury to the fishes. It allows long reaches to be sampled relatively quickly and most safely. Seining on beaches, riffles, or bars is an effective technique for collecting smaller individuals residing in shallow, obstacle free habitats. It can be more efficient than electrofishing. Gill netting can effectively sample many different habitats and may be the only gear that can be employed in remote rivers with minimal access. With appropriate nets and short fishing times, gill netting can have minimal lethality for some species. Snorkeling can be effective in clear waters inhabited by larger, easily-identified fish. It is the preferred method in rivers with excessive obstacles for electrofishing and in situations where non-lethal sampling is required. Effective sampling will always depend on the river and study questions and safety training is essential. We recommend these four techniques singly or in combination as a standardized sampling protocol for coldwater fishes in large rivers.

Isaak, Dan, US Forest Service, 322 E. Front St., Suite #401, Boise, ID 83702; Charles Luce, US Forest Service, Boise, ID 83702; Bruce Rieman, US Forest Service (retired), Boise, ID 83702; Erin Peterson, CSIRO, Indooroopilly, AU ; David Nagel, US Forest Service, Boise, ID 83702

Presentation Type: Oral

Downscaling climate and wildfire effects to assess thermal gains in stream networks: a case history from a central Idaho watershed

Mountain streams provide important recreational fisheries and some of the best remaining habitat for salmonid species of regional importance. A warming climate will bring unprecedented changes to these streams, with temperature considerations being of utmost importance, given that most aquatic organisms are ectothermic. Previous assessments of climate impacts on streams have relied on surrogate air temperature relationships rather than modeling stream temperatures directly because of difficulties associated with downscaling in complex terrain. We compiled a stream temperature database (n = 780) from 1993–2006 for the 6,900 km2 Boise River watershed in central Idaho to assess trends in summer stream temperatures and thermal habitat for two native trout species. New spatial statistical models that account for network topography (i.e., flow direction and volume) were parameterized with these data and explained ~90% of the variation in mean summer stream temperatures. During our study period, we estimate that basin averaged mean summer stream temperatures increased by 0.38°C (0.27°C/decade), primarily due to gradual, but long-term (30 – 50 year) trends in air temperatures and stream flows. Within the 14% of the basin that experienced wildfires after 1993, stream temperature increases were 2 – 3 times larger than basin averages. Thermal habitat for rainbow trout was minimally affected by stream temperature increases, but bull trout habitats are decreasing by ~1% per year. If past climate trends continue, we project that 39% - 63% of bull trout habitat will be lost by the year 2056. Our results suggest global warming has begun to affect stream temperatures and thermal habitat distributions in the Boise River watershed. Similar warming is likely in many western streams, given recent regional climate trends, but impacts will be both species and context specific. Accurate predictions of current and future thermal conditions will be necessary to inform effective stream management.

Jacks, Stewart, U.S. Fish & Wildlife Service, AZ Fish & Wildlife Conservation Office, P.O. Box 39, Pinetop, AZ 85935; Steve Sharon, WY Game & Fish Department, Casper, WY 82601; David Britton, U.S. Fish & Wildlife Service, Albuquerque, NM 87103; Ron Kinnunen, MI Sea Grant, Marquette, MI 49855; Doug Jensen, MN Sea Grant, Duluth, MN 55812; Scott Smith, U.S. Geological Survey, Seattle, WA 98115

Presentation Type: Poster

Controlling the spread of invasive species while sampling

Invasive species have had a huge impact on natural resource management. The economic cost of invasive species to Americans is an estimated $137 billion annually. The environmental cost is much

greater. Nearly half of the species federally listed in the United States' Endangered Species Act are threatened or endangered primarily as a consequence of invasive species that directly prey on native species or out-compete them for limited resources. If our focus is limited to specific projects we may overlook the broader ramifications of our actions and unintentionally contribute to the invasive species problem. This poster focuses on measures that should be taken to prevent, minimize, or control the spread of invasive species in the routine work we do as natural resource professionals. A fundamental responsibility of fishery professionals is to identify the points in our activities where proactive measures are necessary to stop the possible spread of invasive species. The movement of field gear/equipment can potentially provide a pathway for the introduction of invasive species. The most effective control method is simply to avoid moving gear and equipment from one location to another. If it is not possible to have multiple gear sets for different waters, it is critically important to decontaminate sampling equipment, boats, and other gear to a level that will eliminate most invasive organisms. This poster provides a guide to the processes and procedures available to minimize the movement of invasive species during field activities. The techniques in this chapter will increase time and cost of field activities when implemented. However, time and cost applied in prevention is far more cost effective than removal of an invasive species. As stewards of the resource, it is our responsibility to first protect the resource during our activities and then educate the public of these threats as well.

Jacobi, Jerry, NMHU (retired) and Jacobi and Associates, 2314 Calle Colibri, Santa Fe, NM 87505

Presentation Type: Oral

Benthic macroinvertebrate bioassessment of Upper Comanche Creek (Costilla Creek Watershed), Valle Vidal, Carson National Forest, Taos County, New Mexico, USA before and after treatment with rotenone.

Benthic macroinvertebrates (stream bottom dwelling organisms) were collected as part of a monitoring project to observe the effects of a piscicide (50ppb active rotenone) on non-target organisms before treatment (August 2007), immediately after (September 2007), and one-year after (August 2008). Organisms were collected from riffles at four treatment locations, one location downstream of the neutralization application (downstream of a barrier), and two untreated control locations. Major decreases in macroinvertebrate standing crop (density), number of total taxa, and number of sensitive mayfly, stonefly, and caddisfly taxa (EPT) were observed at treatment locations two weeks after treatment; the greatest decreases were noted at the upper treatment location. One year after treatment, standing crop, number of total taxa, and number of EPT taxa had increased; at some locations approaching or exceeding pre-treatment observations.

Johnson, Chris, Methow Salmon Recovery Foundation, PO Box 1082, Twisp, WA 98856; Jennifer Molesworth, Bureau of Reclamation, Twisp, WA 98856; Greg Knott, Methow Salmon Recovery Foundation, Twisp, WA 98856

Presentation Type: Poster

Salmon recovery from the gravel up: An example of community based habitat restoration and protection in

rural eastern Washington.

The Methow Valley is a rural community on the east slopes of the North Cascades in Washington State. Beginning in 1998 Endangered Species Act listings of spring Chinook salmon, steelhead and bull trout led to scrutiny of land use practices such as irrigation. This increased scrutiny led to temporary closure of irrigation ditches, a national media event, local anger, distrust and resentment of government intrusion into the community. Confusion, legal battles, and desperate attempts to fix anything ensued. Public and county government insisted that Salmon Recovery planning be "grass roots" efforts supported by state watershed planning and salmon recovery funding sources. Gradually, "gravel- up" or local based cooperation and a strong desire to protect the environment and way of life have led to collaboration and community based salmon recovery efforts. Landowners, local residents and public officials living in the community are determined to help create a sustainable economy and environment . This is being accomplished through cooperation and practical solutions to fish passage, improved irrigation practices and instream flows, habitat restoration and protection of farm lands and riverine habitat benefitting fish, wildlife, agriculture, and recreation. One outcome is the Methow Restoration Council, a voluntary, informal coordinating forum where project proponents, permitting agencies, and potential funders share salmon recovery ideas and funding opportunities, solve problems, plan projects and track progress. Today habitat protection and restoration efforts are in full swing and have become an important part of the local economy with broad support from the community. This poster presentation will provide an illustration of our success story from the Methow Valley.

Johnson, Jennifer, U.S. Fish and Wildlife Service, PO BOX 39, Pinetop, AZ 85935; Jeremy Voeltz, U.S. Fish and Wildlife Service, Pinetop, AZ 85935

Presentation Type: Oral

Evaluation of brown trout removal on the Fort Apache Indian Reservation

In an ongoing effort to remove brown trout *Salmo trutta* from streams which hold critical populations of Apache trout *Oncorhynchus apache*, the Arizona Fish and Wildlife Conservation Office with assistance from the White Mountain Apache Tribe conducted mechanical removal of brown trout from Crooked Creek, Little Bonito Creek, and Squaw Creek which are located on the Fort Apache Indian Reservation. Brown trout still reside in these three streams in which chemical renovations failed, and co-habit these streams with Apache trout. Removal efforts were conducted on Crooked Creek in 2003-04, 2006-08, Little Bonito Creek in 2003, 2006-08 and on Squaw Creek in 2006-08. We evaluated whether several years of mechanical removal could reduce or eliminate brown trout populations and reduce mean brown trout length. In addition in 2007 and 2008, we evaluated the effectiveness of multiple-pass electrofishing in reducing brown trout abundance.

Kaufmann, Philip, U.S. Environmental Protection Agency, 200 SW 35th Street, Corvallis, OR 97333; Sandra Bryce, Dynamac Corportation, Corvallis, OR 97333; Gregg Lomnicky, Dynamac Corporation, Corvallis, OR 97333

Presentation Type: Oral

Use of survey data to develop sediment criteria for protecting aquatic vertebrates in mountain streams.

We examined the relationship of aquatic vertebrate taxa abundances and an index of biotic integrity (IBI) to reachwide measures of areal percent streambed surficial fines (≤ 0.06 mm) and sand and fines (≤ 2 mm), based on data collected from 557 wadeable streams in the Western Mountain region of the U.S. as part of the recent National Wadeable Streams Assessment (NWSA) carried out by the U.S. EPA and States. Four-person crews typically completed NWSA biotic assemblage and habitat sampling in 6 to 8 hours of field time per site. Quantile regression predicted a 5.3% decline in the potential maximum vertebrate IBI for each 10% increase in areal percent fines, and a 4.5% decline in potential IBI for each 10% increase in the combined percentage of sand and fines. To identify possible impairment thresholds along these continuous linear relationships, we examined 1) the range of areal percent fines and areal percent sand and fines values at 169 least-disturbed reference sites in our sample; 2) sediment tolerance values calculated for a selection of sediment-sensitive aquatic vertebrate taxa for both particle classes; and 3) a literature review of the effects of sand and fines on the survival of salmonid eggs to hatching. Based on this combined information, we concluded that minimum-effect sediment thresholds for fines (≤ 0.06 mm) and sand and fines (≤ 2 mm) for the group of sediment-sensitive aquatic vertebrates were 5% and 13%, respectively. We offer these results as scientific guidance for the process of establishing sediment criteria.

Keefer, Matthew, University of Idaho, Department of Fish and Wildlife Resources, Moscow, ID 83844-1141; Mary Moser, National Marine Fisheries Service, Seattle, WA 98112; Christopher Peery, US Fish and Wildife Service, Ahsahka, ID 83520; Charles Boggs, University of Idaho, Moscow, ID 83844; Eric Johnson, University of Idaho, Moscow, ID 83844; Christopher Caudill, University of Idaho, Moscow, ID 83844

Presentation Type: Oral

Size matters: phenotypic and environmental effects on adult Pacific lamprey migration in the Columbia River

Anadromous Pacific lampreys (*Lampetra tridentata*) along the west coast of North America have experienced broad-based population declines and regional extirpations. In response to precipitous declines in the interior Columbia River basin, we conducted a large-scale (n ~ 5,200) adult lamprey tagging program from 2005-2008. A combination of radiotelemetry and PIT tag studies and a retrospective analysis of lamprey visual counts at hydroelectric dams was used to evaluate associations between upstream escapement and adult lamprey migration behaviors, migration timing patterns, and a suite of environmental factors. From the lamprey count data we learned that pre-spawning migration was earliest in warm, low-discharge years and later in cold, high-flow years. Within each year, migration rate of tagged lampreys was positively correlated with water temperature and negatively correlated with river discharge. These findings suggest considerable environmental control of upstream migration. In contrast, lamprey escapement through multiple study reaches was most strongly associated with fish , with the largest lampreys being 2–4 times more likely to pass upstream than the smallest fish. Multi-model

selection indicated that lamprey was far more associated with upstream escapement than river discharge, water temperature, or migration timing variables. We conclude that phenotype, specifically body s, may influence Pacific lamprey migration distance and eventual spawning distribution. Fine-scale behavioral monitoring using radiotelemetry at Columbia River dams identified several areas of difficult lamprey passage, including near high-velocity fishway entrances. The combined results have substantially broadened our understanding of Pacific lamprey behavior at the scale of local migration obstacles (e.g., individual hydropower dams) and large river reaches (i.e., up to 300 km) and should inform Pacific lamprey management and conservation strategies throughout the species' range.

Kennedy, Tom, University of New Mexico, MSC 03 2020, 1 University of New Mexico, Albuquerque, NM 87131; David Gutzler, University of New Mexico, Albuquerque, NM 87131; Ruby Leung, Pacific Northwest Natinal Laboratory, Richland, WA 99352

Presentation Type: Oral

Student Award Candidate

Predicting future threats to the long-term survival of Gila trout using a high-resolution simulation of climate change

Regional climates are a major factor in determining the distribution of many species. Anthropogenic inputs of greenhouse gases into the atmosphere have
been predicted to cause rapid climatic changes in the next 50–100 years. Species
such as the Gila trout (*Oncorhynchus gilae*) that have small ranges, limited dispersal
capabilities, and narrow physiological tolerances will become increasingly susceptible
to extinction as their climate envelope changes. This study uses a regional climate
change simulation (Leung et al., Clim Change 62:75–113, 2004) to determine changes in the climate envelope for Gila trout, which is sensitive to maximum temperature, associated with a plausible scenario for greenhouse gas increases. These regional climate changes are downscaled to derive surface temperature lapse rates using regression models. This procedure indicates that suitable, warm season habitat for Gila trout will be reduced by 70% by decreasing the of their climate envelope. Warmer temperatures coupled with a decrease in summer precipitation would also tend to increase the intensity and frequency of forest fires that are a major threat to their survival. The climate envelope approach utilized here could be used to
assess climate change threats to other rare species with limited ranges and dispersal
capabilities.

Kinzli, Kristoph-Dietrich, Colorado State University, Colorado State University, 1372 Campus Delivery, Fort Collins, CO 80523; Christopher Myrick, Colorado State University, Fort Collins, CO 80523

Presentation Type: Oral

Student Award Candidate

Bendway weirs: Would they aid the recovery of the endangered Rio Grande silvery minnow

Rehabilitation of the Middle Rio Grande River in central New Mexico river rehabilitation has become necessary to mitigate the effects of over a century of water and land development. The major concern for restoration involves the federally-endangered Rio Grande silvery minnow (*Hybognathus amarus*; RGSM). Bendway weirs, erosion control and channel-stabilization structures placed transverse to the channel flow, have been used to prevent river migration while enhancing aquatic habitat. Habitat improvement plans on the Middle Rio Grande include the installation of bendway weirs, but the potential benefits of these structures for Rio Grande silvery minnow are unknown. We conducted a theoretical study on the flow conditions created by Bendway weirs to determine if it is possible to create physical habitat for RGSM while simultaneously protecting the riverbank. Our study suggested that Bendway weir installation could lead to the reduction of downstream displacement of RGSM eggs, the creation of RGSM feeding and refugia habitat, and the creation of drought/low flow habitat through scour hole formation. We also noted that the weirs could also serve as potential habitat for predators, and suggest further studies to determine the full impact of Bendway weir installation.

Kodric-Brown, Astrid, University of New Mexico, Department of Biology, MSC 03 2020, University of New Mexico, Albuquerque, NM 87131; Christopher Hoagstrom, Department of Zoology, Weber State University, Ogden, UT 84403; James Brooks,
USFWS New Mexico Fish and Wildlife, Albuquerue, NM 87131

Presentation Type: Oral

Fish assemblages of sinkholes in the lower Pecos River Basin of New Mexico

We examined factors associated with the structure of fish assemblages in sinkholes at Bitter Lake National Wildlife Refuge and Bottomless Lakes State Park in New Mexico. The data base consisted of presence/absence of nine native species in 34 sinkholes, along with abiotic environmental variables for these sinkholes. Size of sinkhole and abiotic factors, especially salinity, are the primary determinants of community structure. Fish species richness increases with sinkhole area and decreases with salinity. The communities are highly nested, with Pecos pupfish (*Cyprinodon pecosensis*), a generalist species with a high salinity tolerance occurring in all sinkholes.

Koons, Wendy, Upper Salmon Basin Watershed Program, Upper Salmon Basin Watershed Program, 955 Riverfront Drive, Suite B, Salmon, ID 83467

Presentation Type: Poster

Iron Creek reconnection and habitat restoration: A multi-agency cooperative partnership to restore fish habitat in the Upper Salmon Basin

In the upper Salmon River sub-basin of Idaho, road culverts, irrigation diversions, and water withdrawals delay or impede fish from migrating between the Salmon River and its tributaries. The majority of tributaries in the basin are at least seasonally disconnected, while others have been rendered permanently disconnected. Between the East Fork Salmon and North Fork Salmon Rivers, a distance of 206 km (128 river miles), only three tributaries are connected to provide rearing habitat and thermal refuge for anadromous and resident salmonids. Through the collaborative efforts of a landowner, teamed with federal, state and local conservation and natural resource agencies, Iron Creek, a tributary to the main-stem Salmon River, and one of three aforementioned tributaries, was recently reconnected to provide ESA-listed and resident fish species an important thermal refuge and year-round access to high quality aquatic habitat. Initial planning began in early 2003, and culminated with the closure of the four lower-most irrigation diversions on the creek in 2007. These four diversions accounted for 5.43 cfs (more than one-third of the creeks total water rights), previously withdrawn for flood irrigation. By utilizing multiple federal and state funding sources, combined with landowner in-kind cost share, more efficient agricultural practices and conservation methods were implemented to improve riparian condition, water quality and stream flow for aquatic species, and subsequently provide more efficient irrigation water delivery and application for the landowner. The biological benefits of reconnecting Iron Creek are significant due to its potential to support high numbers of ESA-listed anadromous and resident/fluvial salmonids.

Koons, Wendy, Upper Salmon Basin Watershed Program, Upper Salmon Basin Watershed Program, 955 Riverfront Drive, Suite B, Salmon, ID 83467

Presentation Type: Oral

Playing well with others: Sixteen years of cooperative partnerships to improve aquatic habitat for ESA-listed fish in Idaho’s upper Salmon Basin

The combined drainage of the Upper Salmon Basin (USB) of Idaho is approximately 4,043,261 square miles, encompassing an area from the headwaters of the Salmon River to the Middle-Fork Salmon, including the Yankee Fork, East Fork Salmon River, Pahsimeroi River and Lemhi River watersheds. Nearly 95% of the land within the Basin is owned and managed by the federal government. However, 90% of the river bottoms and remaining occupied salmon habitat is privately owned. Thus, a disproportionate share of the responsibility for recovery of ESA-listed species falls upon private landowners. In 1992, recognizing the ramifications of unchecked habitat impairment for ESA-listed fish, conservation-minded landowners in the USB joined forces with resource professionals, resulting in the Idaho Model Watershed Project, which later became the Upper Salmon Basin Watershed Program (USBWP). This collaborative effort aims to screen irrigation diversions, improve riparian habitat and water quality, remove migration barriers, augment stream flows and restore aquatic habitat. Combining innovative and progressive concepts with funding and technical support from Federal and state agencies, non-governmental organizations, and private landowners, nearly 600 restoration projects have been implemented since 1992, improving over 500 miles of instream habitat and protecting nearly 400 stream

miles of adjacent riparian buffer. Today, these efforts continue through cooperating landowners working with the USBWP's Technical Team; a unique group of Federal, state and local natural resource professionals whose expertise is crucial in identifying impacts of land and water management practices on aquatic habitats, and subsequently evaluating potential restoration measures. By analyzing available passage and aquatic habitat as indicators of success, rather than fish density and productivity, monitoring data indicates initial restoration objectives are being met. However, long-term, significant improvement in populations of ESA-listed anadromous species within the USB will likely be dependent upon alterations in downstream limiting factors beyond the control of USBWP efforts.

Korson, Chuck, DOI, Bureau of Reclamation, Klamath Basin Area Office, 6600 Washburn Way, Klamath Falls, OR 97603

Presentation Type: Oral

Chiloquin Dam Removal: Habitat restoration in the Upper Klamath Basin, Oregon.

The Department of Interior recently implemented a major habitat restoration action by removing Chiloquin Dam on the Sprague River, Oregon. Bureau of Reclamation and Bureau of Indian Affairs worked on behalf of the Department to complete this ambitious 6-year project and provide unimpeded upstream and downstream passage conditions for endangered shortnose (*Chasmistes brevirostris*) and Lost River (*Deltistes luxatus*) suckers endemic to the Upper Klamath Basin. Reclamation and BIA worked in collaboration with several Upper Basin stakeholders to conduct biological, sediment, and hydrological studies to inform the alternative decision making process, leading to the collaborators consensus support for dam removal. Modoc Point Irrigation District, private owners of the irrigation diversion dam, and displaced water users received new pumping facilities to allow for continued irrigation deliveries and a mitigation fund to compensate for new power and long term operation and maintenance costs. The successful completion of the project is one step forward to help recover endangered sucker populations in the Upper Basin.

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Presentation Type: Oral

Evaluating genetic purity and genetic structure of interior Redband trout in the Idaho

Management and conservation of native, redband trout *Oncorhynchus mykiss* gairdneri is an important priority for many state and federal agencies due to dramatic population declines throughout its historical range. A common goal among agencies is to achieve long-term sustainability of viable fish populations. To obtain this goal, an understanding of genetic purity, genetic diversity, genetic structure, and their relationship to habitat features and anthropogenic modifications are needed. In this study, we used thirteen nuclear microsatellite loci and nuclear SNPs to examine levels of genetic diversity, genetic purity,

and genetic structure in both high-mountain and desert stream populations in Idaho. As well as characterizing diversity and purity, a Mantel test was used to determine the association between genetic distance and geographic distance and to test for differences in genetic structure between the environmental extremes. We hypothed significant spatial structuring at a hierarchical stream network scale and that populations within desert environment would be more structured and have lower levels of genetic diversity than those in the mountains due to intermittent water levels. These data will provide essential information on how genetic variation is partitioned in contrasting environments and guide managers in future prioritization and restoration of redband trout throughout its range.

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Presentation Type: Oral

Student Award Candidate

Using Geographic Information Systems to delineate native fish and sport fish management areas in the Verde River watershed, Arizona

There is an increasing need in the Southwestern United States for development of watershed-level fisheries management plans that incorporate both native fish conservation and sport fishing opportunities. This project provides a basis for the development of a watershed-level fisheries management plan for the Verde River watershed in Arizona by utilizing Geographic Information Systems (GIS) to build a landscape level view of fisheries resources in the watershed. The current process for developing watershed level fisheries management plans in Arizona involves dividing the watershed into native and nonnative fish management units and requires substantive discussion, collaboration, and time. GIS offers tools to reduce conflict between native and nonnative fish while streamlining the decision making process. A GIS data framework can delineate discrete management units with specific management emphasis (e.g. native fish, sport fish, or other aquatic wildlife) by identifying anthropomorphic, geologic, hydrologic, and biologic isolating mechanisms between management units. Using the Verde River watershed as a model, this project provides a framework for fisheries managers of other watersheds that will reduce conflict between native fish and nonnative fisheries.

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Presentation Type: Poster

Southwest rgional rsk assssment for whirling disease in native salmonids

Recent decades have witnessed the decline of native fishes throughout the southwest from widespread anthropogenic landscape alterations to the introduction of non-native species. Many of the native salmonids are represented by fragmented populations sparsely scattered throughout remaining habitat restricted to high elevation streams. Of particular interest is the relatively recent introduction and spread of the parasite *Myxobolus cerebralis* and its potentially devastating effects on imperiled native salmonids. This pathogen has been identified throughout the southwest region of the U.S. exhibiting epizootic levels in non-native salmonid populations. Thus, the most devastating potential of infection by the parasite to native fish conservation and recovery efforts lies in the threat it poses to native salmonids. State fishery managers have requested a tool to aid in formulating strategies to prevent the spread of the parasite and assist in mitigation efforts. Spatial data for the risk assessment included known distribution records of Rio Grande cutthroat and Colorado River cutthroat trout, drainage networks, elevation and stream gradient, land use, and road networks. We overlaid data for waters tested for M. cerebralis with severity of infection. In addition, we included overlap with non-native trout and where disease testing has been initiated to delineate parasite sinks and vectors for parasite transmission. We completed one complete exposure pathway, migration of infected fish, as the conceptual model and found that of 141 isolated populations, 42 (30%) are at high risk of whirling disease, 30 (21%) are at medium risk, and 69 (49%) are at low risk. When these risk scores are compared to the streams of known infection, 45% of high risk streams are infected with only 3% of medium and low risk streams showing infection. Using a Bayesian network that incorporates uncertainty, we used habitat, migration and physical factors to calculate risk of disease to Colorado River cutthroat trout.

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Presentation Type: Oral

Identification of ecologically relevant fish hosts for Texas hornshell, *Popenaias popeii*, (Bivalvia: Unionidae)

The obligate reliance of freshwater mussels on fish hosts of glochidia creates significant complications in understanding mussel life history, demography, and development of effective conservation strategies. The typical approach for identifying these hosts is via laboratory trials that identify potential host species, but do not reveal which of these species are actually used by mussel populations. Laboratory trials identified 23 of 30 species as potential hosts for *Popenaias popeii*. We conducted repeated surveys of fishes from the Black River, NM, to determine which species were infested with *P. popeii* glochidia, and to measure the prevalence and intensity of infestations. We calculated an “ecological host index” that integrates fish abundance with infestation prevalence and intensity. We observed a total of 2658 fishes representing 6 orders, 9 families, and 21 species during ichthyofaunal surveys from 2005 to 2008. Of this catch, 249 individuals (9.4% comprising 3 orders, 5 families, 12 species) exhibited cysts consistent with glochidial infestations. Three species of catostomids (*Carpiodes carpio, Cycleptus elongates, Moxostoma*

congestum) had relatively low-to-moderate abundance, moderate-to-high prevalence, and high intensity of infestations; one cyprinid, *C. lutrensis*, had moderate abundance, high prevalence and high intensity. All other species had low abundance or prevalence, and low intensity. *Carpiodes carpio, M. congestum*, and *C. lutrensis* had much higher ecological host indices than any other species. Infestations on benthic-dwelling catostomids occurred on the face and operculum, while more pelagic species (*C. lutrensis*, *Lepomis* spp.) were infested on the gills. We conclude that the list of ecologically relevant host species is much smaller than the list of potential hosts identified in laboratory trials. Successful conservation and restoration of freshwater mussel populations will require the presence of this much smaller set of host species.

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Presentation Type: Poster

Student Award Candidate

Habitat use and overlap of roundtail chub and lake trout in two glacial lakes, Wyoming

The roundtail chub *Gila robusta* is an endemic species in the Colorado River basin that has declined throughout much of its range. Within Wyoming, lakes of the upper Green River drainage are one of the few places where roundtail chub remain abundant. However, predation from introduced lake trout Salvelinus namaycush may pose a threat to the persistence of these lentic populations of roundtail chub. We investigated habitat use of roundtail chub and lake trout in two lakes during periods of thermal stratification and non-stratification, and assessed the diet of lake trout to determine if predation on roundtail chub is prevalent. Gill nets were set in five zones to describe habitat use: (1) littoral zone with cover, (2) littoral zone without cover, (3) benthic zone, (4) pelagic zone at the surface, and (5) pelagic zone below six meters. Roundtail chub were concentrated in the littoral zone and were rarely captured elsewhere. Thermal stratification had little effect on the distribution of roundtail chub. Lake trout were broadly distributed across the littoral and benthic zones when lakes were not thermally stratified. After stratification, lake trout were seldom captured in the littoral zone. Results indicate that roundtail chubs and lake trout habitat use overlaps only when water temperatures are cool and the lakes are not thermally stratified. We are analyzing lake trout stomachs to determine the prevalence of roundtail chub in the diet.

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Presentation Type: Poster

Student Award Candidate

Manipulation of sport fish growth to reduce mercury bioaccumulation on a whole-lake scale

Mercury (Hg) contamination is a known concern for human health worldwide, and is particularly harmful to the nervous system during fetal and early child development. Integration of Hg into aquatic food webs results in contamination levels in fish that are high enough to present health concerns for fish consumers. Resource and sampling limitations have hindered a comprehensive understanding of Hg dynamics in aquatic systems, however, several processes influencing Hg contamination in sport fish have been studied extensively. As a result, many management actions to reduce Hg concentrations in sport fish have been suggested and some have been conducted and evaluated. Here we describe whole-lake study assessing the efficacy of stocking rainbow trout (*Oncorhynchus mykiss*) relatively high in energy density and low in Hg concentration as a means of increasing growth in a northern pike (*Esox lucius*) population to reduce Hg concentrations. A pond component of the project served as a reference and also to evaluate the relative importance of manipulating northern pike densities to increase growth rates and reduce Hg concentrations. We used this project as a teaching opportunity for students as well as faculty. This was a large collaborative effort with resources (including rainbow trout, personnel and equipment), being donated from Colorado Division of Wildlife, Colorado State University (CSU) Faculty and graduate students, CSU-AFS Student Chapter, CSU Zoology Club, Bellvue-Watson Hatchery and private citizens. This project contributed to the development of future fisheries scientists and provides insight into the feasibility of two management strategies aimed at reducing Hg concentrations in sport fish harvested for consumption by anglers and their families.

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Presentation Type: Poster

Sampling coldwater fish in small standing waters of North America

This poster describes standard techniques for sampling coldwater fishes in small standing waters (i.e.< 200 ha surface area). To obtain a reliable index of species abundance, sampling should be conducted during summer when lakes are thermally stable and fish are not congregated due to spawning activity. Thermal stratification during summer implies that optimal temperatures for coldwater species vary with depth and therefore a depth-stratified sampling design is needed. Because target species vary in terms of their association with benthic and pelagic zones, a gear that can sample both habitats is needed. The recommended gear is a sinking gillnet with mesh bar of 19, 25, 32, 38, 44, 51, 57, and 64 mm and corresponding monofilament diameter of 0.28, 0.28, 0.33, 0.33, 0.33, 0.40, and 0.40 mm. A standard gang is ~25 m in length (8 panels x 3.1 m). Net height is 1.8 m for benthic sampling and 6 m for pelagic sampling. Nets are set late afternoon and retrieved the following morning, so that the sample period encompasses both crepuscular periods. For sensitive populations, 2 hr sets during daylight may be used instead, so that fish are more likely to survive after capture. The gillnetting standards described here are compatible with standards proposed for sampling coldwater and warmwater fish in other types of North American waters. The North American gillnet (mesh = 19 to 64 mm) differs from the European standard

(mesh = 6 to 55 mm). Selectivity of the North American net focuses on trout in the approximate length range of 190-650 mm total length. In contrast, the European net targets smaller fish (60 – 550 mm). A different set of meshes was selected because management agencies in North America generally have objectives that target the length of fish typically harvested by anglers.

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Presentation Type: Oral

Forage species in the Gulf of California pelagic ecosystem

Understanding trophic flow dynamics is a key element of the ecosystem approach to fisheries management. This includes the description of food web structure, and the type of energy-control prevailing in the system. The pelagic ecosystem of the Gulf of California is a sea of great importance to Mexico in terms of fish production and conservation. The sea has been traditionally described as a highly productive system, mostly controlled by forage species, such as sardine and anchovy. By compiling information on the feeding habits of large pelagic predators (fish, seabirds, marine mammals) inhabiting the gulf, we show that there are several energetic pathways between primary producers and top predators, and that alterations among these pathways may be climate driven. We discuss potential impacts of sardine, giant squid, and tuna fisheries on the food web structure of this pelagic ecosystem.

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Presentation Type: Oral

Overcoming habitat limitations in managing for the recovery of endangered Rio Grande silvery minnow (*Hybognathus amarus*) population in the middle Rio Grande, New Mexico

Selecting habitat enhancement activities to benefit endangered species often requires a focus on habitat features linked to critical life-history strategies that supported viable populations through historical periods of environmental extremes. Flooding and channel desiccation continue to dominate the habitat extremes in the Middle Rio Grande (MRG) of New Mexico. The consequences that these events produce on habitat have markedly changed between historical and contemporary times. These changes are due to major geomorphic alterations in channel connectivity with the floodplain and to groundwater. Numerous descriptions have been published characterizing the present-day relationship of the state and federal listed endangered Rio Grande Silvery Minnow (*Hybognathus amarus*; silvery minnow) to quantitative and qualitative habitat conditions in the MRG. Limited attention has been paid to how their evolutionary adaptations to habitat extremes have contributed to population viability. Two practical questions can help direct attention to habitat restoration planning priorities for silvery minnows: What are the underlying determinants of their habitat occupancy? And, how can MRG geomorphic and hydraulic processes be

manipulated to better achieve their management goals? The answers lead us to propose a spatial classification of contemporary habitat features along the MRG based on the nature and location of properly or adequately functioning, and degraded habitat reaches. The answers also point to key habitat restoration priorities for select river reaches. These include improving the coupling of the river to the floodplain and establishing deeper-water refugia during channel drying.

Martinet, Maceo, Marilyn Myers and Jason Remshardt, U.S. Fish and Wildlife Service, 2105 Osuna NE, Albuquerque, NM 87113

Presentation Type: Oral

Environmental Flows - ecological principles, application, and lessons from New Mexico

Throughout the 1960's and 1970's, fish biologists and water resource engineers believed that the key principle to maintaining healthy river ecosystems was to define and protect minimum instream flows for fish species. Following enactment of the National Environmental Policy Act (NEPA) in 1970, attention was shifted from minimum flows to the evaluation of water budgets and multiple uses on federal water projects. Beginning in the early 1990's, research scientists began to advocate and develop an improved approach to river management which focused on the natural flow regime to maintain the ecological health of these systems. The natural flow regime, the quantity and seasonal variability of flows based on annual weather patterns, is the driving force shaping the morphology, biology, and ecology of river ecosystems. One of the primary causes of the ecological degradation of river ecosystems is human alteration of the natural flow regime. The scientific community has embraced environmental flows (i.e., quality, quantity, and timing of water flows) as the key principle necessary to maintain healthy river ecosystems. To ensure sustainable healthy river ecosystems it is imperative that water resource engineers, legal institutions, and the general public understand the ecological principles integral to environmental flows. This presentation will provide an overview of these ecological principles and offer suggestions as to how the institutional and legal framework can adopt these principles. We will also discuss how environmental flow principles are considered in the operations of four major river systems in New Mexico: Pecos, Rio Grande, San Juan, and Gila.

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Presentation Type: Oral

The distribution of genetic variation among Chinook salmon life history types in the Columbia River Basin: a landscape genetics perspective

Variable life history types of Chinook salmon (*Oncorhynchus tshawytscha*) likely evolved in parallel throughout much of the species range. However, greater divergence exists between life history types within the interior Columbia River Basin than is observed in other regions. Although ocean- and stream-type Chinook salmon occur in sympatry in the interior Columbia River Basin, they remain highly divergent,

and recent studies suggest they are derived from separate historic lineages as a result of distinct glacial refuges in north and south latitudes. We evaluated the phylogenetic relationship among extant populations and observed the persistence of three primary lineages of Chinook salmon in the basin; two interior forms with distinct biological attributes (ocean- and stream-type) and one lineage in lower Columbia River. Significant geographic structure was observed within lineages, consistent with the philopatric nature of the species. Among lineages, stream-type had the lowest estimates of genetic diversity. Estimates of genetic distance were greatest between ocean- and stream-type (FST = 0.100) in the interior basin, intermediate between stream-type and lower Columbia River populations (FST = 0.076), and most similar between ocean-type and lower Columbia River (FST = 0.030). Nearly complete reproductive isolation of ocean- and stream-types indicated deeper divergence than suggested by previous studies. Severe genetic drift within highly divergent stream-type Chinook salmon was evident from a relatively low level of variation and evidence of population bottlenecks, and may be suggestive of long-term geographic isolation from the other two lineages. Further analyses were conducted using microsatellite and SNP genotypic data to describe patterns of variation among Chinook salmon populations in the Columbia River Basin by mapping genetic distance to the stream sections between populations. Our goal was to provide a better understanding of how landscape features such as barriers or geographic features may be contributing to patterns of variation, and the persistence of lineages.

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Presentation Type: Poster

Matthews, Kathleen, US Forest Service Sierra Nevada Research Center, PSW Sierra Nevada Research Center, Box 245, Berkeley, Ca 94701

Presentation Type: Oral

Will California golden trout and their habitat be resilient to climate change?

The native habitat of the California golden trout (CGT), *Oncorhynchus mykiss aguabonita*, currently includes stream areas on the Sierra Nevada Kern Plateau impacted by cattle grazing. As a result, some areas have reduced streamside vegetation (willows or sedge), warmer stream temperature (up to 24°C), and lower dissolved oxygen (DO) than restored areas. Climate change may further compromise CGT and their habitat in stream areas still subject to cattle grazing with predicted warmer water temperatures, possibly lower dissolved oxygen, reduced flow, and increased sediment. One important management

response to climate warming will be to ensure that habitats are resilient to predicted changes. In the Golden Trout Wilderness (GTW), where most native CGT reside, many sections have yet to recover or are currently being grazed and have shallow, widened, unvegetated sections that could subject CGT to harmful and possibly lethal levels of DO and water temperatures. Because the CGT is a Species of Special Concern and petitioned for USFWS ESA listing, it will be crucial to monitor changes in riparian condition and water quality to ensure their survival as warming occurs. Moreover, the overdue restoration of vulnerable stream sections must quickly proceed to prepare for climate warming. Stream monitoring of degraded and recovering stream sections will compare the temperature, DO, stream depth and width to determine if potentially harmful conditions occur so that management actions can be implemented. While some monitoring actions are already included in the CGT Conservation Strategy, there is no mention of climate change in the Strategy, and currently there is no comparative analysis of stream temperatures in degraded versus recovering areas. To determine the climate change resiliency of golden trout habitat, I propose to undertake a spatially explicit analysis of stream temperatures and DO in restored and degraded sections of Mulkey, Ramshaw, and Templeton meadows in the GTW.

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Presentation Type: Oral

In search of the holy grayling

HDR conducted baseline fisheries studies in the Reynolds Creek drainage in the summer of 2008 to determine the nature of use of the system by an introduced stock of Arctic Grayling. These studies included assessing grayling spawning and fry rearing in the inlets to Lake Mellen and Rich’s Pond, investigate grayling presence and relative abundance in the Rich’s Pond connector reach during summer conditions and to identify potential differences in grayling and abundance, both spatially and temporally in Lake Mellen inlet, Rich’s Pond inlet and Rich’s Pond outlet. The purpose of this study was to allow assessment of the impacts of a proposed small scale hydroelectric project on the fish and aquatic life in the drainage. These surveys have done much to expand our understanding of the seasonal distribution and life history of the introduced Arctic Grayling in the Reynolds Creek system. In general, no spawning was observed and there was a net movement of fish downstream toward Lake Mellen as significant upstream migrations are blocked by waterfalls and cascades. These findings are helping engineers design the proper intake structure in the best location in the system to avoid impacts to the fisheries resource and to create a source of renewable energy for the local community.

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Conservation Services Division, New Mexico Department of Game and Fish, P.O. Box 25112, Santa Fe, New Mexico 87504; James E. Brooks, U.S. Fish and Wildlife Services, New Mexico Fishery Resources Office, 3800 Commons N.E., Albuquerque, New Mexico 87109.

Presentation Type: Oral

Overlooked utility of mtDNA sequence data in native trout? Insights from the native Mexican fauna.

Resident freshwater trout of genus *Oncorhynchus* (Protacanthopterygii: Salmonidae) form a significant component of biodiversity in streams, rivers and lakes of western North America. While trout from the western United States and Canada have received extensive systematic and population genetic investigation, the full range of diversity from native trout endemic to the Sierra Madre Occidental (SMO) of northern Mexico has arguably received less study. Only recently has this native diversity receiving in depth investigation from the binational group *Truchas Mexicanas* for proposing systematic relationships and understanding population history. In this study we present the first phylogenetic hypothesis for this native fauna based on mtDNA sequence data from two loci. We place the recovered lineages in a geographic context and use these hypotheses for understanding the native diversity. Stocking of non-native *Oncorhynchus* threatens the native fauna through hybridization in some regions. A consortium of biologists from Mexico and the USA are diligently working to advise governmental agencies to enable information-based management of the native trout.

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Presentation Type: Oral

New discoveries and insights into diversity and conservation status of native trout of Mexico

Our bi-national *Truchas Mexicanas* team continues exploring Mexico's Sierra Madre Occidental where we have discovered new trout species north and south of the range of the Mexican Golden Trout and in two disjunct areas of the Rio Conchos. Undescribed native trout have been thought to occur in some areas of northwestern Mexico, as well as *Oncorhynchus chrysogaster* in rios Fuerte, Sinaloa and Culiacán. Trout

from rios Presidio, San Lorenzo, Baluarte and Acaponeta basins are newly discovered and are native based on our genetic and morphological studies. Niche modeling of native trout habitats permitted focused surveys, and indicates native trout habitats extending well beyond areas sampled. Analyses of morphological data and mitochondrial and nuclear genetic data support several distinct lineages conflated with *O. mykiss*, and the phylogenetic placement of *O. chrysogaster* renders *O. mykiss* an unnatural grouping if these taxa are not recognized taxonomically. Microsatellite DNA reveal introgression with non-native, hatchery rainbows (*O. mykiss*) in some areas, but genetically uncompromised stocks of each native form are known to exist. All Mexican trout species are endangered by escape of hatchery *O. mykiss* from rapidly expanding aquaculture. IPN-exposed rainbows have been shipped to areas within ranges of native trouts, adding yet another threat. Habitat degradation is common throughout the area, and all Mexican trout are susceptible to climate change. Team members continue to work with Mexican government officials to local residents promoting native trout conservation by increasing awareness, identifying risks posed by human activities, and researching adaptation of native stocks to aquaculture. Our fieldwork and genetic and morphological analyses continue and are focused on, surveys, descriptions of new taxa, evolutionary histories, and conservation.

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Presentation Type: Poster

Continuous, real-time observation of salmon and orca at Lime Kiln State Park, Puget Sound

Continuous, long-term monitoring of an underwater environment can provide insights to presence, abundance, behavior, and ecological interactions that are not possible using more traditional "point-source", instantaneous approaches. Of interest to our project is the interaction of salmon and orca in the area of Lime Kiln State Park. To monitor this interaction, we tested the capabilities of a semi-permenant acoustic monitoring system, based on a commercial scientific echosounder system. Since August, 2008, a 200kHz BioSonics split beam echosounder has been operated as an "observatory" component, to monitor a fixed site and detect fish presence and distributions within the heart of the summer range of the endangered southern resident killer whales. Deployed in 15m of water just offshore from the Lime Kiln lighthouse, the echosounder is aimed horizontally out into Haro Strait and has a 250m range. In addition to revealing the dynamics and distributions of fish (including potential prey of orcas, like Chinook Salmon) in real-time, the echosounder has provided observations of marine mammals that swim through the 6.7-degree-wide beam. From these events, we have measured the echo strength from Orca. We have developed a "tracker" algorithm that can decompose the echoes into movement vectors of individuals or groups of "targets" (fish or mammals). Besides the obvious scientific interest, a practical application for development of a more refined detection algorithm would be to provide input for automatic reporting of the presence and abundance of fish and mammals in the vicinity of tidal energy projects, allowing for project modificaiton in response to the detections.

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Presentation Type: Oral

Heavy metal contamination in fishes from southern Arizona lakes: Radiogenic isotopic analyses of Patagonia and Peña Blanca Lakes, Arizona

Southern Arizona has numerous abandoned mines throughout the region. Tailings and effluent from these mines can contaminate watersheds and impact both native and sport fisheries. This study presents results from high-precision isotopic analyses of lead (^{208}Pb, ^{207}Pb, ^{206}Pb, and ^{204}Pb) to determine levels, sources, and mechanisms of lead contamination in fishes from Patagonia and Peña Blanca lakes in southern Arizona. We find high levels of lead contamination in certain species. We compare lead isotopic ratios from water and invertebrate samples from a heavily contaminated site (Alum Creek) that drains into Sonoita Creek and Lake Patagonia. The isotopic ratios of invertebrates and water from Alum Creek are different from those found in fish from Lake Patagonia. Fish species show variation in lead contamination levels indicating alternative mechanisms of deposition into the food web. We also compare fish species from pre-monsoonal and post-monsoonal sampling and find consistent sources of contamination.

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Presentation Type: Poster

Ecological and morphological divergence in lake trout introduced into Flathead Lake, Montana

Divergent ecotypes of lake trout (*Salvelinus namaycush*) commonly co-occur in their native range, with morphological, physiological, and trophic traits segregating by depth. Previous physiological studies suggested that lake trout introduced into Flathead Lake, Montana, also differ with depth. We compared muscle lipid content, muscle stable isotope ratios, morphology, and multilocus genotypes between shallow (0-25 m) and deep caught (>50 m) lake trout from Flathead Lake. While lipid content was similar between depth groups, stable isotopes of N and C varied between depth groups, demonstrating that individual fish exhibit long term depth preferences. We also observed morphological divergence between deep and shallow fishes, generally in directions expected based on native ecotypes. Lack of genetic divergence between deep and shallow forms in Flathead Lake suggests that either: 1) the patterns observed cannot be explained by separate introductions of different ecotypes; or 2) ecotypic divergence persists despite high levels of gene flow between different source populations.

Meka Carter, Julie, Arizona Game and Fish Department, 5000 W. Carefree Hwy, Phoenix, AZ 85086; Allen Haden, Natural Channel Design, Flagstaff, AZ 86001; Mark Terrill, Arizona Game and Fish Department, Pinetop, AZ 85935; Jeremy Voeltz, U.S. Fish and Wildlife Service, Pinetop, AZ 85935

Presentation Type: Oral

The efficacy of existing artificial fish barriers used to protect Apache trout recovery populations

Natural barriers, mostly waterfalls, protect 10 pure relict populations of Apache trout on the Fort Apache Indian Reservation. The remaining 19 streams with Apache trout recovery populations on tribal and Forest Service lands are protected by artificial barriers of various types. The ability to isolate Apache trout populations above artificial barriers is crucial to their recovery, as the majority of streams within historical Apache trout habitat contain nonnative trout. However, the success of artificial barriers has been highly variable and a cycle of barrier construction, chemical renovation, barrier failure, barrier maintenance, and re-renovation is not uncommon and often repetitive. A series of evaluations on the efficacy of 12 Apache trout barriers was conducted in 2007 and 2008 and revealed that 50% (n = 6) need to be heightened, 58% (n = 7) leak through the gabions, and 67% (n = 8) need moderate to major modification. This presentation provides an overview of the successes and failures of artificial barriers to protect Apache trout habitat and the highly variable and sometimes unpredictable nature of barrier use in general. The methods used to increase the efficiency of existing and future Apache trout barriers are discussed, including the importance of barrier type, of frequent stream monitoring, the shortfalls of shortcuts, and recognizing the pragmatic time and financial commitments barriers require.

Mellison, Chad, U.S. Fish and Wildlife Service, 1340 Financial Blvd., Ste 234, Reno, NV 89502; Alan Jenne, Nevada Department of Wildlife, Elko, NV 89801; Carol Evans, Bureau of Land Management Elko District Office, Elko, NV 89801; James Harvey, U.S. Forest Service Humboldt-Toiyabe N.F., Sparks, NV 89431; Maija Meneks, U.S. Forest Service Humboldt-Toiyabe N.F., Elko, NV 89801; John Elliott, Nevada Department of Wildlife, Elko, NV 89801

Presentation Type: Oral

Recent recovery activites for the threatened Lahontan cutthroat trout in northern Nevada

Similar to most cutthroat trout subspecies, Lahontan cutthroat trout (*Oncorhynchus clarkii henshawi*) suffer from small isolated populations and nonnative species. Numerous projects utilizing piscicides, constructing temporary and permanent fish barriers, and eliminating barriers have been recently implemented in northern Nevada to eradicate nonnatives, protect existing Lahontan cutthroat trout populations, and reconnect larger habitat. We will be presenting information from a recently completed 5-year review and some of our projects aimed at recovering Lahontan cutthroat trout.

Mercado-Silva, Norman, Arizona Cooperative Fish and Wildlife Research Unit, School of Natural Resources, University of Ariz, 325 Biosciences SE, Tucson, AZ 87521; John Lyons, University of Wisconsin Zoological Museum & Wisconsin Department of Natural Resources, Madison, WI 53716;

Edmundo Díaz-Pardo, Laboratorio de Conservación de Peces y Hábitats Acuáticos, Facultad de Ciencias Naturales, Universid, Queretaro, MX 76230; Saúl Navarrete-Vázquez, Laboratorio de Conservación de Peces y Hábitats Acuáticos, Facultad de Ciencias Naturales, Universid, Queretaro, MX 76230; Altagracia Gutiérrez-Hernández, Laboratorio de Conservación de Peces y Hábitats Acuáticos, Facultad de Ciencias Naturales, Universid, Queretaro, MX 76230

Presentation Type: Poster

Ecological gradients and patterns of fish assemblages of high gradient rivers of Mexico's Atlantic slope

Non-metric multidimensional scaling was used to explore associations among species and ecological guilds and to identify ecological gradients and patterns in the fish assemblages of the La Antigua River basin, a high gradient river in the Gulf of Mexico slope, Eastern Mexico. Fish species, ecological guild, habitat, and geographic data were obtained from 53 samples from 31 sites. A total of 13 species (11 native and 2 exotic) and 9 guilds were collected. Guilds were constructed considering species' reproductive strategies, maximum, diet, habitat, and migratory tendencies. All guilds were represented by one or two species, so results for both guild and species analyses were similar. Altitude was the most important variable in explaining the variation in species and guild composition among sites. Rainbow trout (*Onchorynchus mykiss*) and spottail killifish (*Heterandria bimaculata*) were key in separating sites in multidimensional space. Sites dominated by rainbow trout were in high elevations (> 900 m) far from the ocean, and tended to have a small (1^{st} and 2^{nd} order streams). Sites where *H. bimaculata* dominated were small in (1^{st}-3^{rd} order), generally far from the ocean, and located at intermediate elevations. Sites located at lower altitudes, and nearer to the ocean, and of high order had diverse assemblages (5-10 species). Similarly, sites located in lower altitudes, closer to the ocean, had a higher diversity of guilds. Lowermost sites included species, *Sicydium gymnogaster* and *Agonostomus monticola*, that carry out migrations to the ocean as part of their life cycles.

Mercado-Silva, Norman, USGS Arizona Cooperative Fish and Wildlife Research Unit, School of Natural Resources, University of Arizona, 325 Bioscieces East, Tucson, AZ 85721; Charles Rabini, USGS Missouri Cooperative Fish & Wildlife Research Unit, University of Missouri., Columbia, MO 65211; John Lyons, Wisconsin Department of Natural Resources, Madison, WI 53716; Jim Peterson, DB Warnell School of Forest Resources, University of Georgia, Athens, GA 30602

Presentation Type: Poster

Standardized sampling methods for warmwater fishes in wadeable streams

We propose standard sampling methods for fishes in wadeable warmwater streams, which we define as too warm to have sustainable salmonid populations and able to be safely and effectively traversed by wading. Our methods target more than 32 fishes including largemouth bass, smallmouth bass, spotted bass, rock bass, bluegill, northern pike, walleye, several catfishes, and common carp. We have three sampling methods: backpack electrofishing, tow-barge electrofishing, and beach seining. The most appropriate method varies depending on stream characteristics and target species. In most instances, electrofishing is less selective than seining and is probably the best method when the goal is to

characterize the entire fish assemblage. Backpack electrofishing is optimal in narrow (< 2-3 m) streams or wider streams with numerous large obstructions that impede tow-barge passage (e.g., full-channel log jams, boulder fields), whereas tow-barge shocking is preferred in wider streams without such impediments. Seining is most effective in relatively smooth-bottomed (i.e., silt, sand, gravel), unobstructed streams for small-bodied species such as minnows, silversides, killifishes, goodeids, and darters. For each method we provide equipment specifications, guidelines for operation/deployment, considerations on the time of sampling, computation of effort, and sampling design considerations.

Meyer, Kelly, Arizona Game and Fish Department, 2878 E White Mountain Blvd, Pinetop, AZ 85935; Michael Lopez, Arizona Game and Fish, Pinetop, AZ 85935

Presentation Type: Oral

Lessons learned from treating with Fintrol (antimycin-a produced by Aquabiotics) in trout streams in the White Mountains of Arizona

Over the past five years, we have completed over twenty antimycin-a treatments on trout streams in eastern Arizona using Fintrol (produced by Aquabiotics). We had two problems during our stream treatments; the effects of the chemical were variable within the stream and we were unable to kill trout at 20 ppb. The chemical was tested and the chemical bottled from year 1999 to 2007 was found to have degraded to 1.1 to 12.7% of active ingredients. This degradation was variable between years, and the chemical was more compromised each year. The results of the chemical testing were consistent with moisture compromising the units. We were able to use the compromised chemical to make successful treatments by mixing large lots of chemical together (25 to 30 units) to ensure that there was no variability among the chemical and to have the chemical tested prior to treatment to determine the active ingredient concentration. We will also discuss methodology to improve treatments with antimycin-a. We found that most fish that survived the treatment were either in springs or headwaters that had low water flows. We recommend the following: 1) any Aquabiotic chemical from 1999 and later be frozen or stored in temperature as cold as possible and be tested before application; 2) fish should be held after the bioassay for 48 hours or more to determine mortality rates, 3) extra efforts including mechanical removal be made at springs and areas with low stream discharge, and 4) to increase the dosage of chemical in low flow areas and determine the amount of chemical increase by conducting die tests or a separate bioassay in low flow areas.

Meyer, Kelly, Arizona Game and Fish, 2878 E White Mountain Blvd, Pinetop, AZ 85935; Michael Lopez, Pinetop, AZ 85935

Presentation Type: Oral

Using experts and stakeholders to improve the strategic planning process.

In eastern Arizona, we have thirty cold and cool water fisheries and approximately 85% of our angler use is from non local anglers. We are using a new procedure to implement strategic planning in this area. The

steps of this procedure are: 1) Waters are separated into groups based on geographic closeness; 2) waters are inventoried based on current angling use, catch rates, and of fish; 3) a group of experts and stakeholders identify problems and propose a management emphasis for each water; 4) the proposed management emphasis is presented to the public for comment; and 5) A new plan is written that includes the final management emphasis, measurable objectives, and a list of possible strategies to implement. The advantages of this process were: we were able to ensure more of a variety of experiences for anglers by looking at more than one water at a time, we were able to better represent the interests of non local anglers, we were able to have better coordination among the stakeholders, and we had a better product that was defendable to critics.

Miller, Scott, Utah State University and Bureau of Land Management, 5210 Old Main Hill, Logan, UT 84322; Sam Hochhalter, Alaska Department of Fish and Game, Cordova, AK 99574; Michelle Baker, Utah State University, Logan, UT 84322

Presentation Type: Oral

Effects of common carp (*Cyprinus carpio*) on the trophic structure and biodiversity of Spring Creek, Logan, UT

Invasive species represent a primary threat to biodiversity, and aquatic ecosystems are among the most heavily impacted. One of the most notorious aquatic invasives is common carp (*Cyprinus carpio*) whose feeding behaviors can have cascading effects on the structure and function of freshwater ecosystems. While the direct and indirect effects of carp on lentic macrophyte and macroinvertebrate assemblages are well documented, their effects in lotic ecosystems remain less certain. We quantified the effects of carp density on the trophic structure of a basin spring-fed system near Logan, UT. We paired an observational study of two adjacent reaches of low and high carp biomass, with experimental carp removal. Carp biomass was 10 times greater in the high (28.9 g/m2) versus low (2.6 g/m^2) biomass reach, which resulted in significant differences in macrophyte and macroinvertebrate assemblage composition between reaches. Reduced taxa richness, density and biomass contributed to differences in macrophyte and macroinvertebrate assemblage composition within the high carp biomass reach. For example, macroinvertebrate richness and biomass were reduced by 60 and 99 percent respectively. Ash-free dry mass and chlorophyll-*a* concentrations of coarse particulate organic matter were highly variable and did not significantly differ between reaches. Experimental carp removal (1 m^2) resulted in the partial recovery of both macrophyte and macroinvertebrate assemblages within the high carp biomass reach; however, macrophyte and macroinvertebrate richness and density did not return to predisturbance levels. Our observational study demonstrates that carp bioturbation can disrupt the trophic structure of lotic ecosystems and reduce biodiversity. Furthermore, partial recovery of macrophyte and macroinvertebrate assemblages following carp removal highlights the resiliency of stream ecosystems and the viability of using carp removal as a restoration tool given the presence of viable source populations.

Miranda, L.E. (Steve), USGS Mississippi Cooperative Fish and Wildlife Research Unit, USGS Arizona Cooperative Fish and Wildlife Researc, 104 Biological Sciences East, University of Arizona, Tucson, AZ 85721; Jeff Boxrucker, Oklahoma Department of Wildlife Conservation, Norman, OK 73072

Presentation Type: Poster

Standard sampling of warmwater fish in large standing waters

Electrofishing, fyke netting, and gill netting protocols are discussed in Standard Methods for Sampling North American Freshwater Fishes (S. Bonar, W. Hubert, and D. Willis, eds) for collection of population data in warmwater lentic systems. Electrofishing is standard for sampling littoral areas, typically targeting centrarchids. Flat-bottomed, heavy-gauged metal boats should be equipped with a deck and safety rail to accommodate two dippers, two anodes with electrodes arranged in a circular array, and a power supply capable of producing 60 Hz of pulsed DC current. Sampling is conducted by operating the boat slowly (1-3 km/h) along shallow (<3m) nearshore areas. Typically, diurnal samples are collected in spring at water temperatures 13-21ºC; however, in clear waters, nocturnal sampling is recommended. Gill nets are recommended to sample open water species such aspercichthyids, ictalurids, percids, clupeids, and esocids. Sinking gillnets with mesh bar of 19, 25, 32, 38, 44, 51, 57, and 64 mm are recommended. A standard gang is ~25 m in length by 1.8 m high (8 panels x 3.1 m each). Nets are deployed along the bottom, perpendicular to the bank at depths of 3-8 m and set in late afternoon and retrieved the following morning, so that the sample period encompasses both crepuscular periods. Sampling is conducted in late summer through winter, depending on latitude, when water temperatures < 20ºC. Modified fyke nets effectively sample littoral species not adequately collected with electrofishing and gill nets, primarily crappies. The standard modified fyke net consists of a single lead and a trap with 13-mm bar mesh netting. Nets are typically fished in late summer through winter (water temperatures <20ºC), set perpendicular to offshore points, aquatic macrophytes or other obstructions to fish movements that act as natural leads.

Molesworth, Jennifer, US Bureau of Reclamation, 206 Glover St., Twisp, WA 98856; Jeff McLaughlin, US Bureau of Reclamation, Boise, Id 83706; Greg Knott, Methow Salmon Recovery Foundation, Twisp, WA 98856; Chris Johnson, Methow Salmon Recovery Foundation, Twisp, WA 98856; Jeff Peterson, US Bureau of Reclamation, Boise, ID 83706

Presentation Type: Poster

Fish passage for salmonids using a variety of methods utilizing natural materials

The Bureau of Reclamation as part of the 2008 Federal Columbia River Power System Biological Opinion has been working with various partners including the Methow Salmon Recovery Foundation to provide technical assistance for a variety of fish passage, flow augmentation, and habitat complexity projects on the Wentchee, Entiat, and Methow Rivers in North Central Washington State. The program works with voluntary landowners to improve access and habitat on private lands throughout the basin. The program has been in place since 2000 and a significant number of projects have been implemented. Fish passage has primarily used an assortment of natural methods to replace existing manmade fish barriers including the construction of rock weirs, roughened channels, wing dams, barbs, and in some cases complete removal of the existing barrier. The proposed poster presentation will present before and after photos of several sites all with different approaches to fish passage. Some construction photos may also be

included. Several documents will be available as part of the poster display including engineering drawings, completion reports, monitoring results and other information where available. Maintenance, Adaptive Management, and Repair Efforts will also be documented and discussed through the use of photos and other methods.

Muhlfeld, Clint, USGS-Northern Rocky Mountain Science Center, USGS-Northern Rocky Mountain Science Center, Glacier Field Office, Glacier National Park, Building #3, West Glacier, MT 59936; Steven Kalinowski, Montana State University, Bozeman, MT 59717; Thomas McMahon, Montana State University, Bozeman, MT 59717; Mark Taper, Montana State University, Bozeman, MT 59717; Robb Lear, Montana Fish, Wildlife & Parks, Missoula, MT 59812; Fred Allendorf, University of Montana, Missoula, MT 59812

Presentation Type: Oral

Hybridization reduces fitness of cutthroat trout in the wild

Human-mediated hybridization is a leading cause of biodiversity loss worldwide. How hybridization affects fitness and what level of hybridization is permissible pose difficult conservation questions with little empirical information to inform policy and management decisions. This is particularly true for salmonids, where widespread introgression among non-native and native taxa has often created hybrid swarms over extensive geographical areas resulting in genomic extinction. Here, we used parentage analysis with multilocus microsatellite markers to measure how varying levels of genetic introgression with non-native rainbow trout (*Oncorhynchus mykiss*) affect reproductive success (number of offspring per adult) of native westslope cutthroat trout (*Oncorhynchus clarkii lewisi*) in the wild. Small amounts of hybridization markedly reduced fitness of male and female trout, with reproductive success sharply declining by approximately 50 percent, with only 20 percent admixture. Despite apparent fitness costs, our data suggest that hybridization may spread due to relatively high reproductive success of first-generation hybrids and high reproductive success of a few males with high levels of admixture. This outbreeding depression suggests that even low levels of admixture may have negative effects on fitness in the wild and that policies protecting hybridized populations may need reconsideration.

Mulholland, Tim, Headwaters Floating Island, 1018 2nd Avenue North, Billings, MT 59101; Christine Pierce, Headwaters Floating Island, Billings, MT 59101

Presentation Type: Oral

Creating wildlife habitat and expanding fisheries with Biohaven® Floating
treatment wetlands

BioHaven® floating islands are an environmentally low impact and economical way to create new wetland, while augmenting the vitality and biodiversity of a waterway. They are made using non-toxic recycled materials and are hands off and non-mechanical. The biomimetic design gives our fish, wildlife and waters the least carbon footprint and the most natural support for the systems they depend upon for

healthy and productive lifecycles. The benefits are many: Habitat creation and restoration for a myriad of fauna, from microbiological systems to aquatic and wetland wildlife; reduced turbidity and pollution mitigation (with resource recovery of nutrients such as nitrate and phosphate); and aesthetic and unique living water features of any or shape for any water body. Floating Islands used in landscaped water features and pools offer a chemical free approach to managing water quality. Placed in a stream or pond, BioHavens and their suspended root complex give secure habitat for fish, offering shade and protection from currents and predators. The living islands attract a range of insects that also become a food source for fish and wildlife and further promote biodiversity. Unique configurations can be designed for nesting sites, spawning platforms and load bearing hanging banks to increase protective fish habitat. Several projects have developed successful, protective bird habitat specifically for Duck, Loon and Swan and a 22,000 sf Caspian Tern Habitat Island.

Myrick, Christopher, Colorado State University, Department of Fish, Wildlife, and Conservation Bio, Campus Delivery 1474, Fort Collins, CO 80523-1474; Sarah Conlin, University of Florida, Gainesville, FL 32611

Presentation Type: Oral

Copper-based substrates as potential barriers to New Zealand mudsnails

New Zealand mudsnails (*Potamopyrgus antipodarum*) actively disperse in both up- and downstream directions following their introduction to a novel environment, and can rapidly expand their range within a river drainage. Downstream dispersal is particularly difficult to control because New Zealand mudsnails can drift in the water column. However, when moving upstream, New Zealand mudsnails crawl over the substrate, allowing them to invade upstream areas. Particularly disturbing is their ability to move through irrigation canals, pipes, and other manmade structures to gain entry to otherwise inaccessible locations, such as fish hatcheries. Evidence from a Colorado aquaculture facility suggests that coating these potential invasion routes with copper effectively prevented these upstream movements. We tested this observation under controlled laboratory conditions by comparing New Zealand mudsnail (mean length ± SE: 4.7 ± 0.38 mm) crawling distances, crawling velocities, and substrate preferences when presented with substrates coated with copper sheet (CS), copper mesh (CM), a cuprous oxide-based marine antifouling paint (COP), or a cuprous thiocyanate-based marine antifouling paint (CTP) with their responses on an untreated PVC control surface. We found that mudsnails spent significantly less time (T-test; $P < 0.05$) on portions of substrate treated with either COP or CTP than on the control portions; the results for the other copper-based surface treatments were not conclusive. Distances that the mudsnails crawled on treated surfaces ranged from 35 ± 14 mm (mean ± SE) on CM to 116 ± 66 mm on the CTP; these distances were all significantly shorter (ANOVA, $P < 0.05$) than distances covered on the control surface (782 ± 206 mm). Our results suggest that copper-based surface treatments have utility in the control of New Zealand mudsnail dispersal, pending further testing under field conditions.

Nesbit, Shivonne, Oregon State University, 104 Nash Hall, Corvallis, OR 97331; Scott Heppell, Oregon State University, Corvallis, OR 97331; Brett Hodgson, Oregon Department Fish & Wildlife, Bend, OR 97702

Presentation Type: Oral

Student Award Candidate

Getting the story straight in the Crooked River, Oregon: Evaluating movement patterns of redband trout and mountain whitefish

Over the last decade, redband trout (*Oncorhynchus mykiss gairdeneri*) in the wild and scenic section of the Crooked River, below Bowman Dam, have declined from an estimated 8,000 fish per mile to approximately 600 fish per mile while at the same time populations of mountain whitefish (*Prosopium williamsoni*) have remained abundant. The reduction in redband trout led the Oregon Department Fish & Wildlife to partner with Oregon State University to study the effects of river flows and species overlap as potential explanatory variables for why we have seen a decline in redband trout. We undertook a radio telemetry study in the fall of 2007 to determine redband trout and mountain whitefish spatial distributions, migration patterns, spawning timing, home ranges and habitat overlap. We are evaluating the movement patterns of redband trout and mountain whitefish in the Crooked River, OR; further determining how these movement patterns relate to each other, to flow regimes, time of the year, and water quality. Gaining a better understanding of how flow regimes affect fish movements and distribution will help determine appropriate outflow regulation in order to protect fish diversity and fish resources in the Crooked River below Bowman Dam.

Nielsen, Jennifer, USGS, 4210 University Drive, Anchorage, AK 99508; Sara Turner, USGS, Anchorage, AK 99508

Presentation Type: Oral

Genetic analysis of Alaskan Pacific halibut (*Hippoglossus stenolepis*)

Pacific halibut (*Hippoglossus stenolepis*) collected offshore of the Aleutian Islands, Bering Sea and Gulf of Alaska were used to test the hypothesis of genetic panmixia for this species in Alaskan marine waters. Nine microsatellite loci and sequence data from the mitochondrial (mtDNA) control region were analyzed. Eighteen unique mtDNA haplotypes were identified with no evidence of geographic population structure. Significant microsatellite heterogeneity was detected between Aleutian Island halibut and fish from the other two regions (FST range = 0.007 – 0.008). Significant FST values represent the first genetic evidence of locally adapted groups of halibut in the western Aleutian Archipelago. Previous studies have reported Aleutian oceanographic conditions in deep canyons leading to an ecological discontinuity and unique population structure for several marine species. Unique Aleutian Pacific halibut genetic structure may result from oceanographic mechanisms acting as dispersal barriers reducing gene flow with halibut from other Alaskan waters.

Oglesby, Adrian, The Nature Conservancy, 1303 Rio Grande Blvd. NW, Suite 5, Albuquerque, NM 87104

Presentation Type: Oral

Ecological flows in New Mexico: It can be done.

Unlike many western states, New Mexico has no statutory protection for the ecological flow needs of its rivers. While many still think that in-stream flows are illegal in New Mexico, this is not the case. Although they have not been utilized to any great extent, there are legal mechanisms under State law that can be used to maintain water rights while allowing them to flow in-stream. Moreover, federal mandates have required in-stream flows in New Mexico stream systems. This presentation will provide an overview of the variety of ways water can and has been dedicated to ecological flows within New Mexico, under both State and federal law.

Oplinger, Randy, Utah Division of Wildlife Resources, 1465 W. 200 N., Logan, UT 84321; Eric Wagner, Utah Division of Wildlife Resources, Logan, UT 84341

Presentation Type: Oral

Preventing the spread of New Zealand mud snails; lessons from a Utah hatchery

The purpose of our study was to investigate several methods intended to prevent the spread of the non-native New Zealand mud snail *Potomopyrgus antipodarum* (NZMS). First, we derived 15-minute LD50 and LD90 values for formalin, iodine, hydrogen peroxide, and potassium permanganate. LD50 values ranged between 68 (potassium permanganate) and 12,234 ppm (formalin) and LD90 values ranged between 542 (potassium permanganate) and 30,680 ppm (formalin). Concentrations required for 100% mortality in 15-minute exposures generally exceed concentrations considered safe for most fish species. In our second experiment, we exposed green rainbow trout *Oncorhynchus mykiss* eggs to several chemicals that are known lethal to NZMS; 1,940 ppm Hyamine 1622, Clorox Commercial Solutions 409, Pinesol, household ammonia, and a 504 ppm copper solution. All of the eggs exposed to Hyamine 1622, 409, and ammonia died within 24 h of exposure. Among eggs treated with Pinesol and the copper solution, eye-up, hatch, and cripple rates did not differ from the control (water exposure). In our final experiment, we determined both the DC and AC electrical current densities required to inhibit snail movement. When subjected to DC current, we found that the minimum current density required for 100% of snails to detect the presence of the electricity was 0.15 mA/cm^2 and that all movement ceased at 0.78 mA/cm^2. We estimate that NZMS can detect AC current at 0.06 mA/cm^2 and that all movement ceases at 0.23 mA/cm^2.

Oplinger, Randy, Illinois Natural History Survey, 1585 N. 400 E. #224, North Logan, UT 84341; Matthew Diana, Illinois Natural History Survey, Sullivan, IL 61951; David Wahl, Illinois Natural History Survey, Sullivan, IL 61951

Presentation Type: Poster

Population social structure and gizzard shad density influence on the size specific growth of bluegill sunfish

Bluegill sunfish are one of the most popular sportfish in North America. However, many bluegill populations are stunted, and as a result, are comprised mainly of smaller individuals. Thus, there has been much recent interest in determining factors that influence the growth of bluegill so management remedies can be designed that alleviate stunting. Bluegill population structure is unlikely controlled by any one factor. Instead, multiple variables likely interact to regulate adult . We used a multiple linear regression analysis (AIC) to determine how various environmental variables influence the specific growth of bluegill at 50, 100, and 150 mm total length in 16 lakes. The environmental variables assessed included measures of lake morphometry, water quality, prey abundance, bluegill population and social structure, fish community composition, and watershed characteristics. Two environmental variables, gizzard shad density and bluegill social structure have recently been individually found to influence the growth of bluegill but their importance has not been previously evaluated as part of a multivariate study. We found that gizzard shad density had a strong influence on the specific growth of all bluegill. Meanwhile, the average age of maturation of male bluegill in the population had a strong influence on the specific growth of bluegill at 50 and 100 mm but not at 150 mm total length. The other variables considered in this study appeared in fewer models that were deemed parsimonious by the AIC. Overall, 18-43% of the variation in the data was explained by the combined effect of gizzard shad density and average male age of maturation. These results suggest that these are two important factors influencing growth and should be considered when managing bluegill.

Osborne, Megan, University of New Mexico, Department of Biology, MSC03-2020, Albuquerque, NM 87131; Tracy Diver, University of New Mexico, Albuquerque, NM 87131; Thomas Turner, University of New Mexico, Albuquerque, NM 87131

Presentation Type: Oral

Patterns of genetic diversity in a community of cyprinid fish in the Pecos River, New Mexico

Genetic diversity has long been recognized as an important parameter to measure in conservation biology. The level of genetic variation displayed by a species is determined by the interaction of several factors including mutation rate, effective population , selection and evolutionary history. Additionally, contemporary population dynamics and life-history can affect patterns of diversity. In this study molecular data was collected from seven members of the Pecos river (New Mexico) cyprinid community including native and recently introduced taxa, to explore the effects of these factors on diversity. We examined predictions including (i) that recent immigrants should show evidence of having undergone founding events with only a fraction of genetic variants of the native species and, (ii) native species should have higher levels of diversity as they have had longer to accumulate mutations. Results obtained were contrary to expectations with lower diversity in native species including Pecos bluntnose shiner (*Notropis simus pecosensis*), Rio Grande shiner (*Notropis jemezanus*) and speckled chub (*Macrhybopsis aestavalis*) compared to recent immigrants including Plains minnow (*Hybognathus placitus*) and the Arkansas river shiner (*Notropis girardi*). The sand shiner (*Notropis stramineus*) shows patterns of diversity

that align it with the recent immigrants even though it is considered native to the Pecos river. Deeper divergences among haplotypes for recent immigrant imply introductions from multiple source populations. Our results also suggest that the Pecos river supports two sympatric yet genetically distinct forms of red shiner (*Cyprinella lutrensis*).

Patten, Kirk, New Mexico Department of Game and Fish, 1 Wildlife Way, Santa Fe, NM 87507; James Dominguez, New Mexico Department of Game and Fish, Santa Fe, NM 87507; Eric Frey, New Mexico Department of Game and Fish, Raton, NM 87507

Presentation Type: Oral

Native fish restoration efforts in the Comanche Creek watershed, New Mexico

Rio Grande cutthroat trout *Oncorhynchus clarkii virginalis* currently occupy approximately 10% of historically occupied stream miles. To attempt to reverse this decline, New Mexico Department and Game and Fish, U.S. Forest Service, U.S. Fish and Wildlife Service, and non-governmental organizations implemented a fish removal project in 30 km of the upper Comanche Creek watershed, Carson National Forest, Valle Vidal Unit, to benefit Rio Grande cutthroat trout, Rio Grande chub *Gila Pandora*, and Rio Grande sucker *Catostomus plebeius*. Existing road culverts were modified in 2007 to create a leap and/or velocity barrier depending upon stream discharge conditions. Intensive electrofishing removals were conducted in 2007 to reduce non-native fish biomass, primarily white sucker *Catostomus commersoni*. CFT Legumine (5% rotenone) was applied at a maximum concentration of 1.0 ppm to the project area in 2007 and 2008. After the final rotenone application in 2008, no additional target fish were killed by the piscicide or collected during post-treatment electrofishing surveys. Significant ice formation around the splash-pad and within the culverts during winter months has increased uncertainty whether the barrier will function to prohibit non-native fish migration into the project area. At this time, it seems the piscicide element of the restoration was successful though barrier effectiveness is uncertain. These results highlight the importance of fish migration barriers in maintaining restored populations of native fish.

Peterson, Douglas, US Fish and Wildlife Service, 585 Shepard Way, Helena, MT 59601; Bruce Rieman, US Forest Service, Rocky Mountain Research Station (retired), Seeley Lake, MT 59868; Michael Young, US Forest Service, Rocky Mountain Research Station, Missoula, MT 59801; James Brammer, US Forest Service, Beaverhead-Deerlodge National Forest, Dillon, MT 59725

Presentation Type: Oral

Can cattle trampling of redds lead to population declines in stream resident cutthroat trout?

High estimated rates of cattle trampling on artificial redds within federal grazing allotments in southwestern Montana has raised concern that direct mortality from trampling may contribute to imperilment of native westslope cutthroat trout (*Oncorhynchus clarkii lewisi*). To explore the implications of cattle trampling, we built two models. First we used a temperature-driven model of egg-to-fry mortality representative of the developmental stages where embryos would be vulnerable to trampling. We

represented cattle trampling as an additional source of mortality (beyond natural mortality), and modeled egg-to-fry mortality across a range of trampling rates (25-125% per month) for scenarios assuming low (0.60), moderate (0.81), and high (0.95) natural mortality. We then used a matrix model to determine how trampling affected population growth (lambda) assuming initially stable (lambda 1.008) or slow-growing populations (lambda 1.025 and 1.05). The timing of trampling strongly affected the magnitude of egg-to-fry mortality. Fewer redds trampled during sensitive developmental stages caused mortality equivalent to trampling more redds at a steady rate over longer times that included less sensitive periods. Generally the increased mortality only caused small reductions in population growth rate, and persistence depended on the population's inherent demographic resilience. Trampling half the vulnerable redds during August drove an initially stable population with moderate (0.81) egg-to-fry mortality into deterministic decline (lambda<1). Trampling rates >100% were needed for the same outcome in slow-growing populations (initial lambda 1.025 or 1.05). However, even 50% trampling may erode the resilience of slow-growing populations and increase extinction risk. Resident cutthroat trout experiencing redd trampling are likely to also face threats from habitat loss and nonnative trout. In these circumstances a cautionary approach to cattle grazing in riparian habitats may be warranted. The egg-to-fry model and thermograph data can identify dates when limiting cattle presence in or near stream habitat would likely reduce mortality from trampling.

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Presentation Type: Poster

Converting non-standard fish sampling data to standardized data

The ability to capture fishes and detect the presence of fish species varies by sampling method, fish species and , and the physical characteristics of the habitats being sampled. Failing to account for differences in capture and detection when comparing locations with different physical characteristics, species, and among samples collected using different sampling methods, can introduce a systematic error or bias into the data. To incorporate new standardized sampling techniques, fishery biologists need a means for converting sample data collected using old methods (i.e., non-standard data) so they can be compared with data collected using new standardized sampling methods (i.e., standardized data). We propose two methods for converting non-standard data each with relative costs and benefits. The first method, paired-gear sampling, is one of the simplest approaches and involves the collection of fish samples using two different gears at approximately the same time and location to build models for adjusting the non-standard data. It requires relatively little data and additional sampling effort, but cannot be used to account for the biases associated with species and habitats. The second method, gear calibration, involves the collection of data using non-standardized and standardized and comparing catches to unbiased estimators of fish abundance, presence, and species richness using models. These models can be used to adjust catch data and account for biases due to sampling method, species, and habitat. However, calibration requires a greater amount of data and sampling effort to develop useful models.

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Presentation Type: Poster

Identifying and treating sulfide in produced water to eliminate toxicity to fish

Oil and natural gas production, particularly coal bed natural gas (CBNG), results in the simultaneous release of groundwater from the source formations. Millions of gallons of this produced water are released every year, with the discharged volumes rising in concert with increasing exploration and production in the western United States. If discharged to receiving streams, permits usually require produced waters to be evaluated using whole effluent toxicity (WET) tests. Produced water samples from two Wyoming oil fields were found to be toxic to several test species, with the fathead minnow (*Pimephales promelas*) being the most sensitive. Phase I TIEs were conducted using both *Ceriodaphnia dubia*, a cladoceran, and the fathead minnow. Various treatments reduced toxicity, but the fish was found to be much more sensitive to the effluent toxicant. The most effective treatments included those where hydrogen sulfide (H2S) was significantly reduced. Based on solution chemistry and differential species sensitivity, H2S was identified as the primary toxicant. VTX, a commercial product, and hydrogen peroxide were evaluated for their effectiveness in eliminating toxicity via H2S reduction. Studies showed that the chemical treatment was effective in reducing H2S in produced water; however, because fish were very sensitive to H2S, the effluent could still be toxic if even low levels remained. Treating with activated carbon, followed by filtration, eliminated all toxicity. Although many produced waters are not toxic to fish or invertebrates, those that are, such as the one studied here, must be treated so as not to cause adverse effects to biological communities in the receiving streams.

Pillard, David, AECOM Environment, AECOM, 4303 West LaPorte Avenue, Fort Collins, CO 80521

Presentation Type: Oral

Fish impingement mortality and entrainment characterization studies (IMECS) at two plants in the Garrison Reach of the Upper Missouri River

Impingement mortality and entrainment characterization studies (IMECS) were completed at two coal-fired plants using once-through cooling water systems on the Upper Missouri River, near Stanton, ND. As part of the requirements under the 316(b) Phase II regulations, a fish impingement study was conducted at each plant to determine the number and diversity of fish species impinged during the intake of cooling water into the plants. Specially-built metal baskets were used to collect fish and debris when they were flushed from the traveling screens. Two, 12-hour composite samples were collected every two weeks for one year. Nineteen species were collected. Rainbow smelt and gizzard shad were the most abundant impinged fish, comprising over 75% of the 870 fish collected over one year at the facilities. No endangered, threatened or special status species were impinged on the power plant screens. The diversity of impinged fish was lower than the diversity of collections made by North Dakota Game and Fish, and consisted primarily of small forage fish, possibly originating from Lake Sakakawea. Nearly all of the fish washed from the intake screens were dead at collection and may have been dead or unhealthy

prior to impingement. These data indicate that the intake of cooling water at these two facilities has had little or no impact on the fish populations of the Garrison Reach of the Upper Missouri River.

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Presentation Type: Oral

Interagency giant salvinia, *Salvinia molesta*, control

For decade's giant salvinia, *Salvinia molesta*, native to South America, had been kept out of the United States by enforcement of the Federal Noxious Weed Act, prohibiting its importation and transport across state lines. In May 1998, giant salvinia was identified in a schoolyard demonstration pond in Texas. Fish & Wildlife Service biologists had initiated the educational demonstration pond using plants from a local water garden supplier. The diverse assemblage of aquatic plants was quickly overrun by a hardy surface plant which defied their control efforts. Seasoned biologists gave up trying to control the pond and returned the site to landfill. Within a few months new populations were discovered at farm ponds and at the Toledo Bend Reservoir on the Texas/Louisiana border. Giant salvinia had come to North America to stay. Its pathway for spread and introduction was through the popular aqua-gardening trade.

Alert fliers were sent to managers and regulatory authorities in southern states and the southwest. A few months later, August 4, 1999, giant salvinia was collected by a biologist conducting wildlife surveys at the Imperial National Wildlife Refuge on the Lower Colorado River (LCR). The source was quickly tracked to an irrigation drainage ditch of the Palo Verde Irrigation District near Blythe, CA. The Service has provided interagency coordination for extensive giant salvinia control efforts since 1999. This presentation describes partnership efforts to control *Salvinia molesta* and its continued threat to resources.

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Presentation Type: Oral

Thermal Decision Support Systems: How computers and models can help

Hydroelectric project operations associated with storage reservoirs can affect temperature regimes in rivers. Power operations can change temperature, depth, velocity, turbidity and affect dissolved gases and pollutants for hours, weeks or months. Negative consequences to fish can include acute or delayed mortality and disruption of critical fish behaviors such as feeding, reproduction and migration.

Remote data collection systems and software can display the affects of hydropower operations on water quality, temperature and fish behavior. Three examples will show real-time data used in Decision Support Systems (DSS) to change reservoir operations and protect fish. Examples will include a brief description of the Madison River Thermal DSS for managing temperature; the Missouri River Automated Sampler System for assessing turbidity and metals; and the Thompson Falls Fish Tracking software.

The collection and processing of remote data in real-time provides immediate learning experience and allows correlation between dam operations, water quality and fishery response. DSS's can send alarms, warnings, alerts and operating instructions through secure Internet web sites and criteria based e-mail messages. Historical data can be compiled for compliance monitoring and viewed at public websites such as www.madisondss.com/ppl-river.cfg/ppl-madison.php. Fact sheets on examples presented will be available.

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Presentation Type:

Local, watershed, and landscape inputs into the link between headwater fish population dynamics and variability in downstream fish abundance.

Fish abundance and population dynamics in first order headwaters may be linked with similar metrics further down the watershed. The relative strength of local dynamics and inputs into productivity may also be constrained or augmented by large-scale biogeoclimatic control. We hypothed that local processes would decouple dynamics in headwater streams from those in the associated main tributaries. Because headwater streams are nested within watersheds, which are in turn nested within ecological subregions, we further hypothed that local effects would not necessarily be mutually exclusive from large-scale influence. Density of primarily salmonid fishes at several spatial and temporal scales within a major sub-basin of the Columbia River was consistently greater in a cool-dry ecoregion compared with that in a cool-wet ecoregion. Fish responded positively to common metrics of habitat availability, but habitat availability and the pattern of fish density differed among ecoregions. Both headwater fish density and temporal variation in density were correlated with that in the main tributaries within watersheds, but ecoregional influence was limited to overall density differences, particularly at wider temporal scales. Demographic parameters such as growth and emigration indicated stronger density-dependence in the wet ecoregion, but these responses were strongly influenced by the demographic composition of the local fish population. Thus fish population dynamics appear to be primarily under local control, but ecoregional context helps to define the range of variation in these parameters.

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Presentation Type: Oral

Student Award Candidate

Riverscape patterns and environmental drivers of functional diversity and composition of fish communities in the Lower Colorado River Basin

Understanding how natural and anthropogenic factors shape the present-day diversity and composition of fish communities is needed to effectively manage freshwater ecosystems. When investigating fish community-environment relationships at large spatial scales, a functional perspective using biological traits allows the comparison of species compositions that naturally differ due to biogeographic constraints on regional species pools. In addition, species traits allow for a more mechanistic understanding of the functional linkages between the environment and fish species distributions, thus providing a foundation for predicting existing and future impacts of environmental change. In the present study, we explore patterns of fish community composition and diversity associated with dominant natural and human-related environmental drivers in the Lower Colorado River Basin (LCRB). We employ an information-theoretic model-selection approach and multivariate analyses to explore community-environment associations at the watershed scale. Our analysis is based on a comprehensive database constructed as part of the LCRB Aquatic Gap Analysis Project containing fish occurrence records and GIS-derived environmental characteristics for the entire lower basin. Our model results indicate that the functional composition of native fish communities is shaped largely by natural climate variables, where as hydrologic alteration variables more accurately defined non-native fish communities. We also found that the total amount of community composition variation explained by our environmental characteristics was almost twice as large for the functional analysis compared to taxonomic patterns. These findings support the use of a combined taxonomic and functional approach when assessing the influence of broad-scale environmental drivers of fish fauna composition.

Pope, Kevin, NE Cooperative Fish & Wildlife Research Unit, Nebraska Cooperative Fish & Wildlife Research Unit, 424 Hardin Hall, University of Nebraska--Lincoln, Lincoln, NE 68583; Robert Neumann, In-Fisherman, Inc., Baxter, MN ; Scott Bryan, Aquatic Consultants, Albuquerque, NM

Presentation Type: Poster

Standardized sampling of warmwater fish in small standing waters

We suggest standardized sampling techniques for routine monitoring and population assessment of warmwater sport and prey fishes in small (≤200 ha) standing water bodies. Gear recommendations are based on an objective of easily comparing primary indices of population structure and abundance (e.g. presence, length structure, condition, growth, and catch per unit effort) along spatial and temporal gradients in which fish communities are assessed. Given this objective, we recommend four gear types for sampling fishes in small, warmwater lentic systems: (1) boat electrofisher, (2) bag seine, (3) sinking experimental gill net, and (4) modified fyke net. These recommendations are meant to facilitate comparisons of fish populations among warmwater and coolwater fishes in small standing water bodies and provide future opportunities to assess ecological processes in these systems on a broad geographic scale. These sampling techniques do not address all of the unique challenges of sampling warmwater fishes in small standing water bodies and are not appropriate for all sampling needs. Further, it is hoped that the guidelines presented will stimulate further research for greater understanding of fishing-gear selectivity, which ultimately will lead to improved procedures for standardization.

Porter, Michael, U.S. Army Corps of Engineers, U.S. Army Corps of Engineers, Albuquerque District, 4101 Jefferson Plaza NE, Albuquerque, NM 87109

Presentation Type: Oral

Hydrology, geomorphology and life history: Management concepts for endangered fish

The Rio Grande silvery minnow (*Hybognathus amarus*) is an endangered fish species currently found in 170 miles of the Rio Grande in New Mexico. Rio Grande silvery minnows use inundated riparian vegetation for spawning and nursery habitat during spring runoff. The nursery habitat concept links silvery minnow early life history to changes in river channel morphology and hydrology.

Remote sensing and geographic information systems provide tools for quantifying inundation of nursery habitat features as a function of the hydrograph. Habitat restoration projects can use a suite of techniques to create riparian habitats over different spatial and temporal time scales to be inundated at more frequent flows. Hydrograph manipulation as a part of reservoir operations can be used to manage the magnitude and duration of spring hydrographs for specific life history requirements.

Quist, Michael, Iowa State University, 339 Science II, NREM, Iowa State University, Ames, IA 50011; Kimberly Bonvechio, Florida Fish and Wildlife Conservation Commission, Eustis, FL 32726; Micheal Allen, University of Florida, Gainesville, FL 32653

Presentation Type: Poster

Statistical analysis and data management

Collecting fisheries data requires extensive time and financial commitments. Given this high level of investment by management agencies and individual biologists, data storage, summarization, and analysis should be a high priority to ensure that the integrity and accessibility of collected information is maximized over time. Arguably, the most important aspect of sampling is completing an appropriate and thorough analysis of collected data. Standard sampling procedures help ensure that data analysis and database management are appropriate and efficient, but even when data are collected using standardized methods, data structure will vary among species and systems making standardized analyses difficult and sometimes impossible. Different agencies may also have different database management needs and structures, which can influence how data are stored and later accessed for analysis. The purpose of this chapter is to provide an overview of data summarization and analysis techniques, sample estimators, and principles of database management.

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Presentation Type: Oral

Student Award Candidate

Testing the Thermal Tolerance of Various Life Stages of Fish Using the Critical Thermal Method

Increased stream temperatures resulting from global climate change and urbanization will have important implications for fishes worldwide. While there is information on the effects of elevated water temperatures on individual species, there is little information available comparing the susceptibility of different life stages within the same fish species to high temperatures. In our preliminary test, we examined differences in upper temperature tolerances among rainbow trout fry (I), fingerling (II), yearling (III) and sub-adult (IV) using critical thermal (CT) tests. Although small variations were witnessed, we found little evidence of overwhelming differences in the CTMax of fish at different life stages. We are also testing differences in temperature tolerance among life stages of other trout and warm water species. This information will be valuable to identify if life stage is an important consideration when estimating temperature tolerance.

Reeves, Gordon, USDA Forest Service, PNW Research Stn., 3200 SW Jefferson Way, Corvallis, OR 97331

Presentation Type: Oral

Climate Change and the Freshwater Life-history of Pacific Salmon

Freshwater ecosystems used by Pacific salmon (*Oncorhynchus* spp.) in western North America will potentially undergo major changes as a consequence of climate change. Of particular importance to salmonids are the alteration of the timing, duration, and nature of the flow regime, and changes in the magnitude and timing of water temperatures. The magnitude and direction of the changes will vary widely across the distributional range of these fish. The response of Pacific salmon will depend to a large extent the affect on the individual life-history stage as well as on the timing of the transition between life-history stages. The impacts of climate change on key ecological process that influence the freshwater habitats, such as wildfire and floods, may also affect the response of salmonids. Responsible management and regulatory agencies will need to reconsider their perspective on and response to these events to potentially off-set negative consequences.

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Presentation Type: Oral

The relationship between spawning salmon abundance and the fitness of stream-dwelling fishes, Kenai Peninsula, Alaska

Understanding the dose-response relationship between salmon spawner abundance and the ecological benefits of marine-derived nutrients (MDN) is an important step in the development of salmon escapement goals that account for MDN supplies in stream ecosystems. Identifying spawner levels above which stream-dwelling fish cease to gain physiological benefits may be a direct and appropriate measure of the capacity of fish populations to utilize MDN. Juvenile Coho salmon and Dolly Varden were collected during spring and fall from 11 streams on the Kenai Peninsula, south-central Alaska, which varied widely in salmon spawner densities (0.1 to 4.8 kg/m^2). From these samples we measured RNA-DNA ratios (an index of recent growth rates) and energy density (kJ/g dry mass) as fitness measures in addition to nitrogen stable isotopes ($\delta^{15}N$) as a low-cost proxy. Akaike Information Criterion (AIC_c) was used to determine whether linear (i.e., no saturation) or logarithmic (i.e., saturation) models best approximated the relationship between spawner abundance and dependent variables. RNA-DNA ratios and energy density indicated a saturation response where values increased rapidly with spawner abundance up to approximately 1 kg/m^2 and then leveled off (except for Dolly Varden during fall, which were not successfully sampled at sites with high spawner abundance). Coho sampled during fall showed the strongest evidence for MDN saturation effects on RNA-DNA ratios (w_i = 0.64, r^2 = 0.61) and energy density (w_i = 0.87, r^2 = 0.77). Delta ^{15}N showed little or no evidence of a saturation response, indicating that stable isotopes may not necessarily serve as reliable proxies for fitness responses in fish. Saturation points like that identified in this study may indicate a target spawner density that would balance salmon harvest with the ecological benefits of MDN in stream ecosystems.

Rogowski, David, Texas Tech University, Texas Tech University, Department of Natural Resources Management, Box 42125, Lubbock, TX 79409-2125; Suzanne Sitko, The Nature Conservancy, Lakeside, AZ 85929; Scott Bonar, AZ Coop Fish & Wildlife Research Unit, Univ. AZ, Tucson, AZ 85721

Presentation Type: Oral

Optimizing northern crayfish (*Orconectes virilis*) control methods in Arizona streams

The northern crayfish (*Orconectes virilis*) is an invasive species in Arizona that has numerous deleterious effects on the native flora and fauna. Control methods have been attempted in the past with little thought to the efficiency and effectiveness of particular methods. A popular control method involves trapping; however, effectiveness varies due to crayfish activity and temporal susceptibility to traps. We investigated the life history of three introduced populations of *O. virilis* within Arizona streams using mark-recapture methods. The goal was to use information on survival and reproduction to model crayfish populations, and then use sensitivity analyses to examine life history stages where crayfish could be targeted to maximize control and eradication efforts. Based on our survival and reproduction estimates our population models indicated that crayfish populations at the three sites were not viable. It is possible that the particular sites chosen were population sinks and are supported by immigration. Variances around our estimates of survival and reproduction were fairly large. Thus in a simulation where survival values were randomly drawn from a distribution with large variance, the odds are great that a low survival value would be

eventually drawn causing the population to decline significantly. Despite the shortcomings of the modeling approach the mark-recapture results provided some valuable information. It appears that the best time to implement crayfish control efforts is in the fall prior to the onset of colder temperatures at which northern crayfish become inactive. We did not see a consistent pattern of a sex bias using traps. Northern crayfish in Arizona reproduce only once annually. To improve crayfish survival and recapture estimates, as well as to estimate population densities, we suggest a mark-recapture program using a robust sampling approach concentrated during spring and fall periods.

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Presentation Type: Oral

A comparison of the performance and compatibility of protocols used by seven monitoring groups to measure stream habitat in the Pacific Northwest

In order to comply with legal mandates and/or meet local management objectives, many federal, state and tribal organizations have monitoring groups that assess stream habitat to different jurisdictional scales. This myriad of aquatic monitoring groups has difficulty sharing data across groups and scaling up stream habitat assessments to regional or national levels because of differences in group goals and data collection methods. To assess performance and the potential for data sharing amongst monitoring groups we compared measurements made by 7 monitoring groups in 12 stream reaches in northeastern Oregon. We evaluated (1) consistency of measurements within a monitoring group, (2) ability to detect environmental heterogeneity, and (3) compatibility of measurements amongst monitoring groups, and their relation to more intensively measured values determined by a research team. Overall, we found that some stream attributes were consistently measured both within and among groups; however, none of the monitoring groups were able to achieve high precision for all measured stream attributes, and few of the measured attributes had potential for being shared among all groups. Given the high cost of stream habitat monitoring, we suggest that additional effort be focused on developing approaches that increase precision and compatibility of measured stream attributes so that their utility extends beyond the monitoring group that collects the data.

Sandstrom, Steve, Ontario Ministry of Natural Resources, Peterborough, ON K9J 7B8; Nigel Lester, Ontario Ministry of Natural Resources, Peterborough, ON K9J 7B8; George Morgan, Laurentian University, Sudbury, ON K9J 7B8; Tim Haxton, Ontario Ministry of Natural Resources, Peterborough, ON K9J 7B8

Presentation Type: Poster

Efficacy of the proposed North American gill net standard for monitoring fish communities in Ontario, Canada

We evaluated a gillnetting method that has been proposed for sampling fish communities in Ontario lakes. The method uses two types of nets: 1) a large mesh net that targets fish larger than 20 cm in length; and

2) a small mesh nets that targets smaller fish. The large mesh net has been proposed as a North American standard for sampling harvested freshwater species (Bonar et al, in press). The small mesh net is a new standard, developed in Ontario. Depth-stratified sampling with large mesh nets was conducted in 23 lakes where prior information about the abundance of lake trout or walleye was available. For both species,
depth-stratified estimates of mean catch per net correlated well with prior estimates of fish abundance. Small mesh surveys were conducted in 15 lakes where other small fish assessment methods were planned (e.g. seine, fyke nets, Nordic gillnetting). Our results indicate that fish community composition can be described effectively using a combination of large and small mesh gillnets. Our surveys detected, on average, 61% of the fish community, but this detection rate could be substantially improved by a modest increase in sampling effort. Jointly, the large and small mesh nets span a mesh range that is similar to the Nordic net, a standard that has been adopted in Europe. Our method (i.e. large and small mesh nets) produced catches that were very similar to Nordic net catches when sampling effort was the same. We recommend the proposed gillnetting protocol as an effective means of meeting Ontario's fish sampling objectives, while ensuring our data are comparable to data collected by both North American and European standards.

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Presentation Type: Oral

Status of Warner suckers in the Warner Basin, Oregon

The Warner sucker (*Catostomus warnerensis*) is endemic to the Warner Valley, an endorheic subbasin of the Great Basin in southeastern Oregon and northwestern Nevada. This species was historically abundant and its historical range includes three permanent lakes, several ephemeral lakes, and three major tributary drainages. Warner sucker abundance and distribution has declined over the past century and it was federally listed as threatened in 1985 due to habitat fragmentation and threats posed by the proliferation of piscivorous non-native game fishes. In 2006 and 2008, we conducted investigations in Hart and Crump Lakes to quantify the abundance of Warner suckers, to search for evidence of recent recruitment, to estimate sucker abundance relative to nonnative fish abundance, and to track movements during the spawning season. We found the Warner sucker populations in Crump and Hart Lakes were severely depressed. The 2006 and 2008 abundance estimates (CPUE) for suckers in the lakes were some of the lowest on record. In addition, we found little evidence of recent recruitment of suckers to the lake populations. Sucker distributions were dominated by large, older aged fish and the average sucker length has increased steadily since the lakes were recolonized following their desiccation in 1992. We also found that the proportion of nonnative fish in the catch has increased during this time period. Radio tracking of tagged fish documented losses of spawning fish in irrigation canals. In 2007, we conducted distributional surveys and obtained population estimates of suckers in the Warner basin tributaries. We found the distribution of stream suckers to be patchy with a few distinct areas of relatively high abundance. In 2009, we plan to obtain a mark-recapture estimate in one of these areas.

Schutez, Andrea, Oregon State University/USGS, Department of Geosciences, Oregon State University, Corvallis, OR 97331; Jay Alder, Oregon State University, Corvallis, OR 97331; Steve Hostetler, USGS, Corvallis, OR 97331

Presentation Type: Poster

Student Award Candidate

Preliminary results of analyzing the surface hydrology of North America under a doubling of CO^2

We are producing high-resolution simulations of the atmosphere and land surface under a doubling of atmospheric CO2 using the RegCM3 regional climate model. We are applying a several techniques to evaluate model performance and to quantify potential changes in surface hydrology. We are developing a methodology for extracting monthly snow cover and soil moisture from the Advanced Microwave Scanning Radiometer (AMSR-E) on the Earth Observing System Aqua satellite. The AMSR-E data are used both to validate our regional model simulations and to provide a basis for assessing changes. We are also using a standardized index approach similar to the Standardized Precipitation Index (SPI) to evaluate short (3-6 month) and longer (12-36 month) changes in, for example, 500 hPa pressure heights, precipitation and soil moisture. Our standardized indices can be used to assess anomalous wet periods, drought, and wildfire conditions in the doubled CO^2 simulations. This work is ongoing and we anticipate analyzing several decades of simulations to present at the meeting.

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Presentation Type: Oral

Student Award Candidate

Modeling habitat availability in a Great Plains river system to assess the effects of energy development-related flow augmentation

Wyoming’s Powder River has been touted as the last remnant of a pristine Great Plains river system. The biologic integrity of basin may be at risk, however, due to the rampant development of coalbed natural gas (CNG) throughout portions of northeastern Wyoming. Production of CNG requires the removal of groundwater associated with coal seams. Management options for CNG product water include direct discharge to surface water bodies. Concern exists regarding the potential for steady influxes of relatively high-quality water to alter the stochastic nature of the Powder River. In light of these concerns, research was conducted to assess the potential effects of increased flow due to CNG product water on the summer, low-flow habitat for native and introduced fishes. The fish assemblages and habitat for discreet habitat types were described during the summer of 2008 and loaded into a GIS. A cluster analysis was conducted to identify groupings, or guilds, of fishes based on their habitat associations. Habitat suitability functions for each guild were derived using logistic regression. Resultant suitability curves, geo-spatial

mapping data, and hydrologic habitat attributes were used to predict available instream habitat across variable flows using a meso-habitat scale instream flow model. Modeling results indicate that moderate increases in flow result in homogenization of instream habitat and the reduction of suitable habitat for small bodied, native fishes. These data suggest that high volumes of CNG product water could appreciably alter the complexity of instream habitat matrices affecting the native fish community.

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Presentation Type: Oral

LaBarge Creek Restoration: planning, adapting, and lessons learned

Piscicide treatments were conducted in the LaBarge Creek watershed from 2000 - 2006 to remove all non-native fish species from the project area. The treatment area encompasses 21 miles of LaBarge Creek and 37 miles of tributaries for a total of 58 stream miles. There were 19 streams treated not including numerous small unnamed tributaries. A major portion of the project was the logistical requirements of implementing a project of this magnitude and organizing a large crew of up to 40 people annually. Challenges included understanding the toxicity of the piscicide(s) under variable stream conditions, and maintaining the capability and readiness to be flexible and implement changes when necessary. In general, antimycin was applied at 10 ppb for 8 hours of exposure and rotenone was applied at 1 ppm for 8 hours. However due to the cold water temperatures and high pH in most streams, antimycin was consistently less effective than rotenone. From 2004 - 2006 both piscicides were applied, with antimycin the primary toxicant in 2004 and rotenone in 2005 and 2006. Unfortunately, both piscicides were not consistently effective when water temperatures were below 50º F without altering the concentration, exposure time, and distances between drip stations. Beaver ponds, backwaters, seeps, springs and disconnected waters added complexity to the treatments. In 2005 and 2006 sandmix, was applied instead of liquid rotenone, and was extremely effective. In total, 28,547 fish were removed from 58 stream miles from 2000 through 2006 of which 62% were game fish.

Shepard, Bradley, Montana Cooperative Fishery Research Unit and Montana FWP, 65 9th Street Island Drive, Livingston, MT 59047; Mark Taper, Ecology Department, Montana State University, Bozeman, MT 59717; Alexander Zale, USGS Montana Cooperative Fishery Research Unit, Bozeman, MT 59717

Presentation Type: Oral

Recovery of westslope cutthroat trout populations following removal of nonnative brook trout

There is mounting evidence that brook trout (*Salvelinus fontinalis*) can displace westslope cutthroat trout (*Oncorhynchus clarkii lewisi;* WCT) from headwater tributary streams. We tested whether 75 mm and longer WCT occupied a niche similar to 75 mm and longer brook trout by comparing biomass, densities, and individual fish condition factors prior to and following total removal of brook trout in 2.3 to 3.0 km reaches of three headwater streams in Montana. Our estimates of total trout biomass before and after brook trout removals indicated that biomass of WCT in allopatry were either significantly higher or not

significantly different (based on 95% CIs) than total biomass of WCT and brook trout together in sympatry. Thus, we conclude that these two species occupied similar niches in these streams. Densities of 75 mm and longer brook trout were negatively correlated to densities of similar-d WCT (Spearman's rho = -0.59, $p < 0.05$), but we did not find clear associations between densities of juveniles and adults of the two species. We found that densities of juvenile brook trout negatively affected body condition of juvenile WCT using two separate analyses. We found evidence for -asymmetric competition in one stream, but not in the other stream where -asymmetry was tested. Our results indicated that interspecific competition between brook trout and WCT was nearly as strong as intraspecific competition within WCT, especially among juveniles, providing insight into one mechanism by which brook trout displace WCT.

Skaar, Don, Montana Fish, Wildlife and Parks, 1420 East 6th Avenue, Helena, MT 59620

Presentation Type: Poster

American Fisheries Society training course: Planning and executing successful rotenone and antimycin projects

The AFS offers a 4 1/2 day course on the use of rotenone and antimycin in fisheries management at Utah State University in Logan, Utah. This course is offered on an annual basis, and in 2009 it will be given on May 18-22. The goal of the course is to provide students (typically fish biologists) with the tools, information and experience to plan and conduct a treatment. Included are classroom teaching modules, laboratory experiments, and mock field exercises. Classroom modules include lectures on piscicide science, planning and implementing treatments, and case histories of successful and unsuccessful projects. Students also break into smaller groups to plan different elements of a real-life treatment scenario. Laboratory work includes toxicity experiments using trout to gain experience in handling chemicals and to observe their effects under different environmental conditions. Students also construct three different types of drip cans. Field exercises include learning to measure stream discharge to determine proper mixture of chemical:water and correctly calibrate drip can flow rates. Students also determine the proper amount of chemical for a lake treatment after calculating surface area and volume from a nearby lake. Final field exercise includes demonstration of the powdered rotenone aspirator delivery system. Student knowledge is evaluated with a final examination with passing students receiving a certificate of completion.

Smith, Mark, Wyoming Game and Fish Department, 2820 HWY 120, Cody, WY 82414

Presentation Type: Oral

Learning from the history of constructing fish barriers in Wyoming

The utilization of upstream fish migration barriers are central to cutthroat trout restoration in the western U.S. and Wyoming. Native species are often eliminated in the presence of introduced fishes. In Wyoming, the human creation of fish barriers dates to early European settlers who inadvertently created fish migration barriers in their efforts to irrigate the high plains. While fish managers struggle to address this

legacy of fish habitat fragmentation, we also find ourselves learning how to construct fish barriers to protect our cutthroat trout resources. Wyoming's first barriers constructed for cutthroat trout restoration were built with limited understanding of the swimming and jumping abilities of fishes to be excluded and limited foresight into the functionality of the barrier during extreme hydrologic events. Early efforts generally included a desire to create barriers that resulted in minimal disturbance to the stream and surrounding environments. Early fish barriers in Wyoming were built relatively inexpensively often by hand with natural materials such as wood and rock gabions. A common attribute of almost all early fish migration barriers built in Wyoming was that they failed. Failure came in the form of physical degradation of the barrier, particularly those built with gabions. Wyoming fisheries managers have learned from each of these failures and have developed new barrier designs that while relatively new show great promise. Unlike early fish barriers, newly designed barriers incorporate synthetic fabrics, steel and concrete. While these new designs generally result in larger initial surface disturbance, they are also built to function through flood and drought for generations. This presentation will illuminate the evolution of fish barriers in Wyoming.

Steed, Amber, Montana Fish, Wildlife & Parks, 490 North Meridian Road, Kalispell, MT 59904; Clint Muhlfeld, U.S. Geological Survey, West Glacier, MT 59936; Erin Sexton, Flathead Lake Biological Station, Polson, MT 59860-6815

Presentation Type: Oral

Proposed coal mining and coal-bed methane development threaten aquatic resources in the Transboundary Flathead Ecosystem

The Transboundary Flathead River basin in Montana (USA) and British Columbia (Canada) hosts one of the most diverse and unique aquatic ecosystems throughout North America. Migratory bull trout (*Salvelinus confluentus*) and non-hybridized westslope cutthroat trout (*Oncorhynchus clarkii lewisii*) migrate from Flathead Lake upstream to the Canadian headwaters to spawn and rear, representing some of the last remaining strongholds in the basin. However, proposed open-pit coal mining and coalbed methane (CBM) drilling in the Canadian headwaters threaten water quality, invertebrate communities, and migratory fish populations downstream to Glacier National Park (GNP) and Flathead Lake. In response to these threats, a multi-agency, long-term research and monitoring program was initiated in 2005 to examine water and sediment chemistry, contaminant levels, aquatic habitat, and the distribution and genetic diversity of native fishes. Comparative data collected in the neighboring Elk River drainage, a system impacted by coal mining and CBM development, show increased nutrients and heavy metal concentrations in the water and lower invertebrate species richness than the Flathead. In 2008, basin-wide fisheries surveys were initiated and data were collected at 119 sites in Canada and GNP. Native fishes were found throughout much of the system, including proposed mining locations. Additionally, the highest density of bull trout redds in the system was detected immediately downstream of proposed mine sites. Continuation of these collaborative investigations will provide necessary baseline data to inform conservation and management decisions impacting this diverse and sensitive transboundary system.

Sutphin, Zak, Colorado State University, Denver Federal Center, Bldg 56 Room 2010, PO Box 25007 (D868290), Denver, CO 80225; Christopher Myrick, Colorado State University, Fort Collins, CO 80523

Presentation Type: Oral

Student Award Candidate

Effects of temperature and simulated loading stress on fishes of the Sacramento-San Joaquin Delta oxygen consumption and total ammonia production rates.

Fish collection facilities in California's Sacramento-San Joaquin Delta (SSJD) annually salvage and truck-transport millions of fish, preventing water pumping plant entrainment and mortality. Fish-transport operations at such facilities affect important SSJD species like threadfin shad (*Dorosoma petenense*), striped bass (*Morone saxatilis*), the endangered delta smelt (*Hypomesus transpacificus*), and fall-run Chinook salmon (*Oncorhynchus tschawytscha*), a candidate species for federal ESA listing. To determine appropriate fish-transport densities necessary to maintain adequate water quality to support fish health, ammonia nitrogen production (M_{TAN}) and oxygen consumption (MO_2) rates were measured before and after simulated fish-loading stress (30-s air exposure), at four temperatures between 12 and 24ºC for delta smelt and Chinook salmon, and between 12 and 28°C for striped bass and threadfin shad. Pre- and post-stress MO_2 and M_{TAN} of all species generally increased with temperature. Simulated loading stress did not affect threadfin shad or delta smelt MO_2 and M_{TAN}, likely because they were already stressed due to confinement in the respirometry chambers. Mean MO_2 for delta smelt ranged from 0.05 to 0.08 mg O_2 g^{-1} h^{-1}; M_{TAN} ranged from 0.002 to 0.01 mg TAN g^{-1} h^{-1}. Threadfin shad MO_2 ranged from 0.05 to 0.19 mg O_2 g^{-1} h^{-1}; M_{TAN} ranged from 0.001 to 0.01 mg TAN g^{-1} h^{-1}. Simulated loading stress increased striped bass (+13 – 40%) and Chinook salmon (+17 – 34%) MO_2 and M_{TAN} rates. Striped bass pre-stress MO_2 ranged from 0.03 mg O_2 g^{-1} hr^{-1} at 12°C to 0.09 mg O_2 g^{-1} h^{-1} at 28°C; M_{TAN} ranged from 0.001 to 0.004 mg TAN g^{-1} h^{-1}. Chinook salmon tested between 12 and 28°C had MO_2 and M_{TAN} values that ranged from 0.04 to 0.13 mg O_2 g^{-1} h^{-1}, and from 0.001 to 0.003 mg TAN g^{-1} h^{-1}, respectively.

Swenton-Olson, Daniella, Department of Biology, University of New Mexico, Department of Biology, MSC03 2020, 1 University of New Mexico, Albuquerque, NM 87131-0001; Astrid Kodric-Brown, Department of Biology, University of New Mexico, Albuquerque, NM 87131-0001

Presentation Type: Oral

Student Award Candidate

Ecologically driven life history differences between two *Gambusia* species

Environmental temperature can have a profound impact on aquatic ectotherm life histories. Two closely related, livebearing mosquitofishes that have allopatrically diverged in two very different temperature environments. *Gambusia affinis* is typically found in habitats with high daily and seasonal fluctuations in temperature and is considered highly invasive. *Gambusia nobilis* is an endangered species found in spring-fed habitats that are very stable in temperature throughout the year. We predicted that the nature

of the divergent aquatic habitats, eurythermal and stenothermal, has given rise to divergent life history strategies that more close resemble a classic *R* and *K* strategy, respectively. To determine differences in life history strategy we examined the characteristics of both species in a field study at Bitter Lake NWR in the Pecos River watershed, a laboratory breeding study and dissection of museum specimens. Data were collected on traits including egg, brood, maternal investment, age and distributions, and sex ratio. Both species have equal maternal investment per brood and appear to have similar investment over a lifetime. The investment strategy, however, is very different. *Gambusia affinis* is an annual species. Females have a gestation period of approximately one month and have 3-5 broods in a given year. Embryo is at least half that of *G. nobilis'* embryos. Brood is large although it decreases throughout a given breeding season. Growth rates are higher for *G. affinis* and sexual maturity is typically attained at smaller body. *Gambusia nobilis* females appear to live for multiple years. They exhibit slow growth rates and larger at sexual maturity. *Gambusia nobilis* exhibits great variability in embryo but *G. affinis* embryo is highly constrained. These differences in life history strategy may help reinforce unique species' identities in secondary contact zones where the two species are hybridizing.

Sykes, Catherine, US Fish and Wildlife Service, Dexter National Fish Hatchery & Technology Center, P.O. Box 219, Dexter, NM 88230

Presentation Type: Oral

Acute toxicity of potassium chloride to Colorado pikeminnow, razorback sucker, and bonytail

In 2007 quagga mussels were found in the water system of a federal hatchery that rears endangered southwestern fishes for repatriation to native waters. Preventing further movement or transfer of the mussel to other facilities or waters is a priority for State and Federal agencies. Potassium chloride is an accepted treatment for killing mussel veligers when transferring fish from waters that are positive for quagga mussels. Data is available on the effects of potassium chloride on many sport fish species but little research has been conducted on the toxicity to endangered native fish. Acute toxicity tests were conducted for 96 h to determine the median lethal concentration (LC50) of potassium chloride to larval and juvenile stages of Colorado pikeminnow (*Ptychocheilus lucius*), razorback sucker (*Xyrauchen texanus*), and bonytail (*Gila elegans*). Bonytail larvae (7-day-old) were significantly more sensitive to potassium chloride (96-h LC50 970 mg/L) than 7-day-old razorback sucker larvae (96-h LC50 1800 mg/L). Juvenile Colorado pikeminnow (mean total length 37.4 mm, 96-h LC50 1281 mg/L) were significantly more sensitive than razorback sucker of comparable (96-h LC50 1942 mg/L). At 90-100 mm total length, Colorado pikeminnow exhibited a significantly higher sensitivity (96-h LC50 1638 mg/L) than razorback sucker and bonytail (96-h LC50 2598 mg/L and 2669 mg/L, respectively). The results from these tests combined with proposed future research on acute toxicity of potassium chloride will provide resource managers with baseline data for further development of effective quagga mussel treatments that result in minimal effects on endangered native fish species.

Tashjian, Paul, USFWS, USFWS; Refuges: DNR, PO Box 1306, ABQ, NM 87102

Presentation Type: Oral

The restoration of the Pecos River at Bitter Lake NWR

Historically the Middle Pecos River was a wide, sediment-laden river with a diversity of habitats, ranging from backwaters to main channel settings. These habitats were maintained by natural flooding, which moved sediments between the channel and the floodplain. The native biology of the Pecos took many life cycle cues from the hydrology and sediment mobility associated with an active floodplain.

Bitter Lake National Wildlife Refuge is located near Roswell, NM and straddles both quality and poor riparian habitat. North of Bitter Lake National Wildlife Refuge, many of the historic floodplain functions of the river remain intact, however this habitat is in the most likely portion of the Middle Pecos to go dry. Perennial flows on the Pecos River begin at the Refuge however the habitat from the Refuge south has been channelized and lack a functioning floodplain. By restoring the Pecos at the Refuge, the river can mirror habitat to the north in an always wet portion.

The restoration of the Pecos River at the Refuge consists of two phases: Phase I: Reconnection of a bisected oxbow lake (1.5 river miles) and Phase II: repairing floodplain connectivity north of this lake (6 river miles). The Bureau of Reclamation is charged with implementing Phase I. The US Fish and Wildlife Service, in partnership with the World Wildlife Fund and the NM Interstate Stream Commission, received a grant from the New Mexico Environment Department, 2007 River Ecosystem Restoration Initiative for Phase II. Both Phases are beginning construction in February of 2009 and are anticipated to be largely completed by January 2011. Much elbow grease and agency coordination has gone into this project. Many folks have contributed to this project. The fruit of our labor is close at hand- returning a river to its floodplain.

Tave, Douglas, New Mexico Interstate Stream Commission, Springer Square Building, 121 Tijeras, NE, Suite 2000, Albuquerque, NM 87110; Eric Gonzales, SWCA Environmental Consultants, Albuquerque, NM 87109; Grace Haggerty, New Mexico Interstate Stream Commission, Albuquerque, NM 87102; Mike Hatch, SWCA Environmental Consultants, Albuquerque, NM 87109; Nic Medley, New Mexico Interstate Stream Commission, Santa Fe, NM 87504; Anders Lundahl, New Mexico Interstate Stream Commission, Albuquerque, NM 87102

Presentation Type: Oral

Keys to better management through monitoring for Rio Grande silvery minnow (*Hybognathus amarus*) presence on habitat restoration floodplain sites during the 2008 runoff

The New Mexico Interstate Stream Commission has employed a number of habitat restoration techniques in the Middle Rio Grande to benefit the federally listed Rio Grande silvery minnow. Fisheries monitoring was conducted to document Rio Grande silvery minnow presence on five habitat restoration sites in the middle Rio Grande that inundated during the 2008 spring snowmelt runoff. Fyke nets were used to collect fish. Eggs and larval fish were collected with D-frame kick nets. Movement between the main channel and the floodplain was studied at two sites by placing paired fyke nets positioned to capture fish swimming onto and to capture fish swimming off of the sites. Between May 12 and June 11, two thousand one

hundred and eighty adult Rio Grande silvery minnow were collected. The highest single-day catch occurred May 26. Fish were placed into four categories: gravid females, spent females, males (expelling semen), and unknown. The percentage of unknown fish dropped from 58% in week one to between 20-30% during the remainder of the study. The percentage of males went from 7% in week one to approximately 30% for the remainder of the study. The percentages of gravid and spent females were inversely related. In week one, 34% of the fish were gravid females, and only 1% were spent females; by the end of the study, 10% of the fish were gravid females, while 43% were spent females. Many fish expelled gametes while being handled. Floodplain and main channel egg collections indicate that silvery minnow spawning was most pronounced from May 12 through June 1. This study indicates that reproductively mature Rio Grande silvery minnow are moving onto recently constructed habitat restoration sites. Further study will provide information on spawning and recruitment so that habitat can be provided for these critical life stages.

Todd, Andrew, U.S. Geological Survey, Denver Federal Center, Box 25046, M.S. 964, Denver, CO 80225-0046; Mark Coleman, Coleman Ecological, Inc., Fort Collins, CO 80525; Aimee Konowal, Colorado Water Quality Control Division, Denver, CO 80246; Melynda May, Colorado Water Quality Control Division, Denver, CO 80246; Nicole Vieira, Colorado Division of Wildlife, Fort Collins, CO 80523; James Saunders, Colorado Water Quality Control Division, Denver, CO 80246

Presentation Type: Oral

New water temperature criteria to protect Colorado's fisheries

Water temperature fundamentally influences aquatic diversity and ecosystem health. In Colorado, temperature water quality criteria were revised in January 2007 based on a rigorous evaluation of the thermal requirements of fish species resident in Colorado. This is an account of how this process was conducted, and details the resultant criteria. The purpose of developing these criteria was to protect cold- and warmwater fishes, especially native species such as cutthroat trout (*Oncorhynchus clarki*), from thermal stress. As such, lethal temperatures and optimal temperature conditions were determined from a literature review for species of the state, and these data were compiled into the Colorado Temperature Database. Acute and chronic thermal thresholds were then calculated for individual fish species. Finally, assemblages of fish were grouped into thermal tiers and temperature criteria were developed based on biological criteria for each assemblage. A case study is presented detailing the integration of science and policy decisions that shaped the development of Colorado’s coldwater temperature criteria.

Umlauf, Gretchen, National Marine Fisheries Service, 650 Capitol Mall, Suite 8-300, Sacramento, CA 95814

Presentation Type: Oral

Development of an interactive internet platform for the Central Valley Recovery Plan's Evolutionarily Significant Units (ESU) of Sacramento River Winter-Run and Spring Run Chinook salmon and the Distinct Population Segments (DPS) of the Central Valley steelhead

In preparation for the roll out of a major salmon species recovery plan for the California Central Valley, providing a unified body of recovery information in a current format was undertaken using GIS ArcInfo software and programming it to applications in Google, with links to recommended models and services such as NOAA toolbox and SHIRAZ. The process of developing the interactive GIS system for recovery plans will help the salmon managers, scientists, and watershed groups to easily access the recovery information. Recovery information in the past has been presented in report format. While useful, other interactive databases with similar types of reference based materials have been developed for ease of internet use such as Calfish.org, Fishbase and others. The California Central Valley Recovery Planning process incorporates this current access method through the development of Google based applications that influence the user's perception of the strategies, methods and potential outcomes of the recovery plans. The new media approaches to presenting complicated and sometimes technical recovery information furthers the success of the recovery plans by making the plans easily accessible to many people as well as creating a platform in which a large amount of fisheries, management, restoration and outcome information is formatted in a system that helps users to integrate the information.

Valdez, Richard, SWCA, Inc., SWCA, Inc., 172 West 1275 South, Logan, UT 84321; Sarah Beck, Albuquerque, NM 87110; C. Nicolas Medley, New Mexico Interstate Stream Commission, Santa Fe, NM 87504; Schmidt-Petersen Rolf, New Mexico Interstate Stream Commission, Santa Fe, NM 87504; Liz Zeiler, New Mexico Interstate Stream Commission, Santa Fe, NM 87504

Presentation Type: Oral

Habitats that Enhance Abundance and Variability of Macroinvertebrates, Aufwuchs, and Chlorophyll *a* in the Middle Rio Grande

Hypotheses about spatial and temporal variability of macroinvertebrates, aufwuchs (algae, diatoms, molds, fungi, protozoa), and chlorophyll *a* in a sand-bed river were tested on the middle Rio Grande (MRG), New Mexico, USA. Effects of flow, season, mesohabitat type, temperature, depth, velocity, and substrate were evaluated on each resource. We sampled 9 mesohabitat types at 5 sites during 4 months each in 2005 and 2006. Of 32 orders and 102 families of drift and benthic macroinvertebrates, over 80% were collectors indicating a predominantly allochthonous-driven energy source, although a diverse assemblage of algae and diatoms (44 genera) and high chlorophyll a concentrations revealed an important autotrophic component in shallow, low-velocity mesohabitats that may be a key food source for small-bodied fishes. Principal components analysis (PCA) explained 61% of variation and showed that drift macroinvertebrates were strongly affected by flow and temperature; PCA explained 69% and 59% of variation in benthic macroinvertebrates and aufwuchs densities, respectively, and showed mesohabitat type, month sampled, and temperature as strong predictors. Shallow, low-velocity mesohabitats (<0.15 m/s), including backwaters, emergent vegetation, shorelines, and slackwaters comprised < 2% of riverine area and had significantly higher resource densities ($p < 0.05$) than mesohabitats with velocities ≥0.15 m/s; only woody debris had high densities and was associated with high velocity. Our study showed that riverine resources were uniformly distributed throughout the MRG despite variable flows and a near-drying event at the downstream-most site in October 2005. Differences in abundances of benthic macroinvertebrates, aufwuchs, and chlorophyll *a* were greatest among mesohabitat types, indicating that

actions to enhance channel complexity and shallow, low-velocity mesohabitats, including woody debris, are important components of river management in the MRG.

Voeltz, Jeremy, U.S. Fish and Wildlife Service, US Fish and Wildlife Service, P.O. Box 39, Pinetop, AZ 85935

Presentation Type: Oral

Apache trout fish barriers - can an effective barrier be constructed in a remote location?

In 2006, the US Fish and Wildlife Service received funding from the National Fish Habitat Action Plan's Western Native Trout Initiative to construct a fish barrier on lower Bear Wallow Creek to aid in the recovery of the threatened Apache trout. The barrier location is in a primitive area on the San Carlos Apache Indian Reservation and this project presented some unique challenges and opportunities. This presentation will discuss all aspects of the project: site selection, planning, partnerships, environmental compliance, logistics, implementation; and did I mention partnerships?

Wagner, Eric, Utah Division of Wildlife Res., 1465 W 200 N, Logan, UT 84321

Presentation Type: Oral

Rainbow trout egg disinfection with higher doses of hydrogen peroxide and iodine for shorter durations

Four tests evaluated iodine and hydrogen peroxide for rainbow trout *Oncorhynchus mykiss* egg disinfection at higher doses and shorter durations than typically used. Eyed eggs in the first test were exposed to either (1) 2,000 mg/L iodine for 10 min, (2) 100 mg/L iodine for 15 min, (3) 3% hydrogen peroxide for 1 min, (4) 0.6% hydrogen peroxide for 5 min, or (5) no treatment. Higher iodine or hydrogen peroxide concentrations did not significantly affect egg survival or deformity rates. Iodine and hydrogen peroxide significantly reduced bacterial abundance on the eggs relative to untreated eggs, but some bacteria still persisted on the eggs. Hydrogen peroxide at 3% for 1 min was generally better for bacterial control than the other treatments, but 2,000 mg/L iodine also was effective. In the second test, 2,000 mg/L iodine induced higher levels of egg mortality in “green” eggs at both 30 and 60 min after fertilization than buffered hydrogen peroxide (1.5% for 2 min), which did not significantly differ from controls. A third test evaluated the effect of hydrogen peroxide on pH at various water hardness levels. The pH of hydrogen peroxide solutions dropped as total hardness levels decreased, but buffering with baking soda (≥ 1.32 g/L) returned pH to circum-neutral levels. In the fourth test, the serial combination of both 3% hydrogen peroxide and 2,000 mg/L iodine was highly lethal if hydrogen peroxide was the first in order. Treatment of eggs in the reverse order (iodine first) resulted in survival that did not significantly differ from controls. A concurrent treatment using 1.5% hydrogen peroxide in buffered solutions resulted in no significant difference in survival from controls (100 mg/L iodine). Results indicated that hydrogen peroxide was effective in controlling bacteria with little to no effect on egg survival, but soft water must be buffered.

Walter, Jason, Weyerhaeuser Company/University of Washington, WTC-1B10, Weyerhaeuser Company, 33663 Weyerhaeuser Way South, Federal Way, WA 98001; Christian Torgersen, U.S. Geologic Survey, Forest and Rangeland Ecosystem Science Center, Cascadia Field Station, Univers, Seattle, WA 98195; Robert Bilby, Weyerhaeuser Company, Federal Way, WA 98001; Thomas Quinn, University of Washington, School of Aquatic and Fishery Sciences, Seattle, WA 98195; Brian Fransen, Weyerhaeuser Company, Federal Way, WA 98001

Presentation Type: Oral

Student Award Candidate

Variability of coastal cutthroat trout abundance and LiDAR-derived channel morphometry in headwater catchments

Current practices in place to protect aquatic biota and their habitats potentially impacted by forest management typically recognize differences among these habitats at the coarse-scale. This approach does not address the significant heterogeneity of headwater habitats that exists at finer-scales, and contributes to the inability of scientists, managers, and regulators to agree on best management practices to provide protection to aquatic systems. We conducted spatially continuous, single-pass electrofishing and habitat surveys within the fish-bearing portions of eight catchments where coastal cutthroat trout were the sole salmonid species present. Spatial and temporal variability of cutthroat trout abundance within each study catchment was assessed using both fine-scale stream habitat data collected during field surveys and intermediate-scale channel morphometry derived from lidar remote sensing. Geostatistical and multivariate modeling techniques were used to quantify spatial structure in the distribution of cutthroat trout in relation to habitat heterogeneity associated with channel slope, valley width, and network structure. By identifying intermediate-scale habitat characteristics associated with high cutthroat trout abundance land managers can better identify areas of high biological potential where specific habitat protections or restoration efforts may be warranted or most productive.

Wells, Scott, Portland State University, Dept of Civil and Environmental Engineering, Portland State University, P.O. Box 751, Portland, OR 97207-0751

Presentation Type: Oral

Water quality modeling and fish bioenergetics

In many surface water systems, efforts have been made to revive fisheries, such as the Kokanee salmon fishery in the Pacific Northwest, which is of particular interest to Native Americans culturally and economically. There are many reasons for the loss of the fisheries, but the construction of dams along the Columbia River has clearly influenced fish habitat and ecology in the basin. The oftentimes competing beneficial uses of lakes and reservoirs require that fishery and lake managers develop an understanding of their systems in order to make sound decisions as to improve fish habitat and to meet the other operational goals of the reservoir. Interdisciplinary approaches to improving fish habitat and water quality include application of hydraulics, hydrology, aquatic chemistry, limnology, biology, and ecology principles

to surface water bodies. One approach to this has been to couple water quality and hydrodynamic models with fish bioenergetics models. This then ties the management of the surface water system to expected changes in growth of targeted species. A further extension of this is to then couple fish transport or movement models based on the environmental changes the fish experiences, such as velocity, temperature and dissolved oxygen, with the bioenergetics. A review of the coupling of water quality models and fish bioenergetics models will be presented with an example presented for the Lake Roosevelt system on the Columbia River.

Wenger, Seth, Trout Unlimited, 322 E. Front St., Suite 401, Boise, ID 83702; Dan Isaak, U.S. Forest Service Rocky Mtn. Research Station, Boise, ID 83702; Helen Neville, Trout Unlimited, Boise, ID 83702; Charlie Luce, U.S. Forest Service Rocky Mtn. Research Station, Boise, ID 83702; Bruce Rieman, U.S. Forest Service Rocky Mtn. Research Station, Boise, ID 83702

Presentation Type: Oral

Using climate models to predict hydrologic and thermal effects on future habitat distributions of inland trout in headwater streams across the Western U.S.

Climate change will affect freshwater fish distributions through multiple mechanisms, the most important of which are increased water temperatures, altered hydrologic regimes, and modified biotic interactions. These changes will be spatially heterogeneous due to topographic complexity and geographic differences in warming rates and precipitation trends. Most broad scale assessments of climate effects on fish do not address this heterogeneity and are predicated on homogenous changes in a single parameter (air temperature). Here, we use the AR4 general circulation model (GCM) set downscaled to 1/8th degree resolution (~140 km^2) to simulate recent climates and future conditions under the A1B scenario in headwater streams across the western US. These climatic conditions are used to estimate thermal conditions in streams and coupled to the Variable Infiltration Capacity (VIC) macroscopic hydrologic model to determine hydrologic regimes. To examine potential effects on trout distributions, we have assembled a database of 10,000 fish surveys from natural resource agencies across the historical range of inland cutthroat trout (*Oncorhynchus clarkii*). Multilevel models that minimize issues of spatial autocorrelation will be used to predict contemporary trout distributions from recent climatic conditions, geomorphic variables, and occurrence of other trout species. Once the models are constructed, we will compare climatically suitable habitat distributions under current and future conditions to explore how climate-driven changes in hydrologic and temperature parameters may affect several species of trout. Pilot analyses are currently being conducted in the Columbia River Basin and the full study is scheduled for completion in 2010.

Whittier, Joanna, Kansas State University, 205 Leasure Hall, Division of Biology, Kansas State University, Manhattan, KS 66506; Craig Paukert, Kansas State University, Manhattan, KS 66506; Julian Olden, University of Washington, Seattle, WA 98195

Presentation Type: Oral

Modeling local and watershed drivers of native and non-native fishes in the Lower Colorado River Basin

The goal of the Lower Colorado River Aquatic Gap Project is to evaluate spatial distribution of aquatic biodiversity to identify gaps in protection of species and their habitats in the Lower Colorado River Basin. We are conducting a multi-scaled investigation of the anthropogenic and biological factors influencing fish community composition of native and non-native species. Fish presence/absence records since 1980 were incorporated into predictive distribution models including habitat variables tied to hydrology, geomorphology, climate, and land use within a nested hierarchy of spatial scales. Conservation of native fish biodiversity in the Lower Colorado River will require management strategies that focus on identifying and conserving those fish species that are considered to be at the greatest risk to extinction while preventing the decline of currently stable populations, and identifying landscape-level variables and threats that affect these species. A spatial assessment of fish species assemblages and associated habitats will facilitate identification of areas of remaining native fish fauna of the Lower Colorado River and provide a management tool to identify where on the ground conservation strategies are most needed.

Willard, Catherine, U.S. Forest Service, P.O. Box 249, Saratoga, WY 82331

Presentation Type: Oral

Utilization of novel techniques to create barriers for native Colorado River cutthroat trout (*Oncorhynchus clarkii pleuriticus*) restoration

Biologists from Region 2 of the U.S. Forest Service, the Wyoming Game and Fish Department and the Colorado Division of Wildlife, recently utilized novel techniques to create three barriers to non-native fish in an effort to restore Colorado River cutthroat trout (*Oncorhynchus clarkii pleuriticus*) within their native range. Two of the projects included modifying existing partial barriers to complete barriers. The first partial barrier conversion included placement of a pre-fabricated concrete apron at the outlet of an existing culvert. The second barrier conversion included utilization of explosives to modify a plunge pool at the base of an existing waterfall. Both barrier modifications resulted in the reduction of the plunge pool depth below the barriers in order to prohibit non-native fish from successfully leaping over the barriers. The third project included constructing a new barrier in the Flat Tops Wilderness Area of Colorado. The project was successfully implemented while meeting the intent of the Wilderness Act of 1964. Each of these barriers presented unique challenges and required the use of innovative thinking to accomplish the goals of native fish restoration.

Williams, Cindy, Bureau of Reclamation, Klamath Falls AO, Bureau of Reclamation, Klamath Basin Area Office, 6600 Washburn Way, Klamath Falls, OR 97603; Keith Schultz, Bureau of Reclamation, Klamath Basin Area Office, Klamath Falls, OR 97624

Presentation Type: Oral

Complexities in managing the Klamath Basin

Conflicts over water use in the Klamath River Basin have existed for decades, pitting conservationists, tribes, farmers, fishermen, local, state and federal agencies against each other. Recently, settlement discussions associated with Federal Energy Regulatory Commission's relicensing of PacifiCorps' Hydroelectric Project have brought these diverse interests together in an effort to develop a comprehensive and hopefully a lasting solution. While seeking to understand each others' interests, parties to the settlement discussions are developing a comprehensive solution lefted on restoration of aquatic habitat and sustainability of affected communities. Ongoing settlement discussions have led to the signing of an Agreement in Principal (AIP), which includes the removal of the four PacifiCorps hydroelectric dams on the Klamath River. In the mix of all this activity is the Bureau of Reclamation (Reclamation)'s Klamath Irrigation Project consultation with the US Fish and Wildlife Service (FWS) for two species of Endangered Species Act (ESA)-listed suckers in the upper basin and with National Marine Fisheries Service (NMFS) for the ESA-listed Coho salmon in the lower basin. Reclamation currently funds or conducts many of the restoration activities for suckers and salmon throughout the basin. Reclamation has a recent no-jeopardy Biological Opinion from the FWS, which was signed in 2008. However, Reclamation has yet to complete the current consultation with NMFS for the ESA-listed Coho salmon. This ongoing consultation with NMFS has been complicated by the AIP. Many believe the restoration of a healthy Klamath River Basin ecosystem through a settlement agreement is the best method to recover ESA-listed species.

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Presentation Type: Oral

Weighing the added risk of climate change to population persistence in native trout: Management implications

Warmer water, changes in stream flows, and increasing frequency and intensity of disturbances are among the factors associated with climate change that are likely to impact native trout populations. We examined how four of these factors – increased summer temperatures, uncharacteristic winter flooding, drought, and increased wildfires – are likely to affect broadscale population persistence among native trout populations in the western U.S. Within the next 50 years, floods, drought, and wildfire may be more critical for population persistence than gradual increases in water temperature. Our models suggest that risk will vary substantially among and within subspecies with higher risk of population loss in peripheral population zones and areas of habitat fragmentation and population isolation. Stress from climate change is likely to compound existing problems associated with habitat degradation and introgression from introduced salmonids. Recognition of the increased risk from climate change may alter the management paradigm of isolation and require increased control efforts for invasive non-native species. Regardless of the management avenue chosen, more populations are likely to become isolated and vulnerable in the near future. Our results argue for early intervention within certain subbasins to increase resistance and

resiliency to at-risk populations and habitats prior to further disturbances associated with a rapidly changing climate.

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Presentation Type: Oral

(Aquatic invasions)^2: Parasites and pathogens

Invasion of exotic parasites and pathogens are usually associated with introductions of their native hosts to new ecosystems. Unfortunately, basic empirical data and epidemiological and population modeling are lacking for most parasites and pathogens, and their fate after introduction is poorly understood. Some authors have suggested that parasites with simple life cycles and a generalist host range will be more likely to invade an ecosystem than those with more specific host requirements and complex life cycles. However, some examples of successful and devastating parasite invasions suggest that parasites with complex life cycles can successfully invade ecosystems and have catastrophic effects on populations and ecosystems. The introduction of *Myxobolus cerebralis*, the parasite that causes whirling disease in trout, into North America is an example of an invasion of a parasite with a complex life cycle. The parasite was likely introduced and spread by the movement of rainbow and brown trout imported from Germany and has caused population collapses in many rainbow trout populations and altered the community composition of many streams and rivers. Other successful invasions of parasites with complex life cycles are associated with the introduction of Asian mud snails into North America and exotic fishes into Hawaii. In each case, parasites have not only successfully invaded but have also infected native fauna and negatively impacted native populations and communities. In the case of whirling disease, the parasite infects many native salmonids and is particularly virulent to native cutthroat trout in the intermountain west. The success of such parasites and their ability to use alternative native hosts suggest that parasite life history may be more flexible than thought and, more importantly for management; they will persist even if the original host is removed. I will discuss several case studies and the role of parasites and pathogens as aquatic invasive species.

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Presentation Type: Oral

Temperature variation: A fish-eye view of the watershed

Climate change of the predicted magnitude could alter watershed ecosystems and their function, communities, species distributions, and even individual fitness. Many fishes in critical need of conservation have complicated life history patterns, use a variety of habitats, and/or migrate long distances. Effective management of climate change on ecosystems requires understanding how abiotic conditions, in particular temperature, affect fish populations; and how these conditions in current and

adjacent watersheds may change due to climate change. The use of life history and physiological tolerances (i.e., aerobic scope) in dynamic bio-energetic and finite state machine models will help identify habitat requirements, physiological states, and potentially behavioral preferences as they relate to environmental quality. Yet, obtaining further information about the behavior of aquatic animals in their natural environment can be a difficult and intrusive task. Biotelemetry technology still lags behind the needs of researchers, and more importantly, the needs of fish to decrease tagging effects. Tag, shape and weight often preclude use in small juvenile fishes (such as salmonids, lampreys). Additionally, most “active” tags require surgical insertion into fishes, adding to the stress and burden associated with tagging effects. Costs associated with receiver deployments often prohibit data collection from other than main stem river locations. Biotelemetry data that yields 3D position information and thermal histories with minimal tagging effect would greatly improve our understanding of the biology and behavior of juvenile fishes, as well as our ability to more accurately predict climate change effects.

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Presentation Type: Oral

Failure of US Environmental Protection Agency recalculation agency recalculation procedures to produce protective zinc standards for naturally reproducing brown trout populations

US EPA guidance documents allow stream standards to be relaxed in site specific situations based on approved recalculation procedures. Relaxed chronic zinc standards based on the recalculation procedure have been proposed and in some cases accepted in the state of Colorado, USA. Relaxed zinc standards have been proposed for Clear Creek and adopted for the Eagle River. Long-term monitoring data allowed for comparison of actual brown trout population estimates in Clear Creek and the Eagle River to predicted brown trout population estimates based on such relaxed zinc stream standards. Metals contaminated Clear Creek and the Eagle River for many decades. Federally mandated restoration programs resulted in lower metal loading in both waters. Current dissolved zinc concentrations range from low relatively nontoxic concentrations to levels that exceed US EPA chronic zinc criteria. Brown trout populations would decrease in sections of Clear Creek and the Eagle River if zinc concentrations increased to levels allowed by zinc standards determined through use of the US EPA recalculation procedures. The US EPA recalculation procedures do not protect resident brown trout populations in all cases. Use of field data is needed to validate protection of stream standards adopted based on the US EPA recalculation procedure.

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Presentation Type: Oral

Large wood creates dynamic fish habitats under variable flow regimes

Woody debris is an important feature for providing dynamic aquatic habitats for fish. Large wood in particular, helps connect the main stream with its floodplain, creates a more complex channel structure, and strongly influences the formation of pools. Large wood such as snag logs also provides a stable substrate in sandy-bottomed streams for macroinvertebrate colonization and lower velocity habitat and cover for fish. Therefore, the addition of large wood to river systems has become a common restoration technique to enhance fish habitat. We are beginning to understand the role of woody debris in large, complex, and highly-modified desert rivers such as the Rio Grande in New Mexico and hypothesize that large wood was once an important ecological feature, helping to maintain aquatic diversity. Studies suggest a linkage between woody debris and relative abundance of the endangered Rio Grande silvery minnow (*Hybognathus amarus*, RGSM). Our project objectives were to design, install, and monitor cottonwood snag structures in a habitat deficient section of the middle Rio Grande in order to enhance habitat structure, complexity, cover and food for RGSM. Monitoring has shown the cottonwood snags have maintained structural integrity and stability. Macroinvertebrates are colonizing the snags and several fish species, including RGSM, are occupying the snag sites. The dynamic aspects of the created habitats due to variable flow regimes have been observed through stream bed scour and fill around the structures. Notably, sufficient scour during high flow events has maintained pool bed elevations below adjacent ground water levels for extended periods, suggesting the creation of critical refugial habitat for RGSM through the extension of isolated pools under discontinuous flow conditions. This paper will describe the installed snag structures, discuss the associated habitat dynamics, and present the observed response of the aquatic biota.

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Presentation Type: Oral

Effects of nonnative fish removal in a highly variable riverine system

Experimental removals of nonnative fishes have been conducted in the lower portions of the West Fork Gila River, New Mexico for the past three years in an attempt to alleviate predation pressure on populations of spikedace *Meda fulgida,* loach minnow *Tiaroga cobitis ,* and other native fishes in the area. Effectiveness of mechanical removals is likely confounded by large flow events through the study area.

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Presentation Type: Oral

Endangered razorback sucker (*Xyrauchen texanus*): Development of microsatellite markers and

characterization of extant genetic variation in Lake Mohave

The razorback sucker (*Xyrauchen texanus*) was once widely distributed throughout the Colorado River basin. Currently they are found in limited numbers in the Green River, small numbers near Grand Junction, CO, and lakes Mead and Mohave. Mitochondrial DNA studies suggest that Lake Mohave is the most genetically diverse population. We developed RBS markers and screened an additional 20 markers from Lost River sucker, Utah sucker, and copper redhorse. We looked at 560 RBS from Lake Mohave, Grand Junction (Colorado River Fishery Project) broodstock, Ouray National Fish Hatchery broodstock, and Dexter's resident broodstocks: 1981 from Lake Mohave, the offspring from Willow Beach paired-matings (Lake Mohave origin 95-04). Marker diversity at 12 loci, was high (mean Ho=0.89) and differentiation was low (mean FST=0.023). Differentiation between Lake Mohave and the Dexter 1981 broodstock (originally derived from Lake Mohave), Ouray, and Grand Junction was low - pairwise FST=0.016, 0.018 and 0.028, respectively. Our preliminary results indicate RBS broodstocks are more divergent from each other than they are from Lake Mohave.

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Presentation Type: Oral

Genetic characterization of the Virgin River chub, *Gila seminuda*

The Virgin River chub is an imperiled species that inhabits the mainstem Virgin River from Utah to Nevada, and the Moapa River in Nevada. In 1989, the Virgin River chub was listed as endangered in the Virgin River, but the population in the Moapa River was not included. A refuge population of Virgin River chub was established in 1989 at Dexter National Fish Hatchery and Technology. We characterized extant levels of genetic variation, to compare wild and captive populations. A total of 223 fish from five samples were analyzed using nine microsatellite markers. Samples included the Moapa River (N = 66), the lower reach of the Virgin River (N = 15), the upper reach of the Virgin River (N = 50), the Dexter broodstock (N = 42), and the Dexter year class of 2005-6 (N = 50). The population in the Moapa River is moderately divergent from the Virgin River populations (FST ranged from 0.092 to 0.126, $P < 0.001$). There was a low level of difference between chub from the lower and upper reaches of the Virgin River (FST = 0.020, $P < 0.001$). The captive populations at Dexter were also moderately different than the Moapa River population (FST ranged from 0.098 to 0.118, $P < 0.001$), but differences were minor between populations from Dexter and the Virgin River (FST ranged from 0.009 to 0.033, $P < 0.004$), the source of the Dexter broodstock.

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Presentation Type: Oral

Status and conservation of native catostomids in the Lower Pecos River, New Mexico

The native fish assemblage of the lower Pecos River drainage in New Mexico historically included four catostomids: river carpsucker *Carpiodes carpio*, blue sucker *Cycleptus elongatus*, smallmouth buffalo *Ictiobus bubalus*, and gray redhorse *Moxostoma congestum*. All four species were common in various surveys prior to 2000, particularly from Malaga, NM upstream to Brantley Dam. Intensive investigations from 2000 through 2008 documented a dramatic decline of native fishes in this reach beginning in 2003, concurrent with toxic outbreaks of golden algae *Prymnesium parvum*. Blue sucker apparently has been extirpated from the main stem Pecos River. A small number persists in the Black River, one of only two perennial tributaries to the lower Pecos River in NM, but recruitment has not been documented and recent surveys yielded only individuals exceeding 570 mm TL. Gray redhorse is common in the Black River, but in the Pecos River it persists only near the confluence of the Black River and in a 10-km segment below Carlsbad. Seining and trammel net surveys have indicated a balanced structure of gray redhorse in the Black River, including presence of age-0 individuals 35 to 70 mm TL. Size structure and abundance of gray redhorse have shifted markedly in the Pecos River, where recurring outbreaks of golden algae threaten surviving populations. Smallmouth buffalo has not been collected in the Pecos River since 2003. River carpsucker, by contrast, remains common in the lower Pecos River. In response to fish population declines, a golden algae monitoring program was initiated in 2003 and a dialog started with water management agencies on ways to minimize golden algae outbreaks. Captive propagation programs have been started for blue sucker and gray redhorse at Albuquerque BioPark, and a formal New Mexico recovery planning process is underway.

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Presentation Type: Oral

Features in the early development of gray redhorse *Moxostoma congestum*

Collection of larval fish specimens may provide important insights into the ecology and status of fish populations. We artificially spawned gray redhorse *Moxostoma congestum* from the Black River, New Mexico, and reared the progeny under laboratory conditions to obtain information on early life history and enable development of an identification key. Fertilized eggs (day 1) were initially adhesive, 3 mm in diameter, and pale yellow in color. Embryos flexed at three-second intervals and hatched tail-first on day 4 (92 h; 88 Celsius temperature units). Newly hatched protolarvae were 8 mm TL with a transparent body, their heads strongly decurved over the yolk sac. Features of the protolarval phase included the appearance of circulating blood, pigmentation of the retina, alignment of the head with the body axis, and progressively stronger swimming bursts along the tank bottom. Attainment of the mesolarval phase at about 13 mm TL (day 11) was associated with development of caudal fin rays, filling of the gas bladder, residence in the water column, complete absorption of yolk, and onset of exogenous feeding by day 14. Mesolarvae exhibited yellowish-tan dorsal pigmentation and increased density of dorsal melanophores. Metalarval phase was reached by 17 mm TL (day 23) with the presence of pelvic fin buds and all median fin rays. The mouth was distinctly subterminal and individuals were increasingly oriented with the tank

bottom. The larval period was complete by 20 mm TL (day 39) as the full complement of fin rays was apparent and finfolds were entirely absorbed. Morphological measurements and character counts from this developmental series provide the means to distinguish gray redhorse larvae from those of sympatric catostomids as well as other Moxostomids.