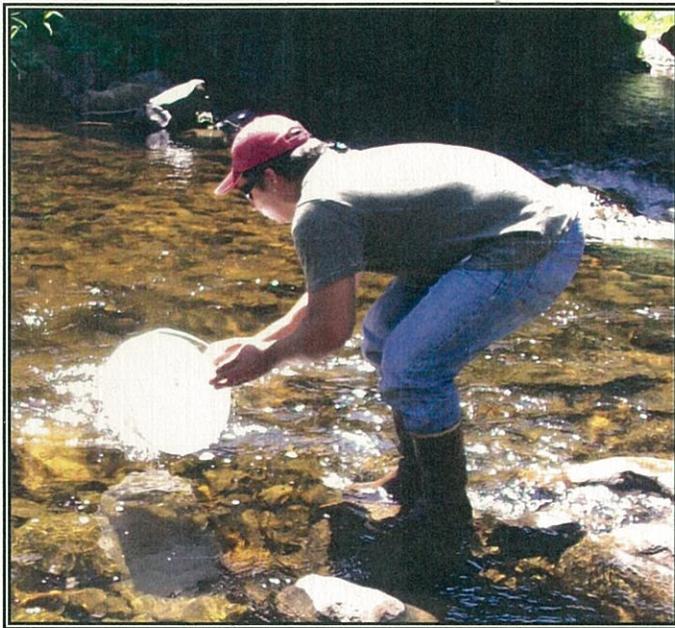


**Idaho Cooperative Fish and Wildlife
Research Unit**
Report to Cooperators



**1 October 2007 to
30 June 2009**



REPORT TO COOPERATORS

1 October 2007 — 30 June 2009

IDAHO COOPERATIVE FISH AND WILDLIFE RESEARCH UNIT

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Introduction

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

WILDLIFE MANAGEMENT INSTITUTE

U.S. FISH AND WILDLIFE SERVICE

The Cooperative Fish and Wildlife Research Unit Program was established in 1937. The program was established 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. The resulting partnership that developed among federal and state resource agencies, the Land Grant Universities 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 Units Program was moved into the U.S. Geological Survey, where it now resides in the Biological Resources Division (BRD). Today, there are 44 BRD Cooperative Research Units in 40 States, from pre-existing research programs of the Fish and Wildlife Service. These units contain more than 160 Ph.D. scientists who oversee as many as 600 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 natural resource scientists; provide technical assistance and consultation to parties who have legitimate interests in natural resource issues; and provide various forms of continuing education for natural resource professionals

Idaho Unit History

The Idaho Cooperative Wildlife Research Unit was established at the University of Idaho September 20, 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 Resources in the College of Natural Resources at the University of Idaho. The unit is staffed, supported, and coordinated by the United States Geological Survey-Biological Resources Division, the Idaho Department of Fish and Game, the University of Idaho, the Wildlife Management Institute, and the U.S. Fish and Wildlife Service.

Program Direction

The unit works toward conducting research on fish and wildlife problems of state, regional, and national interest, training graduate students for careers in the fish and wildlife professions, and providing technical assistance to state and federal managers and researchers.

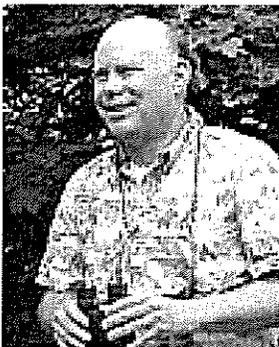
The unit emphasizes research to help find solutions to problems affecting the fish and wildlife resources of Idaho, the Pacific Northwest, and the nation. Special areas of focus include studies

of anadromous fish passage in the Snake River basin, evaluation of methods to enhance fish health of hatchery reared fish, methods of establishing new animal populations or augment existing populations, improved estimators of animal abundance, determining the effectiveness of existing reserve and management areas, methods to assess and control the effects of introduced or invasive aquatic species, study the basic biology and ecology of aquatic and terrestrial animals, evaluate effectiveness of efforts to recover populations of endangered species, develop methods to prevent species from becoming threatened or endangered, and evaluate factors that regulate carrying capacity in fresh water and terrestrial habitats.

Unit 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 primarily within Idaho, though research is conducted in the Pacific and Intermountain West, and occasional locations in North, Central, and South America.

Unit research is supported by state contributions and by contracts from the U.S.G.S.-Biological Resources Division, U.S. Fish and Wildlife Service, U.S. Army Corps of Engineers, U.S. Forest Service, Bonneville Power Administration, Northwest Power Planning Council, and other federal, state, and private agencies. In addition to research activities, unit personnel teach graduate-level courses, serve as advisers for graduate students, and participate in a variety of professional activities.



J. Michael Scott, Ph.D. – Unit Leader and Professor of Wildlife Resources. Recent research activities include studies on: reserve identification, selection, and design in North America; the use of translocation as a tool for establishing or augmenting animal populations; predicting species occurrences; recovery of endangered species; and development of tools to facilitate the transfer of information at the science policy interface. Areas of interest include animal ecology and conservation biology. Specialty course: WLF 515 – Advanced Topics in Conservation Biology.



Christine M. Moffitt, Ph.D. – Assistant Unit Leader and Professor of Fishery Resources. Recent research activities include: host-parasite relationships in an ecological settings; methods to evaluate sustainable aquaculture; interactions between cultured and wild fish; monitoring and control of invasive species; temperature effects on fish physiology and health; efficacy, risks, and regulatory approvals for aquaculture chemicals; and fisheries history. Specialty Courses: FISH 510, Advanced Fisheries Management; FISH/WLF 501, FISH 511 Fish Physiology; Graduate Seminar, and guest lectures in several classes.

Idaho Cooperative Fish and Wildlife Research Unit

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** Indicates Unit Project in 2008-09*

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Professor

David H. Bennett, Emeritus Professor

Ernest Brannon, Emeritus Professor

*Kenneth Cain, Assistant Professor

*Christopher C. Caudill, Research
Scientist

*James L. Congleton, Emeritus Professor

Brian Dennis, Professor

Michael Falter, Emeritus Professor

Alex Fremier, Assistant Professor

*E. O. (Oz) Garton, Professor

*Dale Goble, Professor of Law

*Brian Kennedy, Assistant Professor

*Kirk Lohman, Affiliate Associate
Professor

James Peek, Emeritus Professor

*Madison "Matt" Powell, Adjunct
Assistant Professor

*Janet Rachlow, Assistant Professor

*John Ratti, Emeritus Professor

*Kerry Paul Reese, Professor and
Department Head

*Dennis Scarnecchia, Professor

Kerri Vierling, Assistant Professor

Lee Vierling, Assistant Professor

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*Frank Wilhelm, Assistant Professor

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 Jon Horne, Ph.D., Wildlife Resources
 Kath Strickler, PhD, Wildlife Resources
 Shawn P. Young, PhD. Fisheries Resources

Graduate Students of Unit Staff

Student	Discipline	Adviser
Peter Bloom	Ph.D. Natural Resources	J.M. Scott
Jessica Buelow	M.S. Fishery Resources	C. M. Moffitt
John Cassinelli	M.S. Fishery Resources	C.M. Moffitt
Lubia Cajas Cano	Ph. D. Environmental Science	C.M. Moffitt
Derek Fryer	M.S. Fishery Resources	J.L. Congleton
Adam Kautza	M.S. Fishery Resources	C. M. Moffitt
Jordan Nielson	M.S. Fishery Resources	C.M. Moffitt
Zachary Penney	PhD. Natural Resources	C. M. Moffitt
John Plumb	PhD Natural Resources	C. M. Moffitt
Paul Reyes	M.S. Geography	C. M. Moffitt
David Rupp	M.S. Environmental Science	J.M. Scott
Jan Schipper	Ph.D. Natural Resources	J. M. Scott
Kelly Stockton	M.S. Fishery Resources	C. M. Moffitt
Leona Svancara	Ph.D. Natural Resources	J. M. Scott
Don Zaroban	Ph.D. Natural Resources	J. M. Scott

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Marius Myrvold	M.S. Environmental Sciences	B. Kennedy
Timothy Smyser	M.S. Wildlife Resources	E.O. Garton
John Stephenson	M.S. Wildlife Resources	K.P. Reese
Katherine Strickler	PhD. Natural Resources	J. M. Scott
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Dana Weigel	PhD. Natural Resources	M. Powell

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Charles Boggs	Andrew Pape
Lisa Garrett	Boling Sun
Kala Hamilton	Gina Wilson
Nathan Jensen	

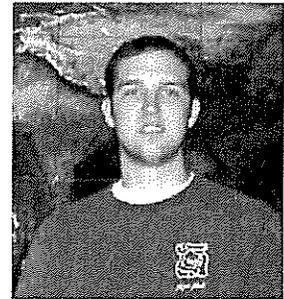
Fish and Wildlife Departmental Administrative Staff

Carrie Barron
Linda Kisha
Cheryl Chambers

Current Projects – Fisheries and Aquatic Resources

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, Ph.D.
Student Investigator:	James Barron
Research Technician:	Nathan Jensen
Funding Agency:	U.S. Fish and Wildlife Service
Completion Date:	30 September 2010



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”.

Progress:

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 extensive culture systems was conducted. Surviving juveniles were observed 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, extensive 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 after a 65 day extensive culture period. Data is currently being analyzed. 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. Data has been collected for this experiment and will be analyzed in the fall of 2009. An additional temperature experiment was conducted in July with slightly larger burbot than those used in Trial 1. Treatments were once again 10, 15, and 20°C for 30 days. Data has been collected for this experiment and will be analyzed in the fall of 2009. An additional temperature experiment is being prepared with burbot juveniles that have transitioned to commercial feeds. Treatments will again consist of 10, 15 and 20°C for 30 days. This experiment will be launched in September of 2009. Extensive culture was explored in 2009 at two pond sites near Bonner’s Ferry Idaho. Around 18,000 burbot larvae were stocked to the larger (Frederick’s Pond) of the two ponds and roughly 4,500 burbot larvae were stocked to the smaller pond (Cow Creek Pond). Data collection is still ongoing for these two ponds, survival has been observed.

EVALUATION OF ADULT SALMON AND STEELHEAD DELAY AND FALLBACK AT SNAKE AND COLUMBIA RIVER DAMS, 2009

Principal Investigator: Christopher Caudill, Ph.D.
Funding Agency: U.S. Army Corps of Engineers
Collaborator: Brian Burke, NOAA-Fisheries
Closing Date: 31 December 2009

Objective:

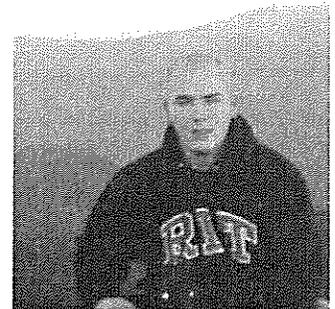
- Evaluate effects of modified Bonneville Dam Cascade Island entrance on passage (passage times, entrance use and efficiency, etc.) of radio-tagged Spring Chinook.

Progress:

In an effort to improve passage of Pacific lamprey, the USACE installed a prototype fishway entrance at one ladder at Bonneville Dam on the Columbia River (the first dam anadromous fishes encounter during upstream migration). Because the changes may affect behavior and passage success of ESA-listed adult salmonids, a radiotelemetry study of spring Chinook salmon is underway. In spring and early summer 2009, 598 Chinook salmon were radio tagged and released below Bonneville Dam and their behavior as they approached the dam was monitored. Data analyses are on-going; preliminary results suggest some indication of slowed passage during early spring compared to years prior to the modification. Final results will guide USACE and regional fish managers as further improvements for lamprey passage are designed and implemented.

IMPROVING ADULT PACIFIC LAMPREY PASSAGE AND SURVIVAL AT LOWER COLUMBIA RIVER DAMS 2009.

Principal Investigator: Christopher Caudill, Ph.D.
Student Investigator: Benjamin Ho
Funding Agency: U.S. Army Corps of Engineers
Collaborator: Mary Moser, NOAA-Fisheries
Closing Date: 31 December 2010



Objectives:

The goal of this study is a continuation of work completed in 2007 and 2008 to develop and evaluate aids to passage and survival of adult Pacific lamprey (*Lampetra tridentata*). For 2009, we radio-tagged and released 588 adult Pacific lamprey and tagged 657 adults with HDX PIT tags, similar to work conducted in 2008. Telemetry monitoring of these fish is ongoing. We had three primary goals:

Progress: Telemetry monitoring of passage behavior and escapement A continuation of work conducted in 2008. Evaluate effects of modified Bonneville Dam Cascade Island entrance on passage (passage times, entrance use and efficiency, etc.) of radio-tagged adult Pacific Lamprey. Fishway entrances have been identified as bottlenecks to upstream

passage of dams. A prototype entrance designed to provide improved flow conditions for lamprey was installed during winter 2008-9. Results will be used to test the effectiveness of the modified entrance and refine the design before installation of similar structures at other fishway entrances at Columbia River dams.

Evaluate the effects of lowered nighttime velocities on adult lamprey passage behavior at Bonneville Dam. Lamprey pass primarily at night while salmonids pass primarily during daylight hours. A modified fishway operation providing lowered fishway entrance velocities was implemented using a modified block design during 2007 suggested improvement in adult Lamprey passage metrics. The experiment was repeated this year at Bonneville Dam and a test of a similar operation was implemented at McNary Dam, also on the Columbia River. The operation may be implemented throughout the Columbia-Snake Hydrosystem, pending the results of 2009 studies.

**IMPROVEMENT IN ESTIMATES OF COLUMBIA RIVER FALL CHINOOK
SALMON (*ONCORHYNCHUS TSHAWYTSCHA*) ESCAPEMENTS**

Principal Investigator:	Christopher Caudill, Ph.D.
Funding Agency:	U.S. Army Corps of Engineers
Collaborating Agency:	CRITFC
Closing Date:	31 December 2010

Objectives and progress:

Naturally spawning Columbia River fall Chinook salmon (*Oncorhynchus tshawytscha*) belong to indicator stocks identified by Pacific Salmon Commission (PSC) Chinook Technical Committee (CTC). A key issue in management of these stocks is the accuracy of escapement estimates. We are collaborating with the Columbia River Inter-Tribal Fish Commission (CRITFC) to improve the escapement model. PSC CTC calculates ocean abundance of a fish stock from the estimate of its escapement using a stock-recruit model such as a Ricker model. If the escapement estimate has a large error, the resultant estimate of ocean abundance will also have a large error. To improve the current methods, we propose to add new information by marking fish with Passive Integrated Transponder (PIT) tags at Bonneville dam, and by detecting those tagged fish later at upstream dams, in hatchery returns, and during spawning ground surveys conducted by multiple regional agencies.

Preliminary results from the first year of this study have been informative. The multinomial likelihood model developed by CRITFC was used for analysis of radio-telemetry data from seven years of 1998 and 2000-2005 collected by the UI (an Objective in Year 1). The model was effective for calculating escapement estimates and standard errors for the Deschutes River, the Snake River and Hanford Reach/Priest Rapid hatchery. The CRITFC model is currently being tested with the 2008 PIT-tag results from dam detections and will include carcass survey results when available. The standard mark-recapture models used by the UI have been successfully applied to the 2008 PIT-tag data.

Initial results from 2008 also indicated significant demographic and phenotypic differences among URB populations. For example, the Snake River group had multiple life history types, including many fish with a year of freshwater residency (e.g., reservoir-type life history). Year-class diversity was also high in the Snake River group, and the distribution of size classes was substantially different than for other URB groups, with many smaller fish. The PIT tag detections at dams clearly showed migration timing differences among stocks, with upper Columbia River fish making up the bulk of the early run and Hanford fish predominating late in the migration.

Specific objectives of the 2009 proposed study are: 1) to mark adult Chinook salmon with PIT tags at Bonneville dam 2) to refine and apply the mark-recapture likelihood model developed in 2008 for calculation of escapements, their variances, and associated parameters 3) to use target populations as URB escapements to Hanford Reach/Priest Rapid Hatchery, the Deschutes River, the Snake River, and the Yakima River 4) to compare estimates from the likelihood model (CRITFC) with those from the US v. Oregon TAC as well as a more standard Mark recapture technique (UI) 5) to address the relationship between precision of escapements and sample size.

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

Principal Investigator:	Christopher Caudill, Ph.D.
Funding Agency:	U.S. Army Corps of Engineers
Collaborators:	Carl Schreck (USGS/OSU) Michael Kent (OSU)
Closing Date:	30 June 2010

Objectives:

- Evaluate condition of adult spring Chinook salmon returning to Willamette Valley
- Evaluate arriving and post-spawning spring Chinook salmon for other potential pre-spawning mortality causes including environmental stressors, disease, and parasites.
- Develop methods for sampling adult migrants at Willamette Falls adult trap.
- Compile and synthesize available literature for anadromous adult salmonid migration in the Willamette Valley ecosystem to identify current knowledge, identify critical knowledge gaps, and to provide a context to prioritize future research needs.

Progress:

The goal of this study is to gain information on the relationships between river environment, fish condition and spawning success/pre-spawning mortality for adult Upper Willamette River (UWR) Chinook salmon (*Oncorhynchus tshawytscha*) in the Willamette River basin. Information will be used to improve natural production from salmon collected at and translocated upstream of USACE Willamette Valley Project dams and reservoirs.

CURRENT PROJECTS – FISHERIES AND AQUATIC RESOURCES

We will address two general research objectives: 1) To what degree is prespawn mortality after trapping and outplanting associated with factors related to ocean experience, mainstem migration conditions, trapping and handling, or conditions encountered in spawning tributaries after outplanting; and 2) does hatchery holding (with broodstock) improve spawning success by reducing prespawn mortality and poaching? Projects and relate condition to spawning success and pre-spawn mortality levels. Test whether holding at Willamette Hatchery improves adult survival and spawning compared to direct outplanting in one population (Middle Fork Willamette River). The review will include analysis of radio-telemetry data collected by USACE personnel on the North Fork Middle Fork Willamette River in 2004-2007.

To date, fish tagging has been completed, spawning ground surveys and collection of carcasses is underway and the literature review is in early draft stage. Consultation on trap design and data analyses from the field season will occur in fall/winter 2009-2010.

LEWISTON ORCHARDS PROJECT: SWEETWATER BASIN FISH & FLOW STUDY

Principal Investigator: Brian Kennedy, Ph.D.
Graduate Research Assistant: Richard Hartson and Marius Myrvold
Funding Agency: Bureau of Reclamation
Completion Date: 30 September 2012



Objectives:

- Quantify temperature and primary stream and riparian habitat features relative to flow levels in Lapwai, Webb, and Sweetwater creeks.
- Evaluate juvenile and adult movement behavior in Sweetwater, Lapwai and Webb creeks relative to flow operations.
- Evaluate indices of system productivity (macroinvertebrate abundance and diversity) relative to stream flow and temperature in Lapwai, Webb, and Sweetwater creeks.
- Evaluate indices of fish (targeting juvenile steelhead) population productivity (abundance, growth, bioenergetics and smolt production) relative to flow regime in Lapwai, Webb, and Sweetwater creeks.
- Evaluate effects of interspecific interactions on juvenile steelhead productivity.

Background:

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 (Almodovar and Nicola 1999, Horne et al. 2004). 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. Rick began course work in the Fall of 2007 and has now led a team of field researches over the past two summers to establish long term study sites and install PIT tag antennas. In February 2009, Rick presented a portion of his work at the Idaho Chapter of the American Fisheries Society, entitled “Effects of an altered hydrologic regime on juvenile *Oncorhynchus mykiss* growth, survival, and emigration” and in May 2009 he traveled to Michigan to attend a special workshop on MARK survival estimation models. In Summer 2009, we recruited Marius Myrvold to follow up on Rick’s foundation laying work as a Ph.D. student in the Water Resources Graduate Program. Marius is a Norwegian student with expertise on juvenile salmon and habitat relationships. He has just arrived to the US and is beginning his coursework.

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

Major Professor: Christine M. Moffitt, Ph.D.
Funding Agency: U of Idaho Multicultural
Scholarship
and Ford Foundation
Student Investigator Lubia Cajas Cano
Undergraduate Intern Rebecca Fritz
Completion Date: 30 August 2011



Objectives:

- To 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 native mussel candidates for rearing within selected finfish aquaculture settings, and simulate the potential of integrating a marine mussel in existing marine environment settings.
- Evaluate the feasibility of raising native mussels in salmonids aquaculture settings in Idaho, simulate the benefits and estimate costs of development.

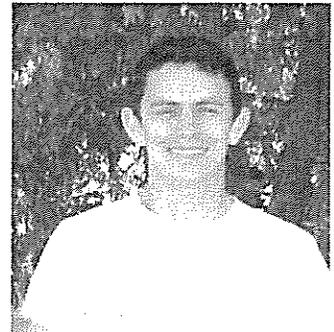
Progress:

This project is part of the PhD dissertation of Lubia Cajas Cano. This dissertation will create models and tools to facilitate the evaluation of the use of resources in the life cycle of food production through aquaculture systems. These models will be easily adapted to any type of aquaculture. To achieve sustainability, aquacultural systems must consider the needs of the natural systems to sustain ecosystem services and in this project the tools will be created and evaluated to identify the use of resources and ecosystem services involved in the life cycle of the aquaculture production. Four chapters will be developed in this proposal: two case studies and two simulation models. The first two chapters will include a holistic approach of the inputs and outputs in the life cycle of the finfish aquaculture in Hawaii and mussel production in Washington. The other two chapters will be based on existing literature and the results of the first two chapters to create simulation models. The two simulation models will assess the integration of native mussels with finfish for fresh and marine farm settings. Mussels can reduce the level of nutrients and suspended particles in water used by finfish production and improve ecosystem services maximizing sustainability. In addition, the mussel production can provide economic and environmental benefits that need to be evaluated. These evaluations will combine strategies to include socioeconomic and environmental factors that can be the key for improvement and

understanding of the ecosystem services and aquaculture sustainability. The evaluation of the life cycle of food production includes aspects of feed production, transportation, effluents, and economic gains, which can highlight opportunities to reduce resource usage along the chain of production to maximize sustainability in the systems. This process will help educate farmers, regulators and the public about the trade offs and potential for growth in this industry.

ASSESSING THE RISKS AND BENEFITS OF BARRIER REMOVAL TO NATIVE FISH POPULATIONS IN IDAHO

Principal Investigator: Christine M. Moffitt, Ph.D.
Student Investigator: Paul Reyes
Agency Collaborator: Jody Brostrom, USFWS
Funding Agency: US Fish and Wildlife Service
Completion Date: 30 December 2010



Objectives:

- Provide GIS derived maps and summaries of the range, migration barriers, and habitat characteristics of native fish species of concern in Idaho.
- Prepare and summarize GIS derived maps of known information on aquatic invasive species and fish pathogens in proximity to the range of fish species of concern, as well as corridors or vectors or pathways of human activity that could increase the likelihood of introduction of invasive species or pathogens within the range.
- Using these spatially referenced data sets, and GIS tools, provide models that can be used to prioritize and select barriers to fish migrations that if removed will result in the greatest benefit to native fish populations.
- Using GIS tools, identify and prioritize areas of risk and needs for further evaluation and monitoring.

Progress:

Removing fish passage barriers can provide risks or benefits to native fish populations. Some of the benefits include improved access to upstream spawning areas, and enhancing the viability of metapopulations. Conversely, eliminating barriers can potentially open access for invasive species and pathogens to areas where native species currently exist. These interactions can adversely affect the health of indigenous fish populations. In this study, we are developing a methodology using GIS tools, to assess the risks and benefits of barrier removal through delineating habitat characteristics of selected target invasive species and assessing stream network connectivity. Our first goal is to characterize habitat that would likely favor the establishment of invasive species populations. Our assessment identifies three levels of risk based on specific geomorphologic characteristics of the watershed (i.e., stream gradient, contributing area and land use). We pose risk factors with models using several hierarchical spatial extents. With areas of risk delineated, our second goal is to simulate the effects of removing improperly designed culverts that constraint fish

passage based on the spatial distribution of these structures within the watershed. Factors that we consider include: upstream length of opened stream connectivity in areas where (1) the risk of infection is lowest and (2) there is no presence of invasive species. The initial phase of our study focuses on assessing risks in the upper part of the Boise River Basin. The methodology developed is flexible enough to be replicated to assess other mountainous watersheds in National Forests and federal lands with native fish species at risk. The results and approach used in this study might help managers to efficiently prioritize the removal of barriers minimizing the associated risks for native fish.

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

Principal Investigator: Christine M. Moffitt, Ph.D.
Collaborating Investigators: Barnaby J. Watten, Ph.D. USGS
Paul Heimowith, Ph.D. USFWS
Bryan Kenworthy, USFWS
Student Investigators: Kelly Stockton
Funding Agency: U.S. Fish and Wildlife Service
Completion Date: 30 September 2010



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 with a state of the science, and sections for details on prevention and control measures on inflow, outflow, depuration strategies, and an outline of decision tools for a rapid response to new or potential infestations

Progress:

With assistance from key managers, and invasive species coordinators, we have identified and contacted researchers with experience and expertise on control barriers for snails, especially information on electrical, and copper barriers. We have compiled this information and included material on toxicity to different compounds, and the conditions of the testing. We summarized data on depuration and volitional feeding of snails by fish species. We are contributing new data with controlled studies of the efficacy of Virkon Aquatic on infested gear. These studies also include objectives to determine the toxicity of Virkon to salmonids. Other collaborations include studies at Dworshak National Fish Hatchery with particle removal in mixed cell raceway systems.

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

Principal Investigator: Christine M. Moffitt, Ph.D.
Collaborating Investigators: William P. Connor, Ph.D. USFWS
Ken Tiffan, USGS
Student Investigators: John Plumb
Funding Agency: Bonneville Power Administration
Completion Date: 31 May 2010



Objectives:

- Determine if the progression of wild 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:

Analyses have been underway to document and characterize historical changes in the juvenile life-history of the wild-reared population within Hells Canyon on the Lower Snake River. The population was listed as threatened under the ESA in 1992, when redd surveys indicated < 200 fish were spawning in over 173 river kilometers of remaining habitat. Multiple regression analysis and stock-recruitment analyses strongly infer that recent (since 1998) hatchery supplementation efforts have been successful in increasing the number of wild-spawning adults, and in turn, the abundance of wild-reared juveniles in the rearing areas of the river.

Both traditional statistical tests (Analysis of Covariance, ANOVA) and more modern model selection techniques (Akaike's Information Criterion, AIC) strongly infer that density-dependent mechanisms may be responsible for earlier emigration of the parr and smolt life-stages from the rearing habitats. Analysis of smolt emigration as fish pass downstream federal hydroelectric dams required special consideration. Differences in spill volume at the dams resulted in differences in sampling effort of PIT-tagged fish at the dams. Thus, fish counts at the dams needed adjustment based on the difference in spill volume, and in turn, sampling effort. Quantifying sampling effort of PIT-tagged fish at the dams was particularly challenging, and required fitting a multi-state mark-recapture model to bi-weekly changes in the counts of PIT-tagged juvenile fall Chinook salmon at the dams. The bi-weekly estimates of sampling effort were then logistically regressed against

the bi-weekly proportions of water that were allocated to the turbine intakes. Currently, we have successfully applied the model to the juvenile fish passing Lower Granite Dam – the first dam downstream from the rearing areas. Current evidence supports the conclusion that the wild-reared population is out-migrating from the rearing areas earlier in accordance with increased releases of hatchery-reared juveniles and increased abundance of wild juveniles in the river. Future efforts will be directed towards studying the emigration timing below other downstream dams as well as the analysis of growth in the wild juvenile population before and after hatchery supplementations.

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

Principal Investigator: Christine M. Moffitt, Ph.D.
Collaborating Investigators: Doug Hatch, CRITFC



Student Investigators: Andrew Pierce, CRITFC

Becky Johnson, NPTF

Jessica Buelow

Zach Penney



Scientific Staff: Shawn Young

Boling Sun

Andy Pape

Kala Hamilton

Funding Agency: Columbia River Intertribal Fisheries Commission

Completion Date: 30 September 2009

Objectives:

- Obtain basic information describing the general physiology and endocrinology of kelts from the point of spawning through the early migration period using hatchery and non-hatchery origin stocks.
- Describe and obtain physiological and endocrinological profiles from downstream migrating wild stocks captured at Lower Granite Dam, and compare and contrast these profiles with fish from upriver and downriver sites.
- Evaluate the physiology of fish collected at Lower Granite Dam and transported via barge or truck to locations below Bonneville Dam.
- Evaluate the physiology and endocrinology of small groups of kelts held for 2 months or more, and compare results with groups of fish from other sites, and with models from fish migrating through river corridors.

Progress:

Within their native range, steelhead trout *Oncorhynchus mykiss* 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 hydro dams were not well designed or constructed to accommodate downstream migrating, post spawning steelhead adults (kelts). This is the first year of a multi-year project to study the physiology, health and

condition of both A and B-run steelhead kelts with a goal of understanding the process of post reproductive recovery, and evaluating the feasibility of strategies for rehabilitating and handling of kelts in the Snake River system. To begin, we sampled small groups of B run steelhead at spawning at Dworshak National Fish Hatchery. We removed blood samples and several tissues from fish over 9 spawning dates from January through April. We captured downstream migrating kelts at Lower Granite Dam from April thru the end of June. We sampled blood, and PIT-tagged 271 downstream migrating wild origin steelhead. These fish were released to migrate downstream, below the dam or were trucked or barged below Bonneville Dam. We also lethally sampled 46 hatchery origin kelts migrating at Lower Granite Dam. We collected blood and tissue samples from each fish that will be used to compare with the other hatchery origin fish. With field assistance from Idaho Department of Fish and Game, we obtained samples from kelts captured moving downstream at weirs on the Clearwater River. High spring flows disrupted our success at one weir, but we were able to obtain blood samples from 25 kelts at the Fish Creek weir. We will be analyzing all samples for a suite of metrics during the fall of 2009, and modeling the association of these metrics with condition and body size of fish.

LOWER METHOW FISHERIES POPULATION GENETIC ANALYSIS

Principal Investigator: Madison Powell, PhD
Student Investigator: Dana Weigel
Key Technical Staff: Joyce Faler
Funding Agency: U. S. Bureau of Reclamation
Pacific Northwest Region
Completion Date: 31 December 2010



Project Objectives: The purpose of this investigation is to provide fisheries population genetic data to: 1) assess the effects of parentage and hatchery fish on naturally spawned endangered fish in the Methow basin; and 2) compare population genetics and life history information across steelhead and Chinook salmon populations in Beaver, Libby and Gold creeks. These data will be analyzed to quantify the effects of passage barrier removal on salmon and steelhead population parameters (such as growth, survival, etc), life history strategies, and the effects of hatchery fish on naturally spawned populations in the basin.

Results Report:

Tissue samples were collected by project cooperators from juvenile steelhead rearing in Beaver, Libby and Gold creeks during 2004, 2005, 2006 and 2007. In addition, tissue samples from migrating adult and juvenile steelhead were collected in upstream-downstream weir during 2005, 2006 and 2007. These samples were delivered to the University of Idaho, Aquaculture Research Institute. DNA was extracted from samples and they are currently being analyzed with 13 standardized microsatellite markers for steelhead. Microsatellite data for 2005 and 2006 samples have been completed. Remaining laboratory analyses are underway.

LIFE HISTORY AND FISHERY CHARACTERISTICS OF REDBAND TROUT IN MANN CREEK RESERVOIR, IDAHO

Principal Investigator: Dennis L. Scarnecchia, Ph.D.
Student Investigator: Dean Holecek
Funding Agency: Idaho Department of Fish and Game
Completion Date: In-progress



Objectives:

- Identify key life history characteristics of an adfluvial redband trout population in Mann Creek Reservoir, Idaho
- Quantify harvest and fishing effort for redband trout in Mann Creek Reservoir
- Predict impacts of potential fishing regulation changes on the fishery and population of redband trout in Mann Creek Reservoir, Idaho

Progress: This project is funded by the Idaho Department of Fish and Game through the Federal Aid in Sport Fish Restoration Act. The primary tasks in this project are to quantify key life history and fishery characteristics of an adfluvial redband trout population in a southwestern Idaho reservoir. Project field work began in March of 2008 with the construction of a weir and the installation of a rotary screw trap. Above average snowpack resulted in high runoff which washed out the weir four times, resulting in few adult fish captures. The screw trap was operated from April 12 – June 13 in 2008 and we estimated 4,854 juveniles outmigrated to the reservoir during that time. The weir and screw trap were operated again in 2009; the weir was installed in February and the screw trap was put in March 18. In the weir we captured 420 upstream adult migrants and 659 downstream adult migrants. We estimated the adult escapement above the weir to be 974 (95% CI 926-1023) using a simple Lincoln-Peterson estimator and correcting for mark loss. The screw trap operated from March 18- June 4, 2009 and we estimated 8,127 juveniles outmigrated in that period. A small subsample of juvenile outmigrants were sampled in 2009 (n = 78) to measure ATPase concentration in their gill filaments to determine if they were undergoing smoltification. The samples have been processed and are now being analyzed. Roving creel surveys were conducted from April 1, 2008-March 31, 2009 and we estimate that 919 wild redband trout and 5,104 hatchery trout were harvested in 22,060 hours of effort. A simple mark-recapture estimate of redband trout was conducted in October of 2008 using a 500' purse seine, experimental gillnets, and boat electrofishing. We estimated there were 4,300 (SD 392.3) wild redband trout in the reservoir. A sub-sample of adult redband trout captured in the October population estimate and adults captured at the weir were floy-tagged so that we can estimate exploitation and compare it to our harvest estimates. Scales, otoliths, and pectoral fin rays were collected from a subsample of the fish we captured in 2008 and 2009 and will be analyzed for age and growth. Monthly temperature/D.O profiles were collected from the reservoir from May 2008-June 2009. Zooplankton tows were conducted in June of 2009. All field work was completed in June 2009 and this project is now in the analysis and reporting phase.

DETERMINATION OF THE ROLE OF MYSIS IN THE NUTRIENT BUDGET OF SURFACE WATERS IN LAKE PEND OREILLE AND ITS RELATION TO KOKANEE SURVIVAL

Principal Investigator: Frank M. Wilhelm, Ph.D.
Student Investigator: Timothy Caldwell
Funding Agency: Idaho Department of Fish and Game
Completion Date: 30 May 2011



Objectives:

- Examine the role of *Mysis relicta* 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 diel vertical migration.
- Quantify the seasonal movement of nutrients
- Determine the density of *Mysis* at each of two sampling sites.
- Incorporate nutrient release rates and *Mysis* densities into a *Mysis* bioenergetics budget
- 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

Background:

The overall goal of the project is to examine and understand the role of the non-native opossum shrimp, *Mysis relicta*, in the nutrient dynamics in the surface waters of Lake Pend Oreille (LPO). *Mysis* was widely introduced into lakes in the Pacific Northwest as a forage supplement for fish, based on the production of large kokanee in Kootenay Lake in the mid 1960's after the introduction of *Mysis* there. Unfortunately, the lack of spatial overlap between *Mysis* and kokanee in most systems means the shrimp grow without significant predation and their populations expand rapidly. Because they are omnivorous, but prefer zooplankton, they directly compete with fish fry for food. This leads to recruitment failure of fish year-classes. A successful method to increase the amount of food available to fish fry has been to undertake whole-lake fertilization programs, e.g. Kootenay and Arrow Lakes in B.C., to stimulate a bottom-up trophic cascade. Success in these lakes has prompted the idea of such a strategy for LPO. However, these lakes differ from LPO because each experienced significant reductions in nutrient inputs (oligotrophication) due to dam construction. Added fertilizer in these lakes replaces that lost to oligotrophication. In LPO, no massive reductions in nutrients have occurred as a result of dam construction and pelagic chemical conditions have remained unchanged since studies in 1911 because the lake is so deep. As well, much effort and money has been expended with several significant agreements to prevent negative changes in the nearshore from excess nutrients. These agreements and directives may make a fertilization program on LPO counterproductive and without societal support. This situation is similar to that at Okanagan Lake, B.C. where long-term efforts to abate nutrients from the watershed precluded the addition of fertilizer to the lake for the production of kokanee. Instead, managers there opted for a *Mysis* fishery to free up nutrients.

The great depth of LPO, mean and max depth of 164 m (538 ft) and 357 m (1,171 ft),

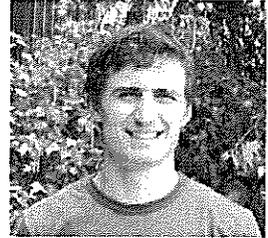
respectively, represents a significant migration depth for *Mysis*. Over such a long migration distance, mysids should arrive in surface waters at night with empty guts. After feeding on zooplankton in surface waters and returning to depth during the day, *Mysis* represent a one way transport or net sink of material and nutrients from surface waters. Other researchers have noted that while not quantified, the loss of P to the lake sediments through diel vertical migration by *Mysis* may be significant. Thus in LPO it may be possible to 'free-up' nutrients transported from surface waters by harvesting *Mysis* rather than adding it.

Progress:

This project was initiated in January 09 with the recruitment of a graduate (MS) student. Currently monthly sampling is underway to quantify the nutrient dynamics associated with the vertical migration of *Mysis*. To date, the most surprising finding has been the measurement of nutrient excretion during the upward migration of mysids, meaning that there is food remaining in their guts or is due to the catabolism of energy reserves associated with vertical migration. However, this is a relatively small fraction compared to nutrients released on the downward migration after feeding on zooplankton in surface waters. Overall, the mysids appear to be a net sink and transport vector for nutrients from surface waters of LPO. Field data collection will continue over the next ½ year followed by construction of the bioenergetics model and determination of how many mysids would need to be removed to free up the desired quantity of nutrients.

Completed Projects – Fisheries and Aquatic Resources

EVALUATE FACTORS LIMITING MIGRATION SUCCESS AND SPAWNING DISTRIBUTION OF ADULT PACIFIC LAMPREY IN THE SNAKE RIVER



Project Investigator: Christopher Caudill, Ph.D.
Student Investigator: Brian McIlraith
Funding Agency: USFWS
Completion Date: 30 June 2009

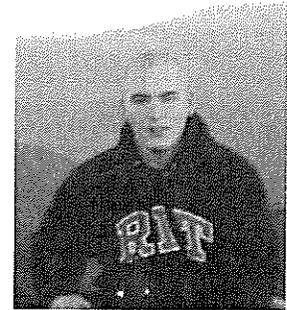
Objectives:

- Evaluate passage of adult lamprey at McNary and four lower Snake River dams and identify areas and factors affecting passage success using radio telemetry.
- Determine final fates, distribution and preferred spawning habitat of adult lamprey migrating in the Snake River upstream from Lower Granite Dam.

Progress: Fifty adult lamprey were collected in 2007 and 50 were collected in 2008 at two dams on the lower Snake River, outfitted with radio transmitters and released upstream of Lower Granite Dam, the last dam fish must pass prior to reaching historical spawning areas in the upper Snake River. More 30 fish were documented in areas that represent potential spawning habitat in the Clearwater and Salmon rivers in 2008 that had been tagged in 2007. These fish were monitored through the winter and early spring using a combination of fixed-receiver sites and mobile tracking by boat and truck. In 2008, 98% of radio-tagged fish had valid telemetry records at one or more upstream locations. Movement peaked during September, declined steeply during winter months, and reinitiated in early March 2009, and continued through June as adults moved into spawning tributaries including the Imnaha, Clearwater, Lochsa, and Selway rivers.

IMPROVING ADULT PACIFIC LAMPREY PASSAGE AND SURVIVAL AT LOWER COLUMBIA RIVER DAMS, 2008

Principal Investigator:	Christopher Caudill, Ph.D.
Student Investigator:	Benjamin Ho
Funding Agency:	U.S. Army Corps of Engineers
Collaborator:	Mary Moser, NOAA-Fisheries
Completion Date:	31 May 2009



Objectives: The goal of this study is to develop and evaluate aids to passage and survival of adult Pacific lamprey (*Lampetra tridentata*), a native anadromous fish, at lower Columbia River dams. The study had three major Objectives:

- Enumerating night passage at dams: Pacific lampreys migrate predominantly at night but have historically been counted at Columbia and Snake River dams only during the day. As a result, annual adult population sizes, escapement past individual dams, and dam-to-dam conversion rates have been unknown or have been defined in relative terms based on daytime-only counts. In 2007 and 2008, we collected video data at the four Bonneville and The Dalles fish count windows to enumerate nighttime lamprey passage, estimate total escapement past each ladder and dam, and to combine video results with results from lamprey tagging studies to develop methods to estimate adult escapement in future years.

Lamprey behavior and upstream passage rates at night were variable among ladders, between years, and within season at each ladder. Numbers passing at day vs. night were inconsistent among years at each ladder, suggesting that expansion metrics based solely on daytime counts would not accurately predict nighttime passage. A major behavioral difference among sites was in the number of lampreys counted moving downstream at night. Downstream movements resulted in a large net negative count at the Washington-shore in 2008 and consequently, overall negative lamprey escapement estimate for both the Washington-shore ladder and for Bonneville Dam. At The Dalles Dam, the addition of nighttime counts to daytime counts increased escapement estimates between 39% (East ladder, 2007) and 269% (North ladder, 2008). At Bonneville Dam, the addition of nighttime counts to daytime-only counts increased escapement estimates 15–20% in 2007 (both ladders) and 33% at the Bradford Island ladder in 2008. The combined results suggest that further nighttime monitoring may be necessary to develop predictive total lamprey escapement models at these sites, though the large interannual differences observed at each site suggest that a simple conversion factor applied to day counts is not likely to provide accurate estimates of total escapement in most years.

- Telemetry monitoring of passage behavior and escapement

For this objective, we tagged lamprey with half duplex (HDX) passive integrated transponder (PIT) tags and radio transmitters 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, to estimate escapement past the monitored sites, and to evaluate potential correlates with

lamprey escapement and behaviors through the study reaches. In 2008, we radio-tagged 595 lampreys and HDX-PIT tagged 908 lampreys. Escapement estimates from release below Bonneville Dam to top-of-ladder antennas were 26%-66% depending on location and telemetry method, and were generally consistent with past monitoring results. Higher escapement estimates by HDX-PIT tagged fish, compared to radio-tagged fish, were consistent with results from a similar study in 2007 and suggest that radio tagging and associated handling may negatively affect adult performance. This suggests a tradeoff between tagging effects and the collection of high resolution, fine-scale data provided by the active radio tag telemetry system. We conclude that the combined radiotelemetry and PIT-tag results provide complimentary data that can be used to inform adult lamprey management actions at a variety of scales.

EFFECTS OF ARSENIC FROM MINE WASTES ON BULL TROUT

Principal Investigator: Brian Kennedy, Ph.D.
Graduate Research Assistant: Tim Kiser
Funding Agency: U.S. Fish & Wildlife Service
Completion Date: 30 May 2009



Objectives:

- Determine the extent and spatial variability of Arsenic (As) contamination in sediments below the Lakeview Mine and throughout Gold Creek drainage.
- Determine the bioaccumulation factors that relate the concentration of As in sediment to As in benthic macro invertebrates and resident salmonids.
- Determine benthic macro invertebrate diversity and abundance relative to spatial variability of sediment As concentrations.
- Determine the seasonal use patterns of juvenile bull trout in Gold Creek and West Gold Creek and relate to sediment As loads and habitat variables (e.g. productivity).
- Determine the extent of As-related toxicity in juvenile bull trout residing in Gold Creek and West Gold Creek by analyzing tissue residues and conducting histological investigations.

Background:

Arsenic (As) is a contaminant of concern in the Inland Northwest. Arsenic can be found at relatively high concentrations in soils and sediment at mine sites in Washington and Idaho. Lakeview Mine is located on the southeast end of Lake Pend Oreille in northern Idaho. The mine and mine wastes are located in Chloride Gulch that flows into Gold creek, then into the lake. The Gold Creek drainage is the second most productive bull trout spawning and rearing area in the lake basin. This stream contains high numbers of juvenile bull trout with relatively low numbers of other salmonid species. Mine-related toxicity may be the

cause, or a contributing factor, to the lack of use of Gold Creek above the confluence with West Gold Creek by juvenile bull trout. Furthermore, As may be adversely-affecting those juvenile bull trout that are present in the system, potentially reducing their long-term survival.

Progress: Funding began in Summer 2006 at which time a graduate student was brought to initiate and lead the first summer of fieldwork. An intensive field effort in 2006 resulted in the collection of sediment, macroinvertebrate, and fish samples as well as extensive habitat measurements throughout the drainage. Efforts focused on five sites throughout the drainage that varied with respect to their distance to mine effects and presumed sediment As concentrations. In 2007, Tim Kiser, has been working hard to process fish samples for histological analysis and analyzing metals data and macroinvertebrate samples. Tim worked with the US Fish and Wildlife Service while he completed his thesis. Tim successfully defended his thesis in May 2009, entitled "Impacts and Pathways of Arsenic and Toxic Metals to an Aquatic Community in a Mine Impacted Idaho Watershed." The first chapter of the thesis "Impacts and Pathways of Mine Contaminants to Bull Trout (*Salvelinus confluentus*) in an Idaho Watershed" has been accepted pending revision at *Archives of Environmental Contamination Toxicology* and the second chapter is in the process of being submitted to the *Journal of the Freshwater Biology*. Tim has secured a position as the Fisheries Biologist at the Eastern Washington Field Office of the US Fish Wildlife.

EFFECTS OF WATER TEMPERATURE ON GROWTH OF PHYSIOLOGY OF REDBAND TROUT

Principal Investigator: Christine M. Moffitt, Ph.D.
Student Investigator: John Cassinelli
Technical Staff: Boling Sun
Agency Collaborator-Kevin Meyer
Funding Agency: Idaho Department of Fish and Game
Completion Date: 31 December 2007



Objectives:

- Do redband trout from a desert population have higher survival in a warm water environment than redband trout from a montane population?
- Do redband trout from a desert population have faster growth in a warm water environment than redband trout from a montane population?
- Do particular physiological characteristics measured within desert and montane populations of redband trout enable desert populations to withstand a warmer environment?

Abstract:

Within their native range in western North America, resident redband trout *Oncorhynchus mykiss gairdneri* occupy stream habitat from high mountains to low desert. To better understand the temperature tolerance, growth and stress physiology of native fish populations and compare the resilience and responses of stocks adapted to desert or montane conditions to reciprocal environments, we conducted controlled laboratory trials. We tested groups of age-0 progeny from naturally reproducing desert and montane fish stocks in temperature cycles that simulated summer conditions typical in regional desert and montane stream habitats. The diel cycles ranged from 8 - 16°C for montane treatments and 18° - 26°C for desert treatments, and our tests were repeated over two years. We evaluated survival, growth, feed efficiency, plasma cortisol, heat shock protein levels, and body proximate composition in samples of fish collected during and at the completion of trials. All stocks tested had high survival in all conditions, regardless of their geographic origin. We found no differences consistently attributable to desert- or montane-origin stocks. Growth rates, and protein and lipid efficiencies varied among stocks, between temperature treatments, and between replicate years. We found the expression of heat shock protein (hsp70) was consistently higher in all stocks maintained in desert temperatures regardless of source, but the absolute quantity of proteins measured varied among populations. We conducted an additional short-term trial to evaluate responses of different stocks to upper lethal temperature cycles that approached a daily maximum of 30°C. Although desert and montane-adapted populations of redband trout were equally dynamic and adaptive in desert or montane diel temperature cycles, we conclude that the desert stocks are likely more at risk from increasing temperatures and reduced stream flows in the summer months as climate changes. A manuscript based on this work has been accepted for publication in *Transactions* of the American Fisheries Society

We completed the work on this contract, and graduate student John Cassinelli was hired by Idaho Department of Fish and Game as a research biologist. We submitted a manuscript that has been accepted for publication in *Transactions* of the American Fisheries Society.

INFRASTRUCTURE TO COMPLETE FDA REGISTRATION OF ERYTHROMYCIN

Principal Investigator:	Christine M. Moffitt, Ph.D.
Funding Agency:	DOE – BPA (LSRCP)
Completion Date:	30 December 2007

Objectives:

- Keep an active dialog with Food and Drug Administration (FDA) to resolve any outstanding issues during their review of submission, and assure that all components of the public master file and drug claim for erythromycin to control bacterial kidney disease are completed.
- Interact with Ms. Roz Schnick, National Aquaculture NADA Coordinator, to assist in information needs for potential drug manufacturing sponsors as they prepare the manufacturing claim.

COMPLETED PROJECTS – FISHERIES AND AQUATIC RESOURCES

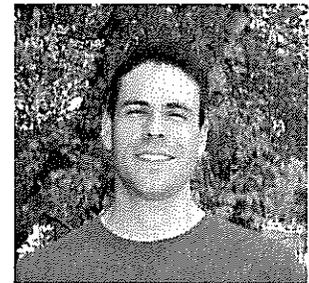
- Maintain an adequate infrastructure to assure a source of experimental premix is in place during completion of the drug approval submission
- Submit for publications manuscripts from studies and data collections previously submitted to FDA. Serve as a resource for others working with erythromycin to control bacterial kidney disease

Abstract:

This project has been a major effort form more than 10 years to approve erythromycin for treatment of bacterial kidney disease in salmon. The requirements of the Food and Drug Administration's, Center for Veterinary Medicine (CVM) for technical data submissions regarding product Efficacy, Target Animal Safety, Human Food Residues, Human Safety from Antibiotic Resistance, and Human Safety from Resistant Microorganisms have been completed, reviewed and accepted by the CVM as adequate to support the label claim. Progress has been slow over the years due to regulatory concern about aquaculture drugs. Outstanding issues of environmental safety were addressed with submission of a risk assessment document following the CVM guidance as an Environmental Impact Assessment, Phase 1 and Phase 2, using Guidance Document 89. This document was reviewed and the CVM determined that further studies need to be completed. Dr. Moffitt is working with a contractor, and with the USGS Upper Mississippi Science Center at La Crosse, WI to complete the studies necessary. Bimeda Animal Health is preparing to submitting the manufacturing claim for this drug. The passage of the MUMS legislation for Minor Use Minor Species drug approval requirements led to this decision by Bimeda, as this legislative act allows a longer exclusivity arrangement and other advantages for drug companies to sponsor products with minor use. We anticipate completion of these requirements soon after the funding cycle of this grant.

GROWTH, AGE DISTRIBUTION, AND POPULATION DYNAMICS OF BLACK CRAPPIES FROM IDAHO

Principal Investigator:	Christine M. Moffitt, Ph.D.
Collaborating Investigator	Kevin Meyer, IDFG
Student Investigator:	Adam Kautza
Funding Agency:	IDFG
Completion Date:	30 May 2008



Objectives:

- Evaluate age, growth and stock differences for populations of Black Crappie from selected reservoir and lake systems in Idaho.
- Pose plausible models for further testing of these populations

Completion Report:

Black crappies (*Pomoxis nigromaculatus*) are fast becoming a very popular warm-water gamefish in Idaho. Angler opinion surveys indicate that warm-water sport fish, like the black crappie, have increased in popularity s over the last thirty years, however, In this study, size-structure, growth, body condition and recruitment variability for black crappies

from five study sites in Idaho were assessed and compared. Samples of black crappie were collected using several types of gear and fish were weighted and measured, and selected fish were killed and otoliths were removed to determine growth and age structure. We found that growth, body condition, population size-structure, and recruitment varied among all the populations sampled. Overall growth rates were highest for fish sampled from Hayden Lake and Winchester Lake and were lowest for black crappies from Brownlee Reservoir and Mann Lake. When we examined the incremental growth rates we found that growth in the first year was highest for black crappie from CJ Strike Reservoir, followed by fish from Brownlee. Growth from the first year was lowest in, Hayden Lake populations, but after age 2 Hayden black crappies grew faster than any of the other populations. After their first year, CJ Strike black crappies were among the slowest growing populations. Body condition was highest for populations in Brownlee Reservoir, followed by samples from Winchester, and Hayden Lake and finally CJ Strike and Mann Lake. Size-structure of the population captured was variable among the five populations. Mann Lake had the highest proportional stock density and CJ Strike had the lowest. Relative stock density for preferred length black crappie was highest for Brownlee and Hayden Lakes. In addition, Brownlee and Hayden Lakes were the only populations where memorable size black crappies were collected. Recruitment was highly variable for all populations, with weaker year classes followed stronger year classes. Several potential factors were likely contributing to the differences in growth, body condition and recruitment witnessed among the black crappie populations. These factors include temperature and length of growing season, density of black crappies, and quantity and quality of food resources within the lake or reservoir. With the distinct conditions found at each of the sites and the differences in growth, body condition, and recruitment among the black crappie populations it is therefore recommended that management strategies be tailored specifically to each population.

FILTRATION STRATEGIES TO REMOVE NEW ZEALAND MUD SNAILS AT FISH HATCHERIES

Principal Investigator:	Christine M. Moffitt, Ph.D.
Collaborating Investigators:	Barnaby J. Watten, Ph.D. USGS Bryan Kenworthy, USFWS Paul Heimowith, Ph.D. USFWS
Student Investigators:	Jordan Nielson
Undergraduate Interns	Katie Teater, Shawn Howard Kala Hamilton;
Funding Agency:	U.S. Fish and Wildlife Service
Completion Date:	30 December 2008



Objectives:

- Evaluate the efficacy of hydrocyclonic filtration to remove invasive New Zealand mudsnails from a hatchery inflow.

- Determine effectiveness of CO₂ as a lethal treatment for snails in fish culture operations.

Progress:

New Zealand mudsnails (NZMS) have infested several fish hatcheries in the western United States. Because of risks of transporting NZMS to naïve locations hatchery managers or regulators have denied permission for shipments of fish from infested hatcheries to non-infested waters. We tested the efficacy of a hydrocyclonic separator to remove New Zealand mudsnails from infested fish hatchery inflow waters. We found the system was fully successful in removing all sizes of NZMS from inflow waters to the underflow of the filter. We modeled transit patterns for water to verify that collection intervals for snails were reasonable and then modeled movement of three different snail sizes through the hydrocyclone at two flow rates to determine if flow affected filtration efficiency. We found that the smallest size of snail, neonate, had the fastest transit rate at both flows and adult and juvenile sizes had similar transit rates to each other. Snail transit was faster at the higher flow rate and remained efficient. As a treatment for snails filtered from hatchery flow by hydrocyclone we conducted laboratory studies of the toxicity of carbon dioxide to NZMS. Three different sizes of NZMS based on life history characteristics were exposed to CO₂ under 100 kPa pressure at several time intervals and three different temperatures to determine survival based on temperature units. Probit models were used to compare the different sizes of NZMS ability to survive pressurized CO₂ treatment. Snails exhibited a dose response to pressurized CO₂ treatment. Models indicated that adult and juvenile sized snails exhibited similar response to the treatment and neonate snails had a reduced ability to withstand treatment. A combination of filtration followed by a toxic treatment of CO₂ is an effective method for removing New Zealand mudsnails from infested hatcheries.

EVALUATION OF PINNIPEDS EXCLUSION GATES ON PASSAGE OF ADULT ANADROMOUS SALMONIDS AT BONNEVILLE DAM (2)

Principal Investigator:	Christopher Peery, Ph.D.
Funding Agency:	U.S. Army Corps of Engineers
Completion Date:	31 December 2007

Objectives:

- Deploy a set of two acoustic transmitting devices and hydrophones in the base of the Washington (north)-shore fishway entrance at Bonneville Dam. The south-Shore entrance area will be left without acoustic deterrents. Hourly counts of sea lions in and near the two fishway entrances will be made daily. Total and median numbers of sea lions at the two locations will be compared using time-series repeated measure ANOVA and paired t-tests(alpha=0.05).
- Make systematic observations of the number and locations of pinnipeds in the vicinity of Bonneville Dam.

COMPLETED PROJECTS – FISHERIES AND AQUATIC RESOURCES

- Use a randomized block design with and without modified entrance dates in place to evaluate for potential effects of the gates on fish passage.

Progress: Placement of sea lion exclusion devices (SLEDS) and acoustic deterrents effectively prevented adult sea lions from entering fishways at Bonneville Dam. However, SLEDS appeared to delay salmon passage. Additional testing is currently being conducted.

Current Projects – Wildlife and Terrestrial Resources

USING THE METAPOPOPULATION CONCEPT TO UNDERSTAND THE SPATIAL AND TEMPORAL POPULATION DYNAMICS OF ELK IN IDAHO

Principal Investigators: Oz Garton
Student Investigator: Jocelyn L. Aycrigg
Funding Agency: Idaho Department of Fish and Game
Completion Data: 31 December 2009



Objectives:

Large mammals, such as Rocky Mountain elk (*Cervus elaphus nelsoni*), exemplify the challenge of managing wildlife populations over large spatial areas because they have seasonal and annual ranges that often cover areas the size of watersheds or sub-basins, respectively (Wisdom & Cook 2000). To address the challenge of managing elk, our research emphasizes spatial analysis of populations at the landscape level. We can meet this challenge by focusing on the metapopulation concept, which encompasses the dynamics, interactions, and processes of multiple populations over large areas. This directs our research to look at the ‘big picture’.

Our goal is to bring the ecological concept of metapopulations into reality where it can be applied to management questions and emphasize the dynamics of management practices at landscape scales. Our objectives are to (1) use demographic and genetic characteristics to delineate elk metapopulations; and (2) model the influence of extrinsic factors (i.e., harvest levels, predator impacts, habitat change, weather, essential mineral levels, and road patterns) on each metapopulation. We will apply a hierarchical approach using both local and large spatial extents to ensure the most appropriate scale is analyzed.

Results:

Based on our genetic analysis of 216 elk muscle tissue samples from 7 regions and 9 elk management zones across Idaho, there is enough movement of individual elk to keep the distribution of genetic variation relatively even. Our results suggest a network (i.e., patchy metapopulation structure) of elk populations linked by extensive gene flow and exhibiting little to no differences in genetic variation, which is common among cervids (Coltman 2008). From a genetic perspective, this network could be managed as a single large population or metapopulation. Implementing elk population management objectives consistently statewide may not be practical, but our findings also indicate current management of elk populations in Idaho is maintaining sufficient gene flow between populations. With respect to maintaining genetic variation, it is vital the area over which management is applied is also the area over which populations are genetically structured (Wiens 1996, Coltman 2008). Based on previous research and our own results there is a

possibility that the area over which elk populations are genetically structured is much larger than Idaho (Polziehn et al. 2000, Hicks et al. 2007). This implies management of elk populations in surrounding states could influence the distribution of genetic variation in Idaho. However, with sufficient movement of individuals between populations, a patchy metapopulation structure will be maintained. To preserve a sustainable harvest of elk and the distribution of genetic variation, it is essential to maintain the perspective of the entire metapopulation while managing individual populations. Given that the Boise River and Lolo elk management zones appear to be less connected genetically to other elk management zones, it will be important to manage those populations to prevent further loss of connectivity and to manage the metapopulation to maintain the current level of connectivity between elk management zones.

Based on our genetic results, past movement patterns do not appear to have been limited by geographic barriers nor led to differentiation of local populations. Combining our genetic results with future research on how current movement patterns and demographic rates influence the metapopulation structure of elk in Idaho will strengthen our understanding of the observed distribution of genetic variation and improve elk population management and conservation.

THE EFFECTS OF HABITAT CHANGE ON IDAHO'S UNGULATE POPULATIONS

Principal Investigators:	Paul Gessler J. Michael Scott
Student Investigator:	Jeff Lonneker
Funding Agency:	Idaho Department of Fish and Game
Completion Data:	30 June 2010

Objectives:

- Address the past and present ungulate habitat changes within Idaho.
- Address quantity and location of forage for animal populations to consider fire suppression, human encroachment, noxious weed invasion and other changes including climate

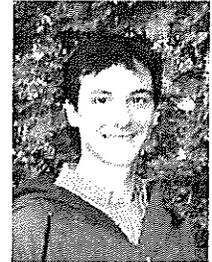
Progress:

Habitat change is a very natural process that animals have not only adapted to, but have become dependent upon. Past efforts to document these changes have been expensive and time consuming. To look at how an entire landscape has changed, satellite data is proving to be a valuable tool. We have acquired satellite data from two different sensors. The Landsat Thematic Mapper (TM) was chosen to document the type of habitat change while the Advanced Very High Resolution Radiometer (AVHRR) was chosen to assess any changes in the timing of the growing season. We are using this satellite information in conjunction with aerial survey data of elk and mule deer from within the state of Idaho. What we are looking at is if landscape changes have influenced these ungulate populations

in the past. If so, can we use these past relationships to suppose what might happen in different future scenarios of a changing climate?

MOUNTAIN QUAIL TRANSLOCATIONS

Principal Investigator: Kerry Reese, Ph.D.
Student Investigator: John Stephenson
Funding Agency: Idaho Department of Fish and Game
Completion Date: 31 December 2009



Objectives:

- Reintroduce mountain quail into Asotin Creek Wildlife Management Area in Washington and Craig Mountain Wildlife management Area in Idaho.
- Analyze data comparing reintroduced to native mountain quail in Idaho.

Progress:

We translocated 322 mountain quail into the two areas on 12 March 2005 (2=145) and 17 March 2006 (n=177) with the goal of establishing self-sustaining populations. We radio-marked 199 of these quail, which were monitored for up to 6 months until batteries failed. The major research objectives were to investigate survival, movements, habitat use, and productivity of translocated birds in the spring/summer period, and to compare these to native mountain quail studied during the 1990s in west-central Idaho. The known spring and summer survival rate was 13%, confirmed mortality was 76% and 11% of radio-marked birds went missing or had faulty transmitters. Spring/summer survival was 22% in 2005 and 15% in 2006. When cause of death could be determined, 74% of mortalities were by avian predators, 22% were by mammals, and 3% were human caused. Movement rate was negatively correlated with survival. Of 24 nests found, 9 were incubated by females, 13 by males, 1 was started by a female and completed by a male, and 1 was not incubated. Clutch size was 8.5 for females and 9.5 for males. Overall nest success was 75% and was higher in 2005 (92%) than 2006 (58%), higher at Asotin Creek (81%) than Craig Mountain (63%), and higher for hatch year birds (94%) than after hatch year birds (29%). Mean hatch date for successful nests was 30 June (range: 15 June – 13 July). Brood success was 61% with a mean of 5.8 chicks per successful brood at 28 days of age. We located 15 (63%) of nests in Douglas fir-dominated plant associations, 4 (17%) in ponderosa pine, 2 (8%) in talus/garland, and 1 (4%) in each of rose/snowberry, bluebunch wheatgrass, and cottonwood/alder riparian communities. Additional releases of birds would likely be necessary for these populations to be self-sustaining. Altering release protocols, locations and number of birds could increase survival of translocated birds and provide for establishing self-sustaining populations.

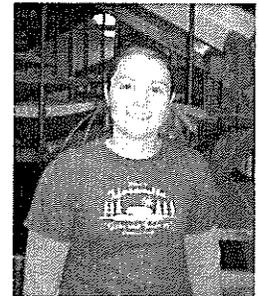
The second portion of this work dealt with comparison of native mountain quail to translocated quail. We calculated survival rates for 181 native mountain quail in west-central Idaho from 1992-1996 and for 199 translocated quail in western Idaho and eastern Washington in 2005 and 2006. Spring/summer survival of native birds over 4 years ranged from 0.237 (SE = 0.069) to 0.826 (SE = 0.086) and their fall/winter survival in 2 years was 0.576 (SE = 0.064) and 0.213 (SE = 0.063). Annual survival rates were 0.532 (SE = 0.078) and 0.278 (SE = 0.074). Higher mortality due to predation coincided with movements to breeding habitat, breeding and incubation in the spring, periods of higher temperatures in the spring and summer, and periods of deeper snow and colder temperatures during fall/winter. Spring/summer survival rate of translocated quail was 0.183 (SE = 0.029), which was lower than rates of native populations in our study. Mountain quail can experience low and variable survival, stressing the potential need for multiple releases in restoration efforts. Mature, well-developed riparian communities may be essential for protection from predators and mountain quail survival during all seasons.

Stephenson, J. A. 2008. Ecology of translocated mountain quail in western Idaho and eastern Washington. MS thesis. University of Idaho.

Stephenson, J. A., K. P. Reese, P. Zager, P. E. Heekin, B. C. Herman, P. J. Nelle, and A. Martens. Factors influencing survival of native and translocated mountain quail in west-central Idaho and eastern Washington. Submitted to Journal of Wildlife Management in April 2009.

DEVELOPING AN INDEX OF ABUNDANCE FOR PYGMY RABBITS

Principal Investigator:	Janet Rachlow, Ph.D.
Student Investigator:	Amanda Price
Funding Agency:	Idaho Department of Fish and Game
Start Date:	19 September 2006



Objectives:

The purpose of this research is to develop a standardized method to monitor abundance of pygmy rabbits and to gain an understanding of how pygmy rabbits affect their habitat.

Specific objectives are to:

- Calibrate an index of abundance based on burrow systems by correlating the index with estimates of population density;
- Design standardized protocols for monitoring abundance, and;
- Evaluate the effect of pygmy rabbits on vegetation around burrow systems

Progress:

In the Lemhi Valley, 6 sites were delineated during 2007 and 2008. A census of burrow systems and mark-resight surveys were completed on all 6 sites. Censuses of burrow systems provide an evaluation of the density and activity status of rabbit burrows, and mark-resight surveys provide an estimate of the abundance of rabbits.

Trapping in the Lemhi Valley was conducted for approximately 18 days between the two

CURRENT PROJECTS – WILDLIFE AND TERRESTRIAL RESOURCES

study areas in 2007, and 28 days at the 4 sites in 2008. In 2007, 13 animals on Cedar Gulch were fitted with radio-collars (5 males, 8 females) and 14 animals on Rocky Canyon were collared (6 males, 8 females). Captured animals were fitted with 4.2-g radio transmitters (Holohil Inc., Toronto), PIT tags were implanted, and standard mammalian measurements were collected (weight, hind foot, ear length).

Upon completion of trapping events, mark-resight surveys commenced. Animals were resighted by using maps and GPS units to navigate to all active and recently active burrow systems as determined from the burrow censuses. A telemetry receiver was used to identify whether a rabbit was collared and to record which rabbit (if collared) had been located. Upon completion of the resight occasion, all collared animals not detected were located to determine if they were onsite for survey.

Vegetation measurements were conducted during May – June of 2009 to assess the influence of pygmy rabbit browsing and digging on vegetation surrounding burrow systems. We assessed systems that have been active for differing periods of time, sites that have been abandoned, and sites that have not been associated with burrows during the past 7 years for which burrow data were available. The M.S. student will complete the analyses and thesis by December 2009.

USE OF ADVOCACY IN PEER REVIEWED ARTICLES IN THE NATURAL RESOURCE SCIENCES

Principal Investigators:	Janet Rachlow Ph.D. J. Michael Scott, Ph.D.
Funding Agency:	U.S. Geological Survey, Idaho Department of Fish and Game
Completion Date:	June 2008

Objectives:

- Determine the frequency with which value-laden language is used and preferred policy outcomes are stipulated in peer reviewed journals in the Natural resource sciences.

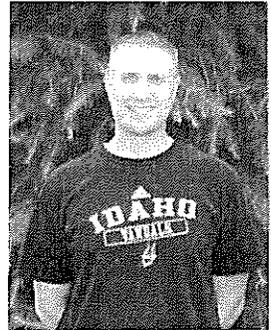
Progress:

We concluded a graduate seminar on Advocacy in Science in three semesters. Fifty articles from each of six natural resource journals; Ecological Applications, Journal of Wildlife Management, North American, Journal of Fisheries, Management, Forestry Science, Conservation Biology and Journal of Range Management were reviewed for use of value laden language and stipulation of preferred policy outcomes. The use of value laden language was found in all journals most frequently in Conservation Biology and Journal of Range Management. The stipulation of preferred policy outcomes was also found in each of the journal again most frequently in Conservation Biology and Journal of Wildlife Management.

We co-hosted a symposium on advocacy in Natural Resource Sciences at the 2006 meeting of the Society for Conservation Biology. Presentations by prominent conservation biologists and senior administrators of natural resource agencies as well as a roundtable discussion by editors of Conservation Biology and Bioscience were featured at the symposium. An overview of our results was presented.

**IMPACT OF ELEVATED INFRASTRUCTURE ON GREATER SAGE-GROUSE:
COLLISION, MITIGATION AND SPATIAL ECOLOGY**

Principal Investigator: Kerry Reese, Ph.D.
Student Investigator: Bryan S. Stevens
Funding Agency: Idaho Department of Fish and Game
Completion Date: 30 June 2010



Objectives:

Collision mortality is a widespread and relatively common phenomenon among European grouse species. Research concerning the relative extent and impacts of collision mortality on North American grouse are limited. Wolfe et al. (2007) studied mortality patterns of lesser prairie-chickens in Oklahoma and New Mexico, and found 39.8% of all mortality in Oklahoma was caused by collisions with fences. Beck et al. (2006) found 33% of the juvenile mortality of greater sage-grouse on an Idaho study area was caused by collisions with power lines. Recent concerns involving impacts of elevated infrastructure on greater sage-grouse in Idaho (Idaho Sage-Grouse Advisory Committee 2006) have brought to our attention the lack of empirical data concerning collision frequency and grouse in North America. The spatial extent of fences and other elevated structures has increased dramatically in sagebrush habitats during the last 50 years (Connelly et al. 2000, Connelly et al. 2004), and their potential impact on sage-grouse has not gone unnoticed (Braun 1998, Connelly et al. 2000, Connelly et al. 2004). Few studies have evaluated collision rates over large geographic areas, and no studies have evaluated factors influencing collision rates across multiple spatial scales, further limiting our knowledge of what influences collision risk across the landscape. For these reasons, this research was pursued with the following objectives: 1) estimate collision rates of greater sage-grouse with barbed-wire fences on study areas in greater sage-grouse winter and breeding habitats, 2) estimate carcass and collision sign detectability and longevity in sagebrush steppe habitats.

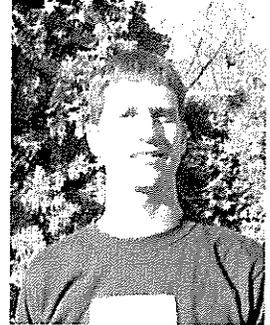
Progress:

We estimated greater sage-grouse (hereafter sage-grouse) collision rates with barbed-wire fences within winter and breeding habitats, and I intend to model the influence of topographic, biological, and technical features on sage-grouse collision rates. In the second aspect of the project, we used pen-raised hen ring-necked pheasant carcasses as the sampling unit to evaluate factors influencing scavenging and detectability of fence

collision victims in sagebrush-steppe habitats. This was done using a completely randomized design with two levels of treatment effects for habitat type (big sage or low sage), and carcass distance from the fence as a covariate, with carcasses placed at random distances from 0-15 meters. Field work was conducted from January through May 2009 and will continue in January 2010. Preliminary analysis of data is underway.

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

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



Objectives:

- Our objective was to estimate the probability of birds attending leks and the probability of detecting attending birds during a lek route count in order to relate counts of birds at leks to the actual population abundance.
- We also attempted to estimate survival of nests and survival of yearling and adult birds in our study population.

Progress:

Recent trends based on lek counts indicate populations of greater sage-grouse (*Centrocercus urophasianus*) are generally declining throughout their range. We used mark-resighting techniques to model the probability of male greater sage-grouse attending leks and counts of birds from blinds located within 20 m of leks to estimate detectability. Birds were captured in the winters of 2006, 2007, and 2008 and fitted with 16.5 g necklace style radio transmitters. Triangulation from 2 locations off each lek (during 2007, 2008, and 2009) was used to “re-sight” marked birds. We fit a Cormack-Jolly-Seber model to these data using program MARK. We restricted our predictor variables to time (Julian date), year, age of birds (adult or yearling), and their interactions. The top model chosen by AIC model selection procedures included the variables of year, age, and a quadratic time trend. For our final analysis of the complete data set, we will include additional variables such as time of day and weather in our candidate set of models, which should result in more precise estimates of attendance probability. Preliminary analysis of our detectability study indicates that between 87% and 91% of the birds actually attending a lek are included in the counts performed during a lek route. Nest success for our study area ranged from 13.3% and 27.6% during the period from 2007-2009. Further analysis of these data should produce estimates of yearling and adult survival for this population, in addition to identifying variables that affect the probability of individual birds being included in lek route counts, adult and yearling survival, and nests surviving to hatch.

HOW IS RECOVERY DEFINED BY THE NUMBERS?

Principal Investigator: J. Michael Scott Ph.D., U.S.G.S.
Cooperating Investigators: Dr. Dale Goble, College of Law
Dr. Maile Neel, University of Maryland
Post Doctoral Researcher: Dr. Aaron Haines
Agency Funding: Center for Research on Invasive Species and Small
Populations (CRISSP)
& U.S. Geological Survey
Completion Date: January 2010

Objectives:

- To determine if there has been an increase in the proportion of species listed under the Endangered Species Act (ESA) that can be considered for recovery.
- Has the proportion of species with sufficient information to develop measurable recovery criteria increased over time?
- Have the levels of abundance at listing, at recovery plan writing, and required for delisting changed through time?

Progress:

A database of all listed species with completed recovery plans has been developed. The database includes information on species population size and number of populations at time of listing, at time recovery plan was written, and what has been stipulated for recovery goals. In addition, a database has been developed that outlines the listing and recovery record for species that have been delisted from the ESA. Initial efforts have been made to analyze data and begin writing of a manuscript.

The purpose of the ESA is to conserve at-risk species and the ecosystems on which they depend (16 U.S.C sec. 1531(b)). This purpose is achieved when the measures provided by the Act are no longer necessary to ensure long-term survival of the species in the wild, i.e., when species are recovered (16 U.S.C sec. 1532(3)). In this project we quantified the *de facto* operational definitions of these categories as they are specified in recovery plans and *Federal Register* documents.

In the last decade (1996-2007), some aspects of the recovery process have improved. Use of population viability analysis has increased from 3% of species to 7.5%; population size of plants at listing has increased from 300 to 1,443, and delisting criteria for vertebrates population size has increased from 2,000 to 5,000. Based on the consistency and improvements made within the recovery process the USFWS should be commended for its efforts in trying to define recovery for a growing list of species in danger of extinction, especially with the lack of guidance provided by the ESA (Rolf 1991, Stokstad 2005) and lack of resources provided to recovery plan authors (Foin et al. 1998). At the same time, we found that the median population size for invertebrates at listing has declined from 999 to 99, and the percentage of listed species with recovery criteria \leq

population size at listing increased from 17% for downlisting) and 14% for delisting in recovery plans before 1996 to 21% and 17.5% respectively in recovery plans after 1995.

NPSCAPE – A BASIS FOR LANDSCAPE MONITORING

Principal Investigators:	J. Michael Scott
Student Investigator:	Leona K. Svancara
Funding Agency:	National Park Service
Project Status:	In progress
Estimated Completion:	December 2010



Objective:

- Assess the ecological context of the National Park System and its connectivity to other conservation areas.

Progress:

The ecological setting and context of parks can be described by the broad-scale context in which the park exists, and the ‘ecological footprint’ of human activities that can affect park natural resources. The size of habitat patches, the intensity of development along park boundaries, and population density in nearby areas are examples of landscape features that will very likely affect park resources and visitor experiences. This study (NPScape) addresses these sorts of broad-scale factors, focusing on a limited number of attributes that have been linked to the condition of park natural resources. These variables provide information that is useful at local, regional, and broader scales, and that is often not readily available because the data are difficult to acquire, process, or evaluate.

The overall goal of NPScape is to report and evaluate broad-scale measures that improve our understanding and management of park resources. Reports produced by the NPScape project focus on individual parks or groups of close-by parks, but the overall scope of the project encompasses more than 270 park units with significant natural resources. The scope of the project requires the use of data that are consistent over large areas and that can be relatively easily processed and interpreted. Because NPScape can address only a small number of questions and we have a very limited ability to customize analyses and reports to address park-specific situations, a core goal of NPScape is to provide data and methods that empower parks and Inventory and Monitoring (I&M) Networks to enhance and extend these results if they wish to do so.

The measurements and analyses we are providing fall into three broad categories: Natural systems, human footprint, and conservation status. We produced a Measurement Description Summary (MDS) for each category of measurements (e.g., Land Cover, Population/Housing, Roads, and Landscape Pattern) which provides additional information on the data used and other data sources evaluated. Data sets, results, graphics, and algorithms are available to NPS staff. We documented data processing and analyses in standard operating procedures consistent with NPS I&M guidance (Oakley et al. 2003), in the format of standard operating procedures that facilitate incorporation of our methods into I&M Protocols.

IMPLICATIONS OF CLIMATE VARIABILITY FOR OPTIMAL MONITORING AND ADAPTIVE MANAGEMENT IN WETLAND SYSTEMS.

Principal Investigators: J. Michael Scott
Brad Griffith, USGS, Alaska
Student Investigator: Leona K. Svancara
Project Status: In progress
Estimated Completion: December 2010



Objectives:

- Consult with refuges to determine programs for monitoring
- Document feasible management actions

Progress:

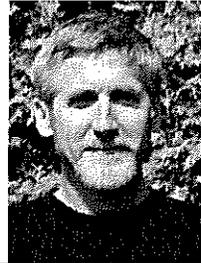
We completed consultation with refuges” as outlined in Figure 2 and the text of the proposal. We designed and executed a survey for each of the four refuges for each of two regions. The surveys: 1) identified existing monitoring programs and their rationale, priorities, uses, evaluation methods, and costs; 2) identified climate related system drivers, their mode of action and relative magnitude effect compared to non-climate drivers; and 3) documented the management actions that were feasible, climate related and the relative costs of actions. We then held 2-day face-to-face meetings with refuge personnel from each region where we: 1) presented a primer on adaptive management and 2) developed a “Decision Elements Worksheet” for each region. The Decision Element Worksheets outlined a regional refuge objective, the expected benefits from achieving the objective, monitoring actions that were available and hypothetical models of how the monitored system was expected to work and the expected environmental drivers and the monitoring elements and expected costs of monitoring. The summary objectives were to 1) Maintain an optimum mix of water depth classes in managed wetlands during the spring to fall period for Region 6 refuges and 2) Monitor seasonal trends in wetland ponds for Region 7 refuges. Specific details of each regional refuge objective were specified and these details set the nature of the problem for devising the tasks necessary to attain our second objective of identifying the spatial and temporal frequency of sampling necessary to attain reasonable statistical power for detecting relevant changes in habitats/populations. In addition we developed the recruitment advertisement for hiring the modeling Post-Doctoral Researcher who will execute much of the modeling in year 2.

In FY2009 we will hire the Post-Doctoral Researcher as soon as practical and execute the processes of 1) estimating the variance and trends in putative climate drivers relevant to each region in conjunction with refuge personnel and 2) conducting the stochastic dynamic modeling of the frequency and intensity of surveys necessary to detect a range of magnitudes of management activities as denoted in Figure 2 and the text of the proposal.

Some trepidation by refuges regarding the exact nature of the project was overcome by the face to face meetings. It is likely that we will need to specify a range of potential variance in monitored attributes of refuges rather than estimate the variance directly from data. A

concerted effort to re-establish direct contact with refuges will be made as soon as the Post-Doctoral Researcher is hired.

NATAL DISPERSAL AND PHILOPATRY IN TWO SPECIES OF SYMPATRIC BUTEOS IN SOUTHERN CALIFORNIA



Principal Investigator: J. Michael Scott, Ph.D.
Student Investigator: Peter Bloom
Completion Date: June 2010

Objectives:

Evaluate the long-term conservation implications of philopatry in heavily modified Coastal sagebrush and chaparral and associated environments to determine several questions:

- Where do they go?
- Are the two species philopatric? Why or why not?
- What proportions of each sex of the two species are philopatric?
- What proportions of the fledgling red-tailed hawks migrate outside the natal region and what proportion remain?
- What proportion of the fledgling red-shouldered hawks disperse outside the natal region and what proportion remains.
- Do the two species exhibit sex-biased dispersal?
- Is there any evidence that breeding dispersal moves of red-shouldered hawks are closer to the natal territory?
- What proportion of young move > 100 km?
- Is there a latitude or other factor that predicts northward vs. southward movement of Red-tailed Hawks across North America?
- Do the data on natal dispersal distances provide any support for Wright's "isolation by distance" hypothesis?

Progress:

During the springs of 1970-2002, we banded 3,860 nestling red-tailed hawks and of 2,112 nestling red-shouldered hawks (Figure 3) resulting in 73 (1.89%), breeding age red-tailed hawk recaptures, and 99 (4.69%) breeding age red-shouldered hawk recaptures of known sex respectively. Another in as yet unanalyzed, nearly equal number of pre-breeding aged red-tailed hawks and pre-breeding aged red-shouldered hawks were also recaptured of presumed known sex. The BBL provided 121 (3.13%) breeding aged red-tailed hawk recoveries and an unanalyzed number of pre-breeding aged red-tailed hawks, as well as 82 (3.88%) breeding aged and an unanalyzed number of pre-breeding aged red-shouldered hawk recoveries, all of mostly unknown gender from the above total bandings during this study.

Migratory movements of juvenile red-tailed hawks banded in southwestern California are atypical for avian species. First year juvenile red-tailed hawks were recovered, and sometimes recaptured in Idaho, Montana, Utah, Nevada and northern California as much

as 1,000+ km away from their natal territory. However, no live or fresh mortalities were found in any state other than California after approximately 24 months age. Mean post migration red-tailed hawk natal dispersal distances for 45 recaptured males was 5.61 km +/- 0.63 SE with a median of 4.45 (range 0 - 26.25 km). The mean for 28 recaptured female red-tailed hawks was 5.41 km +/- 0.67 SE with a median of 4.48. Interestingly, female red-tailed hawks did not disperse significantly further than males ($P=0.90$). Distances moved between the natal territory and breeding area were relatively short for a bird with the demonstrated flight capabilities of a large hawk. Preliminary analysis of recapture data indicates that sex-biased dispersal does not exist in red-tailed hawks of this population.

Fifty-four recaptured male red-shouldered hawks moved a mean of 8.73 km +/- 1.07 SE with a median of 5.76 (range 0 – 31.0), while 45 females moved a mean of 13.49 km +/- 1.66 SE with a median of 9.00 (range 0 -49.0). Female red-shouldered hawks dispersed significantly further than their mates on the study area ($P=0.0189$).

In contrast to red-tailed hawks, only four red-shouldered hawks moved more than 100 km and none undertook predictable large scale north bound juvenile migrations, although the majority of short distance movements were north bound. However, two radioed hawks did exhibit what could be referred to as vagrancy to the east into Nevada and to the south into Baja California del Sur, or what Mayr (2001) described on a larger scale as "... the spread of individuals of a species beyond the current species range," essentially potential founders.

Preliminary analysis of recapture and recovery data from both species suggests that the red-tailed hawk is highly philopatric and that the red-shouldered hawk is less so. The fact that the red-tailed hawk is strongly philopatric is of particular interest because many juveniles make a large >500 km north-northeast movement and could nest anywhere between the natal area and their summering range but usually return to within 10 km of where they fledged. First two chapters of thesis are completed and student plans to defend in the Spring of 2010.

AMPHIBIAN CHYTRID FUNGUS DISTRIBUTION

Principal Investigator: Lisette Waits
Student Investigators: Caren Goldberg
Funding Agency: IDFG
Completion Date: June 2010



Objectives: 1) Provide IDFG with sampling supplies for the amphibian pathogen *Batrachochytrium dendrobatidis* (Bd); 2) quantify the amount of Bd in each sample; 3) map and archive results to be used with other data for a publication on the prevalence of Bd in different amphibian species.

Progress: We provided IDFG with supplies for sampling 100 amphibians during the spring and summer of 2008-2009. So far, we have received and analyzed 28 samples from three species [23 Columbia spotted frogs (*Rana luteiventris*), 1 Western toad (*Bufo boreas*), 1 Pacific treefrog (*Pseudacris regilla*), and 2 unknown] at 22 locations. Seventeen of the samples tested positive for *Bd*: 16 Columbia spotted frogs and 1 unknown. These data have been mapped and archived. We are currently awaiting samples from the 2009 field season.

BRUNEAU DUNES TIGER BEETLE TAXONOMY

Principal Investigator: Lisette Waits
Student Investigator: Caren Goldberg
Funding Agency: IDFG
Completion Date: June 2010



Objectives: 1) Design a protocol to efficiently and successfully extract high quality DNA from Bruneau Dunes Tiger beetle samples while preserving as much tissue as possible for morphological analysis; 2) extract DNA and collect mitochondrial sequence data for over 100 beetles collected by IDFG; 3) conduct phylogenetic analyses to determine the genetic relationships of these samples; 4) publish these results in a peer-reviewed journal and present results at an Idaho Chapter of the Wildlife Society Meeting.

Progress: We have determined that the optimal protocol for extracting DNA for this project is to use the middle and hind leg from each individual with a DNeasy Blood and Tissue kit (Qiagen, Valencia, CA), with the substitution of PBS for ATL, complete maceration of the tissue before enzymatic digestion, and the final elution in 200µl of AE. We have obtained 132 beetle samples and have extracted DNA and collected sequence data for 12 so far at

the cytochrome oxidase III mitochondrial gene using primers developed by Vogler and Welsh (1997). We will continue to collect sequence data at this locus for the remaining samples and conduct phylogenetic analyses to determine if data from additional loci will be necessary to determine the relationships among these groups.

Vogler AP, Welsh A (1997) Phylogeny of North American *Cicindela* tiger beetles inferred from multiple mitochondrial DNA sequences. *Molecular Phylogenetics and Evolution* 8:225-235.

PYGMY RABBIT SURVEY MARKER

Principal Investigator:	Lisette Waits
Student Investigator:	Caren Goldberg
Funding Agency:	IDFG
Completion Date:	June 2010



Objective(s): 1) Complete optimization of protocol to distinguish between pellets of all North American lagomorph species using a single PCR reaction; 2) work with IDFG to organize an effort to collect pygmy rabbit pellets from multiple locations in southern Idaho; 3) identify all collected pellets to species; 4) publish these results.

Progress: We are in the final stages of completing optimization of the PCR protocol for the lagomorph species identification reaction, which has been tested on at least 15 of each 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*). All species have been accurately identified with one exception. We found that mountain and desert cottontail gene sequences are so similar that this test will not be able to distinguish between them. However, all pygmy rabbit samples were identified as pygmy and no other species was misclassified as a pygmy rabbit.

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 were considerably higher for samples collected in the winter (94% success vs 74% success). We are now ready to begin a survey for this species across Idaho using fecal DNA analyses.

RED WOLF MICROSATELLITE GENETICS AND HABITAT USE PROGRAM

Principal Investigator: Dr. Lisette P. Waits
Student Investigator: Justin Bohling
Funding Agency: USGS/USFWS
Completion Date: 20 December 2009



Objectives:

- Determine the genetic identity and ancestry of all puppies, captured animals, and fecal samples collected in the Red Wolf Experimental Population Area
- Survey the area immediately adjacent to the Experimental Population Area to collect scats for genetic analysis of ancestry 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
- Optimize and evaluate fecal DNA sampling and analysis methods.

Progress: In eastern North Carolina the recovery of the critically endangered red wolf (*Canis rufus*) is threatened by hybridization with invasive coyotes (*C. latrans*). One of the challenges associated with recovery is evaluating the genetic ancestry of unknown animals so that non-red wolves can be removed from the population. Using previously developed microsatellite genotyping techniques, we employed several different methods to assess the genetic ancestry of unknown canids in North Carolina. These unknown canids included canid puppies captured at den sites, unknown adult animals captured due to general monitoring, and animals identified via non-invasive genetic sampling of fecal samples. For puppies, the principal method used to evaluate ancestry was a previously reconstructed pedigree of the wild red wolf population. Ancestry of other unknown individuals was determined mainly through use of maximum likelihood methods previously developed for red wolves and newly developed Bayesian clustering methods.

In the spring of 2008, the US Fish and Wildlife Service (USFWS) captured 60 canid puppies in the Red Wolf Experimental Population Area; 50 of these were identified as the offspring of wolves using the pedigree and 10 were identified as F1 red wolf-coyote hybrids using the maximum likelihood method. In addition, 16 unknown adult animals were identified as coyotes, six as hybrids, and two as red wolves.

In the winter of 2008 we conducted a non-invasive genetic survey of fecal samples from a 22,000 km² region surrounding the Red Wolf Experimental Population Area to assess the extent of red wolf dispersal. This region was divided into 326 grid cells that were stratified based upon the presence of protected areas across >10% of a cell's area. From this classification 30% of the 'protected area' cells and 10% of the 'non-protected area' cells were selected at random to be surveyed. Surveys were conducted along 10 km of rural dirt roads per grid cell selected at random using proportional probability sampling. Over the course of the survey 435 km of roads were sampled across 26 'non-protected area' cells

CURRENT PROJECTS – WILDLIFE AND TERRESTRIAL RESOURCES

and 20 'protected area' cells. 615 scats were collected during this survey and 250 were identified as canids by sequencing the mitochondrial DNA (mtDNA) control region. MtDNA sequencing assigned 220 scats to coyotes, 18 to dogs, seven to gray wolves, and five to red wolves. Microsatellite genotyping at 17 loci was able to identify 82 unique individual canids. Bayesian clustering programs suggested that 63 of these individuals were coyotes, 14 were dogs, one was a gray wolf, and four were hybrids. No pure red wolves were identified by this survey; the only animal with significant red wolf ancestry was a red wolf-coyote hybrid that was estimated to be 30% red wolf. All five of the scats that produced the red wolf mtDNA haplotype were identified as coyotes, although one program suggested that one of the scats may have belonged to an animal that was 35% red wolf. Overall we found little evidence of red wolf dispersal and genetic introgression outside the Experimental Population Area.

For optimization, two separate PCR multiplexes were developed, one containing DNA primers for nine loci and another for eight loci. The first multiplex was used to screen canid scats and the second multiplex was used to gain further resolution in assessing admixture if needed. Calculations for the probability of identity for siblings suggested that six loci needed to be successfully amplified to correctly identify unique individuals. From the 250 canid scats, 135 (54%) were successfully amplified at six or more loci and regrouping of these genotypes identified 82 unique individuals. The average per locus amplification success rate was 60% and error rates per locus for allelic dropout varied from 0 to 42% and for false alleles from 0 to 5%.

Completed Projects – Wildlife and Terrestrial Resources

SOCIAL, LEGAL, AND ECONOMIC DIMENSIONS OF INVASIVE SPECIES AND THREATENED/ENDANGERED SPECIES

Principal Investigator: Cort Anderson, Ph.D./Mike Scott, Ph.D.
Funding Agency: Center for Research on Invasive Species & Small Populations (CRISSP)
Post doctoral Scientist: Aaron Haines, Ph.D.
Date of Completion: 31 May 2008

Objectives:

- Work with an interdisciplinary team to research questions on the social, legal, and economic dynamics of invasive species and threatened/endangered species management.
- Research the listing policy for threatened/endangered species and develop landscape management frameworks to effectively evaluate the conservation planning process.

Results:

We developed a database for all federally listed species with completed recovery plans (i.e., 1,136 species) to evaluate the recovery process used in the implementation of the Endangered Species Act. Of the species we evaluated, we found that 84% would require continuing long-term management investments to maintain their existence in the wild (i.e., conservation reliant species). Of these conservation reliant species, 66% required control of other species (mainly control of invasive species) and 51% required active habitat management as main management investments to maintain conservation reliant species in the wild. Based on these findings, it is apparent that future conservation policies will need to include innovative and interdisciplinary approaches to address greater logistic, economic, and political challenges for managing threatened and endangered species.

BLACK BEAR HABITAT SELECTION AND HIGHWAY CROSSING PATTERNS

Principal Investigator: Janet Rachlow, Ph.D.
Student Investigator: Jesse Lewis
Funding Agency: Idaho Department of Fish and Game
Completion Date: 30 June 2008



Objectives:

- Evaluate habitat selection and movement patterns by black bears (*Ursus americanus*) within the corridor of Highway 95 in northern Idaho.
- Develop predictive models of habitat association for crossing locations along Highway 95.
- Compare results of habitat selection across a range of GPS telemetry acquisition intervals.
- Quantify how habitat variables affect Global Positioning System collar performance across the range of variation within the study area.

Progress:

During 2005, 11 black bears (9 males, 2 females) and 1 female grizzly bear were fitted with Lotek GPS collars that store data on board. We downloaded location data sets for 7 black bears during the summer of 2005 from collars that were dropped (n=5), from one animal that was recaptured, and from one bear that was harvested.

During January - March, 2006, we visited winter dens of 6 black bears to retrieve GPS data and to replace GPS collar batteries. During the summer, we trapped an additional 13 black bears and 1 grizzly bear, and fitted each with GPS collars. We also recaptured a grizzly bear previously collared in Canada and fitted a yearling black bear with a VHF collar. I also surveyed relative shrub abundance, presence of fence, and presence of cut-banks along Highway 95.

We completed an assessment of how habitat variables affect GPS collar performance. Results of this work are currently in press in the *Journal of Applied Ecology* (Lewis et al. 2007). The M.S. student, Jesse Lewis, will be completing the project and his thesis during August 2007. We anticipate 3 additional publications addressing: 1) Habitat characteristics associated with highway crossings by black bears; 2) Habitat selection by black bears and the influence of highways and human development; and 3) Influence of location fix rate on evaluations of habitat selection: GPS and VHF technology.

**WINTER ECOLOGY OF VANCOUVER CANADA GEESE IN
SOUTHEAST ALASKA**

Principal Investigator: John Ratti, Ph.D.
Student Investigators: Trevor Fox
Funding Agency: U.S.G.S. Alaska Science Center
Completion Date: 04 June 2008



Objectives:

- Compare characteristics of shorelines that are used by Canada geese to intertidal areas that are not used. Use GIS coverages to develop a predictive model of the distribution of potential wintering areas in Southeast Alaska
- Evaluate how habitat area, snow cover, intertidal substrate, and plant community composition affect numbers of geese that use a wintering site.
- Determine how Canada geese are distributed among available habitats within a wintering site, and whether patterns of habitat use change with tide, weather, or date

Progress:

Report was completed Thesis was defended successfully in June 2008. Canada goose use of shoreline characteristics in Southeast Alaska was modeled using logistic regression. Shoreline characteristics were sampled within 500-m and 1000-m circular buffers placed around used and available locations. These buffers were used to develop 2 separate sets of models (small- and large-buffer model). Because geese are gregarious animals, spatial dependency was a concern in the analyses. To account for this, I included the number of geese within additional buffers up to 3000 m from location and used these as potential explanatory variables. At least one of these dependency variables appeared in 81.8% and 77.4% of candidate models of small-buffer and large-buffer models; respectively.

A portion of sampling data was withheld for model validation. This data was scored using the Score option in PROC LOGISTIC (SAS version 9.1). The discriminatory capacity of models was evaluated by looking at the area under the curve (AUC) of relative operating characteristic (ROC) curves. All AUC values were above 0.7, which indicates reasonable discriminatory capacity. Work is completed, final report completed June 2008.

TRANSLOCATION OF TRUMPETER SWANS

Principal Investigator: Kerry Reese, Ph.D.
Student Investigator: Darlene Kilpatrick
Funding Agency: Idaho Department of Fish
and Game
Completion Date: 30 December 2007



Objectives:

- The primary objective is to determine whether winter translocation of trumpeter swan cygnets is effective at increasing the distribution of the species.

Results:

Trumpeter swan cygnets have been trapped each of the past several winters in the Island Park area of Idaho. Control birds were radio-marked and released at point of capture and translocated cygnets were radio-marked and moved to release sites along the Bear River, Idaho. In the winter of 2002-2003, 78 cygnets were captured and 39 were translocated. In 2003-2004, 100 cygnets were captured and 51 were translocated. In 2004-2005, 103 cygnets were captured and 51 were translocated. Birds were monitored over each winter until migration moved them north. Darlene Kilpatrick will complete her thesis in December.

ASSESSING AVIAN DIVERSITY AND IDENTIFYING CONSERVATION TARGETS IN THE NATIONAL WILDLIFE REFUGE SYSTEM

Principal Investigator: J. Michael Scott, Ph.D.
Student Investigator: David Rupp
Funding Agencies: U.S. Geological Survey
Environmental Science
Completion Date: 10 March 2009



Objectives:

- Create a list of bird species ranked by conservation priority to present to the National Wildlife Refuge System (NWRS) for use in strategic growth at the national level and for habitat management strategies at the refuge level.
- Assess the representation and redundancy of America's bird diversity on the NWRS.
- Identify bird species that could serve as conservation targets for strategic growth and habitat management in the NWRS.

Progress: Documenting the occurrence of species on refuges in the Refuge System is an integral initial step in the process of conserving the biodiversity of the System. To assess the current refuge data on bird occurrence and abundance, we surveyed all refuges for the format and availability of bird checklists. We obtained 381 bird lists covering 427 (78.3%) of the 545 refuges. A high percentage of these lists contained breeding, seasonal, and abundance data, yet only 46.2% followed the *Graphic Standards* for checklists developed by the Service. Refuges without checklists were more likely to be small satellite or easement refuges, closed to the public, and without local support groups. We used the refuge bird checklists to assess the representation and redundancy of bird species nationally, regionally, and by Bird Conservation Region across the System. Waterfowl and shorebirds had much higher levels of occurrence in the Refuge System than waterbirds and landbirds. Of the 90 bird species listed under the Endangered Species Act, 34 (37.8%) were not recorded on a refuge; of these, the ranges of 32 (94.1%) were limited to one Bird Conservation Region. Hawaiian species were among the least represented species in the System in several of our analyses of birds of conservation concern. Among continental species, the high priority birds with a lack of representation or redundancy of occurrences in the Service's Southwest Region could serve as conservation targets for System growth. We also assessed the distribution of Refuge System land by Bird Conservation Region. Forty-seven percent of the System's refuges occurred in BCRs in the northern plains and the southeastern coast, regions where the System has protected waterfowl breeding habitat and wintering habitat, respectively. BCRs that ranked in the lowest quartile for total refuge acres and percent of land area in refuges included several in the south central United States: Edwards Plateau, Oaks and Prairies, and Shortgrass Prairie. Our evaluation of new acquisitions to the System—including new refuges and prioritized additions to existing refuges—suggested that this growth has been largely opportunistic rather than strategic in regards to bird conservation.

We propose that gaps in species protection in the National Wildlife Refuges cannot be understood independently from the entirety of conservation lands in the United States and surrounding regions.

A RISK ASSESSMENT FRAMEWORK FOR DEFINING SCIENTIFICALLY-DEFENSIBLE RECOVERY GOALS FOR LISTED SPECIES

Principal Investigators:	J. Michael Scott, Oz Garton Scott Mills, University of Montana
Post Doctoral Researcher:	Jon Horne
Student Investigator:	Katherine Strickler
Funding Agency:	Department of Defense
Completion Date:	31 Mar 2009



Objectives:

- Develop and test tools that can be used to better manage listed species on Department of Defense (DoD) installations by estimating management effects and

extinction risk under a range of life history attributes, available data, and training, testing, and management actions.

Progress:

Military land managers increasingly are faced with the challenge of balancing threatened and endangered species (TES) conservation with military testing and training activities, which must not impede species' recovery. This challenge is often complicated by incomplete information on species' populations and demography that precludes conducting quantitative, complex viability analyses to assess the effects of military and conservation activities on the health of these populations. Military land managers are uniquely situated to enhance local populations of TES and, if provided the tools to conduct thorough viability analyses, can facilitate more robust TES populations and alleviate current training restrictions.

We have compiled demographic data for 219 species (18 amphibians, 26 birds, 20 mammals, 5 reptiles and 150 plants) for the parameterization of our Life History Typology matrix models. Calculated vital rate elasticities concurrently with construction of matrix models. Developed a new analytical technique that combines meta-analysis with a model selection approach to determine which variables (e.g. ecological or life history variables) best explain variation in effect size (the increase in survival or reproductive rates of a particular species as a result of management) across species. We have finalized a spatially-explicit simulation model for assessing metapopulation viability. This model is a stage-matrix based population projection model that incorporates the effects of species-specific parameters such as mean vital rates (i.e., fecundity and survival), variation in vital rates, and density dependence as well as effects due to metapopulation dynamics (i.e., number of populations, dispersal among populations, and correlations in vital rates among populations). We have developed beta versions of software programs including: PopGrowth for analysis of exponential population growth using time-series abundance estimates, and MetaPVA for global sensitivity analysis of metapopulation models. Developed R programs to 1) fit a stochastic density dependent population model to time series observations of population abundances and 2) calculate maximum likelihood or restricted maximum likelihood estimates of unknown parameters in the Gompertz state space model of stochastic population growth. To apply modeling approaches and software to threatened and endangered species on DoD lands, we have formed collaborations with Fort Hood (Texas), Texas A&M University, The Nature Conservancy-Texas, and Eglin Air Force Base (Florida). Two graduate seminars were conducted during spring semester 2007: 1) spatially explicit modeling of meta populations at UI and 2) life history typologies at University of Montana.

CONSERVATION RELIANT SPECIES

Principal Investigators: J. Michael Scott and Dale Goble
Funding Agency: Idaho Department of Fish and Game
U.S. Geological Survey
Completion Date: December 2009

Objectives:

Test the assumption that imperiled and endangered species will no longer require specific management intervention after down listing or delisting.

Results: Study of delisted and down listed threatened and endangered species found that 54% require continuing species specific management intervention if recovered status is to be sustained.

Thirty-five years after passage of the Endangered Species Act, it has become evident that two major assumptions of those who wrote and passed the Act -- that once the recovery goals for a species are met it will no longer require continuing management and recovery of threatened and endangered species will be accomplished by the federal government with federal funds – are false. Even when management actions succeed in achieving recovery goals, continued maintenance of viable populations of many species will require continuing, species-specific human intervention. We term such species “conservation reliant.” Our analysis indicates that fully 84% of the species listed under the Endangered Species Act are conservation reliant. These species will require continuing, long-term management investments. If these listed species are representative of the larger number of species thought to be imperiled in the United States, the challenge facing conservation managers will be logistically, economically, and politically overwhelming. Conservation policies will need to be adapted to include ways of prioritizing actions and implementing innovative management approaches within the scope of the Endangered Species Act.

Results of this work have been presented at several professional society meetings; Principal Investigator chaired two symposia on conservation reliant species at international meetings of professional societies and has presented findings to US Fish and Wildlife Service Biologists. Final report has been completed two manuscripts published and one other in review.

A THEORETICAL APPROACH TO USING HUMAN FOOTPRINT DATA TO ASSESS LANDSCAPE LEVEL CONSERVATION EFFORTS

Principal Investigator: J. Michael Scott Ph.D.
Cooperating Investigators: Dr. Matthias Leu, USGS
Forest and Rangeland Science Center, Boise.
Leona K. Svancara
Kerry Reese PhD
Post Doctoral Researcher: Aaron Haines PhD
Agency Funding: Center for Research on Invasive
Species and Small Populations, (CRISSP)
& U.S. Geological Survey
Completion Date: 30 April 2008

Objectives:

- Develop a theoretical approach to measure conservation success.
- Outline how the use of human footprint spatial data layers can be used to evaluate if conservation strategies are being effective on the ground.

Results:

Conservation organizations are increasingly being held accountable for identifying and documenting measures of conservation success. We propose the use of human footprint data to aid in the assessment of conservation efforts by monitoring qualitative change in the human footprint (i.e., spatial land use measures of negative anthropogenic activity) within a hypothesis driven framework to assess the effects of conservation efforts (i.e., positive anthropogenic activity). If human footprint data shows that implemented conservation strategies mitigated or reduced negative anthropogenic influences, then a potential conservation approach is working. In contrast, if the implementation of conservation strategies did not mitigate or reduce the human footprint, then new conservation approaches may need to be developed or old ones refined. Human footprint data may offer great potential for assessing conservation efforts when used as part of a larger conservation monitoring strategy.

Findings from this research were presented at several scientific meetings, shared with cooperators in Idaho Department of Fish and Game and Governor's Office for Species of Conservation Concern. Publication entitled "A Theoretical Approach to Using Human Footprint Data to Assess Landscape Level Conservation Efforts" was accepted for publication in Conservation Letters: A.M. Haines: L. K. Svancara J. M. and Scott: K.P. Reese. Two related manuscripts are in review.

ESTABLISHING NEW PATHWAYS TO RECOVERY OF THREATENED AND ENDANGERED SPECIES

Principal Investigator: J. Michael Scott Ph.D., U.S.G.S.
Cooperating Investigators: Donald Pitts, U.S. Army Corp. of Engineers;
Dr. Barry Noon, Colorado State University
Student Investigator: Gina Wilson
Agency Funding: U.S. Department of Defense (DoD)
Completion Date: 31 Mar 2008

Objectives:

- Assess the recovery status of threatened and endangered species on military lands
- Compare their status with that of populations and endangered species not found on military lands
- Identify those species that could be future success stories in relatively short time periods
- Develop realistic time frames for evaluating the recovery status of a listed species
- Apply the insights derived from the modeling exercises to real existing data sets that occupy a wide range of ecological conditions.

Progress:

The work to be conducted will estimate meaningful time frames to evaluate a species recovery status based on the unique ecological and life history attributes of each listed species and recovery actions taken. We have assembled a multidisciplinary team of researchers who together have more than a hundred years of experience with threatened and endangered species these investigators will compile a database of recovery status for T and E species on military lands and those found elsewhere. Successful management of threatened and endangered species on Army installations will be identified with a literature survey, and through polling endangered species and natural resource managers on the installations. Management systems both planned and those innate to the unique situation of Army installations will be compared to those directly off the installations and within the region, thereby gaining insight into management priorities region-wide. The rate of recovery of a listed species, even under the most optimal conditions for its population growth, will ultimately be limited by the demographic characteristics of its life history. That is, a species' maximum rate of population growth will be constrained by its demographic potential that is a function of its age-specific rates of survival and reproduction. Demographic attributes such as age at first reproduction, average number of young produced, and survival of young to reproductive age will determine the maximum possible time period over which a listed species can possibly experience "recovery."

Recovery status of U.S. DoD installations has been assessed. Initial findings suggest threatened and endangered species on DoD lands have no conservation advantage over threatened and endangered species on other U.S. lands. DoD success stories have been identified; low hanging fruit - species that could be moved along the recovery gradient in a

COMPLETED PROJECTS – WILDLIFE AND TERRESTRIAL RESOURCES

very short amount of time have been also identified. Initial modeling efforts have identified factors that have influenced time to recovery for delisted and downlisted species. Initial answers for recovery time have been identified and further analysis is being done. A sampling framework for recovery plans and Integrated Natural Resource Management Plans (INRMPs) is being created. Databases that include management actions in recovery plans and INRMPs, conservation status, and recovery status of threatened and endangered species have been assembled. Literature on demographic and life history information for selected threatened and endangered species on DoD lands, e.g. brown pelican, least tern, peregrine falcon, bald eagle has been gathered. Initial work has analyzed time frames for recovery of species on DoD lands that have been downlisted or delisted. We have developed algorithms for determining factors that influence time to recovery. Final report to be completed by March 31, 2008

Awards, Publications, Service and Other Activities FY 2008 – 30 June 2009

HONORS AND AWARDS

J. Michael Scott

- George Fell Award, Natural Areas Association. 2009.

C. M. Moffitt

- Outstanding mentor award, Idaho Chapter, American Fisheries Society, March 2008.

Lisette Waits

- Best professional presentations at Idaho Chapter of the Wildlife Society Meeting, Moscow Idaho.

David Rupp, MS Student

- Outstanding Graduate Student 2008-2009. University of Idaho Environmental Sciences.

Lubia Cajas Cano, PhD Student

- Dissertation Support, Regional Program of Graduate Fellowships for Latin American Students. Ford Foundation, New York. 2006 -2008.
- Multi-cultural Scholarship, University of Idaho 2008-1010.
- Best student oral presentation, Idaho Chapter, American Fisheries Society, March 2008.

PEER REVIEWED PUBLICATIONS

Anlauf, K. and C. Moffitt. 2008. Models of stream habitat characteristics associated with tubificid populations in an intermountain watershed. *Hydrobiologia*. 603:147–158.

Blanchfield, P.J., L.S. Tate, J.M. Plumb, M.L. Acolas, and K.G. Beaty. 2009. Seasonal habitat selection by lake trout (*Salvelinus namaycush*) in a Canadian shield lake: constraints imposed by winter conditions. In press *Aquatic Ecology*.

Bruce, R. L., C. M. Moffitt, and B. Dennis. 2009. Survival and passage of ingested New Zealand mudsnails through the intestinal tract of rainbow trout. *North American Journal of Aquaculture*.

Bruce, R. L., and C. M. Moffitt. 2009. Quantifying risks of volitional consumption of New Zealand mudsnails by steelhead and rainbow trout. *Aquaculture Research*.

- Cajas Cano, L., and C. M. Moffitt. 2008. Comparing Footprints of Trout and Beef Production. *World Aquaculture* 39 (3): 10-13; 70-72.
- Colvin, M. E., and C. M. Moffitt. 2009. Evaluation of irrigation canal networks to assess stream connectivity in a watershed. *River Research and Applications*.25: 486-496.
- Haines, A. M., M. Leu, L. K. Svancara, J. M. Scott, and K. P. Reese. 2008. A theoretical approach to using human footprint data to assess landscape level conservation efforts. *Conservation Letters* 1:165-172.
- Lindenmeyer, D., J.M. Scott et al. 2007. Ecological Management and Design of Landscapes for Conservation - Are there General Principales? Submitted 2008-08-15
- Lindstrom, N. M. D. R. Call, M. L. House, C. M. Moffitt, and K. D. Cain. 2009. A quantitative enzyme-linked immunosorbent assay (ELISA) and filtration-based fluorescent antibody test (FAT) as potential tools to screen broodstock for *Flavobacterium psychrophilum* infection. *Journal of Aquatic Animal Health*.21:43-56.
- McGrath, K.E., J. Michael Scott, Bruce E. Rieman. 2008. Length Variation in Age-0 Westslope Cutthroat Trout at Multiple Spatial Scales. *North American Journal of Fisheries Management* 28:1529-1540.
- Muir, Rachel, J. Michael Scott. 2008. A Natural Connection: USGS Monitoring and Endangered Species Research and Monitoring. *Endangered Species Bulletin* 33: 4-8.
- Plumb, J.M., and P.J. Blanchfield. 2009. Performance of Temperature and Dissolved Oxygen Criteria to Predict Habitat Use by Lake Trout (*Salvelinus namaycush*). In press *Canadian Journal of Fisheries and Aquatic Sciences*.
- Price, A.J, W.A. Estes-Zumpf, and J.L. Rachlow. (in press) Survival of juvenile pygmy rabbits. *Journal of Wildlife Management*.
- Scott, J. Michael. 2009. Foreword to "Conservation Biology of Hawaiian Forest Birds: Implications for Island Birds." Yale University Press.
- Scott, J. M., Janet Rachlow, Robert Lackey. 2008. The science-policy interface: What is an appropriate role for professional societies? *Bioscience* 58(9): 865-869.
- Scott, J. M. Timothy H. Tear. 2007. What are we Conserving? Establishing Multiscale Conservation Goals and Objectives in the Face of Global Threats Published 2007-09-01

- Scott, J. Michael, F. Ramsey, M. Lammertink, K. Rosenberg, R. Rohrbaugh, J. Wiens, M. Reed. 2008. When is an "Extinct" Species Really Extinct? Gauging the Search Efforts for Hawaiian Forest Birds and the Ivory Billed Woodpecker. In Press 2008-09-01
- Scott, J.M., B. Griffith, R.S. Adamcik, D.M. Ashe, B. Czech, R.L. Fischman, P. Gonzalez, J.J. Lawler, A.D. McGuire, and A. Pidgorna. 2008: National Wildlife Refuges. In: Preliminary review of adaptation options for climate-sensitive ecosystems and resources. Published 2008-07-31
- Scott, J. Michael, Jon S. Horne and Edward O. Garton. 2009. Protecting the Hawaii akepa population. *Nature* 457: 456.
- Svancara, L. K., J. M. Scott, T. R. Loveland, and A. B. Pidgorna. 2009. Assessing the landscape context and conversion risk of protected areas using satellite data products. *Remote Sensing of Environment* 113:1357-1369.
- Svancara, Leona K, J. Michael Scott, Thomas R. Loveland and Anna B. Pidgorna. 2009. Assessing the landscape context and conversion risk of protected areas using remote-sensing derived data.

BOOKS AND BOOK CHAPTERS

- Baron, J. S., B. Griffith, L.A. Joyce, P. Kareiva, B.D. Keller, M.A. Palmer, C.H. Peterson, and J.M. Scott (Authors), [Julius, S.H., J.M. West (eds.), Preliminary review of adaptation options for climate-sensitive ecosystems and resources. A Report by the U.S. Climate Change Science Program and the Subcommittee on Global Change Research. U.S. Environmental Protection Agency, Washington, DC, USA, 873 pp. Published 2008-07-31
- Haro, A. J., K. L. Smith, R. A. Rulifson, C. M. Moffitt, R. J. Klauda, M. J. Dadswell, R. A. Cunjak, J. E. Cooper, K. L. Beal, and T. S. Avery, editors. 2009. Challenges for diadromous fishes in a dynamic global environment. American Fisheries Society, Symposium 69, Bethesda, Maryland.
- Julius, S.H., J.M. West, J.S. Baron, B. Griffith, L.A. Joyce, B.D. Keller, M.A. Palmer, C.H. Peterson, and J.M. Scott. 2008: Annex A: Case Studies. In: Preliminary review of adaptation options for climatesensitive ecosystems and resources. A Report by the U.S. Climate Change Science Program and the Subcommittee on Global Change Research [Julius, S.H., J.M. West (eds.), J.S. Baron, B. Griffith, L.A. Joyce, P. Kareiva, B.D. Keller, M.A. Palmer, C.H. Peterson, and J.M. Scott (Authors)]. U.S. Environmental Protection Agency, Washington, DC, USA, pp. A-1 to A-170. In Press 2008-07-31

Moffitt, C. M. 2009. Climate Change and Anthropogenic Influences – Preamble. Pages 151–153 in A. J. Haro, K. L. Smith, R. A. Rulifson, C. M. Moffitt, R. J. Klauda, M. J. Dadswell, R. A. Cunjak, J. E. Cooper, K. L. Beal, and T. S. Avery, editors. Challenges for diadromous fishes in a dynamic global environment. American Fisheries Society, Symposium 69, Bethesda, Maryland.

TECHNICAL AND SEMI-TECHNICAL REPORTS

Plumb, J. M., K. M. Cash, T. W. Hatton, E. C. Jones, N. M. Swyers, M. D. Sholtis, R. E. Reagan, and N. S. Adams. 2009. Juvenile salmonid passage and survival with respect to operation of tandem temporary spillway weirs at McNary Dam, 2007. Pages 1-126 *in* N.S. Adams and T.D. Counihan, editors. Survival and migration behavior of juvenile salmonids at McNary Dam, 2007. U. S. Geological Survey Report to the U. S. Army Corps of Engineers, Contract W68SBV70178419, Walla Walla, Washington.

THESES AND DISSERTATIONS

- Cassinelli, John D. 2007. Effects of Water Temperature on Growth and Physiology of Different Populations of Redband Trout (*Oncorhynchus mykiss gairdneri*). Master's Thesis, Department of Fish and Wildlife Resources. University of Idaho. December 2007.
- Fox, Trevor 2008, Winter ecology of Vancouver Canada geese in southeast Alaska. MS. Thesis. University of Idaho.
- Fryer, Derek. 2008. Swimming performance of hatchery-reared yearling Chinook salmon *Oncorhynchus tshawytscha*, before and after passage through the Snake Columbia River hydropower system. MS. University of Idaho.
- Kautza, Adam. 2008. Growth, Age Distribution, and Population Dynamics of Black Crappies From Idaho. Report Prepared for Idaho Department of Fish and Game. Non thesis project for Master's Degree, May 2008.
- Kilpatrick, Darlene. 2008, Translocating trumpeter swans from the Rocky Mountain population: habitat, movement, and survival. MS. Thesis. University of Idaho.
- Lewis, Jesse. 2007, The effects of human influences on black bear habitat selection and movement patterns within a highway corridor. MS Thesis.
- Nielson, R. Jordan. 2008. Control of New Zealand Mudsnaills in Fish Hatcheries. Master's Thesis. Department of Fish and Wildlife Resources, University of Idaho. May 2008.
- Rupp, David A. 2009. The strategic role of the National wildlife Refuge system in coordinated bird conservation in the United States. Environmental Sciences. University of Idaho.
- Strickler, Katherine, May 2008, American dippers (*Cinclus mexicanus*) and montane streams: habitat selection, nesting ecology, and movements in relation to stream conditions. PhD. Dissertation. University of Idaho.

POSTERS AND PAPERS PRESENTED AT PROFESSIONAL MEETINGS

Cassinelli, J.* and C. Moffitt. 2008. (oral) Effects of water temperature on growth and physiology of different populationsof redband trout (*Oncorhynchus mykiss*

- gairdneri*). Idaho Chapter, American Fisheries Society. 6-8 February, 2008. Post Falls, ID.
- Cajas Cano, L*. and C. Moffitt. 2008. (invited oral) "Putting aquaculture production into reality: recognizing environmental and other factors affecting sustainability. "Jornada de Piscicultura Marina AECI-Guatemala". June 2008.
- Cajas Cano, L.*, and C. M. Moffitt. 2008. (oral). Estimating water, land, and other resources used to produce beef and trout for human consumption in Idaho. Idaho Chapter, American Fisheries Society. 6-8 February, 2008. Post Falls, ID.
- Cajas Cano, L. and C. M. Moffitt. 2007. (poster). Estimating water, land, and other resources used to produce beef and trout for human consumption in Idaho. Idaho Water Resources Research Symposia, Idaho Environmental Summit, December 12 and 13, 2007 – Boise, Idaho.
- Cajas Cano, L*. and C. M. Moffitt. 2008. (invited oral presentations and workshop leader) Environmental considerations in considering sustainable development for Chile. and Aquaculture development and social and economic measures of sustainability. NSF Pan American Advanced Study Institute, Human, Physical, and Natural Capital Investment in Patagonia: A Predictive Approach under the Sustainability Criterion. 11 – 23 August 2008. Conception Chile.
- Fritz, R., L*. Cajas-Cano, L.* and C. M. Moffitt 2009. An Assessment of the Potential Use of for Mollusks to Improve Water Quality in Aquaculture Systems Filtration. 4-6 March. Idaho Chapter AFS. Boise.
- Goldberg, C. S. and L. Waits (2009) Patterns of amphibian chytrid fungus on pond-breeding amphibians of north Idaho. Idaho Chapter of the Wildlife Society, Moscow, ID
- Moffitt, C. M. 2008. Factors affecting establishment and control of New Zealand mudsnails. Annual meeting, Oregon Lakes Management Association, Wallowa Lake, Oregon 13 September. Invited
- Moffitt, C. M. 2008. Review of research on New Zealand mudsnails with emphasis on control strategies for hatcheries. Western Regional Panel on Invasive Species. Annual meeting, Fort Collins, Colorado. September 9 – 11. Invited.
- Moffitt, C.M. 2008. Keynote Luncheon Speaker, Equal Opportunity Section, AFS Annual Meeting, Ottawa, Canada. 18 August 2008. Subject: Highlights of successful women in the history of the American Fisheries Society. Invited.
- Moffitt, C. M. 2008. Update and Progress on AQUAMYCIN 100® Claim. 14th Annual Aquaculture Drug Approval Coordination Workshop July 29- 31, 2008, Bozeman, Montana. Invited
- Moffitt, C. M. 2008. Summary of research on control of New Zealand mudsnails at fish hatcheries. Idaho Invasive Species Taskforce, Hagerman, ID. 15 July 2008. Invited
- Moffitt, C. M. 2008. Environmental Assessments for Therapeutants for Aquaculture Models, Process and Variables. Idaho Chapter, American Fisheries Society. 6-8 February, 2008. Post Falls, ID. Invited
- Moffitt, C. M. 2008. Idaho Chapter of the American Fisheries Society, Post Falls, ID. "Palouse Unit: 1978-2008. 30 Years of Excellence." Invited panel presentation moderator.

- Moffitt, C. M. 2008. Plenary and Business meeting Awards Ceremonies for Annual Meeting of the American Fisheries Society, Ottawa, Canada. 17-22 August.
- Moffitt, C. M. and L. Cajas. 2008. (poster) Life cycle analysis approach to understanding sustainable aquaculture production. American Fisheries Society Annual Meeting, Ottawa, ON. CANADA. 17-21 August.
- Nielson, J., C.* Moffitt, and B. Watten. 2008. (oral) Feasibility of two step system for removing New Zealand mudsnails from infested hatchery inflow waters. Idaho Chapter, American Fisheries Society.6-8 February, 2008. Post Falls, ID.
- Nielson, R.J.,* Moffitt, C.M., and Watten, B.J. 2007. "Feasibility of two step system for removing New Zealand mudsnails from infested hatchery inflow waters." Contributed Oral Presentation. 4 December 07. Northwest Fish Culture Conference 2007, Portland, OR.
- Plumb, J.M. and N.S. Adams. An information-theoretic assessment of subyearling Chinook salmon passage and survival at McNary Dam on the Lower Columbia River. 2008. Presentation at the 138th annual meeting of the American Fisheries Society, Ottawa, Ontario, Canada.
- Plumb, J.M. and P.J. Blanchfield. 2008. Climate-driven changes in seasonal habitat use by lake trout in a small boreal lake. Presentation at the 138th annual meeting of the American Fisheries Society, Ottawa, Ontario, Canada.
- Price, A.J. and J.L. Rachlow. 2009. Development of an Index for Estimating Abundance in Pygmy Rabbit Populations. American Society of Mammalogists, Fairbanks, AK.
- Reyes, P. C. Moffitt, and J. Brostrom. 2009. Using GIS to estimate the risks and benefits of barrier removal to native fish populations in Idaho. Idaho Chapter AFS.4-6 March. Boise.
- Scott, J. M. 2008. Plenary presentation. Idaho Environmental Summit 12/12 – 12/13/2007
- Scott, J. M. 2008. Conservation Reliant" Recovery and the Endangered Species Act 1/25/2008. 15th Annual Endangered Species Act Conference. Seattle, WA
- Scott, J. M. 2008.Co-Chair State Wildlife Action Plans Graduate Seminar 2/1/08 University of California, Santa Barbara
- Scott, J. M. 2008. Managing for Change: Climate Change and the National Wildlife Refuge System 2/13/2008 US Fish & Wildlife Service SW Region Project Leaders Meeting. Albuquerque.
- Scott, J. M. 2008.Invited Participant: Climate Change Symposium 2/15/2008 American Association for the Advancement of Science. Boston, MA
- Scott, J. M. 2008. Plenary Speaker, Climate Change Symposium 2/24/2008 Desert Tortoise Council Annual Meeting. Las Vegas, Nevada
- Scott, J. M. 2008.Managing for Change: Climate Change and the National Wildlife Refuge System 2/27/2008 National Wildlife Refuge System Leadership Team Meeting. Sonoma CA
- Scott, J. M. 2008. Invited Presentation. Adaptive Management and Climate Change. 3/24/2008. Wildlife Management Institute Meeting. Phoenix
- Scott, J. M. 2008. Plenary speaker, Climate Change and Wildlife Refuges: Managing for resilience in the face of uncertainty. 3/6/2008 The Wildlife Society Idaho Chapter. Boise

- Scott, J. M. 2008. Invited presentation, Co-chair of Climate Change Workshop USFWS Friends of the Future Conference. 4/4 to 4/6/08. Shepherdstown, West Virginia.
- Scott, J. M. 2008. USGS Global Change Seminar Series. Climate Change and the National Wildlife Refuge System: Managing for Change in the face of Uncertainty. 5/29/2008. USGS Visitors Center. Reston, VA.
- Scott, J. M. 2008. Invited presentation, Drivers of Change: Global Climate Change, Population and Economic Development. 6/5/2008, University of Colorado Law School, Boulder CO
- Scott, J. M. 2008. USFWS Invited Workshop Coordinator, Hawaiian Forest Birds Status, Trend and Threats. Hilo, Hawaii. Oct 6 - 10, 2008
- Scott, J. M. 2008. Climate change adaptations in National Wildlife Refuge System. USFWS Regional meeting. November 4, 2008 Atlanta, GA
- Scott, J. M. 2008. Conservation reliant species on Department of Defense Lands. USFWS Regional Meeting. Nov 6, 2008. Minneapolis
- Scott, J. M. 2008. Invited Presentation "Metapopulations" The Wildlife Society annual meeting. Nov 7 - 13. Miami, FL
- Scott, J. M. 2008. SERDP Symposium and Post Recovery Tech session Dec 2 - 5, 2008. Washington. D.C.
- Scott, J. M. 2008. "Endangered Species and Other Conservation Reliant Species" National Council for Science and the Environment. Biodiversity Conference, Washington. D.C. Dec 7 - 10, 2008
- Scott, J. M. 2009. National Parks 2nd Century Commission Meeting in Yellowstone Park. Invited presentation on "Future of the NPS." 1/27 - 1/29, 2009
- Scott, J. M. 2009. USFWS Coastal Ecosystems and Climate Change Workshop in San Francisco. Plenary Session on "Managing for Change in Coastal Area Refuges." 1/29 - 1/30 2009
- Scott, J. M. 2009. Science Day presentation to the Environmental Defense Fund Directors, donors and guests. "Implications of Climate Change on wildlife in the working landscape." 2/2 - 2/4/09
- Scott, J. M. 2009. Adaptation 2009 Conference. Invited Plenary presentation 2/18 - 2/19
- Scott, J. M. 2009. USFWS Friends for the Future Academy. Invited presentation and leading a session on Climate Change. NCTC Shepherdstown. 2/20 - 2/23
- Scott, J. M. 2009. Invited panel participant on climate change in the national parks. George Wright Society. Portland OR 3/2-3/5 2009
- Scott, J. M. 2009. Seminar. Wildlife Society Moscow, Idaho 3/10-3/12
- Scott, J. M. 2009. N.A. Wildlife and National Resources Conf, present results of SERDP project to military managers and research collaborators. Washington, DC. 3/14-3/21 2009
- Scott, J. M. 2009. SERDP workshop to Military staff and tribal representatives. Yakima, WA 3/14-3/21 2009.
- Scott, J. M. 2009. Invited Plenary speaker at National Meeting of the Association of Military Biologists. San Diego, CA, 5/25-5/27
- Scott, J. M. 2009. Workshop Participant, USGS workshop for strategic decision making and adaptive management. Salt Lake City, UT. 6/1 - 6/4

- Scott, J. M. 2009 Climate change panel for the National Wildlife Refuge System planning. Shepherdstown, West VA 6/8-6/12
- Stockton, K. A. 2009.(oral) Colorado's Zebra/Quagga Mussel Monitoring Program. Idaho Chapter of American Fisheries Society, Boise, ID. 3-6 March 2007.
- Stockton, K.A. and Moffitt, C.M. 2009.(oral) 2009. Aquatic Invasive Species and Aquaculture: Examples from Colorado for Idaho. Idaho Aquaculture Association, Twin Falls, ID. 13 June 2009.
- Svancara, L. K. 2009. Assessing Accuracy. Idaho BLM GIS and Resources Annual Meeting, Boise, ID (Invited)
- Svancara, L. K., R. Dixon. 2008. The Next Step for Idaho's CWCS. Northwest Chapter of The Wildlife Society, Spokane, WA
- Svancara, L. K. 2008. Planning for Change: A Change for Planning? Idaho Chapter of The Wildlife Society, Boise, ID
- Teater, K., C. M. Moffitt, and B. Watten. 2009. Evaluation of mixed cell raceways at Dworshak National Fish Hatchery. Idaho Chapter AFS, 4-6 March. Boise.
- Waits, L. P., J. Adams, B. Bosworth, J. Rachlow. 2009. Development of a fecal DNA detection method for pygmy rabbits. Idaho Chapter of the Wildlife Society Meeting, Moscow, Idaho.

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

Lubia Cajas Cano

Association of Latinamerican and Iberoamerica Students of the University of Idaho, member and Treasurer of the Committee. Aug 2005 to present.

Graduate and Professional Student Association (GPSA), University of Idaho. Senator for Environmental Science. Aug. 2006 to present

Christine M. Moffitt

"Ecology and Management of New Zealand Mud Snails:", Webinar for USFWS/USGS collaborative training: June 2009.

http://training.fws.gov/branchsites/CSP/WebSeminarSeries/june_09/information_page.html.

Associate Editor, Transactions of the American Fisheries Society 2007-present

Faculty Advisor to the Palouse Unit of the Idaho Chapter of the American Fisheries Society

Member Steering Committee "Challenges for Diadromous Fishes in a Dynamic Global Environment." 2005 to 2009

Chair, Transition Committee for moving headquarters, American Fisheries Society

Past President Fisheries History Section, 2008-2010.

Multimedia Plenary and Business Meeting Awards Ceremonies for Annual Meeting of the American Fisheries Society, Ottawa, Ontario, Canada, 2009.

Potlatch Corporation Community Advisory Board. 2004-2009.

2005-9. United States - Israel Bi-national Agricultural Research and Development Fund Review Board. Proposal reviewer. 2005-9.

Great Lakes Fisheries Commission, Fishery Research Program, 2008, 2009.

Animal Health and Disease proposals: Oregon Agricultural Experiment Station Sun Grants. May 2008, 2009.
Member of the Board of Governors, The Council for Frontiers of Knowledge, Uganda, Africa. 2007- Present
Mentor. Water of the West REU student interns: Jonathan Megli and Amanda Eckhart. 2009.
Mentor. CRISSP REU student, Liz Marchio. Studies of invasive New Zealand mudsnails. 2009.
Mentor, Water footprints and sustainability. Water of the West REU student intern, Anthony Lopez. 2008.
Hoist (Helping Orient Indian Students to Science and Technology) Student mentor research on invasive species. June – July. Kristine Atto, 2008.

J. Michael Scott

Invited advisor to the Nature Conservancy and the Channel Islands National Park Biologists on recovery plans for the Santa Cruz Island Scrub Jay and other endemic species. 2008-09-28
Invited expert to the National Parks Second Century Commission meeting. National Park Service 2008-09-26
Invited Participant: North American Wildlife Conservation Technical Workshop. 2008-04-07
Invited Plenary Co-presenter at Holland & Hart Natural Resources Law Retreat. "Demographics, Goods and Services: Oikos Opportunities in Our World of Change." 2008-06-06
Coordinator Bull Trout Workshop, June 10 – 12, 2008, Orofino, ID
Invited Panel member on "Conservation in a Changing Climate." 6/24/2008 USFWS Region 8 Project Leaders Meeting
Plenary speaker at Climate Change Workshop for USFWS Region 6 meeting 7/31/08 Denver, CO
Invited presentation "Global Climate Change" at the USFWS Friends Academy 8/19/08 WV
Invited presentation "Framing Management Questions" for the USGS Webinar Series 8/21/08
Member, Society for Conservation Biology Publication Committee. Feb 2008 – Present
Member, Board of Directors, American Institute of Biological Sciences, Budget Committee. February 2007 – Present
Member, Board of Directors, American Institute of Biological Sciences, Policy Committee. November 2004 – Present
Member, Natural Areas Association. June 2002 – Present
Member, Editorial Board, Biological Conservation. July 2001 – Present
Member, Ecological Society of America. February 2001 – Present

Leona Svancara

Natural Resource Applications in GIS: An Introduction to ArcGIS, Idaho Department of Fish and Game, Northern Regions Training, Moscow, ID, March 2009