

# Report to Cooperators

## Idaho Cooperative Fish and Wildlife Research Unit



**1 October 2010 to 29 February 2012**



Burrowing owl held by Mark Ogonowski



Laura Hughes and Jenna Davis, prepare for an experiment with New Zealand mudsnails in the CNR wetlab.



Kokanee salmon spawning in South Gold Creek, Lake Pend Oreille

# University of Idaho

Cover Photos: Left: Meghan Camp holds pygmy rabbit in field site  
Right: Amber Barenberg holds fall Chinook salmon at the Lower Granite Dam fishtrap

**REPORT TO COOPERATORS**  
**1 October 2010 — 29 February 2012**

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**FISH AND WILDLIFE RESEARCH UNIT**

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**Unit Cooperators**

**U.S. GEOLOGICAL SURVEY**  
**IDAHO DEPARTMENT OF FISH AND GAME**  
**UNIVERSITY OF IDAHO**  
**U.S. FISH AND WILDLIFE SERVICE**  
**WILDLIFE MANAGEMENT INSTITUTE**

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# Introduction

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## **Idaho Cooperative Fish and Wildlife Research Unit**

*A cooperative research and educational program of*

U.S. GEOLOGICAL SURVEY

IDAHO DEPARTMENT OF FISH AND GAME

UNIVERSITY OF IDAHO

U.S. FISH AND WILDLIFE SERVICE

WILDLIFE MANAGEMENT INSTITUTE

## **HISTORY OF COOPERATIVE RESEARCH UNITS**

The Cooperative Fish and Wildlife Research Unit Program was established in 1935 in the U.S. Fish and Wildlife Service in response to a recognized need for trained biologists and increased scientific analysis and skills in fish and wildlife management. In 1960, the Unit Program was formally sanctioned with the enactment of the Cooperative Units Act (PL 86-686). The resulting partnership that developed among federal and state resource agencies, the land grant universities of the nation, and private entities evolved into a well-respected nationwide program. Beginning in 1984, wildlife and fishery units were combined into Cooperative Fish and Wildlife Research Units. The Unit Program operated as part of the U.S. Fish and Wildlife Service until November 1993, when the program was moved into the National Biological Survey, established by a Secretarial Order under the FY 1994 Interior Appropriations Act. In October 1996, the Unit Program was moved into the U.S. Geological Survey. Today, there are 40 Cooperative Research Units in 38 states. The Units support nearly 120 Ph.D. scientists who oversee more than 400 graduate students per year. Staff in the Cooperative Research Units conduct research on renewable natural resource questions; participate in the education of graduate students destined to become managers and scientists in natural resources; provide technical assistance and consultation to parties who have interests in natural resource issues; and provide various forms of continuing education for natural resource professionals.

The Idaho Cooperative Wildlife Research Unit was established at the University of Idaho 20 September 1947, and the Idaho Cooperative Fishery Research Unit was established in 1963. The two units were combined into the Idaho Cooperative Fish and Wildlife Research Unit in 1985. The Unit is housed in the Department of Fish and Wildlife Sciences in the College of Natural Resources at the University of Idaho. The Unit is staffed, supported, and coordinated by the U. S. Geological Survey, the Idaho Department of Fish and Game, the University of Idaho, the U.S. Fish and Wildlife Service and the Wildlife Management Institute.

The Unit emphasizes research to help find solutions to problems affecting the fish and wildlife resources of Idaho, the Pacific Northwest, and the U.S. Special areas of focus include: studies of anadromous fish passage and ecology in the Snake River basin; evaluation of methods to enhance fish health of hatchery-reared fish; developing methods for establishing new animal populations or augmenting existing populations; developing and evaluating sample designs for monitoring fish and wildlife populations; evaluating dynamics of recreationally harvested fish and wildlife populations; improving estimators of animal abundance; determining the effectiveness of existing reserves and management areas; developing methods to assess and

control the effects of invasive aquatic species; and evaluating the effectiveness of efforts to recover or prevent listing of endangered species.

### **Idaho Unit Federal Scientists, Research, Expertise, and Interests**

Unit personnel maintain close working and professional relationships with the University of Idaho faculty, Idaho Department of Fish and Game, and U.S. Fish and Wildlife Service personnel. Research studies are conducted with a focus on Idaho, in the Pacific and Intermountain West, but include studies throughout North America and at various geographic scales.

The Unit is directly supported through funding from Idaho Department of Fish and Game, the University of Idaho and U.S. Geological Survey. Contract funds support research from federal, state, tribal, and private entities including: Idaho Department of Fish and Game, U.S. Geological Survey, U.S. Fish and Wildlife Service, U.S. Army Corps of Engineers, U.S. Forest Service, U.S. Department of Defense, Bonneville Power Administration, Northwest Power Planning Council, Columbia River Inter-tribal Fish Commission, Coeur d'Alene Tribe, Kootenai Tribe, and National Park Service. In addition to mentoring graduate students engaged in this research, Unit personnel teach graduate-level courses, serve actively in the university community, and participate in a variety of professional activities.



**Courtney J. Conway** – Unit Leader and Associate Professor of Wildlife Resources. Recent research has focused on: 1) the ecology, habitat requirements and survey methods for marsh birds, including endangered or threatened species; 2) the habitat requirements, distribution, and ecology of burrowing owls throughout North America.



**Christine M. Moffitt** – Assistant Unit Leader and Professor of Fishery Resources. Recent research activities include studies of steelhead physiology and migrations; assessing risks of aquatic invasive species; interactions between cultured and wild fish; evaluating the sustainability and risks of aquaculture systems; and fisheries history.



**Michael C. Quist** – Assistant Unit Leader and Assistant Professor of Fishery Resources. Recent research as focused on understanding the relative importance of abiotic characteristics and biotic interactions in regulating fish population dynamics; identifying factors regulating the structure and function of fish assemblages across multiple spatial and temporal scales; and developing and evaluating techniques that allow managers to more effectively and efficiently evaluate fish populations.



**Candy Ihm** - Program Specialist for the Idaho Cooperative Fish and Wildlife Research Unit. She provides administrative support for research and cooperative agreements for federal and state contracts. Candy has transitioned into this job in the past year, where she formerly worked in the budget office in CNR.

## Transitions:

### RETIREMENT OF J. MICHAEL SCOTT

After more than 40 years of federal service, and serving as Leader of the Idaho Cooperative Fish and Wildlife Research Unit for 25 years, Mike Scott retired in June of 2011. He continues at the University of Idaho as a Distinguished Professor of Wildlife Sciences. We are grateful for his years of service and wish him well in his transition.



### WELCOME TO COURTNEY CONWAY

Dr. Courtney J. Conway began his tenure in Idaho as Unit Leader in August of 2011. He came to us from the CFWRU at the University of Arizona, where we was Assistant Unit Leader for more than 10 years. He received a B.S. in Wildlife Biology from Colorado State University, a M.S. in Zoology from the University of Wyoming, and a Ph.D. in Organismal Biology & Ecology from the University of Montana. Growing up in Cincinnati, he spent weekends camping, hiking, backpacking, fishing, and climbing in Ohio and nearby states. His research interests include studies of the effects of land-use and management actions on game and non-game birds. Courtney, his wife Amy, and their two boys Devon and Dalton have settled in Moscow and are already enjoying the outdoors.



## **Federally Funded Scientists and University Administrative Staff Contact Information**

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### **Fish and Wildlife Departmental Administrative Staff**

Linda Kisha, Administrative Assistant II

**Department of Fish and Wildlife Faculty, Emeriti, and other Faculty Cooperators with  
Unit Projects in 2010-2012**

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Kenneth Cain, Professor  
 Christopher Caudill, Research Assistant  
 Professor  
 E. O. (Oz) Garton, Professor Emeritus  
 Dale Goble, Professor of Law  
 Kathleen (Katy) Kavanagh, Professor  
 Brian Kennedy, Associate Professor  
 Beth Newingham, Assistant Professor  
 Madison "Matt" Powell, Adjunct Associate  
 Professor

Janet Rachlow, Associate Professor  
 Kerry P. Reese, Professor and Department  
 Head  
 J. Michael Scott, Distinguished Professor,  
 Emeritus  
 Kerri Vierling, Associate Professor  
 Lisette P. Waits, Professor  
 Frank Wilhelm, Associate Professor

**Graduate Students on Coop Unit Projects 2010- 2012**

\* indicates completed

<b>Student</b>	<b>Discipline</b>	<b>Adviser</b>
*Jennifer Adams	Ph.D. Wildlife Resources	L. Waits
Amber Barenberg	M.S. Fishery Resources	C. M. Moffitt
*James Barron	M.S. Fishery Resources	K. Cain
*Jeremy Baumgardt	Ph.D. Natural Resources	K. P. Reese
*Peter Bloom	Ph.D. Natural Resources	J. M. Scott
*Justin Bohling	Ph.D. Natural Resources	L. Waits
Samuel Bourret	M.S. Fishery Resources	B. Kennedy, C. Caudill
*Jessica Buelow	M.S. Fishery Resources	C. M. Moffitt
Meghan Camp	M.S. Wildlife Resources	J. Rachlow
Lubia Cajas Cano	Ph. D. Environmental Science	C. M. Moffitt
*Timothy Caldwell	M.S. Fisheries Resources	F. Wilhelm
*Gifford Gillette	Ph.D. Wildlife Resources	K. P. Reese
*Richard Hartman	M.S. Fishery Resources	B. Kennedy
Benjamin Ho	M.S. Fishery Resources	C. Caudill
Bryan Jones	M.S. Fishery Resources	C. M. Moffitt
Amber Lankford	M.S. Wildlife Resources	J. Scott, K. Reese, K. Vierling
Josh McCormick	M.S. Fishery Resources	M. Quist
Marius Myrvold	Ph.D. Water Resources	B. Kennedy, C. Caudill
Christopher Noyes	M.S. Fishery Resources	C. Caudill
Zachary Penney	Ph.D. Natural Resources	C. M. Moffitt
John Plumb	Ph.D. Natural Resources	C. M. Moffitt
Maggie Picard	M.S. Environmental Science	C. M. Moffitt
Elliott Reams	Ph.D. Fishery Resources	F. Wilhelm
Adrienne Roumasset	M.S. Fishery Resources	C. Caudill

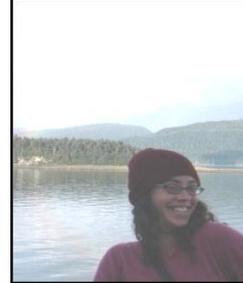
*Jan Schipper	Ph.D. Natural Resources	J. M. Scott
Elise Suronen	M.S. Restoration Ecology	B. Newingham
Chris Smith	M.S. Fishery Resources	M. Quist
*Carisa Stansbury	M. S. Environmental Science	L. Waits
*Bryan Stevens	M.S. Wildlife Resources	K. P. Reese
*Kelly Stockton	M.S. Fishery Resources	C. M. Moffitt
John Walrath	M.S. Fishery Resources	M. Quist
Carson Watkins	M.S. Fishery Resources	M. Quist
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Steven Whitlock	M.S. Fishery Resources	M. Quist
Bonnie Woods	M.S. Wildlife Resources	J. Rachlow
*Don Zaroban	Ph.D. Natural Resources	J. M. Scott

## Current Projects – Fisheries and Aquatic Resources

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### CONDITION AND SPAWNING SUCCESS OF ADULT SPRING CHINOOK IN THE WILLAMETTE RIVER

Principal Investigator: Christopher Caudill  
Student Investigator: Adrienne Roumasset  
Collaborators: Carl Schreck (USGS/OSU)  
& Michael Kent (OSU)  
U.S. Army Corps of Engineers  
Funding Agency: USGS - RWO 147  
Completion Date: 31 May 2012



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#### Objectives:

- Evaluate upstream migration behavior, distribution and fate of upper Willamette River (UWR) spring Chinook salmon in the Willamette River and tributaries.
- Determine the factors affecting fate and spawning success in UWR spring Chinook salmon specifically focusing on prespawning mortality (PSM).
- Determine relationships between PSM temperature history, collection and holding regime, and interactions among factors, e.g., disease development at high temperatures.
- Determine the relationships between PSM and watershed-scale factors among 11 spawning populations within the Willamette Basin.

#### Progress:

UWR spring Chinook salmon are listed as threatened under the Endangered Species Act and we are providing research in support of the implementation of the 2008 Willamette Valley Project (WVP) Biological Opinion. In 2011, we expanded work in spawning tributaries to include monitoring of adult salmon migration from Willamette Falls in Portland, Oregon to spawning tributaries.

The first objective of this study was to determine the basic behavior, distribution, and migration success of adult spring Chinook salmon through the main stem Willamette River and to evaluate their exposure to potentially high temperatures that may contribute to pre-spawn mortality in tributaries. From 15 April through 8 July 2011, we collected and intragastrically radio-tagged 150 Chinook salmon at Willamette Falls Dam (WFD) and released them back into the fishway upstream from the trap. Almost all (97%) radio-tagged salmon also received an archival temperature tag. An additional 100 salmon were outfitted with archival temperature tags only. The radio-tagged and temperature-tag-only samples represented ~0.4% and 0.3%, respectively, of the salmon counted at WFD during the tagging period. Approximately 25% (38/150) of the radio-tagged salmon had intact adipose fins and ~75% (112/150) had clipped adipose fins (i.e., were of certain hatchery origin). Radio-tagged salmon received one of two handling treatments. Thirteen percent (19/150; unclipped only) received an experimental, eugenol-based anesthetic, AQUIS<sup>®</sup>E. The remaining ~87% were tagged without anesthesia and with the use of a fish restraint device.

Of the 150 radio-tagged salmon, three (2%) regurgitated or lost their transmitters, 109 (73%)

were last recorded or recaptured in spawning tributaries, and 38 (25%) were last detected at main stem sites (21 downstream from WFD, 2 at WFD, and 15 upstream from WFD). Of the 109 radio-tagged salmon with last detections in tributaries, ten were last recorded in the Clackamas River, three were in the Molalla River, 50 were in the Santiam River, 29 were in the McKenzie River, and 17 were in the Middle Fork at or near Dexter Dam. The run composition varied seasonally for the 109 salmon last recorded in tributaries. Among salmon radio-tagged in May, 54% returned to the Santiam River and smaller percentages returned to the McKenzie River (20%), and the Middle Fork Willamette River (25%). For salmon tagged in June and early July, run composition again included a relatively high percentage that returned to the Santiam River (40%), followed by the McKenzie (25%), Clackamas (18%), Molalla (10%), and Middle Fork Willamette rivers (7%).

Migration rates through the main stem river for tagged salmon that returned to the Santiam (WFD to Buena Vista, OR), McKenzie, or Middle Fork Willamette rivers (WFD to near Harrisburg, OR), averaged 22.3 km/day ( $SD = 10.5$ ,  $n = 96$ ). Few downstream movements were observed by tagged salmon in the main stem or in tributaries. Willamette River environmental conditions in 2011 were characterized by high discharge and cool temperatures compared to ten-year averages. Preliminary evaluations of individual temperature histories from recovered archival temperature tags suggest that few tagged salmon experienced main stem or tributary temperatures  $> 18^{\circ}\text{C}$  in 2011. Data from the system-wide migration study will be integrated with results from spring Chinook salmon studies in Fall Creek and the North Fork Middle Fork Willamette River to evaluate the potential contribution of main stem versus tributary factors to pre-spawn mortality on spawning grounds. The data will also provide valuable general and baseline data on the relationship between upstream migration, Willamette Valley Project operations, and environmental conditions.

In recent years, high percentages (80-90%) of adult Chinook salmon transported above dams in some Willamette River tributaries have died prior to spawning. In 2011 we continued to survey the energetic status and prespawn survival rates of two populations of Willamette River spring Chinook salmon, monitored river environmental conditions, and investigated the relationships among prespawn mortality and a suite of potential causative factors.

A total of 200 Chinook salmon were sampled at Fall Creek. Fish were collected, assessed for energetic condition, PIT-tagged and/or radio-tagged, and then transported above the dam and allowed to spawn naturally. Eighteen of the radio-tagged fish were released in Fall Creek reservoir. Of these 16 (89%) were later recorded at a fixed receiver or mobile tracked upstream from the reservoir and were generally distributed with the in-stream release group. A total of 48 (including one released in the reservoir) PIT- and radio-tagged salmon were recovered from spawning ground surveys on Fall Creek, a recapture rate of 24%. Prespawn mortality estimates were 16.7% for PIT-tagged fish and 40.0% for radio-tagged fish. Previous years' prespawn mortality estimates were 9.4% in 2008 ( $n=3$  recovered carcasses), 84.8% in 2009 ( $n=28$ ) and 41.9% ( $n=26$ ) for PIT-tagged carcasses, with associated recovery rates of 16.4%, 16.5%, and 31% respectively. River temperatures in 2011 remained below  $22^{\circ}\text{C}$  and the peak temperatures occurred in mid-August, relatively late compared to previous study years.

One hundred eighty Chinook salmon collected at the Dexter trap were outplanted into the North Fork Middle Fork (NFMF) Willamette River in 2011. Eighteen (10%) of the PIT and radio-tagged fish were recovered (11 females) during NFMF carcass surveys. Prespawn mortality of immediate NFMF outplants was 50% (n=6 females) for radio-tagged fish while none of the PIT-tagged females recovered on the spawning grounds was a prespawn mortality (n=5 females). To assess whether hatchery holding might reduce prespawn mortality, an additional 79 Chinook salmon were sampled and held at Willamette Hatchery in Oakridge, Oregon. Seventy-two of these fish were recovered from hatchery ponds and outplanted to the NFMF prior to spawning. Eight (11.1%) of the 72 were subsequently recovered on the spawning grounds. One of five females (20%) from the hatchery-held group recovered on the spawning grounds was a prespawn mortality. These results, in combination with those from 2010, suggest that holding fish prior to outplanting may reduce prespawn mortality in years with stressful in-stream conditions but may be of little benefit in relatively cool years such as 2011. Prespawn mortality for NFMF outplants was 36.4% (n=21) in 2009 and 57.1% (n=41) in 2010. Fish were not assessed in the NFMF in 2008.

Across the four study years (2008-2011) the combined results suggest: 1) there is an association between prespawn mortality rate and temperature conditions encountered during holding, 2) the underlying causal mechanism of prespawn mortality is probably an interaction of fish condition and disease status, energetic status, and environment (e.g., temperature), 3) management actions such as in-reservoir releases and hatchery holding may reduce prespawn mortality, particularly in years with stressful environmental conditions. Monitoring migration behavior, disease status and fate in the lower river in conjunction with multi-year sampling of adult energetic status, other fish condition metrics, and environmental variables in tributaries will: 1) provide insights into the factors causing prespawn mortality; 2) determine how mean salmon condition varies from year to year in response to environmental factors such as main stem conditions and ocean conditions; and 3) will assist in the development of effective management strategies to reduce prespawn mortality in Willamette River spawning tributaries.

Prespawn mortality (PSM) rates vary considerably both between sub-basins within year and between years in the same sub-basin in the WVP, and have ranged from 1% in the Upper McKenzie River in 2008 to 95% in the Middle Fork Willamette River in 2007. Our goal was to examine the relationship between PSM and environmental factors that vary from year-to-year (e.g., stream temperature, spawner density) and relatively static watershed-scale features (e.g., % basin agriculture) for populations in Willamette River tributaries (Middle Fork, upper and lower McKenzie, upper and lower Clackamas, upper and lower North Santiam, South Santiam, Fall Creek and the North Fork Middle Fork) and the adjacent Sandy River basin. GIS layers were compiled and analyzed to compare channel characteristics including slope, watershed area, percent agriculture and percent high cascade geology. Archived USGS records provided annual 7-DAM (seven day average maximum) stream temperatures and peak and low flow values. Population variables included percent wild spawners and fish density (number of Chinook salmon/km spawning habitat) obtained from ODFW annual reports. Preliminary analyses reveal a complex and hierarchical set of relationships between prespawn mortality and predictor variables and among the predictor variables themselves (i.e., many predictors were inter-correlated). Nonetheless, consistent positive associations between annual prespawn mortality rate and 7-DAM, percent wild, and fish density were found. The associations between PSM and percent wild and 7-DAM is consistent with other observations of increased

PSM rates at higher stream temperatures, and 7-DAM itself may be largely controlled by differences among sub-basins in underlying geology. The association between increased PSM with increased fish density was strongest in spawning reaches below dams where spawning habitat is of marginal quality. The association between PSM and percent wild was observed at the among-basin scale and may reflect direct effects of hatchery-wild interactions on spawning ground or may simply indicate lower levels of river impoundment, trapping, and agricultural and other development in basins with high percentages of wild fish. Further investigation of these relationships will generate testable hypotheses about major underlying causes and will assist with the prioritization of management action within and among sub-basins.

## **COMPARATIVE SURVIVAL OF RESERVOIR- REARED AND RESERVOIR-BYPASSED SPRING CHINOOK SALMON IN THE WILLAMETTE RIVER BASIN**

Principal Investigators: Christopher Caudill  
and Brian Kennedy.  
Student Investigator: Sam Bourret  
Collaborators: Lisa Borgerson (ODFW)  
U.S. Army Corps of Engineers  
Portland District  
Funding Agency: USGS – RWO 144  
Completion Date: 31 October 2012



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### **Objectives:**

- Determine the degree of life history variability in three Willamette River subbasins (McKenzie, Santiam, and Middle Fork Willamette basins) by surveying juvenile growth patterns and otolith isotopic ratios from individuals collected from stream and reservoir rearing habitats.
- Evaluate the ability of scale and otolith analyses to resolve the natal stream, juvenile rearing habitat, and ocean entry timing for adult salmon of unknown source.

### **Progress:**

Understanding the distribution, abundance and relative performance of life history types is an important element of the Willamette Valley Biological Opinion and is critical for development of effective management strategies for juvenile Chinook salmon in the Willamette Valley Basin (WVB). Recent analyses of screw trap data suggest that juvenile Chinook salmon life history strategies are variable within and among WVB populations, including traits that resemble both an ocean-type life history with subyearling emigration in summer or fall as well as a stream-type life history with yearling emigration the following spring. We reconstructed the juvenile rearing and migratory patterns of a sample of natural-origin adult Chinook salmon that returned to the Middle Fork Willamette Basin. Scale morphometric patterns and otolith isotope ratios of  $^{87}\text{Sr}/^{86}\text{Sr}$  were used to characterize juvenile life histories and estimate juvenile size at freshwater emigration. We also used alkaline earth elements Sr, Ba, Mn, Mg, and Ca in otoliths and water, combined with otolith morphometric attributes, to discern movement and rearing of natural-origin juvenile Chinook salmon in natal rearing (adult outplant) tributaries and downstream project reservoirs.

We found that a substantial portion of sampled juvenile Chinook salmon rear in project reservoirs and emigrate from freshwater at large sizes, which may provide a survival advantage to adulthood. We found a high correlation between otolith and scale freshwater age in adult samples. Elemental water samples from the North Fork Middle Fork Willamette and Lookout Point reservoir were variable, and similar patterns were found in otoliths from juveniles captured in each habitat. Preliminary results from analysis of otolith microstructure suggest increased growth in project reservoirs relative to natal rearing streams. Many life history traits inferred from scales were substantiated by otolith analyses.

Qualitative observations suggest that survival to adulthood is relatively high for reservoir-reared juveniles but that out-migration survival may be lower. Characterizing life history types and developing monitoring methods is a necessary first step to quantifying juvenile habitat use, emigration ecology, and the relative fitness of life history types. In particular, determining the relative fitness of rearing types will assist in estimating the potential benefits of alternative management options such as improved downstream dam passage for juvenile salmon vs. head-of-reservoir collection and transport around dams.

## **IMPACTS OF HYDROLOGIC ALTERATION ON JUVENILE STEELHEAD (*ONCORHYNCHUS MYKISS*) HABITAT, GROWTH, SURVIVAL AND MOVEMENTS**

Principal Investigator: Brian Kennedy  
Laboratory Technician: Richard Hartson  
Graduate Student Researcher: Marius Myrvold  
Funding Agency: Bureau of Reclamation  
Completion Date: 31 March 2012



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### **Objectives:**

- Quantify temperature and primary stream and riparian habitat features relative to flow levels in Lapwai, Webb, and Sweetwater creeks.
- Quantify spatial variation in stream productivity (macroinvertebrate abundance, community composition and diversity) relative to stream flow and temperature in Lapwai, Webb, and Sweetwater creeks.
- Quantify demographics and bioenergetics of juvenile steelhead (*Oncorhynchus mykiss*) populations and the relative impacts of hydrologic alteration.
- Quantify the effects of interspecific interactions on juvenile steelhead demographics (growth, survival and emigration).
- Evaluate juvenile and adult movement and migration behavior in Sweetwater, Lapwai and Webb creeks relative to flow operations.

### **Progress:**

The Bureau of Reclamation owns a series of water storage reservoirs, diversion dams and canals that provide irrigation water to the Lewiston Orchards area of Lewiston, Idaho. The Lewiston Orchards Project (LOP) is operated by the Lewiston Orchards Irrigation District (LOID), which distributes the water to agricultural, urban and suburban users. Lapwai watershed provides spawning and rearing habitat for a distinct population segment (DPS) of a

federally endangered salmonid, *Oncorhynchus mykiss*, or steelhead, of the Snake River Basin. The LOP withdraws water from these creeks that are designated as critical habitat for this species. Importantly, the major temporal impact that water withdrawals have are during the summer months when juvenile fish are trying to gain mass before smolting (migrating to the ocean) and diversion operations can potentially leave the streams dry. Decreased flows during spring may also impact spawning of adult A-run *O. mykiss* in the basin (NMFS 2006).

Understanding the effects of hydrologic changes on fish populations requires an integrative approach that addresses 1) how the growth potential of individual fish is affected, 2) how changes in growth and growth potential influence survival of individuals and, ultimately, how processes for the individual scale up to population level dynamics, and 3) how population dynamics are influenced by altered connections among subpopulations. These changes can be a direct result of hydrologic change (Lopes et al. 2004) or an indirect effect through altered temperatures, productivity or trophic relationships. Our study is addressing how flow alterations in the Lapwai system influence growth and survival of juvenile *O. mykiss*. We are developing integrated models for flow-foraging relationships, bioenergetics (i.e., energy gains and losses), productivity relationships, and fish movements, which collectively are designed to identify mechanistic relationships between fish performance and habitat. In Fall 2009, Marius Myrvold began working in the Lapwai basin as a Ph.D. student in the Water Resources Graduate Program.

## IMPROVING ADULT PACIFIC LAMPREY PASSAGE AND SURVIVAL AT LOWER COLUMBIA RIVER DAMS, 2011

Principal Investigator: Christopher Caudill  
Student Investigators: Benjamin Ho  
Christopher Noyes  
Collaborator: Mary Moser, NOAA-Fisheries  
US Army Corps of Engineers  
Portland District  
Funding Agency: USGS – RWO 151  
Completion Date: 30 June 2012



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### Objective:

- Evaluate passage and survival of adult Pacific lamprey (*Lampetra tridentata*) at lower Columbia River dams during the 2011 adult lamprey migration.

### Progress:

The research (RWO 151) is the annual installment in an on-going monitoring program evaluating the effects of improved fishway operations, fishway structures, and simultaneously monitoring general passage behavior and success of lampreys over the large lower Columbia River dams using an integrated set of methods (See COMPLETED for results from the 2010 migration (RWO 146)). As in past years, we tagged lamprey with radio transmitters and half duplex (HDX) passive integrated transponder (PIT) tags or modified Juvenile Salmonid Acoustic Telemetry System (JSATS) tags and monitored their passage at Bonneville, The Dalles, John Day, McNary, Ice Harbor, and Priest Rapids dams, including use of Lamprey Passage Structures (LPS). Our aims were to calculate lamprey passage times, estimate

escapement past the monitored sites, and evaluate potential correlates with lamprey escapement and behaviors through the study reaches. The JSATS telemetry study tracked lamprey behavior and fate between dams. A new objective in 2011 was to evaluate the ability of Dual-Frequency Identification Sonar (DIDSON) acoustic cameras to quantify lamprey behavior at fishway entrances and in fishway environments.

We tagged 929 adult lampreys with HD-PIT tags and 85 with HD-PIT tags and acoustic transmitters in 2011. At this writing, some lampreys tagged in 2011 were still active, monitoring sites were still deployed, and data were not yet fully processed. Preliminary results show high attrition rates occurred as the lamprey run progressed upstream, consistent with findings in previous years (e.g., see results for the completed RWO 146 below). Multi-year comparative analysis indicates that lamprey passage at dams is sensitive to environmental and operational conditions, but also that major behavioral patterns repeat across years. Standardized passage metrics (i.e., adjusted for among-year differences in lamprey size and environmental conditions) provide some evidence for incrementally improving lamprey performance at dam fishways in response to structural and operational changes.

We note, however, that determining true migration success in adult Pacific lamprey continues to be difficult because the underlying motivation(s) for migration past dams remains unknown. Available data suggest that migration behavior in lamprey differs fundamentally from salmonid fishes and that comparing passage metrics among dams is tenuous. Prioritization for lamprey managers in the short term should continue to focus on addressing known passage issues and addressing the critical uncertainties about adult lamprey migration behavior.

Substantial numbers of adult lamprey have final records in the Bonneville reservoir in past radiotelemetry studies and whether these adults spawned or perished is unknown. Unlike radiotelemetry, acoustic telemetry is well suited for deep reservoir habitats, provides longer battery life and may reduce tag effects. In this study, we evaluated the effectiveness of the Juvenile Salmon Acoustic Telemetry System (JSATS) for monitoring the migration of JSATS-tagged adult Pacific lampreys through reservoir, tailrace, and tributary habitats. We also conducted a preliminary evaluation of JSATS tag detection efficiency in fishway environments at Bonneville Dam.

We tagged 85 adult lampreys with JSAT tags from 11 June through 3 September 2011 with tags rated for 60 days ( $n = 20$ ) or 400 days ( $n = 65$ ). Lampreys were released into Bonneville reservoir at Stevenson, WA (rkm 243;  $n = 62$ ) or below Bonneville Dam (rkm 232.3;  $n = 23$ ). We established gates using one or two autonomous receivers at nine locations from the Bonneville Dam tailrace to The Dalles Dam tailrace (rkm 305). One site was 300 m inside of the mouth of the Klickitat River (rkm 291). Adult lampreys were also monitored on cabled arrays used in juvenile salmonid JSATS studies. Detection efficiency of JSATS test tags was evaluated at seven locations within the Bonneville Dam Bradford Island Fishway.

The 23 adults released to the Bonneville Dam tailrace have been undetected ( $n = 9$ ; 39%), or last detected in the Bonneville tailrace ( $n = 8$ ; 35%), in the Bonneville reservoir ( $n = 2$ ; 9%), or in the The Dalles tailrace ( $n = 4$ ; 17%). Mean travel time from release to the first detection in The Dalles tailrace was 7.3 d (median 7.1, range 2.8-13.4 d). Mean migration rate from release

to first detection in The Dalles tailrace was 15.2 km/d (median 10.6 km/d, range 5.4-32.3 km/d). All 62 fish released at Stevenson were detected on at least one receiver in the array and 58 (94%) were first detected on the Stevenson receivers. Twenty-two (35%) were last detected in The Dalles tailrace and 4 (6%) were last detected in the Klickitat River. The mean travel time from release to the first detection in The Dalles tailrace was 4.2 d (median 1.8 d, range 1.1-23.8 d). The mean migration rate from release to the first detection in the tailrace of The Dalles was 29.7 km/d (median 34.7 km/d, range 2.6-56.5 km/d).

In the Bradford Island fishway, we detected the test transmitters at all seven locations tested, though detection range was limited in some locations. Additional testing will determine the range of application for JSATS in fishway environments. Continued monitoring of the 400-day tags through winter and spring 2011-2012 will provide important information on the final distribution of adult lamprey and help determine to what degree adult lamprey overwinter in reservoirs prior to spawning in reservoir tributaries.

Monitoring adult Pacific lamprey (*Lampetra tridentata* / *Entosphenus tridentatus*) migration behaviors at Columbia River basin dams is important for identifying areas of difficult passage. Surveys using DIDSON tools may provide new insights into lamprey behavior and help identify sites and structural configurations needed to improve lamprey attraction, passage, or collection at dams. The scale of DIDSON imagery (<10 m) can potentially complement data collected using lampreys monitored with passive (i.e., PIT tags) and active (i.e., radio transmitters) telemetry systems. In summer 2011, we completed a DIDSON pilot study at Bonneville Dam to evaluate potential applications of this technology for evaluating lamprey behavior and passage. Two DIDSON cameras were deployed among six locations at Bonneville Dam during the lamprey passage season. Data were collected in high frequency mode at each location for periods of 24 to 72 hours. DIDSON imaging was collected in landscape mode to obtain the horizontal distribution of lampreys in the water column and to assess the direction of lamprey movements. Images were also collected in portrait mode to identify lamprey depth distributions. Lamprey data collected from DIDSON image files included number of lamprey observed, range from camera (m) and angle from center for each passage event, and locations and durations of lamprey attachment to structures. We also summarized the presence / absence of white sturgeon, a lamprey predator.

We collected ~1400 hrs of DIDSON imagery at Bonneville Dam in 2011. Analysis of the results of stratified random sampling of the DIDSON imagery is currently underway. Qualitative preliminary findings indicate that we can: (1) develop repeatable protocols for lamprey identification, (2) infer lamprey swimming direction, including entrance and exit behavior, (3) quantify differences in day- versus night-time activity, (4) identify lamprey depth distributions at the monitoring sites, and (5) enumerate sturgeon activity in the junction pool. This year's pilot study will provide information for future DIDSON deployments and data processing techniques and will help inform lamprey passage improvements.

## MITIGATION OF MARINE-DERIVED NUTRIENT LOSS IN THE BOISE-WEISER SUBBASIN



Principal Investigator: Katy Kavanagh  
Co-Investigator: J. Michael Scott  
Collaborators: Greg Servheen, IDFG  
Colden Baxter, Idaho State Univ.  
Amy Marcarelli, Michigan Tech Univ.  
Mark Wifli, USGS AK Coop. Fish & Wildlife Research Unit  
Laura Felicetti, Washington State Univ.  
Student Investigators: Tadd Wheeler and Andrea Noble-Stuen  
Funding Agency: Idaho Department of Fish and Game  
Completion Date: 31 December 2012

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### Objectives:

- To investigate the mechanistic behaviors and mitigation potential of marine-derived nutrients in central Idaho's riparian forests

### Progress:

The decline and extirpation of Pacific salmon from their natal inland streams removes a primary nutrient input to oligotrophic riparian forests. Anadromous fish historically contributed up to 3 million kg of N and 15 million kg of C annually to the Columbia River basin (Gresh et al., 2000). Studies in intact salmon systems suggest 12-58% of a salmon run is killed by bears and 20-80% of the carcasses transported into the riparian forest (Quinn et al., 2009; Quinn et al., 2003). These findings suggest that historic annual contributions of N and C to riparian forests within the Columbia basin could have been as high as 1.4 million kg and 7 million kg, respectively. The persistence and availability of these nutrients within plant and soil communities has been observed. However, a clear mechanistic understanding of the processes involved and stimulated by these contributions is needed for effective mitigation of their loss. Further, most published works to date in this area of knowledge are based on coastal ecosystems which differ greatly in climate, geology, and seasonality from inland ecosystems. The riparian forest component of this project is our piece of a larger project with collaborators working on aquatic components (Mark Wifli, Colden Baxter and Amy Marcarelli) and wildlife (Laura Felicetti and Greg Servheen).

Approximately 8,000 pounds/year of salmon carcasses, and a similar nutrient amount of salmon analog were applied to 9 stream reaches in the North Fork of the Boise River in 2008, 2009 and 2010. In the final year, and a similar nutrient amount of inorganic slow release fertilizer was applied to an additional 3 replicate streams. The riparian group has focused our studies on the soil plant nutrient cycle and scaling up the N inputs through time using an ecosystem process model. Sample collection yielded approximately 120 inorganic N samples, 120 microbial biomass samples, 120 labile C samples, 120 soil C and N isotope samples, and 500 foliar C and N isotope samples. Samples are currently being processed and prepared for analysis at the University of Idaho lab. As of December 31, 2011 approximately 80% of the samples had been processed and analyzed. Sample analysis is occurring simultaneously at the University of Idaho and Washington State University. Completion of sample analysis is targeted for spring of 2012. Data are currently being compiled and will continue through 2012.

## **LIFE CYCLE ASSESSMENT AND ECOSYSTEM SERVICES FRAMEWORK FOR SUSTAINABLE AQUACULTURE PRODUCTION**

Major Professor: Christine M. Moffitt  
Student Investigator: Lubia Cajas Cano  
Funding Agency: U of Idaho Multicultural  
Scholarship  
and International Programs  
Completion Date: 30 August 2012

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### **Objectives:**

- Create a model to evaluate relevant environmental and socioeconomic factors involved in a life cycle of marine mussel production, and assign and obtain data using the model in an existing marine mussel production farm.
- Create a Life Cycle Assessment model to evaluate the main socioeconomic and environmental factors involved in the life cycle of marine fish production, and assign and obtain data using the model in an existing marine fish farm.
- Evaluate suitable candidate species for rearing within a selected finfish and mollusk aquaculture settings, and simulate the potential of integrating these species into the systems.

### **Progress:**

This project focuses on creating models and tools to evaluate the use of human and natural resources in the life cycle of food production through aquaculture systems. These models will be easily adapted to any type of aquaculture. Research in this project includes analysis of socioeconomic and environmental costs and benefits of monocultures systems, and simulating the results in an Integrated Multi-Trophic Aquaculture systems (IMTA). The use of an IMTA may increase environmental sustainability as secondary species can use wastes and nutrients released from the target product production. Marine and freshwater mussels are capable of filtering phosphorus, nitrogen, and other nutrients from content source water. Proper placement of mussel aquaculture systems close or within aquaculture systems can result in reduced nutrient loading, and increase community diversity through recycled nutrients. The Life Cycle Assessment (LCA) model framework evaluates water, energy, and socioeconomic inputs and outputs associated with the production system. We have estimates of water and energy use by Taylor Seafoods for production of blue mussels. We are simulating the benefits of adding seaweed production to this system. Graduate student Cajas traveled an experimental farm on Vancouver Island and obtained data from their IMTA. These tools can illustrate to regulators and policymakers the benefits of including LCA models and basic factors from socioeconomic and environmental factors to better understand and evaluate production systems for sustainability.

## EVALUATION OF THE ECOSYSTEM SERVICES OF NATIVE FRESHWATER MUSSELS IN THE PACIFIC NORTHWEST

Major Professor: Christine M. Moffitt  
Student Investigator: Maggie Picard  
Funding Agency: Bonneville Power Administration  
Office of Tribal Affairs  
Environmental Science Program  
Completion Date: 30 May 2012



### Objectives:

- Interact with professionals with the Confederate Tribes of the Umatilla Indian Reservation (CTUIR) conducting restoration efforts of native freshwater mussels.
- Estimate the ecosystem services obtained through their restoration program.

### Progress:

Freshwater mussels in North America are useful indicator species for assessing the health of freshwater environments. Each mussel is capable of exchanging as much as 30 L of water per day. In aquatic ecosystems, freshwater mussels aid in the recycling of nutrients, specifically nitrogen and phosphorus, decrease turbidity, increase diversity, and positively affect the food web. Ecosystem services have been defined as “conditions and processes through which natural ecosystems, and the species that make them up, sustain and fulfill human life”. Freshwater mussels have a long American history, they served as a dietary staple for Native Americans and their shells were utilized as buttons and regalia. Freshwater mussels increase water quality and present residual nutrients in a usable form to macroinvertebrates and other organisms in the river/lake beds and hyporheic zone. In a natural setting, freshwater mussels supply ecosystem services to the freshwater environment that improves the sustainability and improves aquatic habitat restoration and conservation. Through interactions, and use of the literature, we are preparing a publication to review the benefits to ecological services resulting from the restoration efforts underway on the Umatilla reservation.



Freshwater Anodonta Mussel

## **GUIDANCE DOCUMENT TO PREVENT, REDUCE, ELIMINATE OR CONTAIN NEW ZEALAND MUDSNAIL INFESTATIONS AT FISH PROPAGATION FACILITIES**

Principal Investigator: Christine M. Moffitt  
Graduate Students: Kelly Stockton, Amber Barenberg  
Collaborating Investigators: Barnaby J. Watten USGS  
Bryan Kenworthy, USFWS  
Larry Peltz, USFWS  
Funding Agency: U.S. Fish and Wildlife Service  
Completion Date: 30 June 2012



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### **Objectives:**

- Summarize and synthesize the state of knowledge on control measures.
- Evaluate completeness of data on control measures and determine areas of needed additional data.
- Provide a clear and accessible manual for hatchery biologists and managers that summarizes the state of the science, provides details on prevention and control measures and an outline of decision tools for a rapid response to new or potential infestations.

### **Progress:**

Kelly Stockton completed her Master's thesis in May 2011, and Amber Barenberg began work to help complete the project in January 2012. This document provides guidance for hatchery personnel or others to 1) assess pathways of invasion, 2) evaluate the likelihood of infestations, and 3) reduce the risks of invasion by the New Zealand mudsnail, *Potamopyrgus antipodarum* (NZMS). Fish hatcheries and aquaculture facilities are at risk of harboring and transporting invasive species because of the features and practices that occur at these facilities. Constant water flows, use of groundwater or springs with characteristically minimal temperature variability, increased nutrients from fish production and waste from fish feed, movement of fish and equipment between locations, public visitation and fishing access near or on facilities are all features of many aquaculture facilities. The NZMS has become established in many locations throughout Western North America and areas of the Great Lakes and Midwest. This freshwater prosobranch has several characteristics that make it an effective invader such as the ability to survive for long periods out of water, and tolerate a range of water characteristics, and habitats. Once established, the NZMS is very difficult to eradicate. This guidance document provides a summary of information that can assist in preventing infestations.

This document uses a step-by-step process to assess a facility for critical control points, uses information from the scientific literature to rank the likelihood of risks, and provides information that can be used to reduce risks. Tools that can be used for disinfection and monitoring are explained in additional documents that can be provided if needed. Using guides in this document, the manager can summarize all features of the facility to achieve a final ranking of risk of infestation as low, medium or high. After ranking, a manager should consider next step scenarios for when and how to monitor so that the options for rapid response can be pursued. Information on monitoring and decontamination can be provided through

supplemental documents. We are preparing the assessment document for testing at regional hatcheries. The guide uses a decision analysis approach to understanding and ranking risks. It provides the most up to date tools for monitoring, collection of samples and analysis. Details on sample labeling and retention are provided, as well as quality assurance recommendations.

## **HIGH RISK BALLAST WATER: TESTING OF EFFICACY OF HYDRATED LIME AND SODIUM HYDROXIDE BIOCIDES TREATMENTS ON SELECTED TARGET INVERTEBRATES**

Principal Investigator: Christine M. Moffitt  
Graduate Student: Amber Barenberg  
Collaborating Investigators: Barnaby J. Watten, USGS  
Funding Agency: U.S. Geological Survey RWO 153  
Completion Date: 31 December 2013  
Undergraduate Interns: Laura Hughes  
Tasha Britton  
Charlie Winthers-Haley  
Jenna Davis



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### **Objectives:**

- Develop laboratory tests to determine appropriate protocols of dosage, and exposure time to achieve complete mortality of selected more resistant invertebrate species
- Test and refine protocols for testing in laboratory trials
- Design appropriate procedures and experimental designs for scaled up for trials on board the ships to establish efficacy in field applications of ballast tanks.

### **Progress:**

The National Park Service (NPS) has identified a need for methods that can be used to protect the integrity of natural systems from invasive species. Of particular concern is the release of organisms in residues and within the ballast of shipping tanks in the Great Lakes. These studies are part of a multidisciplinary team effort in the US Geological Survey (USGS) to test the efficacy and safety of using high pH treatments as a rapid and easily reversible treatment to kill invertebrates and other target organisms. Our studies are the direct result of a successful bench scale testing of a treatment proposed by Dr. Barnaby Watten and colleagues at the US Geological Survey's Leetown Science Center. The Great Lakes Initiative (GSI) conducted bench-scale tests of the efficacy of elevated pH in sodium hydroxide treated water and concluded pH levels of 11.5 to 12.5 were effective in killing rotifers, Daphnia, and copepods within 4 hours of exposure.

Our project will develop laboratory tests to determine appropriate protocols of dosage, and exposure time to achieve complete mortality of selected more resistant invertebrate species including crustaceans, bivalve and prosobranch mollusks, and resistant myxospores, or other propagules in both hydrated lime and sodium hydroxide treated systems. Upon determination of appropriate model species, we will test and refine protocols for testing in laboratory trials. Using an adaptive approach, we will design appropriate procedures and experimental designs for scaled up for trials on board the Ranger III to establish efficacy in field applications of ballast tanks. We will then conduct a minimum of three shipboard field trials to determine the

efficacy and feasibility of hydrated lime and (or) sodium hydroxide as treatments to disinfect ship ballast systems. If successful this application will provide an inexpensive and effective method for treating ballast systems to assure that no harmful species are released into the environment.

## **RESEARCH, MONITORING AND EVALUATION OF EMERGING ISSUES AND MEASURES TO RECOVER THE SNAKE RIVER FALL CHINOOK SALMON ESU**

Principal Investigator: Christine M. Moffitt  
Student Investigators: John Plumb  
Collaborating Investigators: William P. Connor, USFWS  
Ken Tiffan, USGS  
Funding Agency: Bonneville Power Administration  
Completion Date: 31 August 2012

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### **Objectives:**

- Determine if the progression of wild fall Chinook salmon life history events is changing over time due to biological or physical alterations in the environment.
- Analyze the fork length, weight and morphology of PIT-tagged wild fall Chinook salmon subyearlings, and determine densities in fish rearing areas.
- Determine if the joint probability of active migration and survival to the tailrace of Lower Granite Dam is affected by biological or physical alterations in the free following river environment during the latter period of rearing.
- Determine if acclimating hatchery fall Chinook salmon subyearlings leads to different behavioral and life history patterns when compared with hatchery subyearlings released directly to the river or with wild-reared fall Chinook salmon.
- Determine if summer spill operations decrease travel time and increase the probability of migration and survival for fall Chinook salmon migrating from Lower Granite Dam to the tailrace of McNary Dam.

### **Progress:**

Snake River fall Chinook salmon (*Oncorhynchus tshawytscha*) were among the first Pacific salmon stocks to be petitioned for federal listing under the Endangered Species Act, and in 1992 were given threatened status. An integral part of population recovery was to increase the numbers of hatchery-reared juveniles (from native brood-stock) released into the river, with the intent to offset the reproductive loss of wild salmon. In 1995, ~ 16,400 hatchery-reared juvenile fish were released into the lower Snake river, yet by 2008 over 4 million fish were released upstream of Lower Granite Dam. In years subsequent to hatchery supplementation (since ~ 1999), it has been noted that the naturally-produced subyearlings are much smaller and emigrating at much earlier dates than observed during 1990s, suggesting there may be population-level consequences as result of hatchery supplementation and higher fish abundance. Inferences about the abundance and survival of the fish have been complicated; however, by a wide range in dam operations and a protracted life history, which alters the ability to sample fish and make statements about population status. Thus, the over-arching goal of this research is to use existing data collected from a variety of sources to provide a formal,

self-supporting body of research aimed at evaluating density-dependent effects on the naturally-produced subyearling fall Chinook salmon in the lower Snake River.

Mark-recapture techniques and models are used to measure fish collection and detection, to potentially improve daily fish abundance estimates at Lower Granite Dam – the first dam encountered by millions of hatchery and naturally-produced subyearlings during seaward migration from the lower Snake River. The multistate (multinomial) approach enables the assessment of whether (and if) dam operations may affect fish detection, and in turn, abundance estimation at a dam. Recapture data were obtained from radio-tagged subyearlings detected by multiple radio antenna arrays placed just upstream, in, and downstream the dam during annual passage studies at Lower Granite Dam. When coupled with relatively fine-scale information from telemetry studies, multistate models have been shown to provide information on key demographic parameters for juvenile salmon populations. Because of the demonstrated flexibility in using multistate mark-recapture models to estimate demographic parameters of fish populations, I took this approach to quantify daily fish detection and abundance of the subyearling fish passing Lower Granite Dam. This modeling approach enabled fish abundance and survival estimates (and the uncertainty) to be obtained from daily information on fish sampling and dam operations, and in turn, relate abundance estimates to the growth potential, behavior, and survival of naturally-produced subyearlings as they traveled to the dam

We use the Wisconsin bioenergetics model for Chinook salmon by using data obtained from four different laboratory studies. Taking this “evaluation step” with respect to the bioenergetics model seemed prudent given that (1) bioenergetics models are a common means (with strong theoretical support) to evaluate fish growth and consumption from field observations, yet (2) systematic error in consumption and growth estimates have been shown to be widespread in the literature, particularly when model parameters are applied to other species, life stages, or locally-adapted populations from which the models were originally calibrated. Evaluating the bioenergetics model prior to its application was important because high growth rates for subyearling Snake River fall Chinook salmon have been reported in both a laboratory and in the wild. This research compares inland Snake River subyearlings to subyearlings from British Columbia, Canada, and thus, may also evaluate the application of the Wisconsin bioenergetics model to different populations of subyearling fall Chinook salmon

Abundance estimates are used with the projected bioenergetics estimates of fish mass at the dam in a standard ANCOVA model to quantify the relationship between observed and predicted fish mass to determine whether fish abundance may explain variation in fish mass over and above that expected by fish bioenergetics. The overall objectives of this dissertation are to: 1) provide (and potentially improve) daily abundance estimates for subyearling fall Chinook salmon at Lower Granite Dam, (2) assess and potentially improve bioenergetics models for this early life stage and stock of Chinook salmon, (3) explore the contribution of free-flowing versus reservoir habitats on per capita consumption and growth, and 4) evaluate the prospective role of hatchery-induced increases in abundance on the growth, emigration, and survival by the naturally-produced subyearlings in the lower Snake River. This project aims to shed light on the factors that are primarily responsible for determining the population demographics of the naturally-produced subyearling Chinook salmon. Likewise, this study

should provide key information on the use of hatchery supplementation to recover endangered salmon populations upstream of a large (if not the largest) hydrosystem.

## **DEVELOPING STRATEGIES TO IMPROVE SURVIVAL AND RETURN RECRUITMENT OF STEELHEAD KELTS FROM SNAKE RIVER STOCKS**

Principal Investigator:  
Student Investigators:

Christine M. Moffitt

Jessica Buelow

Zach Penney

Bryan Jones

CRISSP-NSF Intern:

Veatasha Dorsey

EPSCoR-NSF Intern:

Heath Hewett

HOIST Intern:

Janae Crispin

Scientific Staff:

Boling Sun

Collaborators:

Doug Hatch, CRITFC

Brett Bowersox and Tim Copeland, IDFG

Brian Marston, Alaska Fish and Game

Funding Agency:

Columbia River Inter-tribal Fisheries Commission

Completion Date:

30 June 2012



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### **Objectives:**

- Obtain and synthesize physiological metrics into models that describe changes observed in hatchery - and natural-origin steelhead trout stocks from fall upriver migration through spawning and early kelt migration.
- Obtain a complete profile of the condition and physiology of downstream migrating natural origin stocks captured at Lower Granite Dam bypass facility, and compare and contrast these profiles with fish examined at upriver sites.
- Evaluate the survival and migration behavior of natural origin steelhead kelts collected from the bypass facility at Lower Granite Dam, tagged with acoustic tags and transported via barge or truck to locations below Bonneville Dam.
- Evaluate the emigration of natural origin steelhead kelts PIT tagged and released below Lower Granite Dam to migrate through the Snake and Columbia River hydro system.

### **Progress:**

Within their native distribution, steelhead trout are iteroparous and the proportion of fish observed repeat spawning varies from ~ 50% to < 1%. In the Snake and Columbia river systems, fish passage facilities at hydroelectric dams were not designed or constructed to accommodate downstream-migrating, post spawning steelhead adults (kelts). Our research focus is to understand and pose a model of the physiology and sequence of changes in pre - and post-reproductive steelhead trout in the Snake River system that tests factors affecting stock iteroparity. This year was the final year of data collection on the project, and our efforts are now on data analyses and reporting. We used the data collected in 2010-2011 to increase our knowledge of energy utilization in steelhead trout throughout their freshwater residency. Using data from fish spawning in 2011, we created profiles of energy in steelhead trout at several stages including: the late summer and fall upstream migration through the Columbia and Snake

ivers; overwintering in Snake and Clearwater river tributaries; spawning, and kelt migrations at Clearwater River tributaries and Lower Granite Dam. We are examining the relationship of fish size and energy stores through the use of bioenergetic modeling, verified with proximate analysis and use of plasma metrics from fish within and outside of the Columbia River.

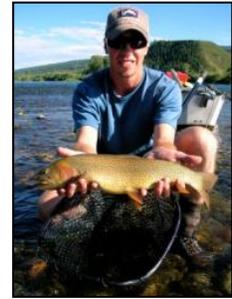
Data from non-lethal samples of plasma and observations of fish condition are being compared with all metrics obtained from lethal samples. Comparisons include: features evaluated at time of necropsy (including condition of stomach and intestinal tract), analyses of the architecture of selected tissues via paraffin histology, proximate composition of fish tissues for proportions lipid, moisture, ash, and protein, and estimates of total tissue energy from bomb calorimetry. These empirical data will be further compared with models developed using computer generated bioenergetic models. There are very few bioenergetic models developed for fish that are not actively feeding, and our models are being developed under assumptions of average temperature profiles at the time of migration upstream, estimated temperatures at overwintering and spring spawning temperatures.

To increase our understanding of the energy reserves expressed in samples of plasma from stocks with high levels of iteroparity outside of the Columbia River, we contacted several researchers working with steelhead stocks. We collaborated with Brian Marston of the Alaska Department of Fish and Game to evaluate kelts at the rigid/ floating weir on the Situk River. The Situk River is Alaska's largest steelhead trout system and is located near the town of Yakutat, Alaska. The Situk River is 35.2 km and drains three lakes with an accumulative draining area of 397 hectares. Situk steelhead trout exhibit a high rate of iteroparity compared to Snake River steelhead trout with annual totals of emigrating kelts ranging from 6,000-15,000 individuals. Our primary goal for sampling Situk River kelts was to compare the blood plasma factors of coastal winter-run steelhead with a known high rate of iteroparity to inland summer run steelhead in the Snake River. Graduate student Zachary Penney traveled to Yakutat, Alaska to sample kelts, and we obtained 37 natural origin kelts (24 females and 13 males) at the weir. All female kelts were in good condition, 8 of the male kelts were in fair condition and 5 were in poor condition. In addition, 11 kelt mortalities were sampled for muscle and liver tissues for proximate analysis. Carcasses were collected above or on the weir and believed to be less than 6 hours old. All mortalities were males; however no length was collected for these individuals.

In 2011, we sampled plasma from kelts at Idaho weirs in collaboration with Idaho Fish and Game biologists. From April to the end of June 2011 we obtained 43 steelhead kelts for our studies. These fish were sampled for blood, surgically implanted with acoustic transmitters, held for recovery, and released alive to migrate downstream.

Student Jessica Buelow completed revisions on her master's thesis, and submitted it to the graduate school in December to complete her master's degree requirements. She is now working as fisheries manager for Idaho Department of Fish and Game. Bryan Jones completed his revised thesis proposals and presented it for committee review. He is working on analysis of all data, and preparation of his draft thesis for anticipated spring graduation. Graduate student Zachary Penney made significant progress in organizing all data from samples collected in 2009 – 2011. After completion of revisions to his final PhD proposal he will set the dates for his written and oral examinations, and work toward completion of manuscripts and dissertation.

## ASSESSMENT OF ANGLER SURVEY METHODS FOR MANAGING IDAHO'S ANADROMOUS FISHERIES: ANGLER SURVEY DESIGN AND THE ROLE OF SOCIAL DESIRABILITY BIAS



Principal Investigator: Michael C. Quist  
Student Investigator: Joshua L. McCormick  
Collaborating Investigator: Daniel J. Schill, IDFG  
Funding Agency: Idaho Department of Fish and Game  
Completion Date: 31 May 2013

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### Objectives:

- Assess bias and precision of creel survey sampling designs to estimate Chinook salmon harvest in Idaho.
- Quantify self-reporting bias in Chinook salmon and steelhead creel surveys in Idaho.
- Develop sampling designs to collect Chinook salmon and steelhead parentage based genetic tagging samples throughout fisheries in Idaho.

### Progress:

The number of allowable hatchery Chinook salmon *Oncorhynchus tshawytscha* that can be harvested by sport anglers in Idaho is regulated by the U.S. v. Oregon Management Agreement which determines harvest shares for sport and tribal fisheries. The Endangered Species Act limits allowable incidental mortality of listed Chinook salmon (from 0-2% depending on the run size) that are caught and released in fisheries that target hatchery fish (i.e., Snake, Salmon, and South Fork Salmon rivers) and fisheries must be closed when this condition is met. Historically, fisheries have been closed because the harvest share of hatchery fish was met before the allowable mortality quota of wild fish was reached. Fisheries may also be closed to allow fish to escape to upriver fisheries or to hatcheries for broodstock collection. Total catch and harvest are estimated using creel surveys. Due to the unique constraints on Chinook salmon fisheries, accurate, precise, in-season estimates of total catch and harvest are necessary to properly manage wild and hatchery Chinook salmon populations.

To evaluate temporal trends in effort and catch, and to obtain information on angling populations, observations of Chinook salmon anglers were conducted on the Clearwater, Middle Fork Clearwater, Little Salmon, South Fork Salmon, and upper Salmon rivers. A total of 783 angler trips was observed throughout the summer of 2011, which included 2,457 hours of angling effort and 323 Chinook salmon caught. Monte Carlo simulations were conducted using data from field observations to estimate the relative bias and precision of total catch estimates using two different survey designs and three catch rate estimators. Preliminary results suggest that the ratio-of-means estimator provided the most accurate and precise estimates. Root mean square error was 40% lower on average when roving-access surveys were used compared to roving-roving surveys. Future efforts will focus on survey methods associated with steelhead fisheries and refining techniques used to characterize Chinook salmon fisheries in Idaho.

## ASSESSMENT OF SAMPLING TECHNIQUES FOR JUVENILE BURBOT IN THE KOOTENAI RIVER, IDAHO

Principal Investigator: Michael C. Quist  
Student Investigator: Christopher D. Smith  
Collaborating Investigator: Ryan Hardy, IDFG  
Funding Agency: Idaho Department of Fish and Game  
Completion Date: 30 December 2013

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### Objectives:

- Evaluate gear efficacies targeting juvenile burbot using several sampling techniques (e.g., hoop nets, benthic trawls, boat-mounted electrofishing).
- Determine the influence of habitat characteristics (e.g., width, depth, presence of large woody debris) on gear efficiency and juvenile burbot detectability.
- Describe juvenile burbot ecology in nonwadeable lotic systems.

### Progress:

The lower Kootenai River burbot *Lota lota* population (i.e., downstream of Libby Dam, Montana) has experienced substantial declines in abundance over the past forty years. Due to these declines, managers have placed increased attention on burbot in the Kootenai River system. However, few effective techniques are available for sampling burbot in nonwadeable river systems, particularly for juvenile fish. The focus of this project is to evaluate different sampling techniques for juvenile burbot in the Kootenai River, Idaho.

Although the focus of the project is on the Kootenai River, the Green River, Wyoming was selected as a secondary sampling location. The Green River contains an introduced burbot population and has reached extremely high density in the last five years; therefore, sampling in the Green River provides an excellent opportunity to evaluate different sampling techniques in a system with high densities of burbot. Ten sites on the Kootenai River and 10 sites on the Green River will be sampled multiple times during the summer and fall (May – November) in 2012 and during the summer in 2013. In addition to the collection of data on fishes (e.g., length, weight), habitat characteristics (e.g., substrate characteristics, channel morphometry) will also be described to determine relationships between gear efficiency and habitat conditions. Current work involves preparation for the field season (e.g., acquiring and preparing sampling gear).

Results from this study will provide a detailed comparison of sampling techniques targeting juvenile burbot, thereby allowing managers to better assess population structure, recruitment dynamics, and management actions. Furthermore, information regarding gear efficacies, seasonal variations in catch, detection rates of gears, and inferences regarding juvenile burbot ecology will also be generated as part of this research. Such information will further our understanding of juvenile burbot ecology, guide current management efforts, and help direct future research.

## EFFECTS OF HABITAT RESTORATION ACTIVITIES ON FISH ASSEMBLAGES AND POPULATIONS IN SIDE CHANNELS OF THE KOOTENAI RIVER

Principal Investigator: Michael C. Quist  
Student Investigator: Carson J. Watkins  
Collaborating Investigators: Sue Ireland and Shawn Young, KTOI  
Funding Agency: Kootenai Tribe of Idaho  
Completion Date: 31 August 2014

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### Objectives:

- Determine spatial and temporal variation in fish assemblage and population structure and function among side channels.
- Evaluate relations between habitat characteristics (e.g., instream cover, current velocities) in side channel habitats and fish assemblage and population structure and function.
- Evaluate sampling designs for monitoring the effect of habitat restoration activities on fishes in side channels of the Kootenai River.

### Progress:

The Kootenai River is one of Idaho's most unique and important resources, and supports a diversity of native species. Native fishes of high cultural and ecological importance include burbot *Lota lota*, Kootenai River white sturgeon *Acipenser transmontanus*, kokanee *Oncorhynchus nerka*, redband trout *O. mykiss gairdnerii*, westslope cutthroat trout *O. clarki lewisi*, bull trout *Salvelinus confluentus*, and mountain whitefish *Prosopium williamsoni*. All of these species use the Idaho portion of the Kootenai River for all, or a significant portion of their life history. Like many other large rivers in North America, the Kootenai River has been degraded due to changes in land use (e.g., logging, mining) and water development (i.e., Libby Dam). These disturbances have had deleterious effects on ecosystem function of the Kootenai River. The Kootenai Tribe of Idaho has been active in the past and is moving forward with ambitious plans to restore habitat and ecosystem function in the Kootenai River and its floodplain. On-going and planned restoration efforts provide a unique opportunity to evaluate the effects of habitat restoration on fish assemblages and populations. In particular, restoration activities on side channels are likely to elicit large positive responses due to their importance to fishes and other organisms in the system. The purpose of this project is to provide information on the effects of habitat restoration activities on fish assemblage structure and function in side channels of the Kootenai River. A major benefit of this project is that it will provide an understanding of the distribution and abundance of fishes, by species and life history stage, in side channel habitats of the Kootenai River. This information is critical for evaluating the effect of management actions (e.g., habitat restoration) on fish assemblages and populations. Information on side channels will also provide insight that can be used to develop more effective and efficient sampling designs. A student was recently selected for the project and sampling during late summer or early fall. The spring and early summer will be spent acquiring and organizing sampling equipment, and finalizing the sampling design.

## KOKANEE SPAWNING ECOLOGY AND RECRUITMENT RESPONSE TO WATER LEVEL MANAGEMENT IN LAKE PEND OREILLE, IDAHO

Principal Investigator: Michael C. Quist  
Student Investigators: Steven L. Whitlock  
Collaborating Investigator: Andrew M. Dux  
Funding Agency: Idaho Department of Fish and Game  
Completion Date: 31 December 2013

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### Objectives:

- Evaluate the procedure for the estimation of lakeshore spawning kokanee egg-to-fry survival,
- Describe the population dynamics and spawning characteristics of segregated kokanee breeding groups in Lake Pend Oreille, and
- Directly measure relationship between kokanee incubation success and spawning habitat characteristics.

### Progress:

In the 1950s, Lake Pend Oreille (LPO) produced an average annual kokanee *Oncorhynchus nerka* harvest of over a million fish, while also providing a trophy bull trout *Salvelinus confluentus* and rainbow trout *O. mykiss* fishery. Kokanee, which function as both a prey and sport fish species, declined precipitously beginning in the late 1960s following several biological and hydrological alterations to the system. The most significant alteration is believed to be the initiation of deep winter water level drawdowns associated with power production at Albeni Falls Dam. A sizeable portion of the kokanee population spawns over-winter on the lakeshore in LPO. Drawdowns are thought to decrease recruitment by reducing the availability of suitable spawning gravels, which primarily exist above the minimum winter lake elevation. Since 1996, the Idaho Department of Fish and Game (IDFG) evaluated a lake level manipulation strategy to determine if raising winter lake levels would increase kokanee recruitment. The method for evaluating the lake level hypothesis is to fluctuate between years of the preexisting low lake elevation (625.1 m) and years with an experimentally raised lake elevation (626.4 m) and to measure kokanee recruitment response to habitat changes. The goal of this project is to improve the IDFG assessment methodology for the lake level management strategy and broaden understanding of kokanee spawning ecology.

Kokanee recruitment response to raised lake levels is assessed using a back-calculated estimate of egg-to-fry survival (EF survival); this estimate is calculated using five sub-estimates and does not account for the error of each estimate. To better understand the influence of sampling variability on the estimate of kokanee egg-to-fry survival, we used sensitivity analysis to assess sources of variability among the various sub-estimates and nonparametric bootstrapping to calculate the variability surrounding each year's estimate. The results of our sensitivity analysis and preliminary findings of our bootstrapping reveal imprecision in EF survival estimates. In the future, alternative estimation techniques will be evaluated to reduce the influence of sampling variability, retrospectively.

The second objective of our study provides insights for improving the EF survival estimation procedure, while broadening understanding of kokanee reproductive ecology in LPO. From

September to November, 2011 we sampled over 2,000 spawning kokanee in lakeshore habitats and tributaries to draw comparisons between segregated breeding groups of kokanee. Subsamples of aging structures, ovaries, and gravid eggs were also collected and are currently being processed. This work will provide a thorough description of the population dynamics (e.g., length-at-age, hatchery-wild origin) and spawning characteristics (e.g., egg size, fecundity) of each segregated breeding group, and potentially provide insights for more representative sampling when assembling the components of the EF survival estimate.

The EF survival estimate is indirect and involves measuring the abundance of mature adults at the time of spawning in the fall and the abundance of young of year the following summer. Our third objective attempts to directly test the lake level hypothesis using an *in situ* incubation experiment in LPO, and by building a relationship between substrate size composition and embryo survival using a laboratory incubation experiment at the University of Idaho. Both of these experiments are currently underway. The *in situ* experiment for this season comprises three lakeshore sites and a total of 96 Whitlock-Vibert incubation boxes (WV boxes). The laboratory experiment includes 144 WV boxes divided among eight gravel treatments. The lake level will be held at the low elevation (625.1 m) for this year's *in situ* experiment and will be maintained at the high elevation (626.4 m) when the experiment is continued next year, allowing the effect of raised lake level on survival to be ascertained.

**POPULATION STRUCTURE, DYNAMICS, AND FOOD HABITS OF NORTHERN PIKE AND SMALLMOUTH BASS IN COEUR D'ALENE LAKE: POTENTIAL EFFECTS ON ADFLUVIAL CUTTHROAT TROUT AND MANAGEMENT ALTERNATIVES**

Principal Investigator: Michael C. Quist  
Student Investigator: John Walrath  
Collaborating Investigator: Jon Firehammer, Coeur d'Alene Tribe  
Funding Agency: Coeur d'Alene Tribe  
Completion Date: 31 December 2013

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**Objectives:**

- Describe the population structure and dynamics of northern pike and smallmouth bass.
- Determine seasonal food habits of northern pike and smallmouth bass and model consumption of cutthroat trout.
- Evaluate alternatives for managing northern pike and smallmouth bass populations within the context of adfluvial westslope cutthroat trout conservation efforts.

**Progress:**

The Coeur d'Alene Tribe has recently documented poor survival of adfluvial westslope cutthroat trout *Oncorhynchus clarki* originating from Lake and Benewah creeks (small tributaries to Coeur d'Alene Lake). Although a number of factors likely contribute to mortality of cutthroat trout in the system, low survival is thought to be primarily due to intensive predation by northern pike *Esox lucius* and smallmouth bass *Micropterus dolomieu* in Coeur d'Alene Lake. Research has shown that the introduction of northern pike and smallmouth bass in the western United States has had a detrimental effect on native fishes. To assess northern pike and smallmouth effects on cutthroat trout in Coeur d'Alene Lake, sampling will be conducted at four locations: Cougar, Wolf Lodge, and Windy bays, and Benewah Lake. Fish will be sampled using a variety of techniques, including gill nets, modified fyke nets, and boat electrofishing. Bimonthly sampling will occur in Windy Bay and Benewah Lake when adfluvial westslope cutthroat trout are outmigrating; monthly sampling will occur when cutthroat trout are not outmigrating. Cougar and Wolf Lodge bays will be sampled monthly. Consumption of cutthroat trout and other prey items will be modeled using a bioenergetics model. Bioenergetics models will also be coupled with yield-per-recruit models to compare management strategies for northern pike and smallmouth bass populations.

In November 2011, three temperature loggers were deployed in each bay at various depths to record a temperature (°C) every six hours. Preliminary field sampling was also completed in November in each of the four bays. The highest presence of northern pike occurred in Benewah Lake and the lower portion of Benewah Creek. The formation of ice in December prevented sampling of the study sites. Sampling will continue once ice has dissipated from the bays.

**AN EXAMINATION OF THE SPATIAL AND TEMPORAL DISTRIBUTION AND DENSITY OF *MYSIS* AND ZOOPLANKTON AND IMPLICATIONS FOR THE SURVIVAL OF KOKANEE FRY IN LAKE PEND OREILLE**

Principal Investigator: Frank M. Wilhelm  
Student Investigator: Elliott Reams  
Funding Agency: Idaho Department of Fish and Game  
Completion Date: December 2013

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**Objectives**

- Determine spatial and temporal distribution of zooplankton and *Mysis* in Lake Pend Oreille.
- Modify the IDFG zooplankton production and quality index (ZPI/ZQI) for kokanee.
- Collect and analyze historic climate data for immediate LPO watershed to determine potential to predict the date of stratification to allow managers to optimize the timing of the release of hatchery-reared kokanee.

**Progress:**

Since the turn of the 20<sup>th</sup> century, the Lake Pend Oreille (LPO) ecosystem has undergone large changes resulting from the construction of dams, the introduction of a large number of fish species, the addition of nutrients from upstream and nearshore areas, and the introduction of *Mysis diluviana* (a shrimp) as prey for fish. Fluctuations in fish populations have been large, with significant declines of kokanee, and since the late 1990s, increases in the abundance of lake trout which prey on kokanee. The introduction of mysids to lakes throughout the Pacific Northwest has led to the disruption of entire ecosystems and the collapse of targeted fisheries because mysids compete with fish fry for zooplankton food. One approach to manage the abundance of mysids is to harvest them, as is being done in Okanagan Lake, B.C. However, this requires an understanding of the spatial distribution of mysids. Anecdotal evidence suggests that mysids in LPO move to shallow nearshore areas over winter. Such spatial aggregations may afford an efficient means to capture them for removal. It also has been well-established that the thermal stratification of LPO affords zooplankton a thermal refuge from predation by mysids and that zooplankton production as well as survival of kokanee is higher in some areas, especially bays. The timing of, and location of stocking hatchery-reared fry could enhance their survival if released in areas favorable to their survival.

To date we have undertaken two pilot surveys on LPO to establish general whole-lake zooplankton distributions and fine tune methods to process the large number of samples that will be generated from depth and spatially intensive sampling regime. We intend to process samples using a zooplankton index modified for kokanee in LPO. To modify the index for kokanee, we are in the process of measuring kokanee gill rakers on a range of fish sizes. We are also developing a color index to distinguish zooplankton quality. Copepods tend to be reddish in color, while cladocerans tend to be white or brownish. Initial examination of samples indicates that it should be possible to correlate color and copepod/cladoceran proportions in samples, which would give a ready index of quality. We consider cladocerans to be high

quality, as they are overwhelmingly selected by fish fry. We have collated and partially analyzed climatic records for NSDA-NCRS meteorological stations in the immediate vicinity of LPO extending back to the 1970's. These are being examined for additional data extending back further in time. We have digitized the entire LPO bathymetric map and created ESRI shapefiles to calculate thermal volumes and masses in the stratified layer as we explore the data set for predictive relationship(s) to reliably forecast the date of stratification. Intensive sampling will begin in the spring of 2012.

Right: Governor Otter visits  
CNR wetlab to observe  
projects with K. Cain. Visible  
are the troughs with different  
sizes of gravel substrate for  
studies of kokanee salmon  
embryo survival. See page 29  
in this report.



Left: Creel  
census of anglers  
along the South  
Fork of the  
Salmon River,  
Idaho

## Completed Projects – Fisheries and Aquatic Resources

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### DEVELOPMENT AND EVALUATION OF EXTENSIVE LARVAL AND JUVENILE REARING TECHNIQUES AND SYSTEMS FOR BURBOT (*LOTA LOTA MACULOSA*) TO MEET CONSERVATION AQUACULTURE NEEDS

Principal Investigator: Kenneth D. Cain  
Student Investigator: James Barron  
Research Technician: Nathan Jensen  
Funding Agency: USGS – RWO 135  
Collaborator: U.S. Fish and Wildlife Service  
Completion Date: 30 September 2010

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#### Objectives:

- Determine growth, condition, and survival of burbot reared from larval to juvenile life stages in replicated extensive (outdoor pond/tank) rearing systems.
- Evaluate existing natural ponds and potential pond sites at the Kootenai National Wildlife Refuge and other sites in Boundary County (or elsewhere) for further developing and testing extensive rearing requirements for burbot.
- Determine optimum hatchery rearing temperature and density for maximum growth of burbot fed commercial diets.
- Test various commercial diet formulations for use in burbot culture.
- In conjunction with our ongoing production program, compile data from this project for incorporation into a draft “Burbot Hatchery Manual”.

#### Summary:

This project was initiated in June of 2008. The overall project goal is to improve survival of burbot from larval to juvenile life stages and investigate “natural” rearing options that may better meet conservation aquaculture needs for this species. Demographic analysis in 2004 of the Lower Kootenai River burbot (*Lota lota maculosa*) population indicated that approximately 50 fish currently remain. A series of factors appear responsible for the collapse of riverine burbot populations in the Kootenai/y Basin, including: habitat alteration and loss (increased winter discharge and winter water temperatures, reduced primary and secondary productivity, hydro impoundment and operations, and Kootenay Lake flood control), harvest, reduction in mysid availability, and resulting ecological community composition shifts. Rather than listing burbot as threatened or endangered under the Endangered Species Act (ESA), the Kootenai Valley Resource Initiative (KVRI) Burbot Committee, along with the US Fish and Wildlife Service and additional committed stakeholders, contributed to a Conservation Strategy. The committee proposed the Kootenai River drainage as a “pilot project” to develop, implement, and evaluate this Conservation Strategy for Lower Kootenai River Burbot, in lieu of formal ESA listing. It is this multi-faceted international focus and commitment, and consistency with the proposed federal “Policy for Evaluating Conservation Efforts” (PECE Policy; U.S. Vol. 65 No. 114, June 13, 2000) that empowers this Conservation Strategy. The goal of this Conservation Strategy is to restore and maintain a viable and ultimately harvestable burbot population in the Kootenai River and in the South Arm of Kootenay Lake through habitat restoration and conservation aquaculture efforts. The need to investigate the potential of rearing burbot larvae under “natural” conditions has been identified as essential. This rearing method

may simplify and/or improve our ability to rear this species for conservation aquaculture efforts. This study is being conducted as a graduate student (MS) project and builds on current burbot culture research at the University of Idaho's Aquaculture Research Institute (UI-ARI). Research on intensive burbot culture has been ongoing since 2004 at the UI-ARI and this project addresses important questions for future development of a conservation aquaculture facility. If extensive pond rearing of burbot is feasible and cost-effective, then facility design plans must incorporate pond construction. Temperature, growth, and feed requirements will also be important when considering water and tank needs.

In 2008 a preliminary investigation to address when burbot should be stocked into semi-intensive culture systems was conducted. The semi-intensive culture strategy used shares many similarities to extensive culture with the addition of aeration. Surviving juveniles were observed 109 days after release in the last stocking treatment, which consisted of larvae stocked after a 45 day period post first feeding under intensive conditions. Treatments which were stocked earlier showed no survival to juvenile life stages. In 2009, semi-intensive culture systems at the University of Idaho were treated with varying stocking densities. Burbot were stocked based on the previous year's findings after 45 days on live feeds under intensive culture. Juvenile burbot were found surviving in all treatments 65 days post stocking. Survival showed a decline as stocking densities increased. In 2010 the density study from 2009 was repeated using the same methods. After 65 days of semi-intensive culture, survival was observed in all tanks, and once again survival decreased with increased stocking density.

An additional experiment was conducted starting in June of 2009 to optimize culture temperature for larval burbot under intensive conditions. Trial one utilized larval burbot held under three temperature treatments of 10, 15 and 20°C for 30 days. Burbot larvae were found to grow faster in warmer water; however, survival was diminished in higher temperatures. Cannibalism rates were elevated in higher temperatures, which lead to reduced survival. Trial two was conducted in July with slightly larger burbot than those used in Trial one. Treatments were once again 10, 15, and 20°C for 30 days. Growth accelerated and survival declined with increased temperature. Cannibalism mortality was high in all temperature treatments claiming over 50% of the population in all treatments by the end of the trial. Trial three was conducted in the fall of 2009 with dry feed transitioned juvenile burbot. Treatments were 10, 15 and 20°C for 60 days. Growth was fastest in the 15 and 20°C treatments. Survival was high in all treatments, over 90% over 60 days. Cannibalism mortality was found to be low to non-existent at this stage.

Due to high cannibalism rates seen in the first two temperature optimization experiments in 2009 a follow up study was conducted to find a method for reducing cannibalism. In the summer of 2010 a grading strategy aimed at reducing cannibalism mortality was developed and tested. The grading strategy utilized a mesh box with square holes measuring 2.0 by 2.0 mm to passively separate a population into two groups based on fish body width. This strategy was tested when burbot larvae averaging 12 mm in total length and 2.3 mm wide began to show signs of cannibalism. The two populations separated by the grader were monitored for 15 days along with an ungraded control population. The grader effectively separated burbot larvae by width, resulting in differences in mean width between treatment groups. Grading also reduced size variation relative to the control, which may have reduced the potential for cannibalism.

Over 15 days the graded populations showed improved survival due to reduced cannibalism mortality compared to the ungraded control. Mean survival was increased from 59% on average in the control to 74% and 93% in the low and high grade treatments respectively. This gain in survival was supported by a decrease in the proportion of fish cannibalized from 29% on average in the control to 14% and 1% in the low and high grade treatments, respectively. This grading strategy was tested again with burbot averaging 21 mm in total length and 3.8 mm wide. This population was about to undergo a transition to dry feed which typically results in high mortality. A larger mesh size (3.0 by 3.5 mm) was used on the grader box. Again a 15 day study was conducted to monitor the low and high grade populations along with an ungraded control. The feeding regime during the 15 day trial included co-feeding live *Artemia* and dry feed for 8 days followed by 7 days of solely dry feed. At this stage the grading strategy did not create a significant change in mean body width. Grading in this instance did not significantly reduce the percentage lost to cannibalism or increase survival over 15 days.

This project provides new insight into several aspects of burbot conservation aquaculture. Basic methods for conducting semi-intensive/extensive culture of burbot developed during this project will be critical in the development and operation of a future conservation aquaculture facility. Temperature optimization trials provide the burbot culturist guidance to make informed decisions when selecting culture temperatures along with baseline data for predicting and comparing growth performance. The grading technique developed in this project provides an effective and applicable method for reducing cannibalism. Three manuscripts describing these studies have been prepared and submitted to refereed journals for publication.

### **EVALUATION OF ADULT SALMON AND STEELHEAD DELAY AND FALLBACK AT SNAKE AND COLUMBIA RIVER DAMS, 2009 (RWO 141) & 2010 (RWO 145)**

Principal Investigator:	Christopher Caudill
Student Investigator:	Christopher Noyes
Collaborator:	Brian Burke, NOAA-Fisheries U.S. Army Corps of Engineers Portland District
Funding Agency:	USGS RWO – 141 & 145
Completion Date:	30 December 2010 (RWO 141) and 30 June 2011(RWO 145)



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#### **Objectives:**

- Evaluate effects of modified Bonneville Dam Cascade Island entrance on the passage (e.g. passage times, entrance use and efficiency, etc.) of radio-tagged spring Chinook salmon during 2009 (RWO 141) and 2010 (RWO 145) Chinook salmon runs.

#### **Summary:**

We used radiotelemetry during 2009 (RWO 141) and 2010 (RWO 145) to assess whether adult spring–summer Chinook salmon at the Bonneville Dam Cascades Island (CI) fishway were negatively affected by modifications intended to facilitate passage of adult Pacific lamprey and reduce fishway maintenance requirements. We compared Bonneville Dam passage time

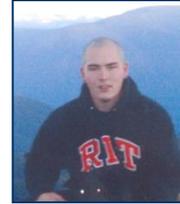
metrics and CI entrance use and passage efficiency metrics collected in April-May 2010 with similar metrics calculated using spring Chinook salmon data collected in 1997-1998, 2000-2004, 2006-2007 (pre-modification years), and 2009 (post-modification). We also compared these same metrics from June 2010 with results from summer Chinook salmon radio-tagged in June 2002–2004 and 2009.

Results from 2009 indicated some behavioral differences near the CI fishway opening relative to pre-modification years but the 2010 results were less conclusive. Specifically, a relatively low proportion of spring Chinook salmon that approached the CI fishway opening subsequently entered through it in 2009 and those that did enter took a relatively longer time to do so. In contrast, the entrance efficiency (entrance events/fishway approach events) estimate in 2010 was 0.90, at the high end of the range from the pre-modification years (*range* = 0.56-0.98). The median CI approach-entrance time in 2010 was 42 minutes, also within the range of median times from pre-modification years (*range* = 2-46 min). For summer Chinook salmon, the entrance efficiency estimate was 0.70 in 2009 and 0.71 in 2010, the two lowest efficiencies of the five study years but similar to 2004. Median CI approach-entrance times for summer Chinook salmon in 2010 was < 1 minute, compared to 6-12 minutes in pre-modification years.

While river conditions explained some of the differences in 2009, there was also some evidence that hydraulic conditions created by the new CI variable-width weir and/or altered olfactory conditions related to the modifications contributed to the low entrance efficiency and longer salmon passage times that year. We concluded that any adverse effects associated with the modifications were reduced in magnitude in 2010 compared to 2009. We suspect that the concentration of any disruptive olfactory cues originating from the modification has declined since 2009 and the new structures may have “seasoned” by leaching and by the accumulation of biofilms. Because effects on salmon appeared to occur principally outside the fishway in both years, we concluded that the hydraulic effects of the floor-mounted bollards and the new lamprey passage structure (LPS) had negligible effects on salmon passage behavior inside the CI fishway.

## IMPROVING ADULT PACIFIC LAMPREY PASSAGE AND SURVIVAL AT LOWER COLUMBIA RIVER DAMS, 2010

Principal Investigator: Christopher Caudill  
Student Investigators: Benjamin Ho  
Christopher Noyes  
Collaborator: Mary Moser, NOAA-Fisheries  
US Army Corps of Engineers  
Portland District  
Funding Agency: USGS – RWO 146  
Completion Date: 30 June 2011



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### Objective:

- Evaluate passage and survival of adult Pacific lamprey (*Lampetra tridentata*) at lower Columbia River dams during the 2010 migration.

### Summary:

During the 2010 monitoring season, we tagged adult Pacific lamprey (*Lampetra tridentata* / *Entosphenus tridentatus*) with half duplex (HD) passive integrated transponder (PIT) tags and/or radio transmitters and monitored their passage and migration behaviors at Bonneville, The Dalles, John Day, McNary, Ice Harbor, Lower Monumental, Lower Granite, and Priest Rapids dams. As part of our multi-year monitoring objectives, telemetry data were to calculate lamprey passage times, to estimate escapement past the monitored sites, and to evaluate potential physiological and environmental correlates with lamprey migration through the study area. We also examined telemetry system detection efficiencies. Near record-low adult lamprey counts at Bonneville Dam in 2010 resulted in reduced lamprey collection and necessitated modifications to our study objectives. To remain below a 2% adult lamprey handling threshold (of the estimated total Bonneville count) established by regional managers, we prioritized radio tagging and eliminated study objectives associated with lampreys tagged only with HD-PIT tags. In total, we tagged 312 lampreys with both radio transmitters, and all of these also received HD-PIT tags. An additional 13 lampreys were tagged with HD-PIT tags only before objectives were re-prioritized.

The 2010 escapement estimate from release below Bonneville Dam to top-of-ladder antennas was 41% for radio-tagged fish, the highest estimate among the 2007-2010 radiotelemetry studies. Escapement from the top of Bonneville Dam to top-of-ladder antennas at The Dalles Dam (55%) and from the top of The Dalles Dam to the top of John Day Dam (49%) was also higher than in recent years. Large lampreys were significantly more likely than small lampreys to pass through most dam-to-dam reaches, and early migrants were more likely than late migrants to escape upstream. Lamprey migration times were highly variable, but tended to be slow at dams and relatively rapid through reservoirs. Median passage times for radio-tagged fish were 12.6 days from release to the top of Bonneville Dam, 4.1 days from tailrace to top-of-ladder antennas at The Dalles Dam, and 1.5 days between tailrace and top-of-ladder antennas at John Day Dam. Median reservoir passage times were 2.7 d (Bonneville) and 1.8 d (The Dalles). Lampreys generally migrated faster later in the summer through most reaches, coincident with increasing river temperatures and decreasing river discharge. Twenty-five percent of the lampreys that passed Bonneville Dam eventually entered tributaries, including the Snake River, or passed the uppermost monitoring sites at Priest Rapids Dam. The largest

group in this category was recorded in the Deschutes River. Lampreys that returned to the Deschutes and John Day River were collected at Bonneville Dam relatively early in the run. In addition, most lampreys that returned to the upper basin were in the largest size classes, indicating probable size and migration timing effects on lamprey distribution in the basin. Almost all of the remaining 75% of the sample was last detected at main stem dams or in dam tailraces. At top-of-ladder sites where both radiotelemetry and HD-PIT detection systems were deployed, the radiotelemetry arrays were more efficient (total efficiency = 92%) than HD antennas (82%) at detecting double-tagged fish, although some fish were detected only on the HD-PIT system. The PIT tags were also detected at lamprey passage systems (LPS) systems at Bonneville Dam, improving overall detection efficiency. The combined basin-wide radiotelemetry results in 2010 indicated improved passage efficiency at Bonneville Dam and through some upstream reaches. Recent modifications made to fishway operations and structures likely improved lamprey passage at dams (especially Bonneville Dam).

As part of ongoing efforts to improve passage conditions for adult Pacific lamprey the USACE modified the Cascades Island fishway opening during winter 2008-2009 to reduce maintenance requirements and improve hydraulic conditions for lamprey. The modifications included a variable-width entrance weir, bollards ("artificial rocks") designed to provide reduced near-floor water velocity refuges for lampreys, and construction of a new lamprey passage structure (LPS) inside the fishway opening. We evaluated behavior and passage success near and inside the modified Cascades Island fishway using radiotelemetry and half-duplex PIT-tag (HD-PIT) studies; use of the LPS by adult lamprey will be reported separately. Lamprey entrance efficiency at the Cascades Island fishway was significantly higher in the post-modification years (2009 = 59.5%; 2010 = 61.1%) than pre-modification years (2008 = 33.3%; 2007 = 0.50;  $P < 0.001$ ), suggesting some post-modification benefit for lampreys. Entrance efficiency at the Bradford Island fishway entrance (located at the south end of the spillway and similar in structure to the Cascades Island entrance prior to modifications) did not differ significantly among years or pre-/post-modification periods, also supporting the hypothesis that the increased entrance efficiency at Cascades Island in 2009 and 2010 was related to the modifications. However, comparison of other lamprey performance metrics between years and locations provided equivocal evidence of a benefit. For example, exit ratios at the Cascades Island fishway were similar or higher in post-modification years, and passage times associated with the Cascades Island entrance were similar to or longer than in previous years. Overall, the results suggest the modifications provided an improvement to movement into the fishway, but that poor passage conditions for adult lamprey persist between the entrance and transition pool, probably upstream of the bollard field. Detection efficiency at the new the HD-PIT antenna system in the Cascades Island entrance was high in 2009 and 2010: 80-87% of lampreys tagged with both radio transmitters and HD-PIT tags were detected on the PIT antenna system. The high detection rate suggested that adults entered near the fishway floor, within the influence of the modified hydraulic field produced by the bollards. The pattern of detections on four separate antennas indicated that a majority (67-76%) of lamprey entered on the north half of the fishway channel. Overall, the analyses indicated that the Cascades Island modifications likely improved entrance efficiency for adult Pacific lamprey and did not have strong positive or negative effects on other passage metrics, possibly because of passage impediments upstream of the modifications.

## LOWER METHOW FISHERIES POPULATION GENETIC ANALYSIS

Principal Investigator: Madison Powell  
Student Investigator: Dana Weigel  
Technical Staff: Joyce Faler  
Collaborator: Patrick J. Connolly,  
Cook, Washington  
Collaborating Agency: U. S. Bureau of Reclamation  
Pacific Northwest Region  
Funding Agency: USGS – RWO 123  
Completion Date: 31 December 2010

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### Objectives:

- Assess the effects of parentage and hatchery fish on steelhead trout colonization of newly-opened stream habitat.
- Compare population genetics and life history information across steelhead populations in several natal tributaries (Beaver, Libby, and Gold creeks).

### Summary:

Access into Beaver Creek, a tributary in the Methow River Washington, has been limited by 7 small irrigation diversions for more than 100 years. In 2002-2004, state and federal agencies began re-designing these irrigation diversions in cooperation with private landowners to allow passage for steelhead (*Oncorhynchus mykiss*) and other ESA-listed species. Fisheries managers were concerned that the high proportion of hatchery steelhead returning to the Methow and a higher probability for these fish to stray would influence the colonization of the newly opened habitat. Therefore, we measured the relative reproductive success and the source population of all adult steelhead spawning in Beaver Creek. Adult steelhead entering this stream and parr and smolts emigrating from the stream were monitored using a picket weir from 2005 through 2008. Microsatellite markers were used to determine the reproductive success and potential source population for colonizers. Most of the returning adults were identified as wild-origin (>90%). Total adult escapement of steelhead trout was stable (no increase or decrease) during the first 4 years after barrier removal; however, the proportion of fluvial rainbow trout using Beaver Creek for spawning varied across years. Individual steelhead had a wide range of reproductive success and only a few individuals accounted for more than 80% of the outmigrants from the stream. Most individual steelhead had multiple spawning partners. Hatchery steelhead made up a small proportion of the colonizers and had poor reproductive success relative to wild fish indicating they likely had little genetic influence on the initial colonization process in our study.

## AGE STRUCTURE AND GROWTH OF ADFLUVIAL CUTTHROAT TROUT IN TRIBUTARIES OF COEUR D'ALENE LAKE

Principal Investigator: Michael C. Quist  
Collaborating Investigator: Jon Firehammer,  
Coeur d'Alene Tribe  
Funding Agency: Coeur d'Alene Tribe  
Completion Date: 31 December 2011

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### Objective:

- Evaluate the age structure and growth of outmigrating adfluvial cutthroat trout in tributaries of Coeur d'Alene Lake.

### Summary:

Cutthroat trout *Oncorhynchus clarki* historically had the broadest distribution of any trout species in North America. The cutthroat trout is often considered a headwater species due to its prevalence in small, high-elevation streams; however, it was historically distributed across western North America in streams, rivers, and lake systems. Like most salmonids, cutthroat trout display a diversity of life history strategies. Although some cutthroat trout populations are anadromous, most are resident and display both fluvial and adfluvial life histories. While cutthroat trout populations have declined across their distribution, declines of adfluvial populations have been particularly extreme. Not only are adfluvial populations susceptible to changes in stream and river habitats, but they must also contend with altered habitat conditions and nonnative fishes (i.e., predators, competitors) in receiving lake systems.

Understanding the population dynamics of fish populations is central to management and conservation activities. In particular, describing age structure and growth is critical for understanding fish populations and evaluating different management and conservation activities. Recent efforts in tributaries of Coeur d'Alene Lake have focused on better understanding the life history (e.g., movement dynamics) of adfluvial cutthroat trout. Unfortunately, little is known about the age structure and growth of fishes moving from tributaries to Coeur d'Alene Lake. Such information would greatly improve the understanding of cutthroat trout life history strategies in the system and thereby enhance that ability of land and fishery scientists to target restoration efforts focused on adfluvial cutthroat trout (e.g., habitat improvement activities, nonnative fish removal efforts). We sampled cutthroat trout from various low-elevation watersheds of the Coeur d'Alene basin during spring migratory periods and summer stream-rearing periods from 2005-2010 to provide information on age structure and growth of cutthroat trout in the system. Scales were removed and processed using standard methods to provide information on age structure and growth of fish.

Seven-hundred-and-ninety-four fish were aged across seasons (i.e., spring, summer-fall) and streams; age could not be assigned to 75 fish. When ages could not be assigned, it was largely because the scales were regenerated and, therefore, not suitable for aging. During the spring, age structure was dominated by age-1 and age-2 fish. Length of fish at age 1 and age 2 was highly variable and exhibited a high degree of overlap. Although annual variation likely explains some of the variation in lengths, high variability may reflect different sources of fish in the watershed (i.e., different rearing tributaries). Electrofishing samples in the summer and fall were dominated by age-1 fishes and lengths generally corroborated lengths from the spring

traps. Across streams, mean length at age was similar among streams. Although ages were obtained for most fish, the quality of scales was generally poor and was reflect in the confidence ratings. Confidence ratings (0-3 rating scale; 0 = no confidence in the age estimate and 3 = maximum confidence in the age estimate) were lower in Evans Creek (mean  $\pm$  SD;  $1.09 \pm 0.86$ ) than in Benewah Creek ( $1.52 \pm 0.64$ ) and Lake Creek ( $1.69 \pm 0.59$ ). The poor readability of scales from Evans Creek is unknown, but may be due to the cold thermal regime and slow growth rates of cutthroat trout in the system. In addition to juvenile fishes, returning adult fish were also sampled. However, an examination of approximately 150 fish indicated that ages could not be assigned with any confidence.

Scales from fish (except for the youngest fish) used in this study were generally difficult to age with a high level of confidence and the age of adults could not be estimated from scales, at least not with any confidence. One method to gain more reliable estimates of age will be through an on-going tagging study. Although it will take some time to build a dataset suitable for evaluating age and growth, data quality will be high. Alternatively, managers might consider taking a different structure for aging adults. Because these fish are of high conservation value, lethal techniques (e.g., otoliths, cleithra) are probably not suitable. As such, fin rays (pectoral or pelvic) will likely provide excellent information on age and growth without the need to sacrifice fish.

## USING SEISMIC AIR GUNS TO REDUCE SURVIVAL OF SALMONID EGGS AND EMBRYOS: A TOOL FOR CONSERVATION

Principal Investigator:	Michael C. Quist
Research Technician:	Benjamin Cox
Collaborating Investigators:	Andy Dux, IDFG; Christopher Guy, USGS
Funding Agency:	Idaho Department of Fish and Game
Completion Date:	31 December 2011



### Objective:

- Evaluate the efficacy of using seismic air guns to reduce survival of salmonid eggs and embryos.

### Summary:

Introduced lake trout *Salvelinus namaycush* have had a number of detrimental effects on native fishes across the western U.S. In addition to disrupting aquatic food webs (i.e., energy flow and nutrient dynamics), lake trout compete with and directly consume native species such as kokanee *Oncorhynchus nerka* and cutthroat trout *O. clarkii*. The detrimental impacts of introduced lake trout to aquatic ecosystems in the western U.S. have prompted natural resource management agencies to implement lake trout suppression programs. Currently, these programs focus on using gill nets or trap nets to remove subadult and adult lake trout. Population models suggest that lake trout population growth is highly sensitive to changes in survival from age 0 to age 1. Thus, developing methods to reduce survival of age-0 fish will

most likely provide the greatest benefit toward obtaining suppression effort goals. This project will evaluate a novel technique, seismic air guns, for reducing mortality of age-0 lake trout.

Seismic air guns are used in both reflection and refraction seismic surveys. The guns use compressed air to produce a steep-fronted percussion wave that is reflected by subsurface geological features. The reflected waves are monitored much like traditional sonar techniques. Common uses of air gun technology oil and gas exploration, engineering site evaluations, or other geologic surveys. Seismic air guns can cause mortality in eggs and larvae of fish; however, mortality caused by seismic air guns varies by species, life stage, and distance from the air gun. Seismic air guns are an attractive alternative to netting efforts because of the comparatively low cost of using air guns. Seismic air guns are also preferred over toxicants for controlling lake trout because of the relatively low mortality induced when fish are > 5 m from the air gun. We conducted a study to explore the potential for using high-intensity sound from a relatively small (655.5 cm<sup>3</sup>, 40 in<sup>3</sup>) seismic air gun to reduce survival in lake trout embryos. Lake trout embryos at multiple stages of development were exposed to a single discharge of the seismic air gun at two depths (5 m and 15 m) and two distances from the air gun (0.1 m and 2.7 m). Control groups for each developmental stage, distance, and depth were treated identically, except that the air gun was not discharged. Mortality in lake trout embryos treated at 0.1 m from the air gun was 100% at 74 daily temperature units in degrees Celsius (TU°C) at both depths. Median mortality in lake trout embryos treated at 0.1 m from the air gun at 207 (93%), and 267(78%) TU°C appeared higher than controls (49%, 48% respectively) at the 15 m depth. Mortality at the 2.7 m distance did not appear to differ from controls at any developmental stage or either depth. These data indicate seismic air guns have potential as an alternative tool for controlling nonnative lake trout and further investigation is warranted.

## OCCURRENCE, HABITAT ASSOCIATIONS AND CONSERVATION ACTIONS FOR THE WOOD RIVER SCULPIN (*COTTUS LEIOPOMUS*)

Principal Investigator: J. Michael Scott  
Student Investigator: Donald W. Zaroban  
Funding Agencies: U.S. Bureau of Land Management, U.S. Environmental Protection Agency, Idaho Department of Environmental Quality, The Nature Conservancy, Lava Lake Foundation for Science and Conservation

Completion Date: 31 December 2010

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### Objectives:

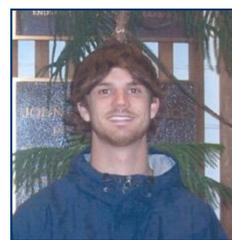
- Inventory Wood River sculpin occurrence across its distribution.
- Develop a multivariate habitat association model to predict species occurrence.
- Assess feasibility of using PIT tags to track individual Wood River sculpins. Use shorthead sculpins (*C. confusus*) as a surrogate to avoid possibility of inter-basin transfer of *Myxobolus* sp. Observe survival, tag retention, net-avoidance behavior and subsequent detectability.

### Summary:

In this project we described the historical and extant range, quantified important habitat associations, and assessed the efficacy of using passive integrated transponder (PIT) technology to track individual Wood River sculpins. Even though it is considered vulnerable, the species has received little conservation attention. Our work indicates an apparent retraction of Wood River sculpin range, but also shows the fish is more widely distributed and abundant within its extant range than previously known. We describe catchment gradient and lithology associations that naturally constrain Wood River sculpin distribution and use them to predict where sculpins are most likely to occur. By combining the known extant range with my model predictions, we describe an “envelope of persistence” where the probability of detecting Wood River sculpins is greater than 50%. Individual sculpins down to 60 mm total length can be tracked using PIT technology and typically the fish will not shed tags inserted into the body cavity. We have recorded electrofishing sampling efficiencies of 0.15 to 0.46 for Wood River sculpin.

Natural resource managers currently have the opportunity to manage the Wood River sculpin outside the realm of the Endangered Species Act, potentially reducing costs and conflicts. Initiation of conservation management to address the immediate threats of barriers, water pollution, predators, and dewatering will likely make the species more resilient to the more pervasive threats of climate change and human economic and population growth.

## THE ROLE OF *MYSIS DILUVIANA* IN THE NUTRIENT AND FOOD WEB DYNAMICS OF LAKE PEND OREILLE, IDAHO



Principal Investigator: Frank M. Wilhelm  
Student Investigator: Timothy Caldwell  
Funding Agency: Idaho Department of Fish and Game  
Completion Date: June 2011

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### Objectives:

- Examine the role of *Mysis diluviana* in the nutrient dynamics of Lake Pend Oreille.
- Quantify the nutrients (phosphorus - P) imported, cycled, and exported to and from surface waters by *Mysis* during their nocturnal vertical migration.
- Quantify the seasonal dynamics of nutrients.
- Determine the density of *Mysis* at each of two sampling sites.
- Develop a life history model for mysids.
- Determine if *Mysis* removal to “free-up” nutrients could be an alternative to adding nutrients to surface waters to stimulate production of zooplankton for kokanee fry.
- Determine the effects of mysid predation on cladoceran populations.

### Summary:

The goal of the project was to examine and understand the role of the non-native opossum shrimp, *Mysis diluviana*, in the nutrient and food web dynamics in the surface water of Lake Pend Oreille (LPO). Because mysids compete for zooplankton food with fish fry, whole-lake fertilization has been applied to some lakes in B.C., Canada to generate a bottom-up trophic cascade to produce more zooplankton food. In light of the nearshore TMDL for sediment and excessive nutrients, as well as interstate efforts to reduce nutrient inputs to LPO from the upstream watershed in Montana, a nutrient addition program in LPO may be counterproductive and socially unacceptable. By understanding the nutrient dynamics associated with mysids, we hoped to identify management strategies other than the addition of nutrients to stimulate the production of zooplankton.

We undertook near monthly sampling at two widely spaced sites in LPO at which we examined the life history of *Mysis* and quantified the amount of phosphorus excreted during their diurnal vertical migrations. We also examined gut contents of mysids to quantify the prey species and sizes ingested. Mysids predominantly displayed a two year life-cycle, with males present in fall, while gravid females overwintered. Young were released in spring and grew to immatures by fall. The excretion of P by mysids was similar between sites and for all three stages of their vertical migration (up, while in surface waters, and down migration) indicating they do not come to the surface with empty guts as originally hypothesized. Selection of food by mysids was highly seasonal, and included a variety of items such as diatoms in winter, copepods in early spring and summer, followed by cladocerans when the lake was stratified. Mysids selected the largest cladocerans. In fact, cladocerans were present in mysids well before any were retained in net hauls. From this we concluded that the predation of cladocerans by mysids significantly delayed the onset of abundant cladoceran populations in LPO, and caused their early demise after turnover. On a whole-lake basis, the mass of nutrients tied up in mysid biomass is significant, as is the loss of nutrients from the surface waters of LPO due to their

sloppy feeding (only partial ingestion of killed prey). We estimated that mysids account for the removal of 108 to 173 mg P·m<sup>-2</sup>·y<sup>-1</sup> through direct predation on cladocerans, while they account for a further loss of 37 to 61 mg P·m<sup>-2</sup>·y<sup>-1</sup> regeneration of P by zooplankton due to predation. Translating these rates to a whole-lake basis was not possible because of high variability in estimates of mysid density and are the focus of a current study. Because mysids strongly select cladocerans and thus directly compete with kokanee fry when they first emerge, a two pronged management strategy may be beneficial which includes the reduction of the abundance of mysids in combination with the application of nutrients for a short period of time to enhance the early season production of cladocerans. Before nutrient additions are implemented it would be beneficial to know if areas of high natural zooplankton production exist in LPO to which hatchery fry could be stocked



Left: Boling Sun prepares for sampling at Lower Granite Dam kelt facility. Boling is retiring from the University after helping with Department and Coop Unit projects for nearly 20 years.

Right: Sieving New Zealand mudsnails after toxicity tests in the wet laboratory.



## Current Projects – Wildlife and Terrestrial Resources

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### **EFFECTS OF SURFACE WATER ON ABUNDANCE AND REPRODUCTIVE SUCCESS OF BIRDS IN DESERT RIPARIAN WOODLANDS**

Principal Investigator:	Courtney J. Conway
Collaborators:	Chris Kirkpatrick (Univ of Arizona) & Don Swann (NPS)
Staff Biologists:	Dominic LaRoche, Gabrielle Robinson
Project Partners:	AZGFD, NPS, DOD, USGS, BLM, TNC, USFWS
Project Duration:	January 2005 to December 2012

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#### **Objective:**

- Quantify the effects of reduction in surface water (due to drought or groundwater withdrawal) on persistence of bird populations in desert riparian woodlands.

#### **Progress:**

Riparian woodlands in the desert southwest are an extremely important resource because they constitute <1% of the desert landscape, yet typically support >50% of the breeding birds. Ground water withdrawal (and subsequent loss of surface water) to support growing human populations in the desert southwest has the potential to degrade or eliminate riparian woodlands throughout the region. During the first 2 years of the study, we surveyed birds, sampled vegetation, and measured surface water at 23 study sites located in riparian woodlands throughout southeastern Arizona. We also sampled avian food resources (i.e., aerial arthropods) and monitored nests of riparian bird species at a subset of 10 and 6 of these study sites, respectively. We examined the role of surface water and vegetation health (proportion of live vegetation) on bird parameters while controlling for potentially confounding variables such as vegetation structure and composition. Results suggest that relative abundances of several species of birds of conservation concern were positively associated with the presence and extent of surface water in riparian woodlands. In addition, we found evidence of substantial declines in breeding populations of riparian-obligate bird species such as Bell's vireo and yellow warbler following a drought-induced die-off of riparian trees at 1 of our 23 study sites (Rincon Creek in Saguaro National Park). Ultimately, results from this project will allow Saguaro National Park to predict the effects of proposed groundwater withdrawal projects on the abundance and diversity of breeding birds within the park. This information will allow the park to predict the effects of applications for new groundwater wells (to support human population growth in the region) on bird populations within the park. Such predictions will support applications from various agencies (e.g., Saguaro National Park) to the state of Arizona to maintain instream flow rights. This research project is addressing an emerging issue that will only become more important as the expanding human population places more demands on ground water resources in the arid west.

## **HABITAT ASSOCIATIONS OF BIRDS IN MONTANE RIPARIAN FORESTS OF THE SKY ISLAND MOUNTAIN RANGES**

Principal Investigator: Courtney Conway  
Graduate Student: Kristen Dillon, University of Arizona  
Collaborator: Chris Kirkpatrick  
Project Partners: USFWS, AZGFD, USGS, T&E Inc.  
Project Duration: 2002 - 2012

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### **Objective:**

- Quantify the habitat associations of birds within montane forests of the southwestern U.S.

### **Progress:**

The Madrean woodlands that cover the upper elevations of Sky Island Mountains in the southwestern U.S. and northwestern Mexico have been listed as a global biodiversity hotspot (Conservation International 2006); 1 of only 2 such hotspots in North America. These woodlands have high species diversity due to a high number of endemic species. Since 2002, we've monitored nests and documented habitat associations of 2 little-studied ground-nesting birds, the red-faced warbler and yellow-eyed junco, within 5 study sites in the Santa Catalina Mountains. We found that red-faced warblers and yellow-eyed juncos selected nest-sites close ( $\leq 30$  m) to drainage bottoms in stands of montane riparian forest characterized by more ferns, forbs, brush, and small woody debris, more saplings and small trees (red-faced warblers), and more shrubs and less canopy cover (yellow-eyed juncos). Although both species nested in close proximity within montane riparian forest, environmental features at nest-sites differed, especially at finer spatial scales. For example, most yellow-eyed juncos nested adjacent to grass, whereas red-faced warblers situated nests adjacent to a variety of plant species, including grass, big-tooth maple, white fir, and Douglas-fir. Both species avoided nesting in areas that were burned by a recent (2003) low-severity wildfire suggesting short-term negative effects of fire for breeding populations of red-faced warblers and yellow-eyed juncos. Our results show that montane riparian forests in the southwestern U.S. provide important breeding habitats for coexisting populations of red-faced warblers and yellow-eyed juncos. These forests are limited in their geographic extent and threatened with disturbance (e.g., catastrophic wildfire).

## **DEVELOPMENT AND FIELD-TESTING OF SURVEY METHODS FOR A CONTINENTAL MARSH BIRD MONITORING PROGRAM IN NORTH AMERICA**

Principal Investigator: Courtney J. Conway  
Staff Biologist: Christopher Nadeau  
Project Partners: USFWS, USGS  
Project Duration: 2001 - 2012

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### **Objective:**

- Develop a continental survey protocol for North America that allows state, federal, and local agencies to conduct marsh bird surveys in a standard manner that maximizes detection probability so that data can be pooled and compared across socio-political boundaries.

**Progress:**

Populations of many species of marsh birds are thought to be declining in North America. Several species of marsh birds (Virginia rail, sora, clapper rail, king rail) are hunted in many states and management agencies need estimates of population trends to set harvest limits. Despite the perceived population declines and game bird status, we currently lack effective monitoring programs to adequately estimate population size or trends (or effects of harvest) of these birds. Developing an effective monitoring protocol is essential for collection of long-term data designed to provide rigorous estimates of population change. We developed a monitoring protocol for marsh birds that is suitable for use throughout North America and field-tested the new protocol at a subset of National Wildlife Refuges and other protected areas across the country. The protocol includes everything from survey route selection and point placement to field methods and data forms, and the data are entered into a pooled database. The development of this survey protocol has led to a dramatic increase in survey data for marsh birds; >200,000 marsh bird point-count surveys have been conducted at hundreds of locations across North America with data entered into the shared database. We have used these data to address a variety of questions regarding optimal survey methodology and effects of management actions (Conway and Nadeau 2006). We have also created a comprehensive website for the project and have worked closely with USFWS Migratory Bird Office and the USGS Patuxent Wildlife Research Center to produce an online data entry and retrieval module on the internet that can be used by agencies across North America.

**EXPANSION OF IRRIGATED AGRICULTURE IN NORTHWESTERN MEXICO AND POPULATION DECLINES OF BURROWING OWLS IN NORTHERN LATITUDES**

Principal Investigators: Alberto Macías-Duarte, Courtney Conway  
Graduate Student: Alberto Macías-Duarte, U of Arizona  
Collaborator: Melanie Culver, U of Arizona  
Project Partners: National Council of Science and Technology of Mexico (CONACYT), World Wildlife Fund, USFWS Sonoran Joint Venture, U.S. Department of Defense NPS, American Ornithologists' Union, Colegio de Posgraduados, Mexico, Canadian Wildlife Service Service, New Mexico State University, Universidad Autonoma de Sinaloa, Universidad Autonoma de Nuevo Leon, T&E Inc., USGS.

Project Duration: 2004 – 2011

**Objective:**

- Determine whether recent population declines of Burrowing Owls in northern latitudes have been caused by conversion of southern latitude desert grasslands to irrigated agriculture.

**Progress:**

Burrowing owl populations have declined or been extirpated in the northern portion of the species' breeding range in southern Canada and the northern United States. We are testing whether formerly migrant burrowing owls from northern latitudes may have become resident



breeders in areas of northern Mexico with extensive agricultural valleys. Subtropical irrigated agriculture may have promoted this change in migratory behavior by providing suitable breeding conditions and year-round food supply that was not provided by native ecosystems. To test this hypothesis, we developed 11 new microsatellite markers to determine the genetic structure of burrowing owl populations throughout North America. In addition, we used stable isotope ratios of owl feathers to determine current connectivity among burrowing owl populations. We collected blood and feather samples from 25 populations of burrowing owls from Canada to Mexico. Results demonstrate that declining migratory owl populations in Canada were more genetically similar to Sonoran burrowing owl populations than would be expected based on the null model. Stable isotope analyses also show a link between burrowing owl populations in Canada and those in northwestern Mexico.

### **IDENTIFYING IMPORTANT AREAS FOR MARSH BIRD MANAGEMENT IN THE UNITED STATES: USING GIS TO MODEL PRESENCE AND ABUNDANCE OF MARSH BIRDS ON NATIONAL WILDLIFE REFUGES**

Principal Investigator:	Courtney J. Conway
Staff Biologist:	Christopher Nadeau
Project Partners:	USFWS, USGS
Project Duration:	2007 - 2012

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#### **Objective:**

- Identify the National Wildlife Refuges that provide the best habitat for each of 13 species of secretive marsh birds in the U.S.

#### **Progress:**

The National Wildlife Refuge System (NWRS) manages a large portion of the freshwater and saltwater wetlands in the United States. Therefore the NWRS must play a key role in monitoring and managing birds that depend on these wetlands (i.e., rails, bitterns and grebes). To assure the proper management and long-term persistence of marsh birds in the United States, we must identify: (1) the specific types of wetlands that are used most by each species of marsh bird, and (2) which NWRs have large amounts of these preferred wetlands types. We have developed preliminary habitat models based on National Wetland Inventory data that are effective at identifying optimal habitat for 13 species of rails, bitterns, and grebes. We will use more marsh bird survey data and a model selection approach to improve upon preliminary models to produce and validate a set of final models (one for each of the 13 species). We will then use the models to estimate the amount of optimal habitat for each of the 13 species on each NWR in the U.S. Ultimately, we will provide the NWRS with a list of NWRs that may want to include habitat for secretive marsh birds in their long-term management plans.

## **RESTORATION OF MANAGED MARSH UNITS TO BENEFIT BLACK RAILS: AN ADAPTIVE MANAGEMENT APPROACH**

Principal Investigator: Courtney J. Conway  
Staff Biologist: Christopher Nadeau  
Project Partners: BOR, USFWS, USGS, AZGFD  
Project Duration: 2008 - 2011

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### **Objective:**

- Determine optimal vegetative features and hydrologic conditions that produce the best habitat for California black rails and Yuma clapper rails

### **Progress:**

California black rails are one of 20 priority species in the Lower Colorado River Multi-species Conservation Program which requires the creation of new black rail habitat (and maintenance of all existing occupied habitat) along the lower Colorado River. Hence, U.S. Bureau of Reclamation needs information on optimal habitat conditions for black rails to help design effective wetland restoration efforts required by the LCR MSCP. This project uses an adaptive management approach for the creation of black rail habitat. We worked with BOR to design and create a wetland with habitat conditions thought to be optimal for black rails, but also incorporated variation in water level so that concurrent monitoring would improve our knowledge of optimal water conditions and help inform future designs for creating black rail habitat. We installed automated piezometers to monitor hydrologic conditions, conducted marsh bird surveys weekly throughout the breeding season, and measured vegetation throughout the restoration site for 2 years to document the range of hydrologic conditions and plant associations preferred by black rails. We then created spatio-temporal models to: 1) document the range of water depths that promote successful establishment of common threesquare (the plant to which black rail distribution is closely tied), and 2) document the range of water depths that black rails use within this narrow range of conditions.

## **INCENTIVES FOR GROWTH: RECRUITMENT AND MENTORING OF MEXICAN GRADUATE STUDENTS**

Principal Investigator: Courtney J. Conway  
Collaborators: Adrian Quijada-Mascareñas, Bill Shaw, Bill Mannan, Melanie Culver; Laura Lopez-Hoffman, Lisa Graumlich  
Graduate Student: Alexander Ochoa  
Project Partners: University of Arizona, CONACYT  
Project Duration: 2009 - 2011

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### **Objective:**

- Recruit more Mexican graduate students to increase collaborations with Mexican scientists.

### **Progress:**

A critical way to build USA-Mexico research partnerships is through the training of students. This project provided funding for Mexican graduate students for the first year of the PhD program at the University of Arizona. During their first year, the students work with their

faculty advisor to apply for outside funding, such as fellowships from CONACYT and Calder Foundation, to support subsequent years of study. The project is intended to help launch new, long-lasting research collaborations between UA faculty and the next generation of Mexican scientists.

## **POPULATION TRENDS, RELATIVE ABUNDANCE AND EFFECTS OF MANAGEMENT ACTIONS FOR WEBLESS MIGRATORY GAME BIRDS**

Principal Investigators:	Courtney J. Conway and Christopher Nadeau
Post-doctoral Investigator:	Leonard Santisteban
Staff Biologist:	Christopher Nadeau
Project Partners:	USFWS, USGS
Project Duration:	2008 - 2012

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### **Objectives:**

- Estimate population trends of secretive marsh birds (rails, bitterns, grebes) at national and regional scales.
- Estimate detection probability during surveys of marsh birds.
- Estimate breeding density of marsh birds.
- Evaluate the effects of some common wetland management actions on marsh birds.

### **Progress:**

Populations of many species of webless migratory game birds that inhabit marshes are thought to be declining in North America. We used distance sampling and circular plot sampling to estimate breeding density and detection probability of 14 species from data gathered during marsh bird surveys conducted between 1999 and 2009. We also calculated density for both estuarine and palustrine marsh for species that were detected in both types of wetlands. We estimated population trends for all 14 species as well using both route-regression approach and loglinear Poisson regression. And we examined the effects of water depth, salinity, and pH on marsh bird abundance. Detection probability varied among species and was lowest for American bitterns (8%) and highest for yellow rails (55%). Estimates of breeding density also varied among species and was lowest for limpkins (0.002 birds/ha) and highest for clapper rails (0.64 birds/ha). Breeding density of individual species varied among FWS regions. Clapper rails had higher densities in estuarine marsh than in palustrine marsh, while all other species had higher densities in palustrine marsh. Prescribed fire led to increased numbers of clapper rails, Virginia rails, and black rails.

## **HABITAT PATCH SIZE AND DETECTION PROBABILITY OF YUMA CLAPPER RAILS**

Principal Investigators: Courtney J. Conway  
Staff Biologists: Christopher Nadeau, Mark Ogonowski, Meaghan Conway  
Project Partners: USFWS, USGS  
Project Duration: 2008 - 2012

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### **Objectives:**

- Determine the relationship between patch size of emergent marsh vegetation and probability of occupancy by Yuma clapper rails.
- Estimate detection probability of Yuma clapper rails during the annual range-wide surveys.

### **Progress:**

Yuma clapper rails (*Rallus longirostris yumanensis*) have been listed as federally endangered since the advent of the Endangered Species Act (U.S. Department of the Interior 1989, Conway and Eddleman 2000). The recovery plan for the Yuma clapper rail (U.S. Fish and Wildlife Service 1983) is currently being revised and the draft revision includes explicit recovery tasks. One of these recovery tasks is the acquisition of information on suitable sizes of habitat patches for clapper rails and the average density of rails in habitat patches of various sizes. Recovery also requires actual estimates of the number of Yuma clapper rails present each year, and so we need estimates of detection probability that are based on the survey methods currently used during the annual interagency survey effort. We estimated detection probability by conducting surveys near 11 radio-marked Yuma clapper rails. We digitized the size of all patches of emergent marshes throughout the lower Colorado River Valley and examined the influence of patch size on occupancy of clapper rails. We are currently conducting analyses in preparation of the final report.

## **DEVELOPING OPTIMAL SURVEY TECHNIQUES FOR MONITORING POPULATION STATUS OF RAILS, SNIPE, COOTS AND GALLINULES**

Principal Investigators: Courtney J. Conway and  
Mark Woodrey, Mississippi State University  
Staff Biologists: Christopher Nadeau and Meaghan Conway  
Project Partners: USFWS, USGS, NOAA, Mississippi State University  
Project Duration: 2008 - 2012

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### **Objective:**

- Improve survey methods for secretive marsh birds in North America

### **Progress:**

A need for more accurate information on population status and trends of marsh birds has been identified as a top research need for 15 years (Tacha and Braun 1994). Efforts have been underway for the past decade to develop continental survey protocols and a sampling frame for conducting marsh bird surveys throughout North America (Ribic et al. 1999, Conway and Gibbs 2001, Conway and Timmermans 2005, Conway and Droege 2006). However, numerous methodological questions related to optimal survey methods were raised at a recent marsh bird symposium. We evaluated: 1) the optimal timing for conducting surveys in each region of the

country, 2) the optimal tide stage for conducting surveys in both freshwater and saltwater tidal systems, and 3) the effect of broadcasting non-local dialects on detection probability. We are preparing data to facilitate analyses.

## **DEVELOPMENT OF A HABITAT SUITABILITY INDEX MODEL FOR THE ENDANGERED MASKED BOBWHITE**

Principal Investigators: Courtney J. Conway  
Student Investigator: Dominic LaRoche  
Project Partners: USFWS, USGS  
Project Duration: 2011 - 2013

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### **Objective:**

- Develop a model for identifying habitat conditions of masked bobwhite.

### **Progress:**

Masked bobwhite are federally endangered in the U.S. and Mexico and appear to be effectively extinct in the wild. We are working with 9 species experts to develop a suite of habitat models to help identify sites for reintroduction. This project has just recently gotten underway and we have conducted two rounds of interviews with the 9 species experts. We are now quantifying their opinions into habitat suitability functions. The next step will be to combine the suitability functions into predictive models.

## **EFFECTS OF PRESCRIBED FIRE ON NORTHERN IDAHO GROUND SQUIRREL HABITAT AND USE**

Principal Investigator: Beth Newingham  
Student Investigators: Elise Suronen  
Christina Sullivan  
Collaborators: Diane Evans-Mack (IDFG)  
Eric Yensen (College of S. Idaho)  
Funding Agency: Idaho Department of Fish and Game  
Closing Date: 30 September 2013

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### **Objectives:**

- Characterize *Urocitellus brunneus brunneus* occupied habitat.
- Determine the effects of thinning and prescribed fire on potential but currently unoccupied *U. b. brunneus* habitat.
- Determine the effects of thinning and prescribed fire on the nutritional value of primary plants in the *U. b. brunneus* diet.
- Examine *U. b. brunneus* use in burned and unburned areas, as well as microhabitat use.

### **Progress:**

We characterized habitat features of *U. b. brunneus* by sampling seven currently occupied sites for vegetation and soils. For vegetation, we measured overstory canopy cover, tree age

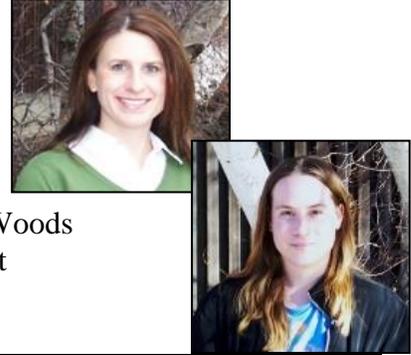
distributions, tree density, understory species composition and vertical structure, at each site. Litter layer depth was determined and soils were analyzed for texture, N, P, Ca<sup>2+</sup>, and pH. We also developed an extensive plant collection (~168 species) for all characterization sites that will be archived at the University of Idaho.

The seven occupied sites had an average overstory cover of 20%. Saplings (less than 3 inch DBH) were prominent, yet the next two size classes (3 - 8 inches) dropped in presence, while tree count increased with the last tree size class (DBH > 8 inches). Understory species diversity across all reference sites is low; however, the abundance of those few species is relatively uniform. Average understory vegetation height for each site fluctuated around 22 cm. There was no clear trend between understory vegetation height and forest dynamics. However, litter layer levels correspond with vegetation height. Litter layer depths within squirrel habitat were around 0.81 cm. Soil texture for five out of seven sites was a clay loam. Squirrel habitat mean soil parameters are as follows: 6.12 pH, 19.17 ppm phosphorus, 2670.7 ppm calcium, 1.28 ppm nitrate and 0.11 ppm ammonia.

We quantified the effects of prescribed fire on NIDGS habitat by implementing prescribed fire in the fall of 2010 adjacent to three of the seven habitat characterization sites. The same vegetation and soil characteristics were collected pre- and post-fire as listed in the habitat characterization objective. Tree density and overstory canopy cover were not altered by the treatment. Dead trees were still standing and holding onto orange needles by the time we collected post-fire data; thus, we did not see an effect of the burn on the forest structure. Understory vegetation height and litter layer depth were slightly reduced by the burned. Species composition after the burn slightly shifted closer to species composition within reference sites. Trends in species data will require more than one year of post-fire data and probably more than one treatment to bring the restoration toward reference conditions. Soil pH levels slightly increase after fire towards levels similar to the pH of reference sites, while calcium, phosphorus, nitrate and ammonia levels were not affected.

To examine changes in nutritional value of forage plants, we collected leaves or seeds from 24 species. Due to low sample sizes, we will only analyze digestible nitrogen for six species, which is a nutritional index for NIDGS. We determined *U. b. brunneus* use in unburned and burned areas at two sites by observing *U. b. brunneus* activity in the morning, afternoon and evening in June and July for 1.5 hours. The types of *U. b. brunneus* microhabitat sites included food acquisition, burrow, food consumption and lookout spots. Vegetation measurements (canopy cover and visual obstruction) were taken at each microhabitat site. There was no significant difference between squirrel use sightings in unburned and burned areas. Used microhabitat understory and overstory canopy cover averaged around 27% with a minimum value of 3% and a high value at 73% (high values largely influenced by ponderosa pine tree canopy). Understory vegetation height of used microhabitat had an average height of 8.99 cm (confidence interval of 7.98 to 10.02 cm).

## RESPONSE OF PYGMY RABBITS TO HABITAT CHANGES ASSOCIATED WITH GRAZING AND PRESCRIBED FIRES



Principal Investigator: Janet Rachlow  
Student Investigators: Meghan Camp and Bonnie Woods  
Collaborator: Bureau of Land Management  
Funding Agency: IDFG (SWG T-3-20)  
Completion Date: 30 September 2013

### Objectives:

- Quantify effects of cattle grazing and prescribed fires on vegetation structure.
- Evaluate predation risk as related to vegetation structure and changes in vegetation structure associated with grazing and fires.
- Contrast quality and quantity of forage for rabbits in grazed/ungrazed and burned/unburned areas.

### Progress:

To estimate the effects of cattle grazing on plant biomass, during the 2011 field season we collected data in 6 grazed pastures. In each, we set up 3-12x12 m exclosures made of electrified poly wire and identified a paired plot pasture next to the exclosures that was open to cattle grazing. Each pasture was grazed for approximately 1 month starting in mid May 2011. Immediately following cattle grazing, we sampled biomass by clipping all live herbaceous biomass in 12 0.5x0.5-m microplots systematically distributed in each of the exclosures and the same number in the paired plots. We sampled a total of 38 plots (18 grazed, 18 ungrazed, 2 ungrazed long-term exclosures) and 456 microplots. We dried and weighed samples, and we will compare the total biomass and biomass of plant genera between grazed and ungrazed plots within each pasture and among months (May, June, July, August) using a nested multivariate analysis of variance (MANOVA). Similarly, we estimated percent shrub cover and height using the line intercept method, and these data will be compared between treatments and across months. To examine the effects of cattle grazing on the nutritional quality of forage immediately after grazing, we collected live samples of the dominant plant species inside and outside of the grazing exclosures and formed composite samples by functional group (grass, forb, shrub). We had micorhistological analysis of pygmy rabbit feces that we collected to determine some of the dominant forage species and used that information to guide which species to collect for the nutritional analysis. Lab analyses were conducted at the Wildlife Nutrition Laboratory at Washington State University. It was not necessary to separate the samples by annual or perennial because there were no dominant annuals at our study site. Samples were freeze-dried and ground before sending to the Wildlife Nutrition Laboratory for analyses. To determine the digestible nitrogen in the plant material, the lab will complete a two-stage *in vitro* digestion with pepsin and cellulose. We will compare levels between the grazed and ungrazed plots and among month of grazing using a nested MANOVA.

To evaluate the effects of grazing on hiding cover for pygmy rabbits, we systematically distributed 10 points within each plot. At each point we measured concealment of a rabbit using a rabbit-sized profile board and visibility from the rabbit's point of view in a random direction. We collected a total of 390 vegetation measurements, and we will compare the

vegetation measurements between grazed and ungrazed plots and among months using mixed-effects linear model. To evaluate the effects of grazing on the integrity of pygmy rabbit burrows, we mapped active burrow systems and counted and rated the activity status of each burrow entrance prior to grazing. After grazing, we revisited the burrows to compare the status of the burrow entrances to the pre-grazing level. We collected data on 90 active burrow systems and will use a chi-squared test to compare the numbers of collapsed burrow entrances pre-grazing and post-grazing.

During the 2011 field season, we completed measurements on 10 prescribed burns, each conducted during the spring, and ranging in age from 6 years to 32 years. Vegetation sampling occurred in groups of 5 30x30 m plots per burn: one plot randomly placed within the perimeter of the historic burn; a reference plot in unburned sagebrush; a third plot with slight conifer encroachment (<10 adult conifers per plot); a fourth plot with mid levels of conifer encroachment (10 to 15 conifer per plot); and a fifth plot with heavy levels of conifer encroachment (>15 conifers per plot). Within each plot, we estimated: 1) concealment and visibility at 48 points; 2) shrub/conifer cover along 4 transects that were 30-m in length; 3) soil texture/effervescence and collected plant samples for biomass within 12 0.5x0.5-m quadrats. Sets of plots per burn were matched as closely as possible with respect to aspect, soil type, slope, and elevation. Plots were all located in the same pasture and where not located within 50 m of a road or 200 m of cattle tank or salt block to minimize other sources of disturbance.

For the biomass collection, we dried and weighed a total of 15 kg of plant material across 73 genera. All plants collected have been confirmed at the University of Idaho Stillinger Herbarium. Of 73 plant genera collected, 27 were confirmed as rabbit forage items in the literature, and 14 genera were identified as forage plants used in the area based on microhistological analysis of fecal pellets. We are conducting *invitro* digestible nitrogen analysis as described above using composite samples from the 13 forage genera that accounted for more than 1 percent in the total biomass. For plants that accounted for more than 5%, we are analyzing samples collected early and late in the growing season. We will be employing a repeated-measures MANOVA on sagebrush/conifer cover, forage/nonforage grasses, and forbs, and concealment/visibility measurements at 3 scales. This will be followed by mixed-model ANOVAs, nesting data from the 4 transects within the sample unit of the plot to test for significant differences between burned, reference, slight, mid and high-encroachment plots. We will employ a mixed-model regression analysis to investigate change in the habitat given the age since the treatment with comparison to the paired reference plot. We will also use nonmetric multi-dimensional scaling (NMDS) to ordinate our plot characteristics in a broader context, using separate responses for each genera, and then we will use a permutational nonparameteric MANOVA to explore the influence of environmental and management-based drivers on the vegetation dynamics that we observe.

## ASSESSING THE VULNERABILITY OF IDAHO SPECIES OF GREATEST CONSERVATION NEED TO CLIMATE CHANGE

Principal Investigators: Kerri Vierling  
Kerry Reese  
J. Michael Scott  
Student Investigator: Amber Lankford  
Collaborators: Leona K. Svancara, IDFG  
Funding Agency: USGS – RWO 148  
Completion Date: 31 May 2013



### Objectives:

- To determine the vulnerability of Idaho's Species of Greatest Conservation Need (SGCN) to projected changes in climate.
- To determine the spatial distribution of vulnerable SGCN species across Idaho.
- To communicate with agency personnel and others concerning: 1) vulnerability database development and 2) findings associated with the vulnerability assessment.
- Incorporate the research results into management planning and implementation efforts.

### Progress:

The present and future management of wildlife species depends upon understanding the degree of vulnerability that they face in dynamic ecosystems. The Intergovernmental Panel on Climate Change (IPCC) defines vulnerability as “the degree to which a system is susceptible to, or unable to cope with, adverse effects of climate change, including climate variability and extremes.” Vulnerability can be broken down into three contributing factors: exposure, sensitivity, and adaptive capacity. Exposure represents the availability of a system to the impacts of climate change and the magnitude and rate of change of those impacts. Sensitivity encompasses the tolerance of a system to change, and adaptive capacity is the ability of a system to cope with impacts of change. Vulnerability is therefore expressed as:  $Vulnerability = (exposure + sensitivity) - adaptive\ capacity$ .

The growing threat of habitat alterations resulting from climate change makes vulnerability assessment a key to effective future wildlife management. There are many potential approaches when developing a vulnerability assessment model, and we are using the “vulnerability cube” approach. In this approach, we are utilizing the three variables necessary for a vulnerability assessment: exposure, sensitivity, and adaptive capacity. The exposure variable will be represented by the % available habitat for each SGCN species. We have collected the exposure data for all of the SGCN species in Idaho. The sensitivity variable will be represented through data that are being generated by the Climate Sensitivity database. The database is being developed by research collaborators at the University of Washington. Many of the sensitivity scores for birds have been completed, but we are still awaiting sensitivity scores for the rest of the SGCN species (mammals, reptiles, and amphibians). The adaptive capacity variable will be represented through an index, which will likely include data on the generation time, age to reproductive maturity, and population size of each SGCN species. The exposure, sensitivity, and adaptive capacity variables will be combined into the vulnerability cube framework, and vulnerability scores will be generated. We presented the preliminary framework for the vulnerability cube approach at the Idaho Chapter of the Wildlife Society Annual Meeting in 2012, and received feedback from agency personnel. We will be finalizing

data collection and running the vulnerability assessments in the summer of 2012. We anticipate examining the spatial distribution of vulnerable SGCN species in the fall of 2012/spring of 2013, and providing vulnerability data to the SWAP for consideration in their planned revisions by the spring of 2013.

## **EVALUATING VITAL RATES AND HABITAT OF COLUMBIAN SHARP-TAILED GROUSE (*TYMPANUCHUS PHASIANELLUS COLUMBIANUS*) IN THE ROCKLAND AND CURLEW VALLEYS**

Principal Investigator	Kerry P. Reese
Student Investigator:	Gifford Gillette
Funding Agency:	Idaho Department of Fish & Game
Completion Date:	30 August 2012

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### **Objectives:**

- Improve population monitoring and demographic information on Columbian sharp-tailed grouse.

### **Progress:**

State wildlife biologists and researchers in Idaho have recently identified a need to improve population monitoring of Columbian sharp-tailed grouse (*Tympanuchus phasianellus columbianus*; hereafter CSTG) and assess the impacts of recent land use changes including the Conservation Reserve Program (CRP) on sharp-tailed grouse vital rates. This project has six objectives: 1) estimate survival rates of male and female CSTG; 2) estimate daily nest survival rates in relation to CRP; 3) determine if interactions between CRP and other covariates explain daily brood survival rates; 4) determine if indirect estimates of demographic rates (i.e., weather variables, loss of CRP, invertebrate abundance) can provide both rough ( $CV = 0.25-0.50$ ) and precise estimates of abundance ( $CV < 0.25$ ); 5) determine if the hunted population of CSTG in Idaho is declining, increasing, or stabilized; and 6) compare population reconstructions at different spatial scales to evaluate how spatial scale influences explanatory power of auxiliary elements and, thereby, the precision of estimates. To compare vital rates and assess effects of CRP, we will trap and monitor CSTG in the Rockland and Curlew Valleys of southeastern Idaho where multiple cover types are available for use but study areas do not represent one specific vegetation type. We trapped and banded 96 CSTG on 18 different leks in the Rockland and Curlew Valleys during April and May of 2011. Ten of 22 (45%) females were alive in the Rockland Valley and seven of 12 (58%) females were alive in the Curlew Valley as of 15 August 2011. Two of 5 (40%) males were alive in the Rockland Valley and 6 of 7 (86%) males were alive in the Curlew Valley as of 15 August 2011. In the Rockland Valley 3 of 13 (23%) nest attempts were successful and 2 of nine (22%) nest attempts were successful in the Curlew Valley. We were unable to detect a nest attempt by 5 females due to logistical constraints, hence, nest success is biased high since each of the aforementioned females most likely attempted to nest at least once. We estimate that at least 12 of 21 (57%) females monitored during the nesting season re-nested. We plan to further analyze 2011 data over the 2011-2012 winter. Field work for 2012 will be similar to that of 2011 with the addition of using pointing dogs to attempt to increase sample sizes of nests.

## PYGMY RABBIT SURVEY

Principal Investigator: Lisette Waits  
Post-doctoral Investigator: Jennifer Adams  
Funding Agency: Idaho Department of Fish and Game  
Completion Date: 30 August 2012

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### Objectives:

- Complete optimization of protocol to distinguish between pellets of all North American lagomorph species using a single PCR reaction.
- Work with IDFG to organize an effort to collect pygmy rabbit pellets from multiple locations in southern Idaho.
- Identify all collected pellets to species.

### Progress:

We have completed development of the PCR-based method to distinguish all lagomorph species in the region. The test was developed and tested on at least 20 tissue samples of the following species: black-tailed jackrabbit (*Lepus californicus*), white-tailed jackrabbit (*Lepus townsendii*), mountain cottontail (*Sylvilagus nuttallii*), desert cottontail (*Sylvilagus audubonii*), eastern cottontail (*Sylvilagus floridanus*), and pygmy rabbit (*Brachylagus idahoensis*). We then optimized our methods for using this test on DNA extracted from fecal pellets so that managers have a non-invasive survey method for pygmy rabbits. Our species ID method was published in Molecular Ecology Resources (Adams et al 2011).

We have evaluated the success rates for our species ID test for pellet samples collected in the field during spring, summer and fall (n = 128) compared to samples collected on snow in the winter (n = 30). Success rates (94%) were considerably higher for samples collected in the winter. We analyzed 143 pellets collected by IDFG in the fall and early winter of 2009 - 2010. Success rate for species identification of these pellets was 73%. Pygmy rabbits were detected at 40 out of 55 plots sampled. We have been using this genetic test to analyze samples for other agency biologists in the region and have helped to identify the first record of pygmy rabbits in Colorado.

## IDAHO GRAY WOLF MONITORING AND POPULATION ESTIMATION



Principal Investigator: Lisette P. Waits  
Student Investigator: Carisa Stansbury  
Funding Agency: Idaho Department of Fish & Game  
Completion Date: 30 May 2012

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### Objectives:

- Collect scat and hair to identify unique numbers of gray wolves with genetic tools.

### Progress:

From 2009 – 2010 we used a predictive habitat model to locate rendezvous sites and conducted noninvasive genetic sampling (NGS) of scat and hair at these sites in four study areas in Idaho, USA. We evaluated species and individual identification success rates across study areas in different climate regimes and estimated population size using the single-session estimator, CAPWIRE. We applied three different recapture coding methods to our datasets and introduce a new method of coding capture data to optimize model performance. NGS population estimates were compared to telemetry-based estimates generated concurrently.

We collected 1999 samples and identified 193 unique individuals which were detected one to 30 times. Species identification success rates were consistently high (>92%) across areas and 82% of samples were identified as wolf. Individual identification success rates for fecal DNA samples were 78-80% in the drier study areas, but decreased 29% in the wettest study area. NGS population estimates were in general agreement with telemetry estimates in our four study areas, but estimates varied by recapture coding method. Our new coding method (PART) produced estimates that had the greatest agreement with telemetry estimates and produced 95% confidence intervals that overlapped telemetry estimates in three of five datasets. The estimates using PART were more precise and closer to telemetry relative to recapture between data types and rendezvous sites (CAP) and it was less conservative than using all of the data (ALL) and likely provided more reliable estimates when one or more packs was missed. This study shows that predictive habitat modeling of rendezvous sites combined with NGS is successful at detecting gray wolf presence, identifying unique individuals, obtaining a minimum count of individuals and estimating abundance across study areas with different precipitation and temperature regimes. We are continuing to analyze this dataset to estimate the number of packs and number of individuals per pack. Carisa Stansbury plans to complete her MS work on this project in May 2012.

## Completed Projects Wildlife and Terrestrial Resources

### AMPHIBIAN CHYTRID FUNGUS DISTRIBUTION

Principal Investigator: Lisette Waits  
Post-doctoral Investigator: Caren Goldberg  
Funding Agency: Idaho Department of Fish and Game  
Completion Date: 15 May 2011



#### Objectives:

- Provide IDFG with sampling supplies for the amphibian pathogen *Batrachochytrium dendrobatidis* (Bd).
- Quantify the amount of Bd in each sample.
- Map and archive results to be used with other data for a publication on the prevalence of Bd in different amphibian species.

#### Summary:

We provided IDFG with supplies for sampling 100 amphibians during the spring and summer of 2008 and 2009. We received and analyzed 36 samples from three species [31 Columbia spotted frogs (*Rana luteiventris*), 1 Western toad (*Bufo boreas*), 1 Pacific treefrog (*Pseudacris regilla*), and 2 unknown] at 30 locations. Twenty-five of the samples tested positive for Bd: 24 Columbia spotted frogs and 1 unknown. These data have been mapped and archived.

### ANALYSIS OF POLAR BEAR MOVEMENTS IN THE CHUKCHI, BERING AND EAST SIBERIAN SEAS

Principal Investigators: Jon S. Horne  
J. Michael Scott  
Collaborator: U.S. Fish and Wildlife Service  
Funding Agency: USGS – RWO 150  
Completion Date: 28 May 2011



#### Objectives:

- Conduct preliminary analyses on polar bear location data to identify analytical methods for determining the spatio-temporal distribution of polar bear movements.
- Conduct preliminary analyses of polar bear habitat selection to identify potentially important environmental and biological factors affecting space use and determine appropriate analytical methods for investigating ecological aspects of habitat use.
- Identify geographic sampling locations that are most likely to provide a representative sample of the population.
- Identify approaches to investigate future changes in habitat use due to changes in climate, management, and population status and assist in defining objectives for future research.

## Completed Projects Wildlife and Terrestrial Resources

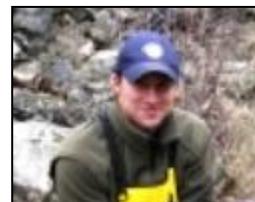
### Summary:

In May 2008, the polar bear (*Ursus maritimus*) was listed as threatened under the U.S. Endangered Species Act and there is an urgent need to better understand the status of the polar bear subpopulation that inhabits the Chukchi, Bering, and east Siberian Seas (i.e., Chukchi Sea polar bears). Important information, including estimates of population size, survival, reproduction, and habitat use, and knowledge of the trends and variability in these parameters, are currently lacking for this population. To address these research issues, U. S. Fish and Wildlife Service (USFWS) and others initiated a long-term research program in 2008. Since then, approximately 50 polar bears have been captured between March and May off the US Chukchi Sea coastline and subsequently monitored via satellite-based telemetry.

The goal of this project was to initiate a collaborative research effort between USFWS biologists and researchers with United States Geological Survey Cooperative Research Units Program and the University of Idaho and assist USFWS staff with preliminary analysis of telemetry data. Specifically, this project evaluated previous methods used for analyzing space use and resource selection of polar bears; identified environmental and biological characteristics associated with habitat selection and use of Chukchi Sea polar bears; and developed methods and computer code to evaluate responses of Chukchi Sea polar bears to changes in environmental conditions and management practices. The results of this project provided the basis for future collaboration to meet long-term research and management objectives of USFWS.

### BIGHORN SHEEP GENETIC DIVERSITY AND STRUCTURE

Principal Investigator:	Lisette P. Waits
Student Investigator:	Nathan Borg, University of Montana
Collaborators:	Nez Perce Tribe, University of Montana
Funding Agency:	Idaho Department of Fish and Game
Completion Date:	20 August 2011



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### Objectives:

- Evaluate the genetic diversity and structure of the Salmon River population of bighorn sheep.
- Assess the genetic uniqueness of the Salmon River population.
- Evaluate gene flow and population structure within the Salmon River and between the Salmon River sheep and sheep in other drainages.

### Summary:

This is a collaborative project involving Idaho Fish and Game, University of Montana, Nez Perce Tribe and the USGS Montana Cooperative Research Unit. We are providing molecular genetics laboratory training for Nathan Borg, a Idaho Fish and Game employee and new MS student at the University of Montana. We have identified genetic samples for 100 sheep in the Salmon River drainage and over 300 sheep from adjacent populations. DNA has been extracted from all samples and we have selected the mitochondrial DNA sequence data and nuclear DNA microsatellite data from these samples. While funding has ended at the UI, the MS student Nate Borg is continuing the field work and data analyses for this project as part of

his thesis work. We have detected significant genetic structure across the region and have evidence for isolation by distance.

## **DISPERSAL PATTERNS AND PHILOPATRY IN RED-TAILED AND RED-SHOULDERED HAWKS**



Principal Investigator: J. Michael Scott  
Student Investigator: Peter Bloom  
Completion Date: June 2011

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### **Objectives:**

- Determine dispersal and philopatry in red-shouldered hawks and red-tailed hawks using historical records from banding and recovery.

### **Summary:**

This study of movement behavior of western red-tailed hawks (*Buteo jamaicensis calurus*) and western red-shouldered hawks (*B. lineatus elegans*) in southwestern California has its origins in my earlier detailed short-term movement study of home-range and habitat use of red-shouldered hawks (Bloom 1989, Bloom et al. 1993). From 1970 through 2009, I banded 5,271 red-tailed hawk and 2,742 red-shouldered hawk nestlings in southern California. I additionally analyzed records from the Bird Banding Laboratory from other red-tailed (n = 189) and red-shouldered (n = 127) hawks banded as nestlings in southern California from 1956 through 2009.

We examined the long distance travels resulting from vagrancy in red-shouldered hawks. We reported the results of a 40-year study of western Red-shouldered Hawks involving the banding of 2742 nestlings in southern California from 1970-2009 (this study), plus 127 nestlings banded in other California studies (1956-2008) and the analyses of 119 subsequent recovery records from the Bird Banding Laboratory (1957-2009). One hundred nine (91.6%) of the Red-shouldered Hawks recovered moved <100 km and were considered short-distance dispersers, while 10 (8.4%) moved >100 km and were considered long-distance dispersers. Three (2.5%), all long-distance dispersers, were vagrants (recovered outside the species range), and were found between 374 and 843 km northeast and south of their banding locations across portions of the Mojave, Great Basin and Viscaino Deserts. The distribution of short-distance dispersal directions was bimodal, closely corresponding with the northwestern-southeastern orientation of the species' range in southern California, while that of long-distance dispersers was mainly to the north. One of 10 long-distance dispersers, a non-vagrant, survived well into breeding age (103.0 months), whereas eight of the other nine perished before 14.5 months. The implications of vagrancy for conservation of this resident subspecies are that a relatively small source area can contribute genetic material over a vastly larger receiving area, but rarely does so because of high mortality rates. Nonetheless, movements of vagrants documented in this study provide evidence for the species' potential to populate new landscapes in response to changing environmental conditions and to maintain genetic heterogeneity within existing populations. The implications of vagrancy for conservation of this resident subspecies are that a relatively small source area can contribute genetic material over a vastly larger receiving area but rarely does so because of high mortality rates. Nonetheless, the movements of vagrants I documented

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provide evidence for the species' potential to populate new landscapes in response to changing environmental conditions and to maintain genetic heterogeneity within existing populations.

We examined the unusual migrations of red-tailed hawks with southern latitude origins. There were 1,534 recoveries of red-tailed hawks banded as nestlings from 1940 through 2009 in other parts of the USA (excluding Alaska and Puerto Rico) and Canada. We also equipped red-tailed hawks with platform transmitter terminals. Thirteen of 16 hawks equipped with Platform Transmitter Terminals (PTT) that survived for at least two months initiated their first northbound migration from southwestern California in summer, from late June to early August, about 4 – 10 weeks post-fledging and also exhibited the same generally northward movement (range 336-18°). Band recovery and PTT data revealed that individuals summered as far as northern Idaho and southwest Montana, a maximum distance of 1,462 km from their natal nest.

Finally, we examined the nuances and details of natal dispersal and philopatry as observed in both species. Specifically, we studied the distances, directions and potential sex bias of dispersing young red-tailed hawks and red-shouldered hawks. The results of a 40-year comparative study of natal dispersal in the sympatric Buteonine species, the western red-tailed hawk, a habitat generalist, and the western red-shouldered hawk, a habitat specialist are compared. Many individuals selected their own nests in close proximity to where they were hatched. In the case of red-tailed hawks, 24.7% were recaptured in the same territory as banded and 97.5 % were found within 10 home range diameters. Ten percent of red-shouldered hawk recaptures were from the same territory as banded and 82.2% were recaptured within 10 home range diameters. No sex biased dispersal was found in the two species.

### **HOW IS RECOVERY DEFINED BY THE NUMBERS?**

Principal Investigator:	J. Michael Scott
Cooperators:	Dale Goble U I School of Law Maile Neel, University of Maryland Aaron Haines
Completion Date:	January 2011

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#### **Objectives:**

- Evaluate the percentage of recovery units considered to have potential to be delisted.
- Determine the percentage of recovery units have quantitative criteria for delisting.
- Compare how abundances required for delisting compare to those reported historically at the time of listing and writing of recovery plans with abundance thresholds suggested in the literature.
- Determine how abundance values for delisted species compare to these values.
- Evaluate how abundances required for recovery differ between threatened and endangered species.

#### **Summary:**

This project has completed with a manuscript in press.

## IMPACTS OF FENCES ON GREATER SAGE-GROUSE: COLLISION, MITIGATION, AND SPATIAL ECOLOGY

Principal Investigator: Kerry Reese  
Student Investigator: Bryan Stevens  
Funding Agencies: Idaho Department of Fish and Game, and U.S. Bureau of Land Management  
Completion Date: 30 June 2011



### Objectives:

- Estimate collision rates of sage-grouse with fences on study areas in breeding habitats.
- Estimate carcass and collision sign detectability and longevity in sagebrush-steppe habitats.
- Evaluate the effectiveness of fence marking as a mitigation method to reduce collision rates in high risk areas.

### Summary:

Conservation concerns over greater sage-grouse (*Centrocercus urophasianus*; hereafter sage-grouse) have drawn attention to the lack of empirical data on impacts of fences on this species. Research suggests grouse as a group may be vulnerable to collision with anthropogenic infrastructure, and sage-grouse fence collision risk has not been systematically studied in any part of their range. Therefore, we studied sage-grouse fence collision on Idaho breeding areas during spring of 2009 and 2010. We sampled fences within breeding areas to quantify relative collision frequency across the landscape, and conducted field experiments to quantify fence sampling biases and effectiveness of fence marking mitigation methods.

Female ring-necked pheasant (*Phasianus colchicus*) carcasses were used as surrogates for sage-grouse to study survival and detection bias associated with avian fence collision surveys in sagebrush steppe during spring 2009. We randomly placed 50 pheasant carcasses on each of 2 study areas, estimated detection probability during fence-line surveys, and monitored survival and retention of carcasses and their sign over a 31-day period. Survival modeling suggested site and habitat features had little impact on carcass survival, and rapid scavenging resulted in estimated daily survival probabilities that ranged from 0.776-0.812. Survival of all carcass sign varied by location, and daily survival probabilities ranged from 0.863-0.988. Detection probability of carcasses during fence-line surveys was influenced by habitat type and microsite shrub height at the carcass location. Carcasses located in big sagebrush (*Artemisia tridentata*) habitats were detected at a lower rate (0.36) than carcasses in little (*A. arbuscula*) and black sagebrush (*A. nova*) habitats (0.71), and increasing shrub height reduced detection probability. Avian fence collision surveys in sagebrush-steppe should be conducted at  $\leq 2$ -week sampling intervals to reduce the impact of sign-survival bias on collision rate estimates. Researchers should be aware that local vegetation influences detection probabilities, and apply methods to correct for detection probabilities to ensure accurate collision estimates.

We used a stratified cluster sampling design to sample fences in breeding areas (2009:  $n = 16$ ; 2010:  $n = 14$ ), quantify fence collision frequency, and estimate fence collision rates across the landscape. We found 86 sage-grouse collisions over 2 field seasons, and found evidence for spatial variation in fence collision rates across sampling areas (2009: range = 0-5.42 strikes/km;

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2010: range = 0-2.63 strikes/km). Despite variation among sites, landscape scale sage-grouse fence collision rates corrected for detectability were consistent across years (2009: = 0.70 strikes/km; 2010: = 0.75 strikes/km). These data suggest sage-grouse fence collision during the breeding season was relatively common and widespread, and corroborate previous studies suggesting grouse are susceptible to infrastructure collision. We collected site-scale data at random and collision fence points, quantified broad-scale attributes of sampling areas using geographic information systems (GIS), and modeled the influence of site and broad-scale features on sage-grouse fence collision. Discrimination between random and collision fence points using site-scale data suggested collision was influenced by technical attributes of the fences. Collisions were more common on fence segments bound by steel t-post and > 4 m wide, whereas random points were more common on segments with  $\geq 1$  wooden fence post and widths < 4 m. Broad-scale modeling suggested probability of collision was influenced by region, topography, and fence density. Probability of collision presence was greater in the Big Desert and Upper Snake regions, and lower in the Magic Valley. Increasing terrain ruggedness reduced probability of collision presence, whereas increasing fence length per km<sup>2</sup> increased probability of collision. Broad-scale modeling also suggested collision counts per km<sup>2</sup> were influenced by distance to nearest active sage-grouse lek, where increasing distance reduced expected collision counts. These data suggest 2 km mitigation buffers around leks in high risk areas may be necessary. However, increasing topographic variation appeared to attenuate the influence of other factors, suggesting high risk areas are most likely at relatively flat sites.

We also conducted a field experiment testing effectiveness of fence marking at reducing sage-grouse collision on high risk breeding areas during spring of 2010. Using 8 study sites, we experimentally marked 3, 500-m segments of fence at each site using reflective-vinyl markers, with 3, 500-m unmarked control segments at each site, and surveyed study segments 5 times during the lekking season. Modeling suggested collision count summed over the lekking season was influenced by marking treatment, lek size, and distance to nearest lek. The top model predicted marking reduced collision counts by 74.0% at the mean lek size and distance from lek. Increasing lek size and decreasing distance to lek increased expected collision counts. Although fence marking reduced sage-grouse collision risk, expected collision counts in high risk areas (i.e., maximum lek size = 127, minimum distance = 104 m) were high (unmarked fence = 8.3 birds/500 m/season, marked fence = 2.2 birds/500 m/season), suggesting these fences may require removal to eliminate collisions. Further, expected collision counts in low risk areas (i.e., minimum lek size = 1, maximum distance = 4,650 m) were very low (unmarked fence = 0.08 birds/500 m/season, marked fence = 0.02 birds/500 m/season), suggesting not all fences require marking mitigation efforts.

## **EVALUATION OF ASSISTED MIGRATION AS A POTENTIAL CLIMATE CHANGE ADAPTATION TOOL FOR ENDANGERED SPECIES**

Principal Investigator: J. Michael Scott  
Post-doctoral Researcher: Katherine Strickler  
Collaborating Agency: U.S. Fish and Wildlife Service  
Funding Agency: USGS – RWO 149  
Completion Date: 19 August 2011

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### **Objectives:**

- Evaluate species translocations that have been conducted to determine factors that best predict failure or success.
- Develop recommendations regarding specific factors for decision makers to consider with regard to assisted colonization as a climate change adaptation tool.

### **Summary:**

Managed relocation, also known as assisted colonization or assisted migration, is described as the intentional movement of individuals or propagules into areas where they do not currently occur. It is being considered as one possible option for landscape-scale approaches to addressing the impacts of climate change. However, prior experience with human-facilitated translocation of species from one location to another has had mixed results. In this study we evaluated and interpreted past translocations to determine how effective have they been, and what characteristics of the species or the translocation effort best predict its success.

We conducted a detailed analysis of 192 species translocations to identify determinants of initial success and implications for future managed relocation efforts. We focused our analysis on species that are or were federally listed as threatened or endangered. We found that initial establishment was more likely with increasing numbers of individuals released, though relatively high success rates have been achieved with relatively small numbers, particularly for listed plant species. For animals, translocations of omnivores tended to more successful than those for herbivores or carnivores. For plants, initial establishment was associated with the number and duration of translocation events. The location of the translocation relative to the species' historical range did not appear to influence translocation success, which has implications for managed relocations of imperiled species outside of their native biogeographic ranges. We will continue to use these findings to develop a recommended decision support tool to help inform and guide decisions related to questions about managed relocation.

**LINKING CONSERVATION ACTIONS WITH POPULATION VIABILITY MODELS:  
REDUCING UNCERTAINTY TO BETTER PREDICT  
MANAGEMENT EFFECTS ON VIABILITY**

Principal Investigators: Kerry P. Reese  
J. Michael Scott  
E. O. (Oz) Garton  
Scott Mills, University of  
Post-doctoral Investigators: Jon Horne  
Katherine Strickler  
Collaborators: U. S. Department of Defense  
Funding Agency: USGS – RWO 143  
Completion Date: 31 December 2010



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**Objectives:**

The overall objective of this program was to develop a set of models and methods for prioritizing management of threatened, endangered, and at-risk species. Specifically, we sought to develop tools for evaluating effects of management on population viability using varying levels of data: 1) life history data when little is known about a species, 2) count data when only estimates of abundance through time are available, and 3) metapopulation models when we have a lot of demographic data about multiple populations.

**Summary:**

We first constructed a framework based on structured population models that can be used to evaluate possible effects of management actions on population growth rates for data-poor species. We demonstrated this approach with the arroyo toad. We then used time series of count data to fit stochastic models of population growth and assess population trend or viability, and applied the approach to evaluate extinction risk for greater sage-grouse at Yakima Training Center. For species with detailed information about vital rates, spatial structure, and metapopulation characteristics, we developed methods for conducting global sensitivity analyses of viability models for multiple populations. We demonstrated these methods using a pilot conservation incentive program for golden-cheeked warblers at Fort Hood. Finally, we combined time-series abundance estimates for multiple populations to evaluate probability of persistence for Sonoran pronghorn at Barry M. Goldwater Range.

We demonstrated that arroyo toad population growth rates are highly dependent on survival of toads during their terrestrial life stages. We also illustrated the strong effect of parameter uncertainty on population persistence estimates. We next applied a set of population growth models to the greater sage-grouse population at Yakima Training Center and showed that the population growth rate is negatively influenced by drought and increasing area of grassland habitat. Overall, the probability of this population dropping below an extinction threshold of 50 lekking males was high under the best growth models. In demonstrating our approach for applying sensitivity analyses to metapopulation models for golden-cheeked warblers, we found that uncertainty in model structure and parameter estimates made it impossible to develop general guidelines for valuing habitat patches, but we identified parameters that need to be targeted in future research. Using time-series estimates of abundance for multiple populations, we estimated the probability of persistence for Sonoran pronghorn under three management

scenarios and showed a clear and substantial benefit to supplementing the wild population with individuals from the captive population at Cabeza Prieta National Wildlife Refuge.

## **PREDICTING THE ATTENDANCE PROBABILITY OF GREATER SAGE-GROUSE AT LEK SITES IN IDAHO**



Principal Investigator: Kerry Reese  
Student Investigator: Jeremy Baumgardt  
Funding Agency: Idaho Department of Fish and Game  
Completion Date: 30 June 2010

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### **Objectives:**

- Estimate the probability of birds attending leks and the probability of detecting attending birds during a lek route count.
- Estimate survival of nests and survival of yearling and adult birds.

### **Summary:**

Proper management of wildlife requires accurate assessments of populations. Often, actual estimates of abundance are difficult and adequate information can be acquired more efficiently through the use of population indices. Indices, however, rely on the assumption that they are proportional to the population. Recently, populations of greater sage-grouse (*Centrocercus urophasianus*) have been declining, resulting in the designation of the “warranted, but precluded” status under the Endangered Species Act, and necessitating careful assessment at the population level. Breeding populations of sage-grouse are typically indexed from the number of males attending groups of breeding sites; however, assumptions of this index have not been verified.

I investigated visibility bias of sage-grouse on leks to identify variables that affect sightability of grouse during lek counts. To test for inconsistencies in the relationship between the index and population abundance, I modeled the probability of individuals attending leks, including year-specific covariates. By correcting lek counts for sightability and attendance probabilities, I generated abundance estimates that I used to examine the proportionality of the index to the population estimates. To relate estimates of male abundance to that of females, I developed a method for estimating sex ratio from DNA analysis of noninvasive genetic fecal samples. I used regular detections of radio-marked male and female sage-grouse to estimate monthly survival probabilities and monitored hens during the nesting season to estimate nest survival.

I found that sightability of male sage-grouse on leks was influenced by lighting conditions, lek characteristics, and factors that appeared to influence the level of activity of attending males. The probability of attending leks varied among years and appeared to be tied to winter severity. These results suggest contemporary methods for monitoring sage-grouse populations have limited power to detect modest population changes. Accounting for visibility bias in lek counts did result in improved correlation with the population abundance; however, accounting for variation in lek attendance due to winter severity would strengthen underlying assumptions and improve the reliability of lek-based indices. Manuscripts of these results are in preparation.

## RED WOLF MICROSATELLITE GENETICS AND HABITAT USE PROGRAM



Principal Investigator: Lisette P. Waits  
Student Investigator: Justin Bohling  
Collaborator: USFWS  
Funding Agency: USGS – RWO - 129  
Completion Date: 30 June 2011

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### Objectives:

- Determine the genetic identity and ancestry of all puppies, captured animals, and fecal samples collected in the Red Wolf Experimental Population Area.
- Complete a scat survey the area immediately adjacent to the Experimental Population Area to determine if any red wolves or red wolf hybrids are present.
- Evaluate the genetic consequences of red wolves dispersing from the Red Wolf Experimental Population Area.
- Use USFWS field data to evaluate proximate causes of red wolf/coyote hybridization events.
- Conduct genetic identification of scats used for red wolf and coyote diet study.

### Summary:

In the winter of 2010 we conducted a scat survey in the region directly outside the Red Wolf Experimental Population Area to search for red wolves or red wolf coyote hybrids. We collected 500 scats along approximately 650 km of roads and are currently in the process of analyzing the results through genetic analysis. 245 of these scats have been identified as belong to *Canis* species using an mtDNA species identification test. This study has provided insights into the patterns of red wolf-coyote hybridization where the two species population come into contact and exist at low densities (Bohling and Waits 2011).

In the spring of 2010, 47 puppies were captured, 39 of which were identified as red wolves and 8 as F1 red wolf-coyote hybrids. From 2009-2011, 36 additional unknown adult canids were captured by the USFWS, 26 of which were identified as coyotes, 4 as F1 hybrids, and 6 as red wolves. We have also tested several computational techniques for evaluating hybridization using genetic data. Using 17 microsatellite loci, we compared the known ancestry to values estimated using BAPS and STRUCTURE. We found that both programs had high power to detect F1 hybrids, but both methods had difficulty distinguishing later generation backcrosses from pure individuals. Our results suggest that these programs are useful for distinguishing early generational hybrids, but may struggle to accurately detect backcrosses using a moderate number of loci.

We also conducted a review of field and genetic data from 2002-2009 to elucidate the factors that may have influenced hybridization events between red wolves and coyotes. We found that hybridization events were bidirectional, with both male and female wolves breeding with coyotes. We also found that hybrid litters compared to red wolf litters were produced by younger female wolves breeding that were more likely to be breeding for the first time. Of the 17 documented hybridization events, six occurred after a breeding red wolf pair was disrupted by gunshot mortality while an additional two pairs were disrupted by other human activities

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(trapping and poison). Justin Bohling completed his PhD in May 2011 and we have published one manuscript from this work and submitted one other.



Bonnie Woods and captive pygmy rabbit at Washington State University lab.

## **Awards, Publications, Service and Other Activities of Unit and Unit Collaborating Scientists and Students 1 October 2010 – 29 February 2012**

### **HONORS AND AWARDS**

*Justin Bohling*

Outstanding Wildlife Graduate Student, April 2011

*Jessica Buelow*

Outstanding graduate student in Fishery Resources program 2011-2012.

*Tim Caldwell*

University of Idaho Alumni Award of Excellence, December 2010

*Courtney Conway*

Top-cited Paper Award from the Association of Field Ornithologists. 2010.

Outstanding Course Award. School of Natural Resources and the Environment, University of Arizona, 2010.

Outstanding Student Paper Award, Organization for Tropical Studies (OTS), for a dissertation chapter published in *Evolutionary Ecology* (co-author with former graduate student, W. A. Boyle)

Best Student Presentation Award 2010, 7th International Conference on Applications of Stable Isotope Techniques to Ecological Studies, Fairbanks, AK (co-author with graduate student, A. Macias-Duarte)

Best Student Presentation Award 2010, Annual Meeting of the American Ornithologists' Union, San Diego, CA (co-author with graduate student, K. Borgmann)

*Christine Moffitt*

Columbia River Intertribal Fish Commission. 2012. Recognition of outstanding partnership and collaboration with tribal entities. Presented to the University of Idaho in recognition of the Moffitt laboratory collaborations.

USGS Performance Award. 2011. For maintaining active research, teaching and outreach programs. November 2012

USGS Star Award for Outstanding Mentoring and Unit Support. September 2011

Outstanding Faculty Member in Environmental Science. University of Idaho. May 2011.

Outstanding Advisor 2010-2011. College of Natural Resources, April 2011

University of Idaho, Virginia Wolf Distinguished Service Award – Faculty. For continuous dedication to activism for gender justice.

USGS, Performance Award. 2010. For maintaining active research and outreach programs. November 2010.

*Zachary L. Penney*

Delpha C. and Robert W. Colby Scholarship

Theresa A. Mike Memorial Scholarship

*Michael C. Quist*

Best Student Paper Award, Honorable Mention, 141<sup>st</sup> Annual Meeting of the American Fisheries Society (co-author with graduate student, A. R. Sindt)

- Best Student Paper Award, Annual Meeting of the Iowa Chapter of the American Fisheries Society, joint meeting with The Wildlife Society (co-author with graduate student, A. R. Sindt)
- Best Student (Poster) Award, Annual Meeting of the Iowa Chapter of the American Fisheries Society, joint meeting with The Wildlife Society (co-author with graduate student, J. R. Fischer)
- USGS, Performance Award, 2010. For maintaining active research and outreach programs. November 2010.
- USGS, Performance Award, 2011. For maintaining active research and outreach programs. November 2011.

*J. Michael Scott*

- University of Idaho, Distinguished Professor, April 2011  
Charles E. Harris Professional Wildlife Award, Idaho Chapter of the Wildlife Society.

*Lisette Waits*

- Interdisciplinary Research Team Excellence Award, University of Idaho

*Frank Wilhelm*

- Alumni Award of Excellence for mentoring Tim Caldwell, December 2010.

## **PEER REVIEWED PUBLICATIONS FROM COOP RESEARCH ACTIVITIES**

- Adams, J.R., C.S. Goldberg, W.R. Bosworth, J.L. Rachlow, L.P. Waits. 2011. Rapid species identification of pygmy rabbits (*Brachylagus idahoensis*) from fecal pellet DNA. *Molecular Ecology Resources* 11:808-812.
- Anlauf, K. A., and C. M. Moffitt. 2010. Modeling of landscape variables at multiple extents to predict fine sediments and suitable habitat for *Tubifex tubifex* in a stream system. *Freshwater Biology* 55:794–805.
- Ausband, D.E., J. Young, B. Fannin, M.S. Mitchell, J.L. Stenglein, L.P. Waits, J.A. Shivik. 2011. Hair of the dog: obtaining samples from coyotes and wolves noninvasively. *Wildlife Society Bulletin* 35:105-111.
- Bartok, N., and C. J. Conway. 2010. Factors affecting the presence of nesting burrowing owls in an agricultural landscape. *Journal of Raptor Research* 44:286-293.
- Bisping, S. M., M. C. Quist, J. R. Fischer, and A. J. Schaefer. 2010. Population characteristics of central stonerollers in Iowa streams. *Prairie Naturalist* 42:109-115.
- Bloom, P. H. J. M. Scott, J. M. Papp, S.E Thomas and J.W. Kidd. 2011. Vagrant western red-shouldered hawks: origins, natal dispersal patterns and survival. *Condor* 113: 538-546.
- Bohling JM, and LP Waits. 2011. Assessing the prevalence of hybridization between sympatric *Canis* species in a region surrounding the red wolf (*Canis rufus*) recovery area in North Carolina. *Molecular Ecology* 20: 2142-2156.
- Bower, M. R., D. B. Gaines, K. P. Wilson, J. G. Wullschleger, M. C. Dzul, M. C. Quist, and S. J. Dinsmore. 2011. Accuracy and precision of visual estimates and photogrammetric measurements of the length of a small-bodied fish. *North American Journal of Fisheries Management* 31:138-143.
- Boyle, W. A., C. J. Conway, and J. L. Bronstein. 2011. Why do some, but not all, tropical birds migrate? A comparative study of diet breadth and fruit preference. *Evolutionary Ecology* 25:219-236.

- Bruce, R. L., and C. M. Moffitt. 2010. Quantifying risks of volitional consumption of New Zealand mudsnails by steelhead and rainbow trout. *Aquaculture Research* 41:552-558.
- Caldwell, T. J., and Wilhelm, F. M. 2011. The life history characteristics, growth and density of *Mysis diluviana* in Lake Pend Oreille, Idaho, USA. *Journal of Great Lakes Research*. 37:doi:10.1016/j.jglr.2011.07.010.
- Conway, C. J. 2011. Standardized North American marsh bird monitoring protocol. *Waterbirds* 34:319-346.
- Conway, C. J., and J. P. Gibbs. 2011. Summary of intrinsic and extrinsic factors affecting detection probability of marsh birds. *Wetlands* 31:403-411.
- Conway, C. J., and C. P. Nadeau. 2010. The effects of conspecific and heterospecific call-broadcast on detection probability of marsh birds in North America. *Wetlands* 30:358-368.
- Conway, C. J., C. P. Nadeau, and L. Piest. 2010. Fire helps restore natural disturbance regime to benefit rare and endangered marsh birds endemic to Colorado River. *Ecological Applications* 20:2024-2035.
- Conway, M., C. J. Conway, and C. P. Nadeau. In press. Intraspecific variation in reproductive traits of burrowing owls. *Journal of Ethology*.
- Cox, B. S., A. M. Dux, M. C. Quist, and C. S. Guy. In press. Use of a seismic air gun to reduce survival of nonnative lake trout embryos: a tool for conservation? *North American Journal of Fisheries Management*.
- Decker, K., C. J. Conway, and J. J. Fontaine. 2012. Nest predation, food, and female age explain seasonal declines in clutch size. *Evolutionary Ecology* 26: in press.
- Dellinger, J. A., T. D. Steury, B. L. Ortman, J. Bohling, and L. P. Waits. 2011 Food habits of red wolves (*Canis rufus*) during pup-rearing season. *Southeastern Naturalist* 10:731-740.
- Dzul, M. C., D. B. Gaines, J. R. Fischer, M. C. Quist, and S. J. Dinsmore. In press. Evaluation of Salt Creek pupfish (*Cyprinodon salinus salinus*) otoliths for use in age and growth analyses. *Southwestern Naturalist*.
- Dzul, M. C., M. C. Quist, S. J. Dinsmore, P. M. Dixon, and M. R. Bower. In press. Identifying sources of error in surveys of Devils Hole pupfish. *Southwestern Naturalist*.
- Dzul, M. C., P. M. Dixon, M. C. Quist, S. J. Dinsmore, M. R. Bower, K. P. Wilson, and D. B. Gaines. In press. Using variance components to estimate power in a hierarchically nested sampling design: improving monitoring of larval Devils Hole pupfish. *Environmental Monitoring and Assessment*.
- Fleishman, E., D.E Sutherland, D. A. Blockstein, J.A. Hall M.B Mascia, MA. Rudd J.M. Scott et al. 2011. Top 40 priorities for science to inform US conservation and management policy. *BioScience* 61: 290-300.
- Fischer, J. R., T. E. Neebling, and M. C. Quist. 2012. Development and evaluation of a boat-mounted RFID antenna for monitoring freshwater mussels. *Freshwater Science* 31:148-153.
- Fischer, J. R., M. C. Quist, S. L. Wigen, A. J. Schaefer, T. W. Stewart, and T. M. Isenhardt. 2010. Assemblage and population level responses of stream fish to riparian buffers at multiple spatial scales. *Transactions of the American Fisheries Society* 139:185-200.
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- Holroyd, G., C. J. Conway, and H. Trefry. 2011. Breeding Dispersal of a Burrowing Owl from Arizona to Saskatchewan. *Wilson Journal of Ornithology* 123:378-381.
- Jackson, Z. J., M. C. Quist, J. A. Downing, and J. G. Larscheid. 2010. Common carp (*Cyprinus carpio*), sport fishes, and water quality: ecological thresholds in agriculturally eutrophic lakes. *Lake and Reservoir Management* 26:14-22.
- James, C. and C. M. Moffitt. 2012. Seasonal dynamics of *Potamopyrgus antipodarum* infestations in a heavily used recreational watershed in intermountain North America. *Aquatic Invasions*. Doi: 10.3391/ai.2012.
- Johnson, E.L., T.S. Clabough, C.A. Peery, C.C. Caudill, M.L. Keefer, and M.C. Richmond. 2010. Migration depths of adult steelhead (*Oncorhynchus mykiss*) in relation to dissolved gas supersaturation in a regulated river system. *Journal of Fish Biology* 76: 1520-1528.
- Keefer, M.L., G.A. Taylor, D.F. Garletts, G.A. Gauthier, T.M. Pierce, and C.C. Caudill. 2010. Prespawn mortality in adult spring Chinook salmon outplanted above barriers dams. *Ecology of Freshwater Fish* 19: 361-372.
- Kirkpatrick, C., and C. J. Conway. 2010. Importance of montane riparian forest and influence of wildfire on nest-site selection of ground-nesting birds. *Journal of Wildlife Management* 74:729-738.
- Kirkpatrick, C., and C. J. Conway. 2010. Nest predators of ground-nesting birds in montane forests of the Santa Catalina Mountains, Arizona. *Wilson Journal of Ornithology* 122:614-617.
- Koch, J. D., and M. C. Quist. 2010. Current status and trends in shovelnose sturgeon (*Scaphirhynchus platyrhynchus*) management and conservation. *Journal of Applied Ichthyology* 26:491-498.
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## **THESES AND DISSERTATIONS**

- Barron, J. M. 2011. Development and evaluation of larval and juvenile rearing techniques and systems for burbot (*Lota lota maculosa*) to meet conservation aquaculture needs. MS Thesis. K. D. Cain, major professor.
- Baumgardt, J. A. 2011. Probability of attendance and sightability of greater sage grouse on leks: relating lek-based indices to population abundance. Ph.D. Dissertation. K. P. Reese and O. Garton, Major Professors.
- Bloom, Peter. 2011. Dispersal patterns and Philopatry in red-tailed and red shouldered hawks. Ph.D. Dissertation. University of Idaho. J. M. Scott, major professor.
- Bohling, J. H. 2011. Exploring patterns and mechanisms of red wolf (*Canis rufus*) hybridization in North Carolina. PhD Dissertation, University of Idaho. L. P. Waits, major professor.
- Borgmann, K. L. 2010. Mechanisms underlying intra-seasonal variation in the risk of avian nest predation: implications for breeding phenology. Ph.D. Dissertation. University of Arizona. C. Conway, major professor.
- Buelow, Jessica. 2011. Physiological and physical characteristics of steelhead kelts (*Oncorhynchus mykiss*) from the Snake River, captured at Lower Granite Dam. M.S. Thesis, C. M. Moffitt, major professor.

- Caldwell, T. J. 2010. The role of the non-native freshwater opossum shrimp *Mysis diluviana*, in the nutrient and food web dynamics of Lake Pend Oreille, Idaho. M.S. Thesis, University of Idaho, Moscow Idaho. F. Wilhelm, major professor.
- Dzul, M. C. 2011. Population ecology and monitoring of the endangered Devils Hole pupfish. M.S. thesis, Iowa State University. M. C. Quist, major professor.
- Hartson, R. 2010. A comparative analysis of habitat and juvenile steelhead (*Oncorhynchus mykiss*) demographics in an altered watershed. MS Thesis, B. Kennedy major professor.
- Holecek, D. 2010. Life history characteristics and status of an impounded, adfluvial redband trout population in the Weiser River Drainage, Idaho. Master's thesis. D. Scarnecchia, major professor.
- McIlraith, B.J. 2011. The adult migration, spatial distribution, and spawning behaviors of anadromous Pacific lamprey (*Lampetra tridentata*) in the lower Snake River. MSc Thesis, Department of Fish and Wildlife Resources, University of Idaho, Moscow, ID. C. Caudill, major professor.
- Macías-Duarte, A. 2011. Change in Migratory Behavior as a Possible Explanation of Burrowing Owl Population Declines in Northern Latitudes. Ph.D. Dissertation. University of Arizona. C. Conway, major professor.
- Sindt, A. R. 2011. Fish species of greatest conservation need in wadeable Iowa streams—status, habitat associations, and effectiveness of species distribution models. M.S. thesis, Iowa State University. M. C. Quist, major professor.
- Stockton, K. 2011. Methods to assess, control, and manage risks for two invasive mollusks in fish hatcheries. MS Thesis, C. M. Moffitt, major professor.
- Stevens, B. S. 2011. Impacts of fences on greater sage grouse in Idaho: collision, mitigation and spatial ecology. MS Thesis, University of Idaho. K. P Reese, major professor.
- Zaroban, Donald. 2011. Occurrence habitat associations and conservation for the Wood River Sculpin (*Cottus leipomus*). Ph.D. Dissertation. University of Idaho. J. Michael Scott, major professor.

## **POSTERS AND PAPERS PRESENTED AT MEETINGS BY STUDENTS, STAFF AND FACULTY SUPPORTED THROUGH THE COOPERATIVE RESEARCH UNIT**

\* indicates presenter

- Bakevich, B.\*, C. L. Pierce, and M. C. Quist. 2011. Distribution and habitat associations of Topeka shiners in west-central Iowa. 72<sup>nd</sup> Annual Midwest Fish and Wildlife Conference, Des Moines, Iowa, December 6.
- Bakevich, B.\*, C. L. Pierce, and M. C. Quist. 2011. Distribution and habitat associations of Topeka shiners in west-central Iowa. 141<sup>st</sup> Annual Meeting of the American Fisheries Society, Seattle, Washington, September 7.
- Bakevich, B. D.\*, C. L. Pierce, and M. C. Quist. 2011. Distribution and abundance of Topeka shiners in west-central Iowa. 4<sup>th</sup> Annual North Central Division Student Fisheries Colloquium, Brookings, South Dakota, January 22.
- Bakevich, B. D.\*, C. L. Pierce, and M. C. Quist. 2011. Distribution and abundance of Topeka shiners in west-central Iowa. Joint meeting of the Iowa Chapters of the American Fisheries Society and Wildlife Society, Moravia, Iowa, January 20.

- Bakevich, B. D.\*, M. C. Quist, and C. L. Pierce. 2010. Distribution and abundance of Topeka shiners in west-central Iowa streams. 71<sup>st</sup> Annual Midwest Fish and Wildlife Conference, Minneapolis, Minnesota, December 15.
- Beeman, J., C.C. Caudill, M.A. Jepson, E.L. Johnson, and M.L. Keefer. 2011. Look out below: juvenile passage operations at Columbia and Snake river dams can slow adult upstream passage. 2011 Oregon Chapter of the American Fisheries Society.
- Benda, S.\*, C.S. Schreck, M. Kent, R. Chitwood, V. Watal, C.C. Caudill, and R. Mann. 2011. Prespawn mortality in spring Chinook salmon in the Upper Willamette River: potential causes and management strategies. 141<sup>st</sup> Annual Meeting of the American Fisheries Society, Seattle, WA.
- Borgmann, K. L\*., C. J. Conway, and M. L. Morrison. 2010. The relationship between avian breeding phenology and the risk of nest predation: from patterns to causal mechanisms. Invited presentation at a special symposium titled “Advancing Climate Science For Wildlife Management: From Impacts And Uncertainty To Decisions”, 17th Annual Conference of The Wildlife Society, Snowbird, Utah, 5 Oct 2010.
- Bourret, S.\*, C.C. Caudill, B.P. Kennedy, and L. Borgerson. 2011. Feasibility of using otolith and scale techniques to characterize life history variation of spring Chinook salmon in the Willamette Valley. 141<sup>st</sup> Annual Meeting of the American Fisheries Society, Seattle, WA.
- Bower, M. R.\*, D. B. Gaines, K. P. Wilson, J. G. Wullschleger, M. C. Dzul, M. C. Quist, and S. J. Dinsmore. Use of diver visual estimates and photogrammetric measurements from a stereo-video camera for determining length of a small-bodied fish. 141<sup>st</sup> Annual Meeting of the American Fisheries Society, Seattle, Washington, September 5.
- Buelow, J.\* C. Moffitt, Z. Penney, K. Hamilton, A. Pape, B. Jones. 2011. Physiological characteristics of steelhead kelts in the Snake River, Idaho. Idaho Chapter AFS Annual Meeting, Boise, ID. March.
- Buelow, J.\*, C. M. Moffitt, Z. Penney, K. Hamilton, A. Pape, and B. Jones. 2011. Physiological characteristics of migrating steelhead trout kelts from the Snake River system. 142<sup>nd</sup> Annual Meeting, American Fisheries Society, Seattle, WA. 4 – 8 September.
- Caldwell, T. J.\* and Wilhelm, F.M. 2011. The role of the opossum shrimp (*Mysis diluviana*) in the food web of Lake Pend Oreille, a large (380 km<sup>2</sup>) and deep (>350 m) oligotrophic lake in Northern Idaho, USA. 31<sup>st</sup> Annual meeting of the North American Lakes Management Society. Spokane, Washington, USA. October 25-28. (Oral)
- Cajas-Cano\*, L., and C. M. Moffitt. 2010. (poster) Life cycle assessment to simulate the benefits of integration of mussels in aquaculture. Life Cycle Assessment X, Portland, Oregon. Nov. 2-4, 2010.
- Caldwell, T. J.\*, and Wilhelm, F. M. The role of *Mysis diluviana* in the nutrient dynamics of Lake Pend Oreille. Lake Pend Oreille Task Force meeting, Sandpoint, ID, USA. November 04.
- Caudill, C.C. 2011. Assessing migration success in altered river corridors. 141<sup>st</sup> Annual Meeting of the American Fisheries Society, Seattle, WA.
- Caudill, C.C. 2001. Migration syndromes and “success” in migratory fishes. National Conference on Engineering and Ecohydrology for Fish Passage, Amherst, MA.
- Caudill, C.C., M. Keefer, and M. Moser. 2010. Estimating upstream passage metrics and performance in Pacific lamprey: overview and patterns from the Columbia River

- Hydrosystem. 2010 USACE Anadromous Fish Evaluation Program Annual Review, Portland, OR.
- Caudill, C.C., M. Jepson, T. Clabough, M. Keefer, and B.J. Burke. 2010. Evaluation of Adult Spring–Summer Chinook Salmon Passage at Lower Columbia River Dams, 2010. 2010 USACE Anadromous Fish Evaluation Program Annual Review, Portland, OR.
- Caudill, C.C., G. Naughton, D. Joosten, T. Clabough, E. Johnson, S. Lee, and C. Noyes\*. 2010. Evaluation of adult Pacific lamprey behavior in Columbia River reservoirs using the Juvenile Salmon Acoustic Telemetry (JSATS) system, 2010. 2010 USACE Anadromous Fish Evaluation Program Annual Review, Portland, OR.
- Conway, C. J\*. 2011. Effects of land-use and management actions on game and nongame birds. Seminar, Idaho Fish and Game Department, Boise, ID. 8 June 2011.
- Conway, C. J\*. 2011. Effects of land-use and management actions on game and nongame birds. Departmental Seminar, Department of Fish & Wildlife Resources, University of Idaho, Moscow, ID. 6 June 2011.
- Conway, C. J\*. 2011. Effects of land-use on migratory behavior and abundance of nongame birds. Departmental Seminar, University of Wyoming, Laramie, WY. 20 April 2011.
- Conway, C. J\*. 2012. Comparative Demography of Burrowing Owl Populations in North America. Idaho TWS Conference, Boise, ID. 6 March 2012.
- Conway, C. J\*. 2012. Comparative Demography of Burrowing Owl Populations in North America. Symposium on Society for Range Management Annual Conference, Spokane, WA. 30 January 2012.
- Conway, C. J\*. 2011. Overlaying research and monitoring to inform management of Yuma Clapper Rails and other marsh birds along the Lower Colorado River. Monitoring Marsh Birds for Sound Conservation and Management Decisions at Multiple Scales. Mobile, AL. 13 December 2011.
- Conway, C. J\*. 2011. Effects of land-use and management actions on game and nongame birds. Seminar, Idaho Fish and Game Department, Boise, ID. 8 June 2011.
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- Conway, C. J\*. 2011. Effects of land-use on migratory behavior and abundance of nongame birds. Departmental Seminar, University of Wyoming, Laramie, WY. 20 April 2011.
- Conway, C. J\*. Ecology and Natural History of Marsh Birds. Arizona Riparian Council. Yuma, AZ, 18 Mar 2011.
- Conway, C. J\*., D. LaRoche, C. Kirkpatrick, and D. Swann. 2011. Effects of drought and groundwater withdrawal on birds, vegetation, and invertebrates within desert riparian woodlands in southeastern Arizona. 44th Joint Annual Meeting of the Arizona-New Mexico Chapter of The Wildlife Society. Pinetop, AZ, 4 Feb 2011.
- Conway, C.J\*. 2010. National Wildlife Refuge System Participation in a National Marsh Bird Monitoring Program. Review of the USFWS-USGS Refuge Cooperative Research Program (RCRP). La Crosse, WI, 13 Oct 2010.
- Conway, C.J\*., D. LaRoche, C. Kirkpatrick, and D. Swann. 2010. Effects of drought on abundance and diversity of birds along Rincon Creek, Saguaro National Park. Special Symposium entitled “How might climate change affect Saguaro National Park?” Tucson, Arizona, 2 Oct 2010.

- Conway, C. J\*., and M. S. Ogonowski. 2010. Partial migration in birds: a test of 4 hypotheses with Burrowing owls. International Symposium: The Ecology and Evolution of Partial Migration, Lund, Sweden, 2010.
- Cox, B. S.\*, A. M. Dux, M. C. Quist, and C. S. Guy. 2011. Use of a seismic air gun to reduce survival of salmonid embryos: a pilot study. Annual Meeting of the Idaho Chapter of the American Fisheries Society, Boise, Idaho, March 4.
- Cox, B. S.\*, A. M. Dux, M. C. Quist, and C. S. Guy. 2011. Use of a seismic air gun to reduce survival of salmonid embryos: a pilot study. Annual Meeting of the Montana Chapter of the American Fisheries Society, Great Falls, Montana, February 11.
- Crozier, L., B.J. Burke, C.C. Caudill, and M. Keefer. 2011. Seasonal variation in the bioenergetic cost of migration in Snake River spring/summer Chinook salmon and potential selection for earlier migration in response to climate change. 141<sup>st</sup> Annual Meeting of the American Fisheries Society, Seattle, WA.
- Dillon, K. G.\*, and C. J. Conway. 2012. Why do birds that breed at high altitude lay smaller clutches? A test of alternative hypotheses. 45th Joint Annual Meeting of the Arizona/New Mexico Chapters of The Wildlife Society and American Fisheries Society. Phoenix, AZ. 3 February 2012.
- Dodd, B.\*, R. D. Schultz, A. Otting, A. Fowler, M. Richardson, J. Euchner, J. R. Fischer, M. C. Quist. 2011. Harvest patterns and exploitation of walleye at Big Creek Lake. Joint meeting of the Iowa Chapters of the American Fisheries Society and Wildlife Society, Moravia, Iowa, January 20.
- Dzul, M. C.\*, D. B. Gaines, K. P. Wilson, S. J. Dinsmore, M. C. Quist, P. M. Dixon, and M. R. Bower. 2011. Devils Hole pupfish population dynamics: estimating growth and survival from length-frequency data. 141<sup>st</sup> Annual Meeting of the American Fisheries Society, Seattle, Washington, September 7.
- Dzul, M. C.\*, M. C. Quist, S. J. Dinsmore, D. B. Gaines, K. P. Wilson. 2011. Movement of Salt Creek pupfish (*Cyprinodon salinus salinus*) living in Salt Creek, Death Valley National Park, CA. January 22. 4<sup>th</sup> Annual North Central Division Student Fisheries Colloquium, Brookings, South Dakota, January 22.
- Dzul, M. C.\*, M. C. Quist, S. J. Dinsmore, D. B. Gaines, K. P. Wilson. 2011. Movement of Salt Creek pupfish (*Cyprinodon salinus salinus*) living in Salt Creek, Death Valley National Park, CA. Joint meeting of the Iowa Chapters of the American Fisheries Society and Wildlife Society, Moravia, Iowa, January 20.
- Fischer, J. R.\*, T. E. Neebling, D. A. Klingenberg, and M. C. Quist. 2011. Feasibility of a boat-mounted RFID antenna for monitoring freshwater mussels. Joint meeting of the Iowa Chapters of the American Fisheries Society and Wildlife Society, Moravia, Iowa, January 20.
- Dzul, M. C.\*, M. C. Quist, S. J. Dinsmore, D. B. Gaines, K. W. Wilson. 2010. Movement of Salt Creek pupfish (*Cyprinodon salinus salinus*) living in Salt Creek, Death Valley National Park, CA. 71<sup>st</sup> Annual Midwest Fish and Wildlife Conference, Minneapolis, Minnesota, December 15.
- Dzul, M. C.\*, P. M. Dixon, M. C. Quist, S. J. Dinsmore, M. R. Bower, D. B. Gaines, K. W. Wilson. 2010. Using variance components to estimate power in a hierarchically nested sampling design: Improving monitoring of larval Devils Hole pupfish. 42<sup>nd</sup> Annual Meeting of the Desert Fishes Council, Moab, Utah, November 18.

- Dzul, M. C.\*, M. C. Quist, S. J. Dinsmore, D. B. Gaines, K. W. Wilson. 2010. Movement of Salt Creek pupfish (*Cyprinodon salinus salinus*) living in Salt Creek, Death Valley National Park, CA. 42<sup>nd</sup> Annual Meeting of the Desert Fishes Council, Moab, Utah, November 18.
- Fischer, J. R.\*, and M. C. Quist. 2011. Seasonal influences on fish sampling data for standing waters: a case study for bluegill population assessments in Iowa lakes and impoundments. 72<sup>nd</sup> Annual Midwest Fish and Wildlife Conference, Des Moines, Iowa, December 6.
- Fischer, J. R.\*, and M. C. Quist. 2011. Seasonal influences on fish sampling data for standing waters: a case study for bluegill population assessments in Iowa lakes and impoundments. 141<sup>st</sup> Annual Meeting of the American Fisheries Society, Seattle, Washington, September 5.
- Fischer, J. R.\*, T. E. Neebling, D. A. Klingenberg, and M. C. Quist. 2010. Design and development of a boat-mounted RFID antenna for monitoring freshwater mussels. 71<sup>st</sup> Annual Midwest Fish and Wildlife Conference, Minneapolis, Minnesota, December 15.
- Gonzalez, R.\*, Caldwell, T. J., and Wilhelm, F. M. 2011. The vertical and spatial distribution of zooplankton in Lake Pend Oreille, northern Idaho, in the presence of *Mysis diluviana*. Aquatic Sciences Meeting of the American Society of Limnology and Oceanography. San Juan, Puerto Rico, USA. February 13-18. (Poster)
- Hartson, R. B. and B.P. Kennedy. 2011. Drivers of juvenile steelhead demographics in a hydrologically altered watershed. 141<sup>st</sup> Annual Meeting of the American Fisheries Society, Seattle, WA, USA. September.
- Hegg, J. A. Fremier, B. Kennedy, and R Zabel. 2011. Using predictions from bedrock lithology to improve geochemical reconstruction of migratory movements in salmon. December. American Geophysical Union Annual Meeting, San Francisco, CA, US
- Jones, B.\*, C. Moffitt, T. Copeland, B. Bowersox, J. Buelow, and W. Schrader. 2011. Migration timing, run characteristics and selected plasma metrics of steelhead trout kelts from three Clearwater River tributaries, Idaho. Idaho Chapter AFS Annual Meeting, Boise, ID. March.
- Jones, B\*. C. M. Moffitt, 2011. Physiological and migratory characteristics of Clearwater River steelhead kelts. 142<sup>nd</sup> Annual Meeting, American Fisheries Society, Seattle, WA. 4 – 8 September.
- Keefer, M. C.C. Caudill, and C.A. Peery. 2011. Adult Pacific salmonids in hot water: behavior and survival studies from the Columbia River basin. 141<sup>st</sup> Annual Meeting of the American Fisheries Society, Seattle, WA.
- Keefer, M., C. Boggs, E. Johnson, C.C. Caudill, T. Clabough, B. Ho\*, and M. Moser. 2010. Adult lamprey passage success and behavior in the lower Columbia River, 2010. 2010 USACE Anadromous Fish Evaluation Program Annual Review, Portland, OR.
- Kennedy, B. P. 2011. Integrating migration and river landscapes: Linking watershed processes and salmon life history strategies. 141<sup>st</sup> Annual meeting for the American Fisheries Society, Seattle, WA, September.
- LaRoche D. D.\*, C.J. Conway, C. Kirkpatrick, and G. Robinson. 2010. The Influence of Environmental Contamination on Riparian Bird Populations at Tumacacori National Historic Park. USGS Border Environmental Health Initiative Interdisciplinary Showcase, Tucson, AZ, 12 Oct 2010.

- LaRoche, D.D.\*, C. J. Conway, G. Robinson, and C. Kirkpatrick. 2011. Factors Affecting Insect Abundance in a Southwestern Riparian Woodland. The Wildlife Society Annual Conference, Honolulu, HI. 7 November 2011.
- LaRoche, D.D\*., C. J. Conway, D. E. Swann, and C. Kirkpatrick. 2011. Effects of severe drought on a desert riparian woodland. The Wildlife Society Annual Conference, Honolulu, HI. 7 November 2011.
- LaRoche, D. D\*., and C. J. Conway. 2012. Development of a Habitat Suitability Model for Masked Bobwhite Based on Expert Opinion. Masked Bobwhite Recovery Team Meeting, Tucson, AZ. 23 January 2012.
- LaRoche, D.D\*., C. J. Conway, D. E. Swann, and C. Kirkpatrick. 2011. Effects of severe drought on a desert riparian woodland. Arizona Hydrological Society Annual Conference, Flagstaff, AZ. 19 September 2011.
- McIlraith, B.J.\*, C. C. Caudill, and B.P. Kennedy. 2011. Distribution, timing, behavior, and habitat of spawning adult Pacific lamprey (*Lampetra tridentata*) translocated into tributaries of the Snake and Clearwater Rivers. 2011 Idaho Chapter of the American Fisheries Society
- McCormick, J. L.\*, and M. C. Quist. 2011. Assessment of bias and precision associated with roving creel survey designs to estimate Chinook salmon harvest in Idaho. 141<sup>st</sup> Annual Meeting of the American Fisheries Society, Seattle, Washington, September 5.
- Merchant, A. Z., E.R. Benson, J. Hegg and B.P. Kennedy.2012. Determining the maternal origin of juvenile steelhead in Lapwai Basin, Idaho. Annual meeting for Idaho Chapter AFS, Boise, ID, March..
- Moser, M.\* , M. Keefer, and C.C. Caudill. 2011. Impediments to lamprey spawning migration and development of lamprey-specific fishways. 141<sup>st</sup> Annual Meeting of the American Fisheries Society, Seattle, WA.
- Myrvold, K. M. and B. P. Kennedy 2011. A Spatial variation in juvenile steelhead (*Oncorhynchus mykiss*) summer growth and consumption in a hydrologically altered watershed. Annual meeting for Idaho Chapter AFS, Boise, ID, March.
- Myrvold, K. M. and B.P. Kennedy. 2011. Spatial and temporal variation in juvenile steelhead (*Oncorhynchus mykiss*) summer growth and consumption in a hydrologically altered watershed. September 2011. Annual meeting for the American Fisheries Society, Seattle, WA, US.
- Parks, T. P.\* , M. C. Quist, and C. L. Pierce. 2011. Influence of dams and instream habitat on fish assemblages in two non-wadeable Iowa rivers. 72<sup>nd</sup> Annual Midwest Fish and Wildlife Conference, Des Moines, Iowa, December 6.
- Parks, T. P.\* , M. C. Quist, and C. L. Pierce. 2011. Longitudinal shifts in fish assemblage structure along a non-wadeable Iowa River. 141<sup>st</sup> Annual Meeting of the American Fisheries Society, Seattle, Washington, September 7.
- Parks, T. P.\* , M. C. Quist, and C. L. Pierce. 2011. Longitudinal patterns of fish distribution in the Cedar River, Iowa. Annual Meeting of the Rivers and Streams Technical Committee, North Central Division of the American Fisheries Society, Rock Island, Illinois, March 22.
- Parks, T. P.\* , M. C. Quist, and C. L. Pierce. 2011. Patterns of fish distribution in the Cedar River, Iowa. 4<sup>th</sup> Annual North Central Division Student Fisheries Colloquium, Brookings, South Dakota, January 22.

- Parks, T. P.\*, M. C. Quist, and C. L. Pierce. 2011. Patterns of fish distribution in the Cedar River, Iowa. Joint meeting of the Iowa Chapters of the American Fisheries Society and Wildlife Society, Moravia, Iowa, January 20.
- Parks, T. P.\*, M. C. Quist, and C. L. Pierce. 2010. Patterns of fish distribution in the Cedar River, Iowa. 71<sup>st</sup> Annual Midwest Fish and Wildlife Conference, Minneapolis, Minnesota, December 15.
- Peery, C.A.\*, M. Keefer, C.T. Boggs, and C.C. Caudill. 2011. Developing a PIT-tag detection system for Pacific lamprey in the Columbia River. 141<sup>st</sup> Annual Meeting of the American Fisheries Society, Seattle, WA.
- Penney, Z.\* C. M. Moffitt, J. Buelow, B. Jones. 2011. Understanding energy expenditure of upstream migration, sexual maturation, and kelt emigration of Snake River steelhead trout with bioenergetic models and empirical data from tissues. 142<sup>nd</sup> Annual Meeting, American Fisheries Society, Seattle, WA. 4 – 8 September.
- Penney, Z.\*, C. M. Moffitt, V. Dorsey, B. Jones, J. Buelow. 2011. Taking a look inside: histological changes within the liver during freshwater spawning cycles of Snake River steelhead trout. (poster). 142<sup>nd</sup> Annual Meeting. American Fisheries Society, Seattle WA 4-8 September.
- Penney, Z. \*, C. M. Moffitt, and B. Jones. 2011. Summary of studies on steelhead trout in the Snake River, and potential collaborations. Russian Academy of Science Meeting with CNR faculty. Moscow, ID. November 16.
- Plumb, J. M.\*, K F. Tiffan, C M. Moffitt, W. P. Connor. 2011. Factors affecting early life history and growth of naturally-produced fall Chinook salmon in the Lower Snake River, Idaho. Idaho Chapter AFS Annual Meeting, Boise, ID. March.
- Plumb, J. M.\*, K. Tiffan , C. Moffitt, and B. Connor. 2011. Bioenergetics and migration of Snake River fall Chinook salmon. 142<sup>nd</sup> Annual Meeting, American Fisheries Society, Seattle, WA. 4 – 8 September.
- Quist, M. C.\*, and J. R. Spiegel. 2011. Effects of temperature and discharge on growth of catostomids in Iowa rivers. Annual Meeting of the Idaho Chapter of the American Fisheries Society, Boise, Idaho, March 3.
- Roumasset, A.\*, C.C. Caudill, R. Mann, M. Keefer, C. Schreck, and M. Kent. 2011. Effects of watershed characteristics, stream temperature, condition and disease on prespawn survival in Upper Willamette River Chinook salmon. 141<sup>st</sup> Annual Meeting of the American Fisheries Society, Seattle, WA.
- Schrader, W.\*, Z. Penney, C. Moffitt. 2011. (poster) Energy and proximate content of selected tissues from Snake River steelhead trout kelts sampled at Lower Granite Dam. Idaho Chapter AFS Annual Meeting, Boise, ID. March.
- Sindt, A. R.\*, M. C. Quist, and C. L. Pierce. 2011. Fish species of greatest conservation need in Wadeable Iowa streams: relative importance of spatial scales. 141<sup>st</sup> Annual Meeting of the American Fisheries Society, Seattle, Washington, September 5.
- Sindt, A. R.\*, C. L. Pierce, and M. C. Quist. 2011. Validation of fish species distribution models based on GIS-measured habitat variables. 4<sup>th</sup> Annual North Central Division Student Fisheries Colloquium, Brookings, South Dakota, January 22.
- Sindt, A. R.\*, C. L. Pierce, and M. C. Quist. 2011. Validation of fish species distribution models based on GIS-measured habitat variables. Joint meeting of the Iowa Chapters of the American Fisheries Society and Wildlife Society, Moravia, Iowa, January 20.

- Sindt, A. R.\*, M. C. Quist, and C. L. Pierce. 2010. Validation of fish species distribution models based on GIS-measured habitat variables. 71<sup>st</sup> Annual Midwest Fish and Wildlife Conference, Minneapolis, Minnesota, December 15.
- Smith, C. D.\*, Fischer, J. R., C. J. Hinz, and M. C. Quist. 2011. Changes in Nebraska's lotic fish assemblages. 72<sup>nd</sup> Annual Midwest Fish and Wildlife Conference, Des Moines, Iowa, December 6.
- Stockton, K.\* and C. Moffitt. 2011. Evaluation of Virkon Aquatic as a potential tool to disinfect mollusk infested field and hatchery gear. Idaho Chapter AFS Annual Meeting, Boise, ID. March.
- Stockton, K\*. T. Allan, C. M. Moffitt, B. Watten, B. Vinci. 2011.(poster) Modeling water and small particle residence times in two rearing units used for intensive culture of steelhead trout in Idaho. Idaho Chapter AFS Annual Meeting, Boise, ID. March.
- Sullivan, C.A., E.S. Suronen, and B.A. Newingham. 2012. Microhabitat use by northern Idaho ground squirrels in response to prescribed fire. Society for Range Management Annual Meeting, Spokane, WA.
- Suronen, E.F. and B.A. Newingham. 2012. Evaluating prescribed fire effects on wildlife habitat used as a restoration tool. Society for Range Management Annual Meeting, Spokane, WA.
- Suronen, E.F., and B.A. Newingham. 2011. Restoring a threatened species' habitat in ponderosa pine forests by thinning and burning. Society of American Foresters, Honolulu, Hawaii.
- Suronen, E.F. and B.A. Newingham. 2011. The effects of prescribed thinning and burning on Northern Idaho Ground Squirrel habitat. Idaho Chapter of the Wildlife Society. Idaho Falls, ID.
- Wilhelm, F. M.\*, and Caldwell, T. J. 2011. Mysids in the Lake Pend Oreille food web: history and current research. 10<sup>th</sup> Annual Regional Lakes Conference. Spokane, WA. February 5. (Oral)
- Wilhelm, F. M.\*, and Caldwell, T. J. 2011. An overview of mysids in the Lake Pend Oreille food web. Departmental Seminar, Eastern Washington University, Cheney, WA. USA. March 11.

## **TECHNICAL ASSISTANCE OUTREACH AND PROFESSIONAL SOCIETY ACTIVITIES**

### *Outreach presentations and workshops*

- Cajas Cano, L. 2011. Workshop leader: Central American Youth Ambassador Program. U.S. Department of State, Bureau of Educational and Cultural Affairs in conjunction with Center for Intercultural Education and Development at Georgetown University, Washington, DC. January and April, 2011.
- Cajas Cano, L. 2012. Workshop leader: Central American Youth Ambassador Program. U.S. Department of State, Bureau of Educational and Cultural Affairs in conjunction with Center for Intercultural Education and Development at Georgetown University, Washington, DC. January.
- Caudill, C. 2011. Conference Advisory Board Member (invited), National Conference on Engineering and Ecohydrology for Fish Passage, June 27-29, 2011, Amherst, MA.

- Caudill, C. 2009 – present. Participant, Lamprey Technical Work Group and Lamprey Passage Metrics Standards Subcommittee, both subcommittees of the Columbia Basin Fish and Wildlife Authority's Anadromous Fish Advisory Committee.
- Conway, C. J\*. 2011. Advantages of implementing a standardized survey protocol for secretive marsh birds in North America. Webinar for U.S. Fish and Wildlife Service staff throughout the U.S. in Refuges, Migratory Birds, and Inventory & Monitoring Programs. 5 October 2011.
- Conway, C. J\*. 2011. Interagency Planning Committee for developing Climate Adaptation Strategies for the Southwestern U.S. including a series of three 2-day workshops for local, state, and federal agencies and NGOs to develop a Climate Adaptation Strategy. 2011.
- Moffitt, C. M. 2010-2012. Member USGS Headquarters Diversity Council. Vice Chair, 2011-2012.
- Moffitt, C. M. 2011. Review of oral and injectable applications of erythromycin to control bacterial kidney disease. Presented in "Practical tools for managing bacterial kidney disease." Continuing education workshop AFS Fish Health Section 52nd workshop. 14 June Nanaimo, BC.
- Moffitt, C. M., K. A. Stockton, and P. Heimowitz. 2011. Lead organizers for 6th National New Zealand mudsnail conference. Moscow, Idaho. March 15-16, 2011.
- Moffitt, C. M., K. A. Stockton. 2011. New Zealand mudsnails and invasive mollusks. Workshop for Idaho Department of Fish and Game and others. Nampa Research. January 2011.
- Moffitt, C. M. 2011. Plenary and Business Meeting Awards Ceremonies. Annual Meeting of the American Fisheries Society, Seattle, WA. Sept 2011.
- Moffitt, C. M. 2012. Diversity and Equality. Workshop and presentation to SEEDS group, 1 February. University of Idaho.
- Moffitt, C. M. 2012. Invasive Species. Guest lecture for Wildlife 314 class. 27 January.
- Moffitt, C. M. 2011. Dams and fish. Guest lecture and discussion leader for Chemistry 400, Honor's Seminar. 26 and 28 September. Instructor Tom Bitterwolf.
- Moffitt, C. M. 2011. Ethical conduct in science and society. Presentation and workshop to SEEDS group. June 24.
- Moffitt, C. M. 2011. Aquatic invasive species invertebrates, parasites and pathogens. Lecture and discussion. 9 February. Environmental Science Capstone Class, University of Idaho.

*Editorial and Professional Society Boards, and other Activities*

*Courtney J. Conway*

Associate editor of *Wetlands*. 2010-2013

Faculty advisor for the Natural Resources Graduate Student Organization (NRGSO) at the University of Arizona. 2007 – 2011

President, Southwest Section of The Wildlife Society, 2010

Past-President, Southwest Section of The Wildlife Society, 2011.

Scientific Program Committee for the 2012 North American Ornithological Conference in Vancouver, British Columbia. 2010-2012.

PI on project to organize and convene a symposium titled “Effects of climate change on Saguaro National Park”. 2010.  
Reviewer for promotion and tenure package for Department of Biology at Franklin & Marshall College, Lancaster, PA. 2011.  
Reviewer for promotion and tenure package for Department of Entomology and Applied Ecology at University of Delaware. 2011.  
Member of the Masked Bobwhite Recovery Team. 2009 – present.  
Co-advisor, University of Arizona Student Chapter of The Wildlife Society, 2010-2011.  
Steering Committee for North American marsh bird monitoring and research summit in Mobile, AL. 2011.

*Christine M. Moffitt*

Chair, American Fisheries Society Award of Excellence Committee. 2010-2012  
Member, Policy Review Committee of the Fish Health Section of the American Fisheries Society. 2011-present.  
Associate editor, *Transactions of the American Fisheries Society*. 2005 – present  
Reviewer for Israel Bi-national Agricultural Research and Development Fund proposals. 2011.  
Reviewer: Ohio Agriculture Research and Development Center (OARDC) Research Enhancement Competitive Grants Program for fiscal year 2012.C  
Outside reviewer for tenure decision. Oregon State University, Hatfield Marine Science Center and Department of Fish and Wildlife Conservation. August and September 2011  
Outside Reviewer for tenure decision, University of California @ Davis (August- Sept 2011)  
Reviewer Lake Tahoe Science Consortium Research Program. 5-6 proposals each year. 2010 – 11.  
Advisor, Palouse Unit of Idaho Chapter, American Fisheries Society  
Member, Steering Committee for the Propagate Fishes in Resource Management Symposium, American Fisheries Society.

*Michael C. Quist*

President, Education Section of the American Fisheries Society. 2011-2012.



Kelly Stockton accepts the Student Club of the Year Award for the Palouse Unit of AFS at the Annual Student Awards Banquet, 2011.



Left: Steve Whitlock assessing survival of kokanee salmon eggs.

Right: Zach Penney and Janae Crispin, HOIST summer intern at poster session at final ceremony 2011.



Left: Burrowing owls during banding.