Idaho Cooperative Fish and Wildlife Research Unit

ANNUAL REPORT

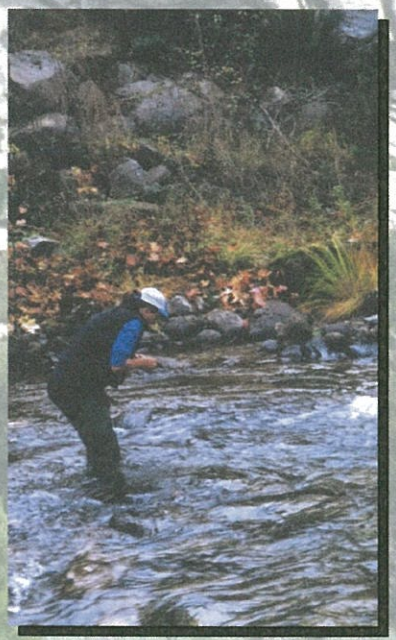
1 October 2003 – 30 September 2004

Ryan Mann

M.S. Fisheries Resources

Chanoane Hartt

M.S. Environmental Science



Katherine Strickler

Ph.D. Fisheries Resources

USGS science for a changing world

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University of Idaho

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IDAHO COOPERATIVE
FISH AND WILDLIFE RESEARCH UNIT

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Idaho Department of Fish and Game
University of Idaho
Wildlife Management Institute
U.S. Fish and Wildlife Service

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Dr. Dennis Scarnecchia – Fishery Resources
Dr. Lisette P. Waits – Wildlife Resources

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Kajsa Stromberg	M.S. Fishery Resources	J.H. Braatne

Introduction

Unit History

The Cooperative Wildlife Research Unit Program began in 1935, when five Wildlife Units were established at land grant universities. Additional Units have been added since that time. In 1961 the Cooperative Fishery Research Unit Program was initiated. Beginning in 1984, Wildlife and Fishery Units were combined into Cooperative Fish and Wildlife Research Units. At the present time, there are 41 Cooperative Research Units. In 1994 the Cooperative Research Units were moved into the National Biological Service under the Division of Cooperative Research. In 1996 the National Biological Service and Cooperative Research Units were moved into the United States Geological Survey under the Biological Resources Division.

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. The Unit is staffed, supported, and coordinated by the USGS/Biological Resources Division, Idaho Department of Fish and Game, University of Idaho, 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 anadromous fish passage in the Snake River basin; develop and evaluate methods to enhance fish health of hatchery reared fish; evaluate methods of establishing new animal populations or augment existing populations; improve estimators of animal abundance; evaluate effectiveness of existing reserve and management areas in the Pacific Northwest; develop methods to assess the input of introduced aquatic species; study the basic biology of aquatic and terrestrial animals; evaluate effectiveness of efforts to recover populations of endangered species; and evaluate factors that regulate carrying capacity in fresh water and terrestrial habitats.

Unit Research, Expertise, and Interests

Unit personnel maintain close working and professional relationships with University faculty, Idaho Department of Fish and Game and U.S. Fish and Wildlife Service personnel. Research studies are conducted primarily within Idaho, though some work is done in Montana, Washington, California, Colorado, North Carolina, Oregon, Alberta, Federated States of Micronesia, Hawaii, Costa Rica, and Eastern Europe.

Unit research is supported by State contributions and by contracts from the USGS/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 advisors for graduate students, and participate in a variety of professional activities.

Dr. J. Michael Scott – 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 – Endangered Species Act at 30: Renewing the Conservation Promise.

Dr. Jim Congleton – Assistant Unit Leader and Associate Professor of Fishery Resources – Recent research activities include studies on: the effects of stress, tissue injury, and infection on components of natural disease resistance; and stress response of Chinook salmon smolts collected and transported from Snake River dams. Areas of interest include mechanisms of disease resistance in fish and stress physiology. Specialty courses: FISH 511 – Fish Physiology, FISH 514 – Fish Population Ecology.

Dr. Christine M. Moffitt – Assistant Unit Leader and Professor of Fishery Resources – Recent research activities include studies on: aquaculture chemical efficacy and approval studies; understanding host-parasite relationships in ecological settings; investigations of interactions between cultured and wild fish; monitoring and control of invasive New Zealand mudsnails; and fisheries history. Specialty Courses: FISH 510 – Advanced Fisheries Management, FISH or WLF 501 – Graduate Seminar, and FISH 504 – Sustainable Aquaculture.

Dr. R. Gerald Wright – Research Scientist and Professor of Wildlife Resources – Recent research activities include studies on: wildlife management in national parks and protected areas; modeling of ecological problems; ungulate ecology and habitat use; and natural resource data management and geographic information systems. Specialty courses: WLF 520 – Human Dimensions of Wildlife Management.

Ongoing Projects – Fisheries Resources

Dr. David H. Bennett — Principal Investigator

- Reduction of northern pikeminnows in Lake Cascade

Dr. Jeff Braatne — Principal Investigator

- Baseline monitoring of floodplain vegetation and geomorphology

Dr. James L. Congleton — Principal Investigator

- Effects of sedimentation on the survival of white sturgeon embryos
- Evaluation of physiological condition of migrating and barge-transported juvenile salmon and effects of multiple-dam bypass

Dr. Kirk Lohman — Principal Investigator

- Macroinvertebrate assemblages in mountain streams in burned and unburned watersheds of the Payette National Forest, Idaho

Dr. Christine M. Moffitt — Principal Investigator

- Assessment of distribution of New Zealand mudsnails in Silver Creek, Idaho
- Completing empirical models to predict risks of infection of *Myxobolus cerebralis* within river drainage
- Effects of water temperature, and PIT-tags on the survival, growth, physiology, and health status of sub-yearling fall Chinook salmon
- Infrastructure to complete FDA registration of erythromycin
- Spatially based monitoring and modeling of resistant microorganisms at freshwater aquaculture facilities
- Strategies that can reduce the risk of New Zealand mudsnail infestation at fish propagation facilities during fish transfer operations

Dr. Chris Peery — Principal Investigator

- Evaluation of adult salmon, steelhead, and lamprey migration past dams and through reservoirs in the Lower Columbia River and into tributaries
- Research and monitoring involving ratio telemetry of adult salmon and adult lamprey throughout the watersheds of Walla Walla district

Dr. Dennis Scarnecchia — Principal Investigator

- Fisheries population assessment

REDUCTION OF NORTHERN PIKEMINNOWS IN LAKE CASCADE

Principal Investigator: Dr. D. H. Bennett
Funding Agency: IDFG
Completion Date: 12/31/04

Objectives:

1. To monitor migration and spawning behavior of the northern pikeminnow.
2. To quantify dietary habits of the northern pikeminnow and estimate yellow perch consumptions
3. To determine the level of northern pikeminnow abundance at which the desired population of yellow perch can be maintained.

Progress: We assessed interactions between northern pikeminnow (*Ptychocheilus oregonensis*) and yellow perch (*Perca flavescens*) in Lake Cascade, Valley County, Idaho during 2001 and 2002. The sport fishery in Lake Cascade became a major statewide concern when the harvest of fishes, especially yellow perch, declined. Initial studies strongly suggested that predation by northern pikeminnow on primarily age 0 yellow perch might be adversely affecting yellow perch recruitment. Mean fecundity of 31 adult northern pikeminnow was approximately 21,000 eggs per female (range 3,207 to 47,355). Movements assessed by radiotelemetry suggested that about 50% of the adult northern pikeminnow population might spawn in the North Fork Payette River while the remaining 50% were relocated along the lakeshore. These findings suggested that some northern pikeminnow may spawn along the lakeshore or that annual spawning may not occur. Diet analyses from July through October indicated that juvenile yellow perch increased in proportional weight in the Northern Pikeminnow diet from <1% to > 27%, respectively. Mean size of yellow perch consumed ranged from 1.0 g to >2.0 g. Bioenergetics modeling indicated that consumption from July through October, a 122-day period, exceeded 1.2 million yellow perch, based on the point estimate of nearly 24,500 northern pikeminnow and could have exceeded 5.1 million with an increased incidence in their diet. Simulation modeling was conducted to quantify the influence of mortality on the potential to recover the yellow perch population. Both the Dynamic Pool and the Yield per Recruit model implicated low juvenile survival as a key factor in low yellow perch abundance in Lake Cascade. Use of data collected in the mid 1980s provided an estimate of survival from swim-up fry to age 1. Other simulations using survival estimates for older age classes from the literature provided additional support for enhancing juvenile yellow perch survival in Lake Cascade. When survival of age 0 to 1 yellow perch was less than 75%, the potential to recover the yellow perch population was doubtful. These simulations also suggested that under current survival rates, few individuals were surviving to spawning age even when a stronger year class was produced. Estimated numbers of age 0 yellow perch consumed exceeded the estimated total number of a weaker year class produced. Our findings indicate that northern pikeminnow predation

on yellow perch could have a major negative effect on the population. The need for management intervention to reduce the northern pikeminnow population was strongly suggested by the bioenergetic and simulation modeling. If juvenile yellow perch survival were increased through reduced predator consumption, the yellow perch population should increase and lead to a population recovery in Lake Cascade. Without strong management intervention, our data indicated that yellow perch recovery would probably not occur rapidly.

BASELINE MONITORING OF FLOODPLAIN VEGETATION AND GEOMORPHOLOGY

Principal Investigators:	Dr. J. H. Braatne Dr. P. B. Shafroth
Student Investigator:	Chanoane Hartt
Funding Agency:	USGS
Completion Date:	5/31/05

Objective:

1. Baseline studies of floodplain vegetation along the Elwha River, WA

Progress: Field data on floodplain vegetation and geomorphology was collected during the summer of '03 and spring/summer of '04. Activities included establishment and sampling of 15 cross-valley transects within the Elwha River Basin: 1) five in the "control" reach in Geyser Valley (upstream of Glines Canyon dam), 2) five in the reach between the two dams on the Elwha River, and 3) five along the delta reach below Elwha Dam (outside ONP boundaries). The topography of each transect was surveyed (GPS & rebar monumented), vegetation patch types and geomorphic surfaces identified, and vegetation plots established for sampling of tree, shrub and herbaceous vegetation (138 tree plots, 273 shrub plots, 275 herbaceous plots). Point and line-intercept data was also recorded along the entire length of each study transect. Investigators are currently analyzing data, preparing manuscripts for publication and seeking funds for additional sampling of floodplain vegetation prior to dam removal in 2008.

Results include: topographic cross-sections for the six transects; tree ages, tree density, cover, and basal area by species; shrub species composition and cover; herbaceous species composition and cover; dominant sediment particle sizes within the vegetation plots.

EFFECTS OF SEDIMENTATION ON THE SURVIVAL OF WHITE STURGEON EMBRYOS

Principal Investigator: Dr. J. L. Congleton
Student Investigator: Toby Koch
Funding Agency: Kootenai Tribe of Idaho
Completion Date: 12/31/04

Objectives: While many factors have been implicated in the failure of white sturgeon (*Acipenser transmontanus*) recruitment in the Kootenai River, North Idaho, the potential effects of sedimentation on embryo survival are of particular interest. The combined effects of diking and decreased peak spring flows have resulted in deposition of fine sediments throughout the reach used by white sturgeon for spawning. Moreover, high spring flows during the sturgeon spawning season result in extensive movement of sediment, raising the possibility that sturgeon eggs, which are demersal, might be covered by fine sand. The objective of this laboratory study was to determine the effects of sediment cover on the survival and development of white sturgeon embryos.

Progress: A simple, inexpensive apparatus (embryo incubation unit, EIU) was developed and used to assess the relationship between sediment cover (Kootenai river sediments, 97% by weight < 0.83 > 0.25 mm diameter) and survival of white sturgeon embryos in the laboratory. Trial 1 assessed the effects of two sediment depths (5 and 20 mm) and three EIU ventilation hole sizes (4.8, 6.8, and 9.5 mm) on embryo survival at two flow velocities (higher, nominal 0.15 m/s; lower, nominal 0.05 m/s) in two otherwise identical fiberglass troughs. Trial 2 assessed the effects of sediment cover duration (5-mm sediment cover for 4, 7, 9, 11, or 14 d) on mean embryo survival and on larval length and weight. In Trial 1, sediment cover reduced ($P < 0.0001$) embryo survival in both the higher velocity and lower velocity troughs. Embryo survival rates were low (0 – 5%) under sediment covers of either 5 or 20 mm. In Trial 2, embryo survival was negatively correlated ($P = 0.001$) with increasing duration of sediment cover. Survival was significantly higher for embryos covered for 4 d (50% survival) or 7 d (30% survival) than for those covered for 9, 11, or 14 d (15 to 20% survival). Sediment cover also delayed hatch timing ($P < 0.0001$) and decreased mean larval length ($P < 0.0001$). Our results suggest that sediment cover may be an important early life-stage mortality factor in rivers where White Sturgeon spawn over fine-sediment substrates.

EVALUATION OF PHYSIOLOGICAL CONDITION OF MIGRATING AND TRANSPORTED JUVENILE SALMON AND EFFECTS ON SURVIVAL

Principal Investigator: Dr. J. L. Congleton
Student Investigators: Tom Welker
Derek Fryer

Funding Agency: U.S. Army Corps of Engineers
Completion Date: 12/31/04

Objectives:

1. Sample spring Chinook (*Oncorhynchus tshawytscha*) smolts of wild and hatchery origin to determine changes in energy reserves and other physiological indices during downstream migration to, and through, the Snake-Columbia River Federal Hydropower System.
2. Determine the cumulative effects of exposure to fish-bypass systems at multiple dams on stress indices, energy stores, and "tissue damage" enzymes.
3. Determine if significant differences exist between wild and hatchery fish Chinook salmon such that they might have different survivorship following exposure to multiple by pass systems.
4. Determine if seasonal changes in stress indices, smoltification, or other indicators of physiological condition are correlated with survival rates of barge-transported wild Chinook salmon smolts.

Progress: In the five years 1998 through 2003, PIT-tagged yearling Chinook salmon *Oncorhynchus tshawytscha* reared at three hatcheries in the Snake River Basin (Dworshak, Rapid River, and McCall) were sampled prior to release, and from bypass systems at selected hydroelectric dams on the Snake and Columbia Rivers. Carcass and gut water, lipid, protein, and ash masses were determined so that the rate of use of energy reserves could be estimated as the fish migrated through the hydropower system. Plasma triglyceride, cholesterol, and total protein concentrations and alkaline phosphatase activity were measured as indices of nutritional status.

In each year of the study, lipid, protein, and caloric reserves of hatchery-reared juvenile Chinook salmon decreased (on a length-controlled basis) as the fish migrated downstream to Lower Granite Dam on the Snake River. Lipid, protein, and caloric reserves continued to decline as the fish migrated an additional 461 km downstream to Bonneville Dam on the Columbia River. Lipid and protein masses were negatively correlated with travel time to the dams. The lipid reserves of fish sampled at Bonneville Dam were depleted (<1% body weight) in all years. Protein reserves were reduced to a greater extent in 2001, an exceptionally low-flow year, than in the other years of the study.

Plasma triglyceride, cholesterol, and total protein concentrations and alkaline phosphatase activities decreased significantly as the fish migrated downstream, indicating that the energetic deficit in migrating fish was in part due to a low rate of food intake. The data did not suggest that increasing food availability in late May and early June might improve the energy status of late-migrating fish.

White-muscle activities of citrate synthase (an indicator of aerobic capacity) also declined significantly as the fish migrated from Lower Granite Dam to Bonneville Dam. These results suggest that an energetic deficit-induced breakdown of body proteins lowers the activities of key metabolic enzymes. Lowered enzyme activities may reduce the performance capabilities of migrating fish for swimming, osmoregulation, and other vital functions. Significant decreases in swimming ability were in fact observed in 2001 and 2002 (thesis work of D. Fryer), and decreases in osmoregulatory ability were observed in 1999, 2000, and 2001 (thesis work of L. Haley).

In all years, fish reared at Dworshak National Fish Hatchery were smaller and less robust than fish reared at McCall and Rapid River hatcheries, with smaller lipid and protein reserves. Marine survival rates for wild fish and those from the three hatcheries will be compared in future years and tested for correlations with physiological condition during smolt migration.

In transported juvenile Chinook salmon, seasonal peaks in stress indices (cortisol and glucose) were correlated with seasonal peak loading densities of Steelhead in the fish-transport barges in 2000 and 2001 as in a previous study. Stress responses by Chinook salmon were attributed to behavioral interactions with larger, more aggressive juvenile Steelhead. In 2002, stress indices in transported wild Chinook salmon were relatively low throughout the season, probably because loading densities of Steelhead were low (6 to 17 g/L, compared with an average Steelhead density of 40 g/L in 2000). In 2003, an experiment was performed to determine the effect of barge loading density on stress indices in barged wild Chinook salmon. Paired barge compartments were loaded at high density (nominal =30 g fish/L water, or about 0.25 lb/gallon) and at low density (=10 g/L) on seven occasions. Comparison of blood-chemistry means for fish sampled from high-density and low-density barge compartments indicated significantly higher ($P = 0.05$) mean plasma glucose concentrations for fish transported at higher densities, but no significant difference for plasma cortisol. Interpreted in the light of earlier studies, these results confirm that juvenile Chinook salmon are stressed by co-transport with Steelhead. Steelhead densities in the "high-density" compartments in the 2003 experiment (mean 27 g/L) were, however, below the range (40 to 60 g/L) previously observed to be associated with sustained stress responses in transported Chinook salmon. Steelhead densities of 35 g/L (0.3 lbs/gallon) or below appear to elicit minimal stress responses in Chinook salmon during barge transportation.

In a retrospective study using smolt-to-adult return rates (SARs) of juvenile Chinook salmon PIT-tagged for NMFS transport studies, we did not find significant correlations between SARs for daily transport groups of Chinook salmon and daily loading densities of co-transported Steelhead in 1998, 1999, or 2000. These results do not support the

hypothesis that co-transportation with Steelhead affects the post-transport survival of Chinook salmon.

MACROINVERTEBRATE ASSEMBLAGES IN MOUNTAIN STREAMS IN BURNED AND UNBURNED WATERSHEDS OF THE PAYETTE NATIONAL FOREST, IDAHO

Principal Investigator:	Dr. K. Lohman
Student Investigator:	Katherine Strickler
Funding Agency:	USDA Forest Service
Completion Date:	8/31/05

Objectives: The overall goal of the study is to characterize the effects of prescribed and wildland fire on aquatic invertebrate communities. Specific objectives include:

1. To compare benthic invertebrate density, diversity, and community composition in watersheds treated with prescribed fire and reference watersheds in the South Fork of the Salmon River sub-basin;
2. To compare benthic invertebrate density, diversity, and community composition in samples collected before and after wildland fire in streams in the Big Creek watershed, Middle Fork of the Salmon River sub-basin; and
3. To relate variation in benthic invertebrate metrics among different watersheds or years to stream habitat variables.

Progress: We collected aquatic invertebrate samples in September 2004 from 12 streams in the South Fork of the Salmon River and Big Creek watersheds. We identified, counted, and calculated macroinvertebrate community metrics on all samples. Preliminary analyses of pre- and post-fire invertebrate samples from the Big Creek sub-basin indicate that relative abundance of true fly larvae (order Diptera) has increased in most streams following the 2000 fires, while relative abundance of mayfly larvae (order Ephemeroptera) has decreased. In streams with larger substrate and lower levels of embeddedness, community composition in 2003 moved toward pre-burn structure. Macroinvertebrate densities in most streams increased over 2002 and pre-burn (1998-99) samples. Further analyses of benthic invertebrate community composition and densities are in progress. An annual report will be completed by June 30, 2004. A final report will be completed by August 31, 2005, followed by one or more manuscripts for peer-reviewed publications.

ASSESSMENT OF DISTRIBUTION OF NEW ZEALAND MUDSNAILS IN SILVER CREEK, IDAHO

Principal Investigator: Dr. C. M. Moffitt
Student Investigator: Christopher James
Funding Agency: IDFG
Completion Date: 06/30/06

Objectives:

1. Determine the distribution of New Zealand mudsnails in the Silver Creek Drainage
2. Examine the seasonal changes in the distribution of New Zealand mudsnails in Silver Creek
3. Evaluate the differences between populations of New Zealand mudsnails located downstream of Hayspur State fish hatchery in the Silver Creek drainage with snail populations downstream of Hagerman National Fish Hatchery.

Progress: Work began during the summer of 2004 with an extensive survey of the Silver Creek watershed. We intend to continue survey work during the summer of 2005 at selected locations to monitor changes in distribution of the snails. The 2004 survey provided a baseline for determining further research objectives. To determine the distribution of New Zealand mudsnails (*Potamopyrgus antipodarum*) in Silver Creek, we sampled at one-kilometer intervals from the spring fed headwaters to approximately 3 kilometers east of Picabo, ID. We projected digital-orthophoto quadrangle maps (1:24,000 scale) and generated sampling sites at 1 km distances, with corresponding Universal Transverse Mercator (NAD-27) coordinates, along the Silver Creek drainage using ArcView/GIS v3.2 (Environmental Systems Research Institute 1999). We located each site using an E-Trex GPS unit (Garmin International, Inc., Olathe, Kansas). Before sampling, areas of macrophyte and gravel beds were sketched and sample sites recorded.

At each site, three separate 10-second kick-net samples were collected from the nearest downstream gravel substrate using a D-framed kicknet with a 500 μm mesh collection net. Samples were collected by vigorously kicking the substrate to suspend the macro-invertebrates into the water column then allowing them to drift downstream into the net. Each sample was processed through a series of three sieves (4.75 mm, 2.36 mm and 1.70 mm) to remove large debris. The contents of the sieves were placed on a sorting tray and sorted individually to determine the presence of the snail using a 10-X OptiVISOR® (Donnegan Optical Company, Lenexa, Kansas) for magnification. If snails of the characteristics of *P. antipodarum* were observed, the samples were retained, labeled, and returned to the lab for further sorting and enumeration. After sorting, specimens were be preserved in 10% formalin solution overnight, and then rinsed and transferred to 70% ethanol for storage for further validation. All specimens of New Zealand mudsnails were preserved for validation.

The specific questions for Objective 2 concern the effect of seasonal changes in Silver Creek on the distribution of New Zealand mudsnails. We are asking if the response to seasonal changes is the same for small and large sized snails. For Objective 3 we pose the question: Do population densities of New Zealand mudsnails differ between winter in summer in areas below two fish hatcheries, one that has fluctuating water temperatures (Hayspur), and on with nearly constant water temperatures (Hagerman National Fish Hatchery)?

From the results of our 2004 distribution survey, we found New Zealand mudsnails are localized in a few locations in the Silver Creek drainage. Not only was distribution limited, but their abundances and densities were low in Silver Creek. Perhaps seasonal changes affect and limit the ability of the snail to spread throughout the system. Samples will be collected in winter and summer to assess the presence or absence of New Zealand mudsnails at locations in the drainage using random point sampling in two areas on the Silver Creek Preserve known to have New Zealand mudsnails, and at known positive sites below Hagerman National Fish Hatchery on Riley Creek.

COMPLETING EMPIRICAL MODELS TO PREDICT RISKS OF INFECTION OF *MYXOBOLUS CEREBRALIS* WITHIN RIVER DRAINAGE

Principal Investigator:	Dr. C. M. Moffitt
Student Investigators:	Kara Anlauf
	Michael Colvin
Funding Agency:	USGS
Completion Date:	12/31/04

Objectives:

1. Understanding the ecology of whirling disease through aquatic habitat modeling of geospatial attributes.
2. Understanding the distribution of early life history stages of fish within the Pahsimeroi River landscape in relation to water control and river access.

Progress: Stream habitat metrics at multiple spatial scales were used to build predictive habitat models of *Tubifex* spp., one of two obligate hosts in the life history of *Myxobolus cerebralis*, the causative parasite of whirling disease. This study was conducted in the Pahsimeroi River drainage, a tributary of the Salmon River located in eastern Idaho. The objectives were to 1) Use landscape variables and field measured reach variables to construct predictive models of fine stream sediments, a favorable *Tubifex* spp. habitat feature, 2) Use bio-physical sediment core variables to identify the best predictive model of *Tubifex* spp. abundance, 3) Describe the relationships between reach habitat variables and core habitat variables, and 4) Use reach habitat variables to identify the best

predictive model of *Tubifex* spp. presence. Using a Geographic Information System (GIS), the drainage was partitioned into strata using stream channel slope. Study reaches were selected within these strata to pursue the study objectives. Four reach scale variables measured in the field and quantified for each 100-m reach and six landscape variables estimated using a GIS at three different geographic scales were used in the analysis. Each scale included the stream reach and three distances upstream (500 m, 2,000 m, and the total length upstream). Using linear mixed effect models, the best models predicting fine sediments were the reach model including the proportion of slow habitat and the multi-scale models that included the proportion of slow habitat measured at the reach scale and stream slope or the proportion of conifer cover or agriculture land types estimated for the total length upstream. Using linear mixed effect models, the most plausible model predicting *Tubifex* spp. abundance included the proportions of silt-clay and fine sand, and the abundance of the tubificid oligochaete (*Limnodrilus hoffmeisteri*). Several notable associations were observed between core and reach variables, with the proportion of silt-clay positively associating with the proportion of fine sediments estimated within a study reach. Finally, the total amounts of potential *Tubifex* spp. habitat and reach slope were the best predictors of *Tubifex* spp. presence when using logistic regression models. These results suggest that the best prediction of fine sediments was based on inter-related variables operating at different spatial scales. Additionally, the selection of particular microhabitats may be defined by the resources required by *Tubifex* spp. and the relationships between stream habitat variables at multiple scales.

We observed a high degree of aquatic habitat fragmentation in the Pahsimeroi River drainage. We found evidence that historically, aquatic habitat fragmentation did exist before the settlement of the valley by European man. We used data from sentinel exposures conducted from 2001-2003 to evaluate factors hypothesized to affect the distribution and intensity of *Myxobolus cerebralis*, the causative agent of salmonid whirling disease. We observed no patterns in infection severity over time with abiotic variables. Over time we observed a variable infection in the middle Pahsimeroi River reach ranging from none to severe *M. cerebralis* pathology. On the lower Pahsimeroi River reach, we observed a consistent detectable pathology. We compared information gathered on the fish distributions and relative abundance to sentinel exposure results to evaluate the possible role of the salmonid host on infectivity of *M. cerebralis*. We observed differences in fish compositions in stream reaches that may be linked to *M. cerebralis* infection dynamics.

EFFECTS OF WATER TEMPERATURE AND PIT-TAGS ON THE SURVIVAL, GROWTH, PHYSIOLOGY, AND HEALTH STATUS OF SUB-YEARLING FALL CHINOOK SALMON

Principal Investigator: Dr. C. M. Moffitt
Collaborator: Dr. J. L. Congleton
Student Investigator: Jeffrey Yanke

Funding Agency: USFWS
Completion Date: 12/31/05

Objectives:

1. Determine the effects of elevated temperatures on the blood chemistry, survival and growth of sub yearling fall Chinook salmon.
2. Evaluate any effects of PIT (Passive Integrated Transponder) tags on the survival and health of sub yearling fall Chinook salmon exposed to different water temperatures.
3. Evaluate blood chemistry parameters and survival of sub yearling fall Chinook following an acute seawater challenge.

Progress: This project was a two-year laboratory based study to assess the effects of water temperature and PIT tags on the survival growth and physiological condition of fall Chinook salmon (*Oncorhynchus tshawytscha*) held in different temperature regimes. We simulated temperature conditions that Chinook salmon are potentially exposed to during their juvenile pre-smolt life history. Previous research with PIT– tagged juvenile fall Chinook salmon released into Lower Granite reservoir in the Snake River demonstrated an inverse correlation between water temperature and fish survival. The causal mechanism for this relationship is unknown, as is the level of post-tagging mortality associated with high temperatures. To compensate for elevated temperatures, cool waters are released into the reservoir each summer when surface temperatures reach 20°C.

Control (i.e., not tagged) and PIT-tagged fish were gradually acclimated to constant temperatures of 16, 20, 24 and 28°C over a period of two weeks. We sampled these groups of fish at intervals during the acclimation and holding period. At each interval we collected blood and separated the plasma for analysis, removed livers for analysis of heat shock proteins, measured the weight and length, removed samples of gills for analysis of NaK Atpase, and saved carcasses for analysis of lipids. At the end of rearing, we lowered the temperatures in all tanks of test fish over 10 d to 13°C, and tested the fish response to an acute seawater challenge of 24 h. Surviving fish were enumerated and sampled for the parameters listed above.

Fish held at 16 and 20°C grew rapidly and survived at high rates in both freshwater and seawater. We observed some detrimental effects on growth, behavior, physical appearance, and survival in freshwater and seawater in groups of control and PIT-tagged

fish that were gradually acclimated to a constant temperature of 24°C for more than 50 days. We observed 100% mortality in groups of control and PIT-tagged fish when temperature exceeded 26°C during the acclimation period of a 28°C treatment. Our preliminary findings support the 20°C management objective for the Lower Granite Reservoir and the use of PIT tags to study temperature-survival relations.

INFRASTRUCTURE TO COMPLETE FDA REGISTRATION OF ERYTHROMYCIN

Principal Investigator: Dr. C. M. Moffitt
Post-Doctoral Investigator: Dr. S. M. A. Mobin
Funding Agency: DOE – BPA
Completion Date: 09/31/05

Objectives:

1. Provide an infrastructure to keep erythromycin registration efforts viable in the Columbia River Basin, while required studies are conducted.
2. Conduct laboratory and field experiments and design monitoring to understand the extent of erythromycin resistant microflora in the GI tract of fish following treatment with erythromycin to satisfy the articulated needs of FDA's Division of Human Food Safety, Center for Veterinary Medicine.
3. Conduct experiments to address the fate of erythromycin in sediment ponds with a history of erythromycin treatment.
4. Conduct studies needed to provide FDA with a satisfactory method of monitoring erythromycin residues in tissues of salmonids.
5. Provide submittals to FDA that detail results and publish in peer-reviewed journals the results of key studies accomplished during drug approval.

Progress: We have provided the infrastructure for use of erythromycin feed additive for fish at Idaho Department of Fish and Game, Washington Department of Fish and Wildlife, Oregon Department of Fish and Wildlife, US Fish and Wildlife Service, and Nez Perce Tribal hatcheries. We collected and summarized data that describes the microflora in the GI tract of salmonids before, during and following treatment with erythromycin rations. We prepared a summary of data and analysis for submittal to FDA in December 2004. This submission consists of four books of data using the guidelines from FDA. These data were collected at Looking Glass Hatchery (Oregon Department of Fish and Wildlife) and Clearwater Hatchery (Idaho Department of Fish and Game). We found the microflora were from several genera of Gram negative and Gram positive bacteria, as well as yeasts. Composition of the GI tract fluctuates over time, and shows some correlation with profiles of feed administered to fish. In addition to these trials, we completed two trials to bridge the microbiological method of analysis of erythromycin in

tissues in salmon (the U of I method) with a new HPLC method developed by FDA at their Arkansas laboratory. Incurred tissue samples from FDA were sent to U of I, and to chemists at the FDA lab. We submitted a summary and analysis of these data to FDA in July 2004.

SPATIALLY BASED MONITORING AND MODELING OF RESISTANT MICROORGANISMS AT FRESHWATER AQUACULTURE FACILITIES

Principal Investigator:	Dr. C. M. Moffitt
Post Doctoral Investigator:	Dr. S. M. A. Mobin
Staff Assistant:	Michael Colvin
Funding Agency:	The Northwest Center for Aquaculture Research and Education
Completion Date:	09/15/05

Objectives:

1. Conduct preliminary screening of fish and their water sources, and effluent from one or two public aquaculture facilities in the Hagerman valley.
2. Use GIS tools to prepare maps of the water network, location of the facilities, treatment reservoirs, and discharge locations of these facilities.
3. After preliminary data are available, and GIS maps prepared, develop plans and collaborations to provide a more comprehensive monitoring and mapping of the region.

Progress: Aquaculture systems have come under increasing scrutiny by regulatory agencies and by natural resource advocacy organizations. Often negative attitudes are perpetuated because of a lack of solid information and more complete understanding of the impacts of these facilities on the environment, and on the quality of food produced by aquaculture. Of particular interest to many regulators and the public is: what are the effects of antimicrobials used in aquaculture? This is a pilot project, to gain information on the suite of bacteria in the inflow, outflow, fish and snails associated with Hagerman State Hatchery. We will consider expanding sampling to other sites in the area after completion of the pilot project. Sampling will be conducted in December and January of 2004-5. We have created a GIS coverage and geo–referenced data sets, and have shared this with Hatchery managers at the State and Federal Hatchery. Samples of bacteria from fish, water, and also New Zealand mud snails will be collected and screened for viable aerobic heterotrophic bacteria. Selected isolates will be profiled for their inhibitory response to oxytetracycline, and to chloramphenicol.

STRATEGIES THAT CAN REDUCE THE RISK OF NEW ZEALAND MUDSNAIL INFESTATION AT FISH PROPAGATION FACILITIES DURING FISH TRANSFER OPERATIONS

Principal Investigator: Dr. C. M. Moffitt
Student Investigator: Rolita Louise Bruce
Funding Agency: USFWS
Completion Date: 08/15/05

Objectives:

1. Determine an ozone dose and associated contact time lethal to New Zealand Mudsnails (NZMSs) for hatchery water treatment.
2. Determine the range of time the NZMS is viable within the GI tract of a typical salmonid to estimate an appropriate fish depuration time before transport.
3. Explore the potential of other practical hatchery control measures.

Progress: Since their initially recognized introduction in 1987, New Zealand mudsnails (*Potamopyrgus antipodarum*) have spread throughout most of the western United States, likely through movements of fish and fishers. More recently, this invasive snail species has established colonies in and around the ponds of several Idaho fish hatcheries. In high enough biomass, the NZMS can affect the function of aquatic ecosystems. The snail also has potential to affect endemic, threatened or endangered mollusks, as well as change nutrient processing pathways in aquatic ecosystems subsequently, reducing available nutritious food for fishes. Fish stocking and fish transfers by hatcheries may accelerate the spread and introduction of NZMSs by passing through a fish's GI tract alive or simply surviving in distribution truck water. We have begun tests of different concentrations of ozone in water for durations up to 10 minutes to determine lethality for NZMSs. We have conducted pilot tests of residency time in the GI tract of rainbow trout. More work is planned for both of these objectives especially during the summer of 2005. We will determine the range of time the NZMS is viable within the GI tract of a typical salmonid to estimate an appropriate fish depuration time before transport. Through this project we will provide a model of the probability distribution of small and large sized snails and their survival in a typical salmonid's GI tract by region (stomach, anterior intestine, and posterior intestine). The analysis will also assess significant differences in snail transit time, snail survival in a gut region, and differences due to fish feeding regimes.

EVALUATION OF ADULT SALMON, STEELHEAD, AND LAMPREY MIGRATION PAST DAMS AND THROUGH RESERVOIRS IN THE LOWER COLUMBIA RIVER AND INTO TRIBUTARIES

Principal Investigator:	Dr. C. Peery
Student Investigators:	Amy Pinson
	Chris Anderson
	David Griffith
Funding Agency:	U.S. Army Corps of Engineers
Completion Date:	12/31/05

Objectives:

1. Evaluating the degree and effects of fish fallback at dams
2. Identifying sources of delay and loss in the system and effects of environmental variables on passage
3. Evaluating homing and straying of returning adult migrants
4. Evaluating the energy use and reproductive success of adult salmonids during their upstream migrations
5. Evaluate reproductive successes and swimming performance of Pacific lamprey, and factors that affect their passage at dams.

Progress: In 2004, we conducted the eighth field season in a basin-wide research study investigating migration of adult salmon, Steelhead (*Oncorhynchus mykiss*), and Pacific lamprey (*Lampetra tridentata*) in the lower Columbia River. Over 2,500 adult fish were outfitted with radio transmitters at Bonneville Dam and monitored as they migrated upstream using a network of fixed-site radio receivers and by mobile tracking from boats and trucks for a variety of study objectives.

Data collected from these studies will be used to determine factors affecting passage, survival, and reproductive successes for adult salmonids and lamprey migrating through the lower Columbia and Snake rivers. Information is used in decisions on how best to manage the lower Columbia River hydropower system.

As part of this project, we conducted a third year of monitoring spawning success and energy use of Chinook salmon (*Oncorhynchus tshawytscha*) returning to central Idaho tributaries of the Snake River. Measures of migration success, spawning success or pre-spawning mortality will be related to estimates of energy expenditure and migration behavior and temperature exposures. The Final Report has been completed

RESEARCH AND MONITORING INVOLVING RADIO TELEMETRY OF ADULT SALMON AND ADULT LAMPREY THROUGHOUT THE WATERSHEDS OF WALLA WALLA DISTRICT

Principal Investigator: Dr. C. Peery
Student Investigator: Ryan Mann

Funding Agency: U.S. Army Corps of Engineers
Completion Date: 12/31/05

Objectives:

1. Evaluate fallback of adult salmon and Steelhead at Columbia and Snake River dams.
2. Evaluate delay of adult salmon and Steelhead at Columbia and Snake River dams.
3. Evaluate homing and the incidence of straying of adult salmon and Steelhead migrating to natal streams in the Columbia River basin.
4. Assess the effects of passage through the Columbia and Snake rivers hydrosystem on the survival and reproductive fitness of adult salmon and Steelhead.

Progress: In 2004, we conducted a basin-wide research study investigating migration of adult salmon and Steelhead (*Oncorhynchus mykiss*) in the Columbia and Snake rivers. Over 2,500 adult fish were outfitted with radio transmitters at Bonneville Dam and monitored as they migrated upstream using a network of fixed-site radio receivers and by mobile tracking from boats and trucks for a variety of study objectives.

Data collected from these studies will be used to determine factors affecting passage, survival, and reproductive successes for adult salmonids and lamprey migrating through the lower Columbia and Snake rivers. We are in the process of developing multi-year summaries and statistical models that will be used by system managers for day-to-day operations of the federally operated hydroelectric dams. A series of manuscripts from this and previous years from this project were submitted to peer-reviewed journals for publication. Many of these were published or are currently in press.

In the Snake River drainage, we conducted an evaluation on the use of cool water released from Dworshak reservoir on adult migration behavior in the lower Snake River during summer, and a test of structural modifications in the fishway to improve passage at Lower Granite Dam, as well as the continuation of passage and survival evaluations conducted in the lower Columbia River.

A study was initiated to investigate effects of temperature exposure while migrating in the Columbia and Snake rivers on gamete quality for female Chinook salmon (*Oncorhynchus tshawytscha*) and Steelhead. Fish collected near the mouth of the Snake River were

outfitted with radio transmitters and temperature recorders. As these fish were collected at hatcheries we assessed gamete quality and survival. These variables will be related back to the temperature histories experienced by the parent fish as the migrated.

FISHERIES POPULATION ASSESSMENT

Principal Investigator: Dr. D. Scarnecchia
Student Investigator: Ryan Kreiner
Funding Agency: USGS
Completion Date: 9/30/05

Objectives:

1. Conduct collaborative research on resident fish population status relative to depressed salmon returns in South Central, Alaska.

Progress: During the summer of 2004, a study was conducted in Lake Clark National Park, Alaska. Resident fish species lake trout and arctic char, were captured from seven different lakes within the park. Length and weight data, as well as otoliths were collected from all fish captured. Current data will be compared with an historic data set. Lab work was completed in May 2005 and a rough draft of the project is expected to be submitted by early summer.

Completed Projects – Fisheries Resources

Dr. Chris Peery – Principal Investigator

- Biological effects of Snake River thermal regimes on endangered salmonid species in the Lower Snake River
- Evaluation of steelhead kelt outmigration from Lower Granite Dam to Bonneville Dam
- Passage and survival of summer steelhead through the Yakima River

BIOLOGICAL EFFECTS OF SNAKE RIVER THERMAL REGIMES ON ENDANGERED SALMONID SPECIES IN THE LOWER SNAKE RIVER

Principal Investigator: Dr. C. Peery
Funding Agency: U. S. Army Corps of Engineers, Walla Walla through Normandeau Consultants
Completion Date: 9/30/03

Objectives:

1. To conduct and compile a literature review on effects of water temperature on life history stages of Chinook salmon (*Oncorhynchus tshawytscha*) and Steelhead (*Oncorhynchus mykiss*).
2. To identify the most sensitive ESA listed salmonid stocks and life stages to water temperature patterns and extremes characteristic of the Snake River, from Hells Canyon Dam downstream to the confluence with the Columbia River and including the Clearwater River from Dworshak Dam downstream to its confluence with the Snake River.
3. To identify the life stages of the affected ESA listed species and examine the critical months, seasons, and timing for operational actions to alter or control water temperatures to maximize biological benefit.
4. To identify the three dimensional distribution of adult and juvenile anadromous salmonids passing through the Snake River corridor with emphasis on Lower Granite Reservoir and if possible, correlate fish locations with water temperature.

Final Report has been completed

EVALUATION OF STEELHEAD KELT OUTMIGRATION FROM LOWER GRANITE DAM TO BONNEVILLE DAM

Principal Investigator: Dr. C. Peery
Funding Agency: U. S. Army Corps of Engineers, Walla Walla through Normandeau Consultants
Completion Date: 3/31/04

Objectives:

1. Evaluate return rates of kelts transported by barge to below Bonneville Dam versus those allowed to migrate in-river from the Lower Granite Dam tailrace

2. Enumerate the number of kelts at the Lower Granite juvenile fish facility bypass, collect data on age structure, general morphology, and fish condition

Results: In the spring of 2004, as part of a continuing study of Snake River Steelhead kelt abundance and survival and the efficacy of transporting kelts to the estuary to enhance repeat spawning, we examined over 2,000 Steelhead collected from the Lower Granite Dam separator. Using ultrasound techniques, we identified 93% as kelts: 17% males and 83% females, about 50% were of wild origin and the majority of all fish were considered to be in good (46%) or fair (26%) overall condition. We PIT tagged the majority of the kelts and randomly assigned half to either be transported to the estuary or released in the tailrace of Lower Granite Dam to migrate in-river. Return rates of these fish will be analyzed in 2005. Analysis of returns of kelts from this study released in 2002 and 2003 indicated a return rate of 2.7% for kelts transported to the estuary versus 0.8% for kelts allowed to migrate in-river.

Final Report was submitted and is expected late 2005.

PASSAGE AND SURVIVAL OF SUMMER STEELHEAD THROUGH THE YAKIMA RIVER

Principal Investigator: Dr. C. Peery
Funding Agency: U. S. Bureau of Reclamation
Completion Date: 9/30/03

Objective:

1. To evaluate migration behavior and survival of adult Steelhead through the Yakima River with respect to a series of low-head irrigation and hydropower dams.

Results: This is a collaborative project between University of Idaho (UI) and Bureau of Reclamation (BOR) who manage the dams in Yakima River. Researchers from the BOR collected and outfitted 250 adult salmon or Steelhead with radio transmitters at Roza Dam in the Yakima River. UI personnel then monitored fish movements through the Yakima River using a series of fixed site receivers and mobile tracking by truck as they migrate upstream to spawning areas. BOR and UI personnel are jointly developing a technical report on the results, which should be completed by early 2006. Results will be used to better manage passage facilities at dams and flows within the Yakima River for adult Steelhead.

Report draft prepared by the Bureau of Reclamation (BOR) researchers.

Ongoing Projects – Wildlife Resources

Dr. Edward O. Garton – Principal Investigator

- Limiting factors for Elk in Idaho
- Pronghorn antelope population inventory methods
- The role of competition in the dynamics of Elk and Deer populations: Interactions and predications
- Using the metapopulation concept to understand the spatial and temporal population dynamics of Elk in Idaho

Dr. Wayne Melquist – Principal Investigator

- Black Bear project
- Fisher project in the Idaho panhandle
- Idaho's important bird areas program
- Population status and habitat use of Clearwater wolverine
- Statewide wolf management

Dr. Janet Rachlow – Principal Investigator

- Black bear crossing patterns
- Boise zoo squirrels
- Lamb production in California bighorn sheep
- Moose on the Palouse
- Pygmy rabbit survey

Dr. Kerry P. Reese – Principal Investigator

- Craig mountain quail ecology
- Greater sage-grouse chick ecology
- Greater sage-grouse nesting
- Jarbidge sage-grouse ecology project
- Mountain quail translocation

Dr. J. Michael Scott – Principal Investigator

- Assessing avian diversity and identifying conservation targets in the National Wildlife Refuge System

- Biological integrity and diversity: Waterfowl and the National Wildlife Refuge System
- Breeding ecology and philopatry in red-shouldered and red-tailed hawks
- Determination of Recovery Plan Populations Goals
- Development of unmanned airborne vehicle for monitoring wildlife
- Focal species as conservation targets
- Habitat analysis: Toward converting a set of competing techniques into a set of competing hypotheses
- The ecological content and context of the National Park Service

Dr. Lisette P. Waits – Principal Investigator

- Red wolf microsatellite genetics and habitat use program

Dr. R. Gerry Wright – Principal Investigator

- An inventory of bat species and a determination of bat roost habitat characteristics at John Day Fossil Beds, N.M.
- Biological data investigation in northern semi-arid national parks
- Black bear food habits at Yosemite National Park
- Characterizing the historic landscape of the Snake River Plain in Idaho
- Digital image library: Channel Islands National Park
- Habitat use and moose browsing effects in Rocky Mountain National Park
- Identification of rare plant populations within fuel reduction areas at Lake Roosevelt National Recreation Area
- Landscape analysis of black bear distributions patterns in Olympic National Park
- Monitoring program for the northern semi-arid network
- Peer reviews of NPS monitoring plans
- Reproduction and habitat use of moose in expanding populations in Idaho

LIMITING FACTORS FOR ELK IN IDAHO

Principal Investigator: Dr. E. O. Garton
Student Investigator: Debra Montgomery
Funding Agency: IDFG
Completion Date: 12/30/04

Objectives:

Project 1: Proximate Factors Influencing Hunting Mortality of Elk in Idaho

1. Do the same proximate factors influence bull Elk vulnerability in different habitat types and under various hunting management strategies?
2. Can consistent, synoptic measurements of habitat structure be used to predict Elk vulnerability?
3. Are the same proximate factors important at different scales?
4. What factors are important for females as opposed to males?

Project 2: Age Estimation and Growth of Rocky Mountain Elk Calves

1. Develop a statistical model to predict age for Rocky Mountain Elk calves (*C. e. nelsoni*) using morphological measurements that are non-lethal and easy to implement in the field;
2. Compare the statistical model to Johnson's (1951) aging criteria;
3. Determine if the captive calves were representative of Elk calves from other experimental and wild populations;
4. Determine if individual variation in size could be explained by maternal nutrition.

Progress: Project 1 We studied the effect of habitat use, hunting season structure and hunter density on mortality of bull Elk (*cervus elaphus*) during the hunting season. Previous research has established road density, hiding cover and topography as important proximate factors related to mortality. Although these previous studies have similar results, they are not directly comparable because different models were used, environmental factors were calculated in different ways and factors were measured at varying scales. We determined whether relationships between environmental factors and mortality were similar for bull Elk living in different habitat types and under various hunting management strategies. To explore this question, we related 8 variables to mortality rates using Cox's proportional hazards models. We examined factors at 2 spatial extents for 3 populations of Elk from 4 different studies conducted between 1985 and 1994. Predictive capabilities of mortality models were explored with concordance (c) and Somers' D statistics. Relationships between mortality and hunting season structure and habitat use differed among study areas and between spatial extents. For example, increasingly rough terrain provided more protection for Elk in 2 populations, while it was related to higher mortality rates for the third. Overall our results demonstrated that Elk

exhibit a variable and flexible adaptive behavior to hunting pressure in each area. Although predictive capabilities of models were poor ($c < 0.5$), our results provide a better understanding about differences among Elk vulnerability in different areas. Because our models relate road density, habitat configuration and hunting season structure to mortality in various ecosystems, they provide site-specific management tools to enhance coordination of Elk hunting among multiple state and federal agencies in the inland Northwest.

Project 2 Age determination for adult Elk is routinely conducted using tooth wear or cementum annuli with a maximum accuracy of 3-4 months. Researchers studying neonatal Elk find it difficult to use these techniques for accurate estimates of age. We developed a model for predicting age of an Elk calf during the first 2 weeks of life using morphometric variables. Body measurements were collected from 83 captive Elk calves used in a feeding experiment at Starkey Experimental Forest and Range Station, near LaGrande, Oregon. Linear, mixed effects models were used to evaluate the relationship between age and body measurements easily acquired in the field. Random effects were added to the models to accommodate the correlation due to nutritional, environmental and genetic variation, and to broaden the applicability of these models to wild populations. The best models for predicting age included tooth length, mass, and a hoof measurement. From model validation, we calculated a 1.5 days average deviation between the true age and the predicted age. This mixed effects model will aid researchers exploring survival, recruitment and birth patterns of young Elk.

PRONGHORN ANTELOPE POPULATION INVENTORY METHODS

Principal Investigator: Dr. E. O. Garton
Student Investigator: Tim Smyser
Funding Agency: IDFG
Completion Date: 12/30/04

Objective:

1. To assess variation in pronghorn antelope fawn/doe ratios relative to environmental variables.

Progress: To address this question, we will be looking at variation in pronghorn antelope (*antilocapra americana*) recruitment at two scales. At the larger scale, we will be compiling fall composition count data for the last 30 years across pronghorn range within Idaho and Wyoming. We will then evaluate variation in recruitment relative to temporally and spatially specific habitat characteristics.

On the second scale we will evaluate the response of populations to lactation season nutritional condition. With the exception of following severe winters, the literature

reports pregnancy rates are uniformly high across pronghorn populations and yet strong differences are observed in pre-harvest recruitment rates. With this emphasis on the lactations season, we have selected five sites, chosen to represent the breadth of pronghorn recruitment within the state. The first site is Eastern Owyhee County characterized by low recruitment and hot, dry conditions. The second site is Southern Camas Prairie supporting higher recruitment rates and cool, moist conditions with populations supplemented with alfalfa. The third site is the Littlewood area, with pronghorn persisting on native, more mesic relative to Eastern Owyhee County. Our fourth and fifth study sites fall within the mountain valley habitats of the Pahsimeroi and Birch Creek. We will use fecal indicators (fecal nitrogen and 2,6 diaminopimelic acid) to quantify nutrition condition. Preliminary analysis indicates nutritional condition, when evaluated from a seasonal perspective, is a good predictor of recruitment rate. The relationship between fecal indicators and recruitment was strengthened by weighting observations to account for season changes in energy demands.

THE ROLE OF COMPETITION IN THE DYNAMICS OF ELK AND DEER POPULATIONS: INTERACTIONS AND PREDICTIONS

Principal Investigator: Dr. E. O. Garton
Student Investigator: Jeff Manning
Funding Agency: IDFG
Completion Date: 12/31/05

Objectives: Our overall objective is to estimate effects of inter- and intra-specific competition and other intrinsic and extrinsic factors on the population dynamics of these three species, and to use this information to develop a model for predicting population responses to changes in habitat conditions, weather severity, predation pressure, and harvest limits. This led to the development of four specific objectives:

1. Estimate the equilibrium density (carrying capacity) for white-tailed Deer, mule Deer, and Elk separately in selected Idaho Department of Fish and Game (IDFG) delineated Game Management Units (GMU).
2. Estimate annual changes in habitat condition, weather severity, predation pressure, and harvest in each GMU.
3. Develop statistical models to identify and estimate the relative and interactive influences of each factor and on growth rates of Elk and Deer populations.
4. Develop a predictive multi-cervid model that simultaneously predicts the population size of each species in response to integrated changes in these factors, including management decisions such as harvest limits or predator control.

Introduction: Elk (*Cervus elaphus*), white-tailed Deer (*Odocoileus virginianus*), and mule Deer (*Odocoileus hemionus*) populations extensively overlap throughout western North America. In Idaho and throughout the western States, their populations are experiencing large-scale changes. Changes in habitat conditions, weather severity, harvest limits, and predation pressure are suspected to alter equilibrium densities and spatial separation among these species, giving rise to various levels of competition (Linzey et al. 1997). Combined, these factors have confounding effects on the fluctuations of Deer and Elk populations, which complicate our ability to predict the effects of management decisions. Combining these spatially and temporally variable factors in a predictive model that accounts for relative and interactive effects, including intra- and inter-specific competition, may provide accurate predictions of management decisions like harvest limits or predator control. Such models will assist wildlife managers in maintaining productive Deer and Elk herds at the regional.

Progress: Estimation of equilibrium densities depend on long-term annual estimates of population size in GMUs. We have compiled a database comprised of 299 estimates of mid-winter, mule Deer population size derived from aerial sightability surveys conducted by the IDFG from 1989-2003. We also compiled 333 estimates for Elk. These estimates often are not available for every year, and numerous estimates are from trend areas that comprise a portion of one or more GMUs. In order to standardize the extent of each sampling unit, we are using regression analyses to predict population estimates across each GMU from their corresponding trend area estimates. We completed these analyses for mule Deer in GMUs 11, 12, and 50, and predicted GMU-wide population sizes for several years.

To determine methods that are appropriate for bridging gaps between annual estimates and increase the length of the data string in each GMU, we evaluated the efficacy of using harvest and other landscape and weather variables to predict population size. In a preliminary analysis, we used mule Deer general harvest per unit effort and snow levels in each GMU in the Salmon Region. We compared the fit of several models to this data, and found evidence that harvest and snow may be used to estimate population size of mule Deer in each GMU. The best model suggested that winter densities of mule Deer were an additive function of harvest per day and snow accumulation, and it predicted winter densities that were from 2-47% of observed sightability densities.

Annual estimates of habitat condition, weather severity, and predation are difficult to obtain, particularly at resolutions necessary for considering them as predictors of Elk and Deer population growth rates. We are currently analyzing annual changes in vegetation cover (as an index of habitat condition); with an emphasis on broadleaf and grassland forage and forest cover in Elk and Deer winter and summer ranges. To accomplish this, we are using annual values of the normalized difference vegetation index (NDVI) between 1989-2003 across north and central Idaho. The data are based on a 30m x 30m resolution, and enable us to track annual changes in seasonal ranges in each GMU.

We recently obtained daily weather data from the DAYMET U.S. Data Center (http://www.daymet.org/). It spans 24 years, from 1980-2003, and is at a 1-km2

resolution across Idaho. The data is currently being extracting into a useable format, and will provide seasonal and annual estimates of precipitation and temperature. A preliminary analysis to assess the adequacy of using the Daymet data for predicting snowfall and winder severity indices was completed. We used Daymet estimates and snowfall levels from a sample of Snotel sites across Idaho, and found statistically significant relationships. We are currently using these significant relationships to estimate accumulation of snow and indices of weather severity in GMUs across the state.

Anticipated Accomplishments for FY 2005:

1. Complete the long-term string of annual population estimates for mule Deer, Elk, and white-tailed Deer. Estimate carrying capacity of each species in each GMU.

2. Quantify amount and extent of suitable winter ranges each month for each species each year (from 1980-2003) using estimated accumulation of snow from Daymet weather data. Compute population densities in winter and summer ranges. Estimate monthly and annual weather severity indices in winter and summer ranges. Estimate changes in habitat conditions (broadleaf and grass forage and forest) in winter and summer ranges of each species using NDVI data. Validate predicted ranges and habitat changes with IDFG managers.

3. Estimate relative effects of change in habitat condition, weather severity, predation pressure, harvest per unit effort, and other extrinsic factors (cattle allotments, roads, and essential mineral levels) on population growth rates. Begin writing methods and results sections for manuscripts on this subject. Present findings at the annual meeting of the Idaho and National Chapters of the Wildlife Society.

4. Begin developing predictive multi-cervid model, followed by model validation and sensitivity analysis.

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

Principal Investigators: Dr. E. O. Garton
Dr. J. M. Scott
Student Investigator: Jocelyn Aycrigg
Funding Agency: IDFG
Completion Date: 6/1/05

Objectives:

1. To use demographic and genetic characteristics to delineate Elk (*cervus elaphus*) metapopulations.
2. To model the influence of extrinsic factors (i.e., harvest levels, predator impacts, habitat change, weather, essential mineral levels, and road patterns) on each metapopulation.

Progress: Objective 1 For the genetic population characteristics, we extracted DNA from 199 tissue samples from 8 locations in Idaho and used polymerase chain reactions (PCR) to amplify DNA at 10-14 polymorphic microsatellite loci. We examined population substructure with 5 approaches. Individuals were assigned to local populations based on their relative similarity or dissimilarity to each local population using genotypes and geographical location. Results indicate that Elk populations in the Northern Rocky Mountains are continuous and there is enough interchange of individuals to limit genetic differentiation. This may in part be explained by the historical translocation of Elk from Yellowstone National Park to various locations in Idaho. Based on these results the management unit for maintaining genetic diversity among Elk populations could potentially extend from Wyoming to British Columbia.

Since obtaining these results we have been increasing the number of samples per location to 30-35 to capture 90-95% of the genetic variability exhibited by each sample location. We have also been assigning specific locations to each sample so that we can use both the genotype and the geographic location in our analysis. These results have been presented at three national, one regional, and one state conference.

Objective 2 Deficiency of essential minerals such as selenium has been linked to lower productivity because of increased infertility, stillbirths, and abortions. Within Idaho, the levels of selenium in vegetation are considered low to variable. However, these levels in the vegetation do not equate to how much selenium is consumed and absorbed by Elk. Other minerals, such as calcium, copper, iron, magnesium, and zinc can inhibit the absorption of selenium in the body. Our objective is to determine if there is a difference in selenium and other minerals (i.e., calcium, copper, iron, magnesium, phosphorus, and

zinc) in the blood of Elk from different regions within the state and pregnancy status. This is an ongoing effort for which additional samples have been obtained.

BLACK BEAR PROJECT

Principal Investigator:	Dr. W. Melquist
Cooperating Investigators:	Jon Rachael
	Neil Johnson
Funding Agency	IDFG
Completion Date:	6/30/05

Objective:

1. Estimate population size and harvest rate of black bears (*Ursus americanus*) in Game Management Unit 39 in southwest Idaho through use of DNA mark-recapture techniques.

Progress: Work was initiated in the 3,069 km2 study area in Game Management Unit 39 north and west of the Middle Fork Boise River in June 2003. The study area is comprised predominately of Boise National Forest land, but includes lands owned and managed by Idaho Department of Lands, Boise Cascade, and private landowners. The study area was divided into 48 8 km2 sampling units in which barbed wire enclosures were set around a small bait or scent lures to capture hair samples from visiting bears. Following an initial "capture" hair trapping session, hair traps were relocated within the sample units for 2 subsequent "recapture" trapping sessions. DNA extracted from bear hair samples will be used to identify bears as individuals, thus resulting in "marked" animals in the study area. The frequency of new captures vs. recaptures in subsequent hair capture sessions will enable estimation of the bear population within the study area. Further, tissue samples were collected from all black bears harvested by hunters in the study area, creating an additional recapture event, and allowing an estimate of harvest rate of the bear population.

From June 16 through August 31, 2003, 180 hair traps were set. Staff collected 232 hair samples from 153 hair traps. During the same period in 2004, 251 hair trap stations were set and 204 hair samples were collected from 184 visited trap sites. IDFG personnel also collected tissue and hair samples from 153 black bears harvested in the Unit during 2003 and 2004.

Lab work for extraction of DNA and identification of individual bears was originally being conducted by Idaho Department of Fish and Game's Wildlife Health lab, but reprioritization of the geneticist's duties at the lab forced us to contract the work elsewhere. We expect to receive lab results from the first two field seasons of the study by mid-May. Work on the third and final field season for this project will commence mid-June and end August 31, 2005.

FISHER PROJECT IN THE IDAHO PANHANDLE

Principal Investigator: Dr. W. Melquist
Funding Agency: IDFG
Completion Date: 6/30/05

Objective:

1. To document the occurrence, distribution and genetic characteristics of fisher (*Martes pennanti*) populations in the Selkirk Mountains of Idaho.

Progress: At this time, we have completed three field seasons on this effort. Winter 2003-4 we conducted hair snaring at 186 locations in 18 hydrological basins in the Kootenai and Priest River watersheds of the Selkirk Mountains. The effort produced over 300 hair samples, which were analyzed at the USFS Rocky Mountain Research Station wildlife genetics lab in Missoula. A total of 22 marten and 20 fisher samples were identified in this sample. Fisher samples were recorded from three basins on the Kootenai side of the Selkirk crest, including Trout Creek, Grass Creek and Smith Creek. Importantly, several of the samples had haplotype characteristics that indicate the presence of a remnant native population in the Selkirks. The haplotype combination is similar to that found in native fisher populations in western Montana.

In the summer of 2004 the USFS Rocky Mountain Research Station conducted hair snaring for fisher and marten on approximately 240 plots distributed on a grid throughout the Selkirk and Purcell Mountains of Boundary County. The samples from this effort are in Missoula awaiting analysis.

Another winter hair snaring effort was conducted by IDFG during the winter of 2004-5. This effort focused on hair snaring in the Priest River drainage of the Selkirk Mountains, and included both Forest Service and Idaho Department of Lands. Simultaneously, the USFS Rocky Mountain Research Station ran a hair snaring effort in Upper Smith Creek and Long Canyon, areas not sampled the previous year due to difficulty of access and roadless condition. Over 300 samples were produced by these two efforts. The samples are in Missoula presently being analyzed. We anticipate final results from the winter 2004-5 effort by July. At that point we should be able to produce reliable estimates of distribution and genetic characteristics of fisher in the northern Panhandle of Idaho.

This project is being conducted in collaboration with Dr. Samuel Cushman (Rocky Mountain Research Station, USFS), Dan Davis and Bob Ralphs (USFS), Jim Hayden and Chuck Harris (IDFG), and their staff.

IDAHO'S IMPORTANT BIRD AREAS PROGRAM

Principal Investigator:	Dr. W. Melquist
Cooperating Investigators:	Dr. Rex Sallabanks – IDFG
	Colleen Moulton – IDFG
Funding Agency:	IDFG
Completion Date:	6/30/05

Objectives:

1. To accept nominations for Important Bird Areas (IBAs) statewide.
2. To review and recognize nominated IBAs.
3. To initiate bird monitoring activities at wetland IBAs.
4. To gather information on the distribution and abundance of non-game birds at Idaho's IBAs.

Progress: Idaho's Important Bird Areas (IBA) Program continued to grow in 2004/2005 under the guidance of Colleen Moulton, Idaho's IBA Coordinator. Colleen made numerous requests for nomination forms for important areas for birds that had yet to be recognized as IBAs. Several nominations were received, reviewed by the IBA technical committee, and officially accepted into the IBA program; examples include Cascade Reservoir, Priest Lake, and Blackfoot Reservoir. Nomination forms are expected in the near future for several other key sites for birds, such as Henry's Lake in the Upper Snake region of eastern Idaho. Colleen's efforts to update Idaho's IBA program have now resulted in 55 officially recognized IBAs, representing 3.8 million acres of wetland and upland habitat throughout the state, and including a variety of land ownerships. All six National Wildlife Refuges in Idaho have been identified as IBAs, as well as 13 Idaho Department of Fish and Game Wildlife Management Areas. Colleen is now focusing on implementing the next phase of the IBA program - bird monitoring. As a result, monitoring was initiated at five wetland IBAs in 2004, with many more sites being added to the monitoring component of the IBA program in 2005. Monitoring is being conducted under the Idaho Bird Inventory and Survey (IBIS) program, which Colleen also coordinates. Wetland IBAs are the initial focus of the IBIS program so that much-needed information on the distribution and abundance of Idaho's waterbirds and shorebirds can be gathered. Six technicians were hired to work with Colleen during the 2005 spring and summer seasons with the goal of implementing statewide, coordinated, all-bird monitoring at most of Idaho's IBAs. Survey efforts are currently underway and will continue through July 2005.

POPULATION STATUS AND HABITAT USE OF CLEARWATER WOLVERINE

Principal Investigator:	Dr. W. Melquist
Funding Agencies:	IDFG U.S. Forest Service USFWS
Completion Date:	6/30/05

Objective:

1. Determine the status and ecology of the wolverine (*Gulo gulo*) and associated forest carnivores, and identify and provide proactive conservation measures for these species.

Progress: The logistics of working in the upper Lochsa River of the Clearwater region has challenged our ability to gather sufficient data to complete the objective as described. Our intention was for this project to compliment the Lolo Pass Redevelopment Project, an effort to determine the impacts of Highway 12 and construction of a major visitor center at Lolo Pass on lynx movement and survival. Because lynx are so rare in the study area (only 1 has been observed during the past 3 years of the study), that aspect of the study had to be addressed off-site. On-site efforts then focused on wolverine and fisher. Our project was intended to bolster the wolverine and fisher effort. The scarcity of wolverines in the area compromised our ability to determine the population dynamics of that species. Conversely, we were much more successful in capturing and monitoring fishers.

Employing 27 "log-cabin" traps in the upper Lochsa area, we anticipated making multiple captures of wolverines, which would have allowed us to address the objective as originally spelled out in the Project Statement. We also constructed 2 traps in the upper St. Joe River drainage and at Gold Creek Summit (between the St. Joe and Coeur d'Alene River drainages) in an effort to increase our capture success. Unfortunately, weather conditions and other factors prevented us from activating either trap. The capture of only 3 wolverines as a result of such extensive and intensive efforts provides evidence that densities are very low in the upper Lochsa/Lolo Pass area. The first wolverine captured provided limited information as it dispersed from the study area and was later found dead near Salmon, Idaho. While the methods designed to fulfill the objective remained the same, our contribution to the ecology of the wolverine in the study area, based on so few captures, is limited. Unfortunately, the cost to activate and monitor traps remains the same, whether or not animals are caught. And aerial tracking flight costs are nearly as high for monitoring a few animals as they are for a larger number of animals. We had intended for this project to cover 3 years, with Segment 1 designed to capture and instrument sufficient wolverines to allow collection of the needed data during Segments 2 and 3. Consequently, a disproportionate amount of the Segment 1 funds had to be focused on the extended capture effort. We conserved funds by not establishing

dedicated survey transects for potential prey species and associated forest carnivores. Instead, we simply documented occurrence data during the course of collecting wolverine and fisher data.

Status of Wolverine and Fisher in the upper Locsha River.
All wolverines captured to date have been captured along the Elk Summit Road. We have seen little evidence of wolverine on the north side of Highway 12; the only observation is a set of tracks followed in spring 2003. Our radio and satellite telemetry efforts have consistently found our 2 instrumented animals on the Bitterroot crest. In fact, Male 3 made several trips between Lolo Peak and Blodgett Canyon's rim, following the Idaho-Montana border. The female we captured is consistently found in the Bitterroot-Selway Wilderness along the Bitterroot crest. Her capture location appears to be at the extreme of her home range. Thus, we are beginning to understand that wolverine are not living in the Lochsa drainage itself, but appear to live on its periphery. It is still unclear, due to low sample sizes, how important the area is as a corridor to other wolverine populations to the North.

Fishers are consistently located within the Lochsa River Drainage. They are most frequently located in the cedar-hemlock river drainages, but have also been found up to approximately 6,000 feet. Some of our male fishers have been wide ranging moving long-distances along the Lochsa Corridor. For instance, 1 fisher has moved from Badger Creek to Tom Beal, while another has moved across Lolo Pass from the East Fork of Lolo Creek to near Powell, Idaho. What remains to be determined is how far off the Lochsa River fishers are located. Efforts initiated in summer 2004 will begin to address this issue.

Fishers have been negatively impacted by highway 12, in that we have had a juvenile male fisher killed by a vehicle during winter 2004. We have evidence of fishers crossing the highway several times successfully. Recreation along the river corridor has not visibly affected fishers, however, trapping has been the source of at least 1 female fisher's mortality in Montana during winter 2003/2004.

Conservation Measures for Wolverines and Fishers in the upper Lochsa River.
For both species, we will identify conservation measures once field work is completed. Both species are currently trapped in Montana. Our male wolverine that was instrumented with an ARGOS satellite collar spent nearly half his life in Montana in areas that are frequently trapped. The ban on trapping wolverine in Idaho is likely the only reason he has not been captured to date.

Fishers may only be located in the immediate vicinity of the Lochsa River. Once we move away from the river, our capture probability declines rapidly. If this is the case, the ban on trapping may be the only reason Idaho has a fisher population. Given its small size, limited distribution, and paucity of females in the population, fishers may be relatively easy to exterminate.

Highway 12 along the Lochsa River has a moderate-to-light amount of traffic on it. If traffic volumes were to increase, we could speculate that we would see an increase in the number of individuals killed by vehicles. Again, given that the highway is the epicenter of fisher distribution in the Lochsa, this could have population-level consequences.

STATEWIDE WOLF MANAGEMENT

Principal Investigator: Dr. W. Melquist
Cooperating Investigator: Steve Nadeau – IDFG
Funding Agency: IDFG
Completion Date: 6/30/05

Objective:

1. Initiate gray wolf (*Canis lupus*) management and associated activities in Idaho by the Idaho Department of Fish and Game

Progress: Michael Lucid and Jason Husseman were hired in May 2004 to work with Idaho Department of Fish and Game as Regional Wildlife Biologists working primarily on wolf management issues. They identified packs, counted pups and estimated pack size, radio collared wolves, flew telemetry flights, verified wolf observations by the public, and otherwise documented wolf activity throughout Idaho. They developed and managed statewide data base on wolves, wolf observations, telemetry, pack activity, and other wolf biological information. They coordinated with state, federal, and tribal personnel in management issues. They tended to complaints from public, dealt with management issues, conducted and participated in training, purchased equipment, and otherwise assisted in developing the state's wolf management program, and assisted in writing reports on wolf status. They conducted several public meetings, gave presentations to schools, sportsmen clubs, made efforts to contact members of the public regarding wolf issues, and otherwise presented the Department in wolf management issues. They also helped develop outreach brochures on wolf management.

As part of regional duties, they conducted other big game monitoring activities particularly as the related to increased ungulate monitoring, working check stations, and providing regional assistance as requested. This has been a very valuable program for Idaho Fish and Game and we wish to continue the program throughout the next fiscal year.

BLACK BEAR CROSSING PATTERNS

Principal Investigator: Dr. J. Rachlow
Student Investigator: Jesse Lewis
Funding Agency: IDFG
Completion Date: 6/30/07

Objectives: In 2004, highway 95 in northern Idaho was expanded and rerouted in portions traversing through the Purcell Mountains. The goal of this research is to evaluate how roads and human development affect black bear (*Ursus americanus*)habitat selection and movement patterns within that highway corridor. The objectives of this study include to:

1. Investigate black bear habitat selection within the study area.
2. Evaluate how roads affect black bear habitat selection and develop predictive models of habitat association for crossing locations along Highway 95.
3. Evaluate black bear movement patterns related to important landscape features and patch dynamics.
4. Compare results across a range of GPS telemetry acquisition intervals.

Progress: We developed GIS layers of canopy cover and satellite view for development of correction factors for GPS acquisition bias. Four bears were fitted with VHF collars during 2004, and two of those have been re-fitted with Lotek 3300L GPS collars. Trapping and radio-collaring, ground-truthing of GIS data layers, and experimental evaluation of GPS collar bias will be conducted during May – August of 2005.

BOISE ZOO SQUIRRELS

Principal Investigator: Dr. J. Rachlow
Student Investigator: Alisse Garner
Funding Agency: IDFG
Completion Date: 6/30/05

Objectives:

1. To apply microsatellite analyses to two additional wild SIDGS populations, Scotch Pines and Sweet.
2. To analyze samples from F1 (first generation) progeny of the Zoo Boise captive population to determine their parentage where possible.

Introduction: The southern Idaho ground squirrel (*Spermophilus brunneus endemicus*), a subspecies of the Idaho ground squirrel, has undergone declines in numbers and has

experienced degradation and fragmentation of habitat. Previously, we documented low levels of genetic diversity in the southern Idaho ground squirrel (SIDGS) populations and identified two genetic complexes. In 2002, a captive population was established at Zoo Boise from individuals originating from the Rolling Hills and Clay Peak populations, which belong to the two different genetic complexes.

Progress: Plucked hair was used as the source for DNA in this study. Samples were obtained from 30 progeny (F1) of the Zoo population in 2003 and from the Scotch Pines (n = 10) and Sweet (n = 13) SIDGS populations in 2004. As in the previous study (Garner et al. in press), eight microsatellite loci were analyzed for each sample by the Polymerase Chain Reaction (PCR).

Genetic diversity was quantified using expected heterozygosity and allelic richness for each population. Genetic divergence and gene flow among populations were quantified with FST statistics and assignment tests, respectively. Following calculation of divergence measures, groups of similar populations were tested for significant divergence from other groups, using hierarchical analysis of molecular variance (AMOVA).

Parentage Assignments for Zoo Progeny -- Microsatellite genotypes of all F1 samples were compared to genotypes of founding individuals. Because the founding males from Clay Peak contained alleles not present in the Rolling Hills founders, offspring were confidently assigned to Clay Peak fathers by a process of elimination. Assignment of all possible mothers was also completed by a process of elimination.

SIDGS exhibited low microsatellite diversity in all populations, and peripheral populations had experienced isolation and further loss of genetic diversity. The populations of SIDGS sampled in this study were grouped most parsimoniously into two genetic complexes, one consisting of the Rolling Hills and Henley Basin populations, and one consisting of all other populations. However, the Squaw Butte and Sweet populations may represent a third, moderately differentiated group. Based upon the number of unique alleles present in each population, the divergence of Henley Basin may reflect both drift and genetic uniqueness, while the divergence of Sweet is more likely due to genetic drift or a founder event.

Assignment of progeny to likely parents indicated very unequal contribution of founding individuals to the F1 generation. A total of 21 of the 30 offspring were attributed to two Clay Peak males, and the remaining 9 offspring were attributed to Rolling Hills males. Founding females (all from Rolling Hills) were too genetically similar to determine maternal relationships with confidence. Because founding individuals contributed very unequally to the F1 generation in the captive population, the effective population size (Ne) of the founding population was much smaller than its census size, which would be expected to lose genetic diversity at a faster rate than the census size would suggest. Captive breeding programs generally employ a number of strategies to maximize the Ne/N ratio of the population. However, captive breeding should be considered a last recourse in conservation because of the genetic risks involved. If captive breeding is intended to produce individuals for reintroduction into populations in the central and

southern portions of SIDGS range, Bissel Creek would be the best population from which to draw individuals to found a captive breeding stock. Individuals from other central populations may also be included to capture the full range of diversity present in the complex.

LAMB PRODUCTION IN CALIFORNIA BIGHORN SHEEP

Principal Investigator: Dr. J. Rachlow
Student Investigator: Regan Berkley
Funding Agency: IDFG
Completion Date: 6/30/05

Objectives: The goal of this research was to investigate potential causes for the decline of bighorn sheep (*Ovis canadensis*) in Owyhee County. Specific objectives included to:

1. Evaluate survival of adult females and production and survival of lambs.
2. Assess dates and causes of mortality.
3. Examine differences in habitat use and selection, and forage quality and quantity across three subpopulations experiencing differing levels of lamb recruitment.

Introduction: In the 1960's, the Idaho Department of Fish and Game (IDFG) began assessing the feasibility of reintroducing mountain sheep into suitable habitat in Owyhee County. The first release in the study area occurred in 1967, when 12 California bighorn sheep from British Columbia were released into the Little Jacks Creek drainage. Until 1993, helicopter surveys conducted in Owyhee County indicated that the sheep population was stable to increasing. Over the next several years, however, both sheep numbers and lamb:ewe ratios declined. In March of 2002, IDFG initiated capture efforts in Big Jacks, Little Jacks, and Shoofly Creek drainages. Fifty-two sheep have been radio-collared throughout the course of the study: 50 ewes and 2 rams. Monitoring of these sheep began in April of 2002, and continued through August 2005

Progress: Mortality-sensing radio collars were used to monitor survival of adult females and to investigate causes of mortality. In order to quantify lamb production, we monitored radio-collared ewes closely during the spring to obtain accurate estimates of the numbers of lambs produced. We tracked survival of the collared females' lambs throughout the summer to quantify juvenile survival and potential recruitment rates.

The total number of collared animals that died during this study was 23, seven of which were positively attributed to cougar (*Puma concolor*) predation. Analyses comparing survival rates across the study area identified some interesting patterns. While ewe survival appeared to be consistent across the three drainages in the study area, lamb survival did not; lamb survival in Shoofly was significantly higher than that in Little Jacks creek. Big Jacks sheep exhibited lamb survival intermediate to that observed in

Shoofly and Little Jacks. This trend was consistent among all three years of data collection, and suggested that predation risk varied across the study area. Specifically, apparent predation risk was higher in Little Jacks than in Shoofly Creek.

We also collected data on behavior and habitat use for groups of sheep throughout each of the three summers (2002-2004). These data were compared to data collected during the 1980s in 2 of the 3 drainages included in our study. The earlier data were collected prior to the start of the bighorn population decline, and we asked whether sheep exhibited shifts in behavior and/or habitat use between the two periods that are characteristic of ungulates under elevated predation risk. In addition, we investigated whether sheep on the recent study made finer scale shifts behavior or habitat use in response to variation in current risk across the study area.

We did not detect differences in behavior or habitat use between the two study periods, however, finer-scale analyses of data from the current study suggested that use of rugged terrain and group size also differed between herds. Sheep in Little Jacks, which experienced higher lamb mortality, formed larger groups and made more use of rugged terrain than did Shoofly sheep. Use of rugged terrain, in particular, was an important component of the behavioral response to increased predation risk.

We collected habitat use information by recording sheep locations and measuring habitat variables at feeding sites. We also collected fecal samples monthly during the summers of 2003 and 2004 in each of the three drainages within the study area. These samples were analyzed for fecal nitrogen, which was used as an index of relative diet quality. Finally, we used GIS technology to assess both the availability and spatial arrangement of habitat features. These data allowed us to examine the relationships among survival, nutrition, and the use, availability, and arrangement of security and nutrition resources across the study area.

Analyses of habitat use during foraging suggested that sheep in Shoofly Creek were feeding at sites characterized by significantly different features than those found at either Little Jacks or Big Jacks feeding sites. While Shoofly sheep consistently fed at sites characterized by cliffs and shrubs, Little Jacks feeding sites were characterized by a greater proportion of grass and loose rock. In Big Jacks Creek, sheep fed at sites dominated by cliffs, but with relatively little grass cover. Analyses of fecal nitrogen levels indicated that diet quality was highest for Shoofly sheep, moderate in the Little Jacks herd, and relatively low for Big Jacks sheep. Analyses of availability suggested that there are no differences in the availability of habitat features across the three drainages; however, sheep in the three herds used habitat differently. In Big Jacks Creek, sheep were selecting strongly for extremely rugged terrain; this selection is weaker in Shoofly, and nonexistent in Little Jacks.

Analyses of spatial structure indicated that Shoofly drainage was characterized by smaller patches of cliff and grass than either Little or Big Jacks drainages. In addition, habitat patches were better interspersed in Shoofly Creek than in Little or Big Jacks. Conversely, Little and Big Jacks Creeks were characterized by larger, more continuous swaths of

cliffs and grass than Shoofly drainage. These data suggested that the relatively high lamb survival in Shoofly Creek might be related to interactions between habitat arrangement and predation. In Shoofly Creek, small grassy patches of forage were often located relatively close to patches of rugged "escape terrain." In contrast, grassy patches in Big and Little Jacks Creeks were often relatively far from the nearest patch of rugged terrain. Because of this, sheep in Big and Little Jacks Creeks may make trade-offs between forage quality or quantity and security, whereas sheep in Shoofly Creek were consistently able to forage in high-quality patches that were relatively close to rugged terrain.

MOOSE ON THE PALOUSE

Principal Investigator: Dr. J. Rachlow
Student Investigator: Jon Muir
Funding Agency: IDFG
Completion Date: 6/30/05

Objectives: The goal of this research is to investigate demographic attributes of moose (*Alces alces*) living in non-traditional habitats. Specific objectives include to:

1. Assess patterns of space use and habitat selection by moose in human-modified landscapes.
2. Evaluate reproduction in adult female moose on the front of range expansion and in non-traditional habitats.
3. Examine relationships among three indices of reproductive status.
4. Explore the possibility of using existing data on occurrence of moose to gain a statewide perspective on patterns of population expansion.

Progress: Moose populations in North America are expanding in many areas in what is believed to be a continuation of their post-glacial spread into unoccupied habitats. Moose have become established in Latah County in the past 20 years, and have experienced a considerable increase in density since that time. Whether human modification of the landscape has created habitat conditions that favor moose expansion or these areas represent marginal habitats into which dispersing animals are pushed is largely unknown.

Moose in the Moscow Mt. study site were fitted with radio collars in March and April 2004. Blood and fecal samples were collected during capture for use in identifying pregnancy status at the time of capture. Results from analysis of pregnancy-specific protein B (PsPB) indicated that 9 of 10 (90%) radio-collared, adult animals were pregnant at the time of capture. Calving began approximately 20 May, and we continued to observe new calves until 23 June. These dates are later and less synchronous than reported for other moose populations. One set of twins was observed with a collared cow, and of the 6 calves observed in the field, all 6 were still alive at the conclusion of the field season on 1 September. However, the winter of 2004-05 was characterized by

extreme winter tick burdens on the moose, and 7 calves were found dead near human dwellings. Necropsies suggested that poor body condition and loss of blood may have contributed to the deaths. Most moose (calves and adults) observed during winter suffered severe hair loss (up to 80%) resulting from winter tick. None of the collared cows have been observed with calves during April and early May of 2005, which suggests that over-winter survival of calves was low.

Exploration of existing survey and occurrence data on a statewide basis was initiated to investigate patterns of range expansion across time. To date, we have on file >300 records of moose occurring for what is believed to be the first time for a given location. We will continue to collect these data over the next year, and will initiate a spatial analysis of patterns of range expansion for moose and associated landscape characteristics in the state of Idaho.

PYGMY RABBIT SURVEY

Principal Investigators: Dr. J. Rachlow
Jim Witham
Funding Agency: IDFG
Completion Date: 6/30/05

Objective:

1. Conduct field surveys for the presence of pygmy rabbits (*Brachylagus idahoensis*) in Idaho.

Progress: Because detailed data about habitat associations for pygmy rabbits are limited, we used a habitat model to select areas for ground surveys, and used the survey results to refine the model of habitat relationships. We evaluated habitat attributes and searched for presence of pygmy rabbits at 141 stratified random survey sites during June – September of 2003. We measured habitat variables (slope, elevation, vegetation type, and soil depth) used to build the habitat model, and also recorded evidence of recent fires and presence of invasive, exotic plant species.

We identified the presence or potential evidence of pygmy rabbits at 12 of the random sampling sites. However, subsequent autumn and winter surveys at those sites revealed that 10 supported cottontails and/or rodent species, but not pygmy rabbits. Presence of pygmy rabbits was confirmed at 2 of the sites, and we also identified an additional 2 populations of pygmy rabbits while navigating to random sampling sites.

We used 112 newly recorded locations of pygmy rabbit presence and 139 locations from our field survey where pygmy rabbits were absent to assess how well the model predicted habitat used by rabbits. Of the 112 new locations, 84% were in areas predicted to fall within the top 2 priority ranks. Thirteen percent were in areas designated as "non-

habitat" primarily because of predicted soil depths <60 cm. Two variables, vegetation type and fire history, were most informative in characterizing sites used by rabbits. Of the 112 new locations, 78% were predicted to have higher priority vegetation (sagebrush types) and 10% fell within lower priority vegetation; use of mountain mahogany (*Cerocarpus ledifolius*) vegetation type, which was classified as lower priority vegetation, was more pronounced in the southwestern portion of the State. None of the 112 new locations were located in areas that were predicted to have burned since 1990. In contrast to fire history, our elevation categories were relatively poor at predicting presence of pygmy rabbits.

Examining performance of individual habitat variables can help identify those habitat components that may be more or less useful in predicting species occurrence. We offer two examples for how this information can be used to refine the habitat model and increase understanding of habitat relationships. First, fire history was an important variable in distinguishing presence of pygmy rabbits; none of the newly identified rabbit sites exhibited evidence of recent fires, and sites that lacked rabbits often included areas that had burned since 1990. In our field surveys, we noted evidence of recent fires that were not recorded in our fire history GIS layer. Up-dated fire data that accurately delineate fire perimeters would improve the accuracy of this model. Second, in contrast to fire, elevation was a poor predictor of the presence of pygmy rabbits. Although mid-range elevations were correlated with known pygmy rabbit locations used to build the model, the underlying cause for this pattern may not be related to the biology of the species. Much of the lower-elevation sagebrush habitat along the Snake River Plains in Idaho has been converted to agricultural land uses, and higher-elevation regions are likely to be less thoroughly explored. Populations of pygmy rabbits have subsequently been documented on the Continental Divide and at other high-elevation locations in Idaho. Thus, elevation appears to be a poor predictor of the habitat needs of this species. Habitat models can serve as tools for both guiding field surveys and for refining our understanding of habitat-wildlife relationships.

CRAIG MOUNTAIN QUAIL ECOLOGY

Principal Investigator: Dr. K. P. Reese
Student Investigator: Ashley Martens
Funding Agency: IDFG
Completion Date: 6/30/04

This project is a portion of the **Mountain Quail Translocation** project described below.

GREATER SAGE-GROUSE CHICK ECOLOGY

Principal Investigator: Dr. K. P. Reese
Student Investigator: Nathan Burkepile
Funding Agency: IDFG
Completion Date: 6/30/04

Objective:

1. Determine age and cause-specific mortality rates in greater sage-grouse (*Centrocercus urophasianus*) chicks in southern Idaho.

Progress: Fieldwork has been completed and the student is nearing completion of data analysis. Expected defense of the students' Ph.D. is Fall 2005.

GREATER SAGE-GROUSE NESTING

Principal Investigator: Dr. K. P. Reese
Funding Agency: IDFG
Completion Date: 6/30/05

Objective:

1. To further understand the role of habitat structure in the nest site selection and nest success of greater sage-grouse (*Centrocercus uropasianus*).

Progress: Sage-grouse hens have been captured on leks during the springs of 2002, 2003, and 2004, radio-marked and monitored throughout the nesting period. Detailed habitat measurements have been recorded from each nest site. Analysis is currently on going, directed by David Musil of Idaho Department of Fish and Game.

JARBRIDGE GREATER SAGE-GROUSE ECOLOGY PROJECT

Principal Investigator: Dr. K. P. Reese
Student Investigator: Jay Shepherd
Funding Agency: IDFG
Completion Date: 6/30/05

Objectives: The general effects of shrubsteppe fragmentation on greater sage-grouse (*Centrocercus urophasianus*) have been implicated as a cause in range-wide declines, yet have not been studied and are not well understood. Research that has been conducted on

greater sage-grouse use of fragmented habitat has not quantified levels of fragmentation. The purpose of this study is to provide land management and wildlife agencies that have jurisdiction over shrubsteppe habitat or greater sage-grouse with a more complete understanding of the effects of natural and man-caused shrubsteppe fragmentation. The objectives are:

1. To determine if the landscape metrics for home ranges with various levels of fragmentation explain movement patterns, productivity, and other measures of general habitat use of greater sage-grouse.
2. To develop a model that uses vegetation patch characteristics (cover type, size, interspersion, and juxtaposition), topography (aspect and evaluation), and soil types to explain observed nesting and brood-rearing habitat use patterns using remotely sensed vegetation data, digital elevation models, and digitized soil maps.
3. To test this model in an area with known nest and brood-rearing success.

Progress: Field work was completed in August 2002. Data analysis is now complete. Draft versions of several dissertation chapters have been produced. Expected date of Ph.D. student defense is early fall 2005.

MOUNTAIN QUAIL TRANSLOCATION

Principal Investigator:	Dr. K. P. Reese
Student Investigator:	Ashley Martens
Funding Agency:	IDFG
Completion Date:	6/30/04

Objectives:

1. The management goal is to successfully translocate and establish a sustainable, breeding population of mountain quail (in the eastern portion of their range.
2. The research goal is to examine relationships between mountain quail movement patterns, survival and productivity, and habitat use in these areas.

Progress: The graduate student developed a research proposal, obtained Animal Care and Use Committee approval for the work and began fieldwork in March 2005. Seventy-two mountain quail were translocated into Craig Mountain Wildlife Management Area, Idaho and 73 birds were translocated into Asotin Creek Wildlife Area, Washington. Fifty birds at each site have 3 g radios attached via a necklace. The graduate student and two technicians are monitoring the birds as they move about and become acclimated to the areas. Fieldwork will continue throughout the spring and summer.

Within the first 4 weeks of the study, 47 of 50 quail at Craig Mountain have been relocated, and 27 of the birds at Asotin Creek have been relocated. Five birds each have

been found dead at Craig Mountain and at Asotin Creek. Media coverage of the releases ran in the Lewiston Morning Tribune on 17 March 2005 and in the Spokesman Review on 3 April 2005. Televison coverage was aired on the local Lewiston, Idaho channel.

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

Principal Investigator: Dr. J. M. Scott
Student Investigator: David Rupp
Funding Agencies: USGS
Environmental Science
Completion Date: 6/1/2006

Objectives: The goal of this project is to create a list of bird species ranked by conservation priority to present to the National Wildlife Refuge System for use in strategic growth at the national level and for habitat management strategies at the refuge level. Specific project objectives are to:

1. Assess the representation of America's bird diversity on the NWRS
2. Identify bird species that could serve as conservation targets for strategic growth and habitat management in the NWRS.

Introduction: When the U.S. Congress passed the National Wildlife Refuge System Improvement Act of 1997, it provided the National Wildlife Refuge System (NWRS) with a mission of putting wildlife concerns first and mandated that the biological integrity, diversity and environmental health of the NWRS land be maintained. As the NWRS continues to work at implementing this act, it has emphasized landscape-level goals for biodiversity conservation, using conservation targets to set acquisition priorities, and coordination with public and private partners to meet these goals.

Progress: To assess bird diversity, we are going to use bird checklists as the source for our abundance and occurrence data. We are in the process of contacting refuges that do not have readily available checklists. We will use this information to build a database that includes variables that will be helpful in understanding the distribution of birds across the NWRS. A list of these variables is currently being developed with input from various agencies and experts. The database will be used to determine bird species that are not represented in the NWRS.

We will use the database to develop a ranking of bird species by their conservation need. Those species that are not represented on NWRS lands (or occur on very few refuges) will be ranked highest. American Bird Conservancy's Green List species will be given priority in this ranking. The North American Bird Conservation Initiative's Bird

Conservation Regions will also be used to analyze bird and refuge distribution as well as to develop the list of priority species. The final ranking will be presented to the FWS and other bird conservation organizations.

BIOLOGICAL INTEGRITY AND DIVERSITY: WATERFOWL AND THE NATIONAL WILDLIFE REFUGE SYSTEM

Principal Investigator:	Dr. J. M. Scott
Student Investigator:	Anna Pidgorna
Funding Agency:	University of Idaho Environmental Science Program
Completion Date:	10/31/06

Objectives:

1. To assess the occurrences and abundance of waterfowl species on each of the 545 National Wildlife Refuges during three stages of waterfowl lifecycle (breeding, wintering, and migration) in order to measure representation and redundancy.
2. To assess the occurrences and abundance of waterfowl species on each of the National Wildlife Refuges within the four North American migratory bird flyways during three stages of waterfowl lifecycle (breeding, wintering, and migration) in order to measure representation and redundancy.
3. To assess the occurrences and abundance of waterfowl species on each of the National Wildlife Refuges within the northern, central, and southern parts of the United States during three stages of waterfowl lifecycle (breeding, wintering, and migration) in order to measure representation and redundancy.
4. To identify whether or not the purposes for which a refuge was established correspond to how waterfowl uses that refuge.
5. To design a method for assessing resiliency of waterfowl species on National Wildlife Refuge lands.
6. To assess the resiliency of waterfowl species on National Wildlife Refuge lands.

Introduction: The main purpose of this study is to assess the potential of the National Wildlife Refuge System to fulfill its mandate of maintaining biological integrity and diversity of waterfowl species on National Wildlife Refuge System lands. We will use the principles of representation, redundancy and resiliency as indicators of biological integrity and diversity. We will do so at three spatial scales: national (covering the entire U.S.), flyway (which includes the four North American migratory bird flyways in the U.S.), and latitudinal (which divides the U.S. into three latitudinal parts: northern, central and southern).

Progress: The occurrence and abundance of waterfowl on National Wildlife Refuge System lands will be assessed through bird checklists collected from each of the 545 National Wildlife Refuges. We have acquired 60% of the checklists to this date. We have

also contacted managers/staff biologists from the remaining refuges and asked them to mail us their checklists. A database is being designed in Microsoft Access, which will contain the information on National Wildlife Refuges and the abundance and occurrence of waterfowl. We will begin entering information from the checklists into the database as soon as it is completed. The database will then be queried to provide information on abundance and occurrence of waterfowl species on National Wildlife Refuge System lands.

There are several potential methods for assessing resiliency that we are considering to use for our study. One method would compare the size of the refuge to the minimum average daily forage area of a species of waterfowl. Another would examine the refuge's proximity to water to the maximum dispersal distance of ducklings. A third method would evaluate the alterations/threats to waterfowl habitat within the refuges. A specific method for assessing resiliency has not been selected at this time.

BREEDING ECOLOGY AND PHILOPATRY IN RED-SHOULDERED AND RED-TAILED HAWKS

Principal Investigator: Dr. J. M. Scott
Student Investigator: Peter Bloom
Funding Agency: Personal
Completion Date: 12/31/06

Objectives:

1. Determine nesting success response of red-shouldered and red-tailed hawks to varying habitats and climatic conditions.
2. Determine philopatry from red-shouldered (*Buteo lineatus*) and red-tailed hawks (*Buteo jamaicensis*) in different habitat and under variable climatic conditions.

Progress: We have banded 2,112 nesting red-shouldered hawks and recaptured 99, and recovered 82. We have also banded 3,860 red-tailed hawks; 8 have been recaptured and 121 have been recovered. Recaptures and recoveries apply to breeding age birds only. An initial analysis has been completed revealing a very atypical movement of young red-tailed hawks in a northward direction followed by a return to the natal area. Both species tend to be philopatric with the red-tailed hawk exhibiting relatively intense philopatry despite 1,000 mile movements north as juveniles. Fieldwork continues and will be completed in October 2005.

One hundred fifty nestlings hawks of each species were banded in 2004 and 2005. I attached 3 satellite transmitters in 2004 and two more will be attached in 2005.

DETERMINATION OF RECOVERY PLAN POPULATIONS GOALS

Principal Investigator:	Dr. J. M. Scott
Student Investigator:	David Stanish
Funding Agency:	USGS
Completion Date:	5/30/05

Objectives:

1. Determine which biological variables are correlated with recovery goals.
2. Evaluate relationships between population goals and listed threats
3. Assess relationship between recovery goals and ecological role of species

Progress: 425 recovery plans were analyzed and completed by December 31, 2004 for animal species, subspecies, and distinct population segments. Remarkably, thirty-one percent of the plans provided no reclassification criteria and forty-five percent provided no delisting criteria. Recovery teams pointed primarily to a lack of available information (22% of 425) and the likelihood that the animal was to remain on the list indefinitely (16%). Where defined, recovery was most often described in terms of stability (72% of 235) or of meeting some qualitative threshold (80%), rather than meeting a quantifiable population size goal (35%). Despite the 1988 amendments to the Endangered Species Act mandating "objective measurable criteria," the use of quantitative population size metrics has not appreciably increased in the more recent recovery plans.

DEVELOPMENT OF UNMANNED AIRBORNE VEHICLE FOR MONITORING WILDLIFE

Principal Investigators: Dr. J. M. Scott
Pete Zager
Funding Agencies: USGS
IDFG
Completion Date: 12/31/04

Objectives:

1. To determine the feasibility of using drones to survey wildlife at 3 levels of complexity:
    a. Large-bodied mammals in a simple environments (e.g., pronghorn in shrubsteppe)
    b. Large-bodied mammals in complex environments (e.g., Elk, bighorn in mountainous terrain with tall trees)
    c. Specialized applications (e.g., predator tracks in snow, leks in grasslands)

Progress: We have reviewed possible platforms, interviewed potential users, and built partnerships. We co-hosted a symposium in April 2003 on Unmanned Aerial Vehicles with Florida Cooperative Research Unit. Field testing was conducted to test the ability of small aircraft to detect life size turkey and waterfowl decoys and transmit video images to the ground. Currently we are continuing collaborations with INEL and with the Florida Cooperative Research unit. We will host a symposium on the unmanned aircraft for monitoring wildlife at the 2005 meeting of the Wildlife Society. Publication on the use of unmanned aircraft for wildlife monitoring will be prepared.

FOCAL SPECIES AS CONSERVATION TARGETS

Principal Investigator: Dr. J. M. Scott
Student Investigator: Jennifer Jensen
Funding Agency: USGS
Completion Date: 09/30/05

Objectives: Habitat management strategies used by the US Forest Service (USFS) and the Bureau of Land Management (BLM) often incorporate the idea of "focal", "indicator", or "umbrella" species, where a select set of species are used to set management priorities. In Idaho, these focal species are often meso-carnivores, raptors, or species associated with specific habitats (e.g., Canada lynx, northern goshawk, Coeur d'Alene salamander, and sage-grouse). Managing the majority of land in Idaho, the USFS and BLM are in the position to provide habitat protection for a number of species.

However, it is unknown whether current management strategies based on focal species allow for adequate protection of other terrestrial vertebrates known to regularly breed in the state. Our objectives were to:

1. Identify the species selected for management by USFS across the US.
2. Assess the adequacy of current and future conservation areas for focal species and/or habitat specialists to provide sufficient protection for other, non-focal, under-represented cover types and terrestrial vertebrates.
3. Evaluate the effect of geographic variability in habitat selection by the focal species.

Progress: To date, we have isolated and summarized the suite of management indicator species identified by approximately 90% of all national forests in the U.S. in a comprehensive relational database. Information summarized for each plan includes species type, habitat selected for, monitoring strategy, reasons for selection, and other general information regarding each forest's decision to include specific species. A final draft is being prepared to characterize indicator species selections based on the various planning rules implemented by the U.S.F.S. over the past three decades, as well as identification of trends in species and habitat selection / monitoring strategies as a whole, within specific management regions, and for Idaho separately. The final report is planned to be completed by July 2005.

For the purposes of characterizing indicator species and habitat management objectives within Idaho, site selection algorithms (e.g., SITES, MARXAN, RESNET) will be used to identify areas important for focal species. These areas will then be compared with the results from the Idaho Comprehensive Conservation Assessment to determine spatial agreement. In addition, these areas will be described by the amount of habitat protected for other sensitive, but not focal, species.

HABITAT ANALYSIS: TOWARD CONVERTING A SET OF COMPETING TECHNIQUES INTO A SET OF COMPETING HYPOTHESES

Principal Investigator:	Dr. J. M. Scott
Post-Doctoral Investigator:	Dr. William Kristan
Funding Agency:	USGS
Completion Date:	09/30/05

Objectives:

1. Develop the necessary understanding of the implicit assumptions of the most commonly used current techniques, and the most promising new techniques, by applying them to data that contain known habitat relationships.

2. Apply the insights derived from the modeling exercises to real, existing data sets that occupy a wide range of ecological conditions.

Progress: Work began in Jan 2003. The project's goal is to evaluate the ecological interpretation of different statistical approaches to modeling animal-habitat relationships, to provide guidance for the use of different approaches, and to use the fit of different models to occurrence data to explore the characteristics of habitat use by a species. We concentrated on laying the foundations to address these questions.

One motivating factor for this study is that the predictive accuracy of habitat models is frequently disappointing. Selecting a model with the best representation of a habitat association is likely to produce the best predictive accuracy. Some sources of erroneous predictions are due to deficiencies in the models used to predict occurrence, in that they are not structured to account for known patterns of habitat use. One such pattern is hierarchical structure, in which a broad-scale, landscape feature constrains the range of variation that can be observed at a fine scale. To explore different approaches used by ecologists to deal with this structure, we organized a symposium on the topic at the Cooper Ornithological Society Meetings in La Crosse, WI in 2004. The symposium was successful and stimulating, and we are currently editing contributed papers for a special section of the Condor. We will be contributing two papers to the collection, and are editing five others. Projected publication date will be late 2005.

We continued to develop our approach to characterizing the relative importance of different sources of prediction accuracy (e.g. incorrect habitat model, inadequate sampling intensity, "rounding error"). One source of error, the "rounding error" that occurs when a continuous predictor is compared against a set of discrete observations, has not to our knowledge been characterized before in predictive habitat modeling. Including explicit measures of expected prediction accuracy from a variety of sources will help the GAP project interpret their predicted vertebrate distribution maps, and to provide adequate caveats to end-users. Another source of error is due to differences in density between the time or place at which models are fitted, and at which predictions are made. Density-dependent habitat use has been known for over three decades, and although it surely confounds predictions of occurrence and abundance, there is not currently a method for adjusting predictions to account for this effect. We are working on such an adjustment, and this work will form the basis for a presentation at a symposium, "Overview and Treatment of Spatial Errors in GIS Applications" at the 2005 meeting of The Wildlife Society.

THE ECOLOGICAL CONTENT AND CONTEXT OF THE NATIONAL PARK SERVICE

Principal Investigator: Dr. J. M. Scott
Research Associate: Leona K. Svancara
Agency Funding: National Park Service
Completion Date: 6/30/05

Objective:

1. To assess the ecological content and context of the national park system at multiple spatial scales by quantifying the level of representation, redundancy and resiliency of natural resources

Progress: What will the National Park Service system look like on its 100th and 200th birthdays? What species and ecological processes will be maintained within park boundaries? The answers depend, at least in part, on the current level of representation of natural resources within park boundaries, the spatial distribution of the parks and the integrity of the surrounding landscape. An ever-increasing human population has resulted in ours being one of the most economically and technologically advanced nations in the world. It has also resulted in numerous ecological impacts including habitat loss and fragmentation, pollution, invasions of exotic species, and species extinctions.

Our objective is to assess the ecological content and context of the national park system at multiple spatial scales by quantifying the level of representation, redundancy and resiliency of natural resources. On a national level, our objectives are to determine the level of representation of biological and geophysical features, quantify the spatial and temporal patterns of broad-scale external threats influencing matrix permeability and consistency and determine relationships among matrix integrity, geophysical and political features across the coterminous US. At the regional and local levels, our objectives are to determine the spatial relationships and potential biological corridors between national parks and other protected areas and combine gradient analysis with landscape metrics to quantify the effective area of the landscapes that contain parks.

At the national level, we have determined the level of ecological representation of approximately 245 National Park units in the coterminous US identified by NPS as containing "significant natural resources" based on several variables including ecoregions, landcover, landform, and nighttime lights. In addition, we have assessed the resiliency of these parks based on county-level data of surrounding lands, a crucial factor in the effectiveness of parks as conservation areas and the ability of the National Park Service to manage for the "unimpaired" mission. Numerous ecological, social, and economical variables still need to be addressed. We anticipate our national assessment will be complete by July 2005. Within the national context, our regional and local level assessments will help quantify the effective area of parks and identify the landscape

patterns and potential biological linkages among parks and other protected areas. We anticipate our regional and local level assessments will be complete by May 2006.

RED WOLF MICROSATELLITE GENETICS & HABITAT USE PROGRAM

Principal Investigator: Dr. L.P. Waits
Student Investigator: Jennifer Adams
Funding Agency: USFWS
Completion Date: 09/30/05

Objectives:

1. Modify existing non-invasive genetic tests (mtDNA) to use nuclear DNA microsatellite markers.
2. Improve existing maximum likelihood genetic test by including data from 14 red wolf founders.
3. Combine data from non-invasive genetic sampling with GIS technology to determine both red wolf home range size and habitat usage.

Progress: Objective 1 We used the 2000 scat dataset to optimize the use of microsatellite markers in collected fecal samples. Using probability of identity calculations, we determined that 6 microsatellite loci are necessary to distinguish between individuals in the wild red wolf population. Because oftentimes loci fail to amplify in fecal samples, we decided to optimize 8 loci. The 8 loci were optimized into 4 PCR reactions, one singleplex, two diplexes, and one triplex. We then amplified the 209 scats that had worked using mitochondrial DNA markers. We were able to obtain reliable data at 110 of those scats for an amplification success rate of 53%. Furthermore, we were able to match the haplotypes found in the 110 scats to a database of known individuals. The haplotypes found in 107 of the scats were matched to 15 known individuals, the highest number of detections for one individual being 21 and the lowest being 1. The haplotypes found in the other 3 scats did not match any individuals in the known dataset and so represent three previously unknown individuals. This documents the ability of this method to identify new, never before captured individuals.

This method was also applied to the 2003 scat dataset in order to test its ability to detect both unknown individuals and hybrid individuals. A total of 271 wolf scats were collected and we have obtained genotype data on 111 of them for an amplification success rate of 41%. Thirty-two individuals were detected, six of which were hybrids. The total number of detections per individual ranged from 1 to 23. Placement of fecal sample locations on a map of the recovery implementation area revealed three hybrids were located in the middle of the red wolf range and three were located on the periphery of the red wolf range. Four of the six individuals were subsequently captured and

removed from the population. This method provides a valuable tool to locate hybrid individuals in the red wolf recovery implementation area thereby reducing hybridization between red wolves and coyotes.

Objective 2 The principal threat to the persistence of the endangered red wolf (*Canis rufus*) in the wild is hybridization with the coyote (*Canis latrans*). To facilitate identification and removal of hybrids, we developed assignment tests, which use genotype data to estimate identity as coyote, 1/4, 1/2, 3/4 or full red wolf. The tests use genotypes from the red wolves that founded the surviving population and the resulting pedigree, rather than a contemporary red wolf sample. The tests are evaluated by analyzing both captive red wolves at 18 microsatellite loci, and data simulated under a highly parameterized, biologically reasonable model. The accuracy of assignment rates are generally high, with over 95% of known red wolves identified correctly. There are, however, tradeoffs between ambiguity and misassignments, and between misidentifying red wolves as hybrids and hybrids as red wolves. These result in a compromise between limiting introgression and avoiding demographic losses. The management priorities and level of introgression determine the combination of test and removal strategy that best balances these tradeoffs. Ultimately, we conclude that the use of the assignment tests has the capacity to arrest and reverse introgression. To our knowledge, the presented approach is novel in that it accounts for genetic drift when the genotypes under analysis are temporally separated from the reference populations to which they are being assigned. These methods may be valuable in cases where reference databases for small populations have aged substantially, pedigree information is available, or data are generated from historical samples.

Objective 3 Field data was collected from September 2004 to December 2004. Telemetry locations were gathered for eight red wolves from three packs. The total number of telemetry locations per individual ranged from 24 to 34. Scat samples were collected once a month from within the territories of the three packs, and GPS coordinates were recorded. A total of 138 wolf scats were collected with the number of scats per pack ranging from 38 to 51. No further analysis has been completed.

AN INVENTORY OF BAT SPECIES AND A DETERMINATION OF BAT ROOST HABITAT CHARACTERISTICS AT JOHN DAY FOSSIL BEDS, NEW MEXICO

Project Investigator: Dr. R. G. Wright
Research Associate: Tom Rodhouse
Funding Agency: National Park Service
Completion Date: 12/31/04

Objectives:

1. To inventory all bat species using the John Day River floodplain in the three units

of John Day Fossil Beds, NM. Inventories to be done using mist-net collection and an Anabat echo location recorder.

2. Use remotely monitored radio-transmitters on bats to locate night roosts and measure their characteristics.

Progress: The study was completed. We identified five species of bats at the monument and radio-marked 8 bats which were tracked to roosts. Roost habitats were quantitatively characterized.

BIOLOGICAL DATA INVESTIGATION IN NORTHERN SEMI-ARID NATIONAL PARKS

Principal Investigator:	Dr. R. G. Wright
Research Associates:	Lisa Garrett
	Tom Rodhouse
	Leona Svancara
Funding Agency:	National Park Service
Completion Date:	5/1/05

Objectives:

1. Complete the compilation of historic data for all species of vascular plants and vertebrates believed to occur in Northern Semi-Arid Lands Network parks from a variety of sources, including park data bases, museum records of voucher specimens, and previous studies, Input this data into the appropriate NPS databases.
2. Complete field surveys for the 8 inventories in the network parks with the goal of documenting 90% of all species estimated to occur in each park. Greater emphasis will be placed on inventories of species of special concern to the parks.
3. Gather inventory information using a study design that will allow information to be incorporated into a long-term monitor program.
4. Develop distribution maps in Geographical Information System format for each species in each park in the Network.

Progress: Final reports completed on this project

BLACK BEAR FOOD HABITS AT YOSEMITE NATIONAL PARK

Principal Investigator: Dr. R. G. Wright
Student Investigator: Schuyler Greenleaf
Funding Agency: National Park Service, Yosemite Fund, Hornocker Institute
Completion Date: 9/1/05

Objectives:

1. To determine the food habits of black bears (*Ursus americanus*) in Yosemite Valley and compare this with a study done in the late 1970s prior to the initiation of a bear management program.
2. To use stable isotopes to characterize the diets of individual bears
3. To track radio-collared bear movement and identify the use of habitats in the valley.

Progress: The study found a 70% reduction in the use of human derived foods by bears in the valley between the two studies. This ostensibly is because of the intensive bear management effort initiated prior to this study. The stable isotope nitrogen offers promise in the determination of bears using anthropogenic foods. (The latter determination is based on characterizing bears as food-conditioned vs. non-food conditioned based on their radio-collar locations in developed vs. non-developed areas.) Radio-collared bears were tracked repeatedly over the study in 24-hour diels. Carbon isotopes were hypothesized to have promise in making a determination between human and nature foods but there was too much noise in that data.

CHARACTERIZING THE HISTORIC LANDSCAPE OF THE SNAKE RIVER PLAIN IN IDAHO

Principal Investigator: Dr. R. G. Wright
Student Investigator: Marcus Swan
Funding Agency: USGS
Completion Date: 5/30/05

Objectives:

1. To characterize the land cover and landscape of the Snake River Plain in southern Idaho at the time prior to European discovery.
2. To evaluate changes that have taken place since and identify causes and potential impacts of these changes.

Progress: This study has been completed. Marcus will defend his thesis on March 31, 2005. The student used two primary sources of data to characterize the historic landscape, GLS data collected primarily in the late 1800s and repeat photography of original photos taken at the turn of the century. The GLS data at 1 square mile resolution were integrated into a GIS for comparison with Idaho GAP data resampled at the same level of resolution. 52 repeat photos were made and interpreted at various points in the plain. Originals were obtained from museum archives, agency files, and by advertising in local papers. The results, too numerous to describe here, were discussed in the thesis and in soon to come publications. The greatest change on the plain has been in the conversion of sagebrush to agriculture.

DIGITAL IMAGE LIBRARY: CHANNEL ISLANDS NATIONAL PARK

Principal Investigator: Dr. R. G. Wright
Research Associate: Marilyn Ostergren
Funding Agency: National Park Service
Completion Date: 9/30/05

Objectives:

1. Compile a complete list of all photography and video archives at Channel Islands National Park.
2. Document the characteristics of each of these items in the format of the NPS Natural Resources Bibliography.

Progress: The project is in progress. The final database should be compiled by September 2005.

HABITAT USE AND MOOSE BROWSING EFFECTS IN ROCKY MOUNTAIN NATIONAL PARK

Principal Investigator: Dr. R. G. Wright
Student Investigators: Jason Dungan
Brad Stumph
Funding Agency: National Park Service
Completion Date: 12/31/05

Objectives:

1. To compile baseline data on moose distribution and a minimum population estimate of moose in the park.

2. To develop a habitat classification of areas used by moose in the park that will characterize the structure and composition of the plant communities within those habitats.
3. To analyze browse condition and availability and nut nutrient content.
4. To ascertain food habits.
5. To develop a nutritional based ecological carrying capacity model for moose in the park.

Progress: We have characterized the nutritional status of all six willow species growing in the western portion of the park, and examined this along an elevational gradient from the valley floor to the highest elevations that willow occur in. We calculated the available biomass of each of the willow types with in communities in three elevation zones. This data will be incorporated into a carrying capacity model which is the subject of Jason's thesis. We have conducted three years of field work examining forage consumption of moose by visually observing bytes by time and by species. We have conducted a total of 36 24-hour foraging surveys of male moose by following them and closely observing their foraging activities. We have estimated that there are about 100 moose in the western portion of the park. We did not radio-collar any moose, but did attempt in one summer to mark animals using paint balls. This proved to be unsuccessful due to the short duration of the marks and the occasional behavioral aberrations the impact caused which made it difficult to subsequently follow that moose closely.

All field work has been completed. Brad Stumph will defend his MS thesis on March 11, 2005. Jason Dungan expects to defend in September 2005.

IDENTIFICATION OF RARE PLANT POPULATIONS WITHIN FUEL REDUCTION AREAS AT LAKE ROOSEVELT NATIONAL RECREATION AREA

Principal Investigator: Dr. R. G. Wright
Funding Agency: National Park Service
Completion Date: 3/1/06

Objective:

1. To map, via GPS and GIS all rare plant species locations in the various areas along the shoreline of Lake Roosevelt in areas owned by the NPS and slated for fuel reduction.

Progress: The first year of data collection (2004) has been completed with surveys done in six separate areas along the lakeshore. No rare plants were found. At the request of the park, noxious weeds were also mapped at this time. NPS land ownership is set at a certain elevation line above the pool of the lake. Thus it varies with topography along the lake

shore. NPS holdings are typically varied along the ~100 km length of the northern arm where this study is being conducted. They depend primarily on the topographic gradient away from the lakeshore. Most areas identified for fuel reduction are about 5-10 ha. The primary fuel being reduced is ponderosa pine. Another 12 areas will be surveyed during the summer of 2005.

LANDSCAPE ANALYSIS OF BLACK BEAR DISTRIBUTION PATTERNS IN OLYMPIC NATIONAL PARK

Principal Investigator: Dr. R. G. Wright
Student Investigator: Kim Sager
Funding Agency: National Park Service
Completion Date: 12/30/05

Objectives:

1. Evaluate black bear distribution and habitat use in the Elwha River drainage of Olympic NP. This project was designed to gather baseline information on bear distribution prior to the removal of the two old Elwha River Dams that have blocked salmon movement for almost a century.
2. Evaluate the feasibility of using GPS-based radio-collars in a mountainous, dense temperate rainforest environment.

Progress: During the course of the study we radio-collared and tracked for varying lengths of time 12 black bears (*Ursus americanus*), 10 male and 2 female. Bears were captured using snares in coveys and occasionally by direct darting. Females were difficult to catch. We identified 16 categories of tree canopy cover, GPS satellite view, and aspect evaluated the accuracy of GPS data and GPS data collection ability at each using stationary GPS collars placed in each location. From these data we developed a weighing formula which was applied to every pixel in the park. These weights were applied to raw GPS bear relocation data. We developed seasonal and annual home range maps for each of the collared bears. We evaluated the distance of bears in the fall from the Elwha River (the time of expected salmon spawning activity) to provide a baseline to evaluate future distribution when the dams are removed.

This study has been completed. Kim will defend her thesis on March 25, 2005.

MONITORING PROGRAM FOR THE NORTHERN SEMI-ARID NETWORK

Principal Investigator: Dr. R. G. Wright
Research Associates: Lisa Garrett
Leona Svancara
Funding Agency: National Park Service
Completion Date: 3/1/07

Objectives:

1. Identify a list of key resource elements that characterize the parks in the network and will be part of the long-term monitoring program for the network. This list and background of the process used to select them will be part of the Phase II report.
2. Develop a long-term monitoring plan incorporating the key resource elements (vital signs) along with protocols and responsibilities for monitoring each. Develop a plan to manage and report on the data collected from this program. These plans will be reported in the Phase III report due to the NPS in 2007.

Progress: Two disciplinary workshops have been held at the UI involving academic and agency personnel from throughout the network, (Eastern WA. Idaho, western Montana.) to a) develop conceptual models to aid in the selection of vital signs; b) to help identify those signs. Workshops on vital sign selection have also been held in each of the 8 parks in the network involving natural resource and administrative personnel form the respective units. The project is ahead of schedule and a draft Phase II report will be submitted to the NPS in the fall of 2005.

PEER REVIEWS OF NATIONAL PARK SERVICE MONITORING PLANS

Principal Investigator: Dr. R. G. Wright
Funding Agency: National Park Service
Completion Date: 9/1/05

Objective:

1. To obtain peer reviews from academic experts for the first 12 Phase III network monitoring plans produced under the NPS service-wide Inventory and Monitoring Program. There are 32 networks in this program.

Progress: I have identified and contacted experts from the given geographic areas covered by the networks and solicited their reviews. An honorarium was paid for each

completed review. At this point, 11 of the 12 reviews have been completed and submitted to the NPS.

REPRODUCTION AND HABITAT USE OF MOOSE IN EXPANDING POPULATIONS IN IDAHO

Principal Investigators:	Dr. R. G. Wright
	Dr. J. Rachlow
Student Investigator:	Jon Muir
Funding Agencies:	USGS
	IDFG
Completion Date:	12/30/05

Objectives: The goal of this research is to gain an understanding of the biology of moose (*Alces alces*) in areas of population expansion in Idaho. Specific objectives include:

1. Contrast habitat use and movement patterns of moose inhabiting traditional and expansion zones.
2. Contrast reproduction and body condition of moose in expanding and traditional areas.
3. Gain a stateside perspective on patterns of population expansion through analyses of existing survey data.

Progress: As moose populations increase and expand in geographic range, observations of moose recorded during aerial surveys conducted for Elk (*Cervus elaphus*) also should increase. This information along with data from surveys conducted for moose in the Panhandle Region, may be useful for characterizing changes in distribution and relative abundances of moose. This information will provide a context for examining current and future patterns of moose population expansion in Idaho.

This project commenced in August 2003. Fieldwork has been underway since. In the first year, 12 moose were radio-collared and have been followed since. In the second year and additional seven moose have been collared. In the winter of 2005 we have been investigating the deaths of at least seven moose calves, all apparently due to heavy infestations of winter ticks which deplete the flood supply and generally weaken the animal.

Completed Projects – Wildlife Resources

Dr. Janet Rachlow – Principal Investigator

- Conservation genetics of Idaho ground squirrel (*Spermophilus brunneus*)
- Evaluation of census techniques for pygmy rabbits
- Investigation of reproduction of pygmy rabbits
- Pygmy rabbit habit modeling

Dr. Gerry Wright – Principal Investigator

- Interior Columbia Basin network inventory

CONSERVATION GENETICS OF IDAHO GROUND SQUIRREL *(SPERMOPHILUS BRUNNEUS)*

Principal Investigator:	Dr. J. Rachlow
Student Investigator:	Alisse Garner
Funding Agency:	IDFG
Completion Date:	5/31/04

Objectives: The goal of this work was to evaluate genetic structure in the Idaho ground squirrel. Specific objectives included to:

1. Develop appropriate microsatellite markers to characterize genetic structure within and among populations of Idaho ground squirrels.
2. Examine divergence among and diversity within populations relative to geographic distance and time since isolation to better understand genetic consequences of population fragmentation.
3. Provide genetic information critical to conservation planning for the species.
4. Develop genetic tools for use in evaluation of future conservation efforts (such as habitat restoration, translocation, or captive breeding).

Introduction: The Idaho ground squirrel (*Spermophilus brunneus*) has undergone severe declines and increasing isolation due to loss and fragmentation of habitat, and remaining populations are susceptible to inbreeding and loss of genetic diversity through drift. The objective of this study was to develop and apply microsatellite markers to quantify patterns of genetic diversity and population divergence in both subspecies of the Idaho ground squirrel. Genetic data provided by our research will assist in evaluating conservation options for Idaho ground squirrels, including translocations, captive breeding, and habitat restoration.

Results: Plucked hair was used as the source for DNA in this study. During February-June of 2002, a total of 467 hair samples were collected from eight populations of SIDGS and seven populations of NIDGS throughout the ranges of both subspecies. Eight microsatellite loci were analyzed for each sample. Four of these loci were isolated in Columbian ground squirrels (*Spermophilus columbianus*), one had been previously isolated for NIDGS, and three novel loci were isolated for SIDGS. To determine whether matrilineal structure among Idaho ground squirrel populations may differ from patterns revealed by microsatellites, and to assess the need for further study, a 510 bp portion of the mitochondrial control region was sequenced for a subset of samples.

Microsatellite diversity was quantified using expected heterozygosity and allelic richness for each population. Genetic divergence among populations was quantified with F_{ST} statistics, Nei's genetic distances, and assignment tests. Mitochondrial sequences were aligned, haplotypes present in each population were recorded, and sequence divergence among populations was examined.

Contrary to expectations, NIDGS exhibited significantly higher levels of genetic diversity than SIDGS. Additionally, within each subspecies we noted populations with markedly lower levels of genetic diversity. All measures of divergence indicated low to moderate differentiation between populations of NIDGS, low levels of genetic differentiation between central SIDGS populations, and high divergence of peripheral SIDGS populations. SIDGS populations can be grouped into two distinct genetic complexes, one in the central and one in the northern portions of SIDGS range.

The most striking result in this study was the contrast in microsatellite diversity levels between the two subspecies of Idaho ground squirrels. A subspecies-wide bottleneck, followed by isolation of peripheral populations, is a likely explanation for lower levels of microsatellite diversity in SIDGS. Patterns of divergence in NIDGS suggested some degree of isolation among all populations. Populations in the central portion of SIDGS distribution remain connected, while peripheral populations have experienced isolation and further loss of genetic diversity.

In contrast to patterns observed with microsatellites, NIDGS exhibited lower mitochondrial diversity than SIDGS. However, patterns of mtDNA divergence among populations were generally consistent with those observed for microsatellite data. One population of NIDGS, Lost Valley, exhibited greater differentiation than observed with microsatellites. However, sample sizes were small, and further mitochondrial analyses are warranted.

Possible explanations of lower mitochondrial diversity in NIDGS include a founder event during northward expansion, though a more in-depth study of mtDNA may further clarify the evolutionary history of NIDGS. Mitochondrial diversity levels observed for SIDGS were only moderate to low compared to other mammals and do not necessarily contradict low levels of diversity observed for microsatellite loci. Population divergence and phylogenetic relationships suggested by our preliminary mtDNA analyses do not differ widely from patterns of divergence observed with microsatellites and do not substantially alter management recommendations based on microsatellite data.

This project has been completed

EVALUATION OF CENSUS TECHNIQUES FOR PYGMY RABBITS

Principal Investigators: Dr. J. Rachlow
Dr. Jim Witham
Funding Agency: IDFG
Completion Date: 12/31/03

Objectives:

1. To evaluate census techniques for pygmy rabbits (*Brachylagus idahoensis*).
2. To test the potential for improving estimates of abundance using thermal imagery.

Results: Surveys were conducted to assess density and activity level of pygmy rabbit burrows at three study sites in the Lemhi Valley, near Leadore, Idaho. Over 1440 burrow systems were evaluated for signs of rabbit activity, and density of active burrow systems ranged from 0.7 to 5.0 per ha across the study sites. We captured and marked 31 rabbits at two sites, and fitted 20 with radio collars. Individual rabbits have been observed using 3–10 different burrow systems, and individual burrow systems have been used by ≥3 animals. We evaluated current occupancy of burrow systems using observations of digging following fresh snowfall, and telemetry was used to confirm occupancy. If the relationship between number of active burrow systems and number of rabbits is consistent across sites, then density estimates for each site were: Cedar Gulch 0.38 rabbits/ha (0.15/acre); Rocky Canyon 0.54 rabbits/ha (0.22/acre); and Warm Springs 2.72 rabbits/ha (1.10/acre). One caveat about extrapolating across areas is that the proportion "active" versus older burrow systems varied markedly across our three study sites. Until we have a better understanding of the turn-over rates of burrow systems (switching between "active" and "in-active" status over time) and patterns of use of burrow systems, caution should be exercised in extrapolating the number of active burrow systems per rabbit (1.84 bs per rabbit in Cedar Gulch) to other areas. A Ph.D. student at the University of Idaho currently is investigating patterns of burrow system use and changes in burrow system status across 3 study areas.

Recently, thermal imagery has been used to census a variety of mammals including arctic ground squirrels (*Spermophilus parryii*) in burrows (Hubbs et al. 2000). One objective of this study was to evaluate the potential for using thermal imagery as a tool to improve estimates of rabbit abundance based on burrow counts by determining current occupancy of burrows. We attempted to address four questions about this application of thermal imagery: 1) Can a thermal camera detect rabbits in burrow systems? 2) Can thermal imagery distinguish empty burrow systems from occupied ones? 3) What factors might influence reliability of this technique? 4) Given our preliminary results, is thermal imagery a useful tool for population census in pygmy rabbits?

We rented a hand-held thermal camera (ThermaCAM E2) from FLIR Systems for a 2-week period during November of 2002. The camera converts infrared energy emitted from objects into visible images that are viewed on a LCD screen and can be downloaded

to a computer. We first tested ability to detect rabbits in burrows by observing rabbits enter burrow systems or radio-tracking rabbits to burrow systems, and then scanning burrow entrances with the thermal camera. Second, we evaluated the ability of the camera to identify empty burrows. Because rabbits actively clear snow from burrow entrances shortly after snowfalls, we interpreted a lack of tracks in the snow at and around burrow entrances to indicate that the system was currently unoccupied. Presence of snow cover during November eliminated the need for using tracking boards as outlined in the grant proposal. We obtained thermal images during the early morning hours (5:30-7:30) when soil temperatures surrounding burrow entrances were lowest, and therefore, the temperature difference between the soil and burrow entrances would be maximized.

A clear visual signature was apparent from occupied burrows. When animals remained near the burrow entrance and occasionally were visible at the entrance, the visual signal was noticeably brighter. Results of the unoccupied burrows were less definitive. In most cases, a faint to moderate visual signal was apparent, even at burrow systems that did not show signs of rabbit activity. Several factors may have contributed to our inability to consistently distinguish occupied and unoccupied burrows for pygmy rabbits using thermal imagery. First, it is possible that some burrows that we categorized as unoccupied were in fact inhabited by rabbits or other small mammals. Second, temperatures in pygmy rabbit burrows during winter remain relatively constant (between -1.3° and -4.3°C; Katzner, 1994). When external temperatures were low, we may have detected a temperature difference between the soil and burrow entrances, even for unoccupied burrows. Third, we noticed that as animals moved within burrow systems, the strength of the visual signal varied. Therefore, position of the rabbit within a burrow, complexity of the burrow system, and perhaps length of time that a rabbit has been inside of a burrow may influence ability to detect animals. Although thermal imagery may be useful for some research applications, this technique has limited utility for census purposes in this species due to the inconsistency in correctly assessing burrow occupancy, as well as the high initial cost (thermal cameras cost between $15,000 - 50,000).

This project has been completed.

INVESTIGATION OF REPRODUCTION OF PYGMY RABBITS

Principal Investigator: Dr. J. Rachlow
Funding Agency: IDFG
Completion Date: 6/30/04

Objectives:

1. Gather data on reproductive behaviors and parameters for free-ranging pygmy rabbits.
2. Provide preliminary information for a more detailed study of population dynamics.

Introduction: Pygmy rabbits (*Brachylagus idahoensis*) are a sagebrush obligate species of conservation concern, and many aspects of their natural history remain poorly understood, especially with respect to reproduction. For example, locations of parturition and nests had not been documented for this species in their natural habitat. Pygmy rabbits dig extensive burrow systems; however, neither nesting materials nor neonates have been found in residential burrow systems that were either excavated or examined with a burrow camera. Wilde (1978) observed 2 isolated juveniles weighing 90 g under separate sagebrush plants, and speculated that females give birth above ground and scatter young to avoid loss of entire litters to predation.

Results: We investigated reproduction of pygmy rabbits at two sites in the Lemhi Valley near Leadore, Idaho. We fitted 20 adult females with radio-collars during March-May 2003 to facilitate observation of reproductive behaviors. Palpation and body weights were used to detect pregnancy. We observed the first 2 juveniles on 5 May, one of which was captured and weighed at 110 g. We recorded weights for a total of 17 juveniles and estimated ages based on growth of captive pygmy rabbits. Given a gestation period of 22-25 days, the estimated conception dates for the first kits we observed were between 8 - 16 March. The distribution of juvenile weights suggested two cohorts approximately 4 weeks apart. However, between 26 and 30 May, we captured juveniles with estimated ages ranging from 3 to 8 weeks. These data suggested that breeding in this population was less synchronous than previously reported for this species in southern Idaho. A lack of birth synchrony was further supported by the distribution of adult female body weights. Some females captured during all of June and early July were in advanced stages of pregnancy, suggesting that a third and less synchronous cohort was produced during July.

We documented locations and characterized nests and natal burrows for free-ranging rabbits during this study. Pygmy rabbits use residential burrow systems throughout the year, and those systems are characterized by multiple entrances, substantial build-up of excavated soil and rocks, and a surrounding carpet of fecal pellets. In contrast, natal burrows had a single entrance that ended in a spherical chamber lined with shredded bark, grass, and hair (Rachlow et al., 2005). Natal burrows were placed at the base of sagebrush and were covered with soil each day making them inconspicuous to observers. We evaluated spatial relationships between natal burrows and residential burrow systems, which indicated that females appeared to locate natal burrows away from areas of residential activity.

This project has been completed

PYGMY RABBIT HABIT MODELING

Principal Investigator: Dr. J. Rachlow
Funding Agency: IDFG
Completion Date: 6/30/04

Objectives:

1. Synthesize existing information on the distribution of pygmy rabbits (*Brachylagus idahoensis*) in Idaho.
2. Create a habitat model to facilitate evaluation of potential habitat for the species within the state.

Results: We first defined a base map of potential habitat for pygmy rabbits in Idaho and then prioritized that area for ground surveys. Potential habitat was defined using the two attributes that were consistently associated with presence of pygmy rabbits in the literature, sagebrush vegetation and soil depth. Priority for survey efforts was assigned across the potential habitat base map using data on habitat characteristics at known locations. Occurrences of pygmy rabbits in Idaho were plotted and assessed for the following variables: vegetation type, elevation, slope, soil depth, and average percent clay in the soil. Values for each variable that encompassed 80-85% of all known occurrences were considered "higher priority", and were assigned a priority rating of "1." Values outside of those ranges were assessed as "lower priority", and were assigned a priority rating of "2." Because fire can have long-term effects on sagebrush habitats, we considered areas that had burned since 1990 to be lower priority rating. Information on response of pygmy rabbits to fire is lacking; therefore, the choice of this cut-off date is intuitive, but arbitrary. All habitat variables were overlaid using a GIS and average priority values were assigned to each pixel of 30 m of the potential habitat base map. Average priority values were collapsed into 4 priority ranks that rated habitat from higher to lower priority for survey efforts.

The model was constructed using a total of 164 locations. We first defined a base map of potential habitat for pygmy rabbits using two attributes, shrub-steppe vegetation and soil depth suitable for burrow construction. Of the 164 known locations of pygmy rabbits in Idaho, all but 8 occurred in one of the xeric shrub vegetation categories defined in the Idaho GAP analysis (Scott et al. 2002), and all existed in areas of average mapped soil depth =60 cm. Therefore, we defined potential habitat for pygmy rabbits in Idaho as those areas that were mapped as xeric shrub with soil depths =60 cm; these two variables defined an area of 5,696,000 ha.

We prioritized the large area designated as potential habitat using a suite of additional habitat characteristics. Continuous variables included percent clay in the soil, elevation, and slope; values for each variable that encompassed 80-85% of the 164 known sites were assigned "Higher Priority." We also used 2 categorical variables, vegetation type and fire history, to prioritize the potential habitat base map. Lastly, areas that burned

since 1990 were assigned a lower priority than sites that had not burned or had burned prior to 1990 (Table 1). Average priority values per pixel ranged from 1 (higher priority for all habitat layers) to 2 (lower priority for all habitat layers). Of the 164 locations used to build the model, 8 points were outside of the potential habitat because they did not occur in xeric shrub vegetation. Of the remaining 156 locations, 140 (85%) fell within the two highest priority categories. Higher priority values indicated areas with habitat characteristics most similar to known occupied sites.

The resulting map ranks potential habitat for pygmy rabbits in Idaho from higher to lower priorities (in 6 categories) for survey efforts. This information can be used to help guide ground surveys aimed at identifying presence of the species.

This project has been completed.

INTERIOR COLUMBIA BASIN NETWORK INVENTORY

Principal Investigator:	Dr. R. G. Wright
Research Associates:	Lisa Garrett
	Leona Svancara
	Tom Rodhouse
Funding Agency:	National Park Service
Completion Date:	1/1/2004

Objectives:

1. To compile a complete and documented inventory (90% of all expected species) of all vertebrates and plant species in the eight parks in the Interior Columbia Basin Network.
2. Use this as a basis to begin to develop a list of key resources to be part of the long-term monitoring plan for this network.

Results: The inventory has been completed. The inventories were complied using documented studies in the parks, park herbaria, park museum collections, and systematic field inventories. The latter were carried out by the research associates working on the study, investigators from the University of Idaho, Idaho State University, Boise State University, BLM, and various park staff at the respective areas.

Honors and Awards:

Kara Anlauf. Matthew Clow Scholarship from the Whirling Disease Foundation. February 2004.

Michael Colvin. Matthew Clow Scholarship from the Whirling Disease Foundation. February 2004.

Michael Colvin. Adams Scholarship for Academic Achievement. 2004.

Michael Colvin. Idaho Chapter American Fisheries Scholarship Recipient. 2003-2004.

Christine M. Moffitt. Who's Who in America; Who's Who of American Women. 2003, 2004.

Jeffrey Yanke. Best Student Paper, Idaho Chapter American Fisheries Society. February 2004.

Jeffrey Yanke. Best Student Poster, 134th Annual Meeting of the American Fisheries Society. August 2004.

Jeffrey Yanke. Ted Bjornn Graduate Scholarship, Idaho Chapter American Fisheries Society. 2004.

Jeffrey Yanke. Bill Van Thiel Memorial Scholarship Award, donated by the Kelly Creek Flycasters of Federation of Fly Fishers. 2004-2005.

Technical Assistance:

James L. Congleton. Reviewed manuscripts for *Aquaculture Research*, *North American Journal of Fisheries Management.*

James L. Congleton. Reviewed four proposals for the CALDELTA program.

James L. Congleton. Reviewed book chapter for AFS publication *Proceedings of the Symposium on Effects of Urbanization on Aquatic Ecosystems.*

Christine M. Moffitt. Sport Fishing and Boating Partnership (USFWS), Fisheries Strategic Plan Steering Committee.

Christine M. Moffitt. Falls Creek Reconnection Project, Interagency Coordination Meeting, Challis, Idaho. *Whirling Disease Monitoring in the Pahsimeroi River Basin.*

Christine M. Moffitt. Reviewed Manuscripts for: *North American Journal of Fisheries Management; Journal of Fisheries Management; Aquaculture; Transactions of the American Fisheries Society; Journal of Aquatic Animal Health; Aquaculture Research.*

Invited Presentations:

James L. Congleton. *Physiological condition and survival of juvenile salmon passing through the Snake-Columbia River Hydropower System.* Workshop on Delayed Hydrosystem Impacts. Fish Passage Center; Bonneville Hot Springs, WA. February 2004.

J. Michael Scott, Dale D. Goble, Frank D. Davis, Geoff Heal. Co-convenors, *Endangered Species Act @ 30: Challenges and prospects.* Conference; Santa Barbara, CA. November 2003.

J. Michael Scott. *Endangered Species Act at 30: Challenges and prospects.* U.S. Fish and Wildlife Service, Regional office; Portland, OR. December 2003.

J. Michael Scott. *Endangered Species Act at 30: Challenges and prospects.* U.S. Fish and Wildlife Service, ESA office; Arlington, VA. February 2004.

J. Michael Scott. *Endangered Species Act at 30: Science Policy and Law.* U.S. Fish and Wildlife Service, Boise field office; Twin Falls, ID. May 2004.

J. Michael Scott, Dale D. Goble. *The Endangered Species Act at 30: Renewing the conservation promise.* Breifing of Senate at House Staffers; Dirksen bldg. Washington, D.C. July 2004.

J. Michael Scott. *The Endangered Species Act at 30: Renewing the conservation promise.* Western Association of Fish and Wildlife Agencies; Sun Valley, ID. July 24, 2004.

J. Michael Scott. *The Endangered Species Act: A review.* Concluding remarks at the Western Association of Fish and Wildlife Agencies; Sun Valley, ID. July 24, 2004.

J. Michael Scott. *The Endangered Species Act at 30: Renewing the conservation promise.* FWS ESA meeting; Seward, AK. September 2004.

Papers/Posters Presented – Fisheries Resources:

Anlauf, K.J., C.M. Moffitt, M.E. Colvin, B.R. Rieman. *Understanding the Ecology of Whirling Disease through Modeling of Tubificid Habitat.* Idaho State Chapter of the American Fisheries Society Annual Meeting; Moscow, ID. 2004.

Anlauf, K.J., C.M. Moffitt, M.E, Colvin. *Modeling the Tubificid Habitat in the Pahsimeroi River Drainage.* Western Division of the American Fisheries Society; Salt Lake City, UT. 2004.

Colvin, M.E., C.M. Moffitt, K.J. Anlauf, K. Johnson. *Piecing Together the Pahsimeroi Puzzle.* Idaho State Chapter of the American Fisheries Society Annual Meeting; Moscow, ID. 2004.

Colvin, M.E., C.M. Moffitt, K.J. Anlauf, K. Johnson. *Effects of Fish Distributions on Whirling Disease in the Pahsimeroi River Drainage, Idaho.* Western Division of the American Fisheries Society, and Whirling Disease Symposium; Salt Lake City, UT. 2004.

Congleton, J.L. *Responses of Hatchery-Reared and Wild Chinook Salmon to In-River Migration and to Dam Bypass Systems.* Annual Program Review of the Pacific Northwest Division of Corps of Engineers; Walla Walla, WA. November 2003.

Congleton, J.L. *Passage of Juvenile Salmon through the Snake-Columbia River Hydropower System: The Major Obstacle to Recovery?* Departmental 501 Seminar. November 2003.

Congleton, J.L. *Responses of Hatchery-Reared and Wild Chinook Salmon to In-River Migration and to Dam Bypass Systems.* Delayed Mortality Workshop; Bonneville, WA., February 2004.

Moffitt, C.M. *Profile of Bacteria in the Gastrointestinal Tract of Chinook Salmon (Oncorhynchus tshawytsha) Before, During, and Following Administration of Erythromycin Rations.* Northwest Fish Culture Conference; Portland, Oregon. December 3-5, 2003.

Moffitt, C.M. *Economic and Environmental Aspects of Animal Protein Production.* 134th Annual American Fisheries Society; Madison, Wisconsin. August 2004.

Moffitt, C.M. *Modeling the Effects of Antibiotic Treatments in Cultured Fish.* 134th Annual American Fisheries Society; Madison, Wisconsin. August 2004.

Moffitt, C.M. *What About Resistant Microorganisms?* World Fisheries Congress; Vancouver, British Columbia, Canada. May 2004.

Pinson, A., C. Peery, J.L. Congleton. *Energy Expenditures, Migration Patterns and Reproductive Success of Adult Chinook Salmon; South Fork Salmon River, Idaho.* Annual Program Review of the Pacific Northwest Division of Corps of Engineers; Walla Walla, WA. November 2003.

Pinson, A., C. Peery, J.L. Congleton. *Migration Patterns, Energy Expenditure, and Reproductive Success of Adult Chinook Salmon of the South Fork Salmon River in Central Idaho.* Annual Meeting of Idaho Chapter of the American Fisheries Society; Moscow, Idaho. February 2004.

Pinson, A., C. Peery, J.L. Congleton. *Migration Patterns, Energy Expenditure, and Reproductive Success of Adult Chinook Salmon of the South Fork Salmon River in*

Central Idaho. Annual Meeting of Western Division of the American Fisheries Society; Salt Lake City, Utah. March 2004.

Yanke, J., C.M. Moffitt, W. Connor, J.L. Congleton. *Temperature Dependent Survival of Juvenile Snake River Fall Chinook Salmon.* USGS Conference on Science in Washington and Oregon; Troutdale, OR. October 2003.

Yanke, J., C.M. Moffitt, W. Connor, J.L. Congleton. *Temperature Dependent Survival of Juvenile Snake River Fall Chinook Salmon.* Annual Meeting of Idaho Chapter of the American Fisheries Society, Moscow, Idaho. February 2004. Best student paper award.

Yanke, J., C.M. Moffitt, W. Connor, J.L. Congleton. *Temperature Dependent Survival of Juvenile Snake River Fall Chinook Salmon.* Annual Meeting of Western Division of the American Fisheries Society, Salt Lake City, Utah. March 2004.

Papers/Posters Presented – Wildlife Resources:

Greenleaf, S. *Seasonal Food Habits of Black Bears in Yosemite Valley Based on Scat Analysis.* Idaho Section Wildlife Society Meeting; Moscow, ID. February 2004. First place poster co-winner.

Greenleaf, S. *Anthropogenic Food in the Diet of Black Bears at Yosemite National Park.* International Bear Conference; San Diego, CA. 2004.

Greenleaf, S. *Seasonal Food Habits of Black Bears in Yosemite Valley Based on Scat Analysis.* University of Idaho Graduate Student Association Symposium; Moscow, ID. April, 2004. First place poster co-winner.

Rodhouse, T., R. G. Wright. *Roost Characteristics of Red Myotis in the John Day River Valley of Oregon.* Accepted: Western North American Naturalist.

Sager, K. *An accuracy assessment of GPS telemetry collars in a mountainous temperate rainforest environment.* Idaho Section Wildlife Society Meeting. Moscow, ID. February 2004. First place poster co-winner.

Sager, K. *Landscape Analysis of Black Bear Distribution Patterns in Olympic National Park.* International Bear Conference; San Diego, CA. February 2004.

Sager, K. *An Accuracy Assessment of GPS Telemetry Collars in a Mountainous Temperate Rainforest Environment.* Washington Section Wildlife Society Meeting; Ellensburg, WA. April 2004.

Sager, K. *An Accuracy Assessment of GPS Telemetry Collars in a Mountainous Temperate Rainforest Environment.* University of Idaho Graduate Student Association Symposium; Moscow, ID. April 2004.

Stumph, B., J. Dungan. *Moose Distribution and Carrying Capacity at Rocky Mountain National Park.* Rocky Mountain National Park Science Conference; Estes Park, CO. March 2004.

Svancara, L.K. and R. Brannon. *What is Representation? A Review of Conservation Targets.* National GAP Analysis Program; Ft. Collins, CO. 2003.

Svancara, L.K. and J.M. Scott. *Scale and Uncertainty: Managing for Elk in the Clearwater.* Society of American Foresters, Idaho Chapter; Lewiston, ID. *(Invited)* 2003.

Svancara, L.K., J. Rachlow. *Identifying and Prioritizing Idaho's Pygmy Rabbit Habitat.* Idaho Chapter of the Wildlife Society Annual Meeting; Boise, ID. 2003.

Svancara, L.K. and J.M. Scott. *Comprehensive Conservation Assessments: A Future for Idaho?* Idaho Chapter of the Wildlife Society Annual Meeting; Boise, ID. 2003.

Svancara, L.K., C.R. Peterson, and C. Jenkins. *Change in the Sagebrush Steppe: a Look at Reptile Distributions.* Idaho Chapter of the Wildlife Society Annual Meeting; Boise, ID. 2003.

Svancara, L.K., R. Brannon, J.M. Scott, C. R. Groves, R. F. Noss, R. L. Pressey. *How Much Really is Enough?* Society for Conservation Biology; New York, NY. 2004.

Wilson, G.M. *Does 15 Meters Matter?* Idaho Chapter of the Wildlife Society Annual Meeting; Boise, ID. 2003.

Wilder, Jim. *Quantifying Bear Populations and Bear-Human Conflicts Using Non-Invasive Genetic Sampling in the Kennicott Valley of Wrangell St. Elias National Park and Preserve.* Western Black Bear Workshop, Chico Hot Springs; Montana. March, 2003

Multimedia Presentations:

Moffitt, C.M. World Fisheries Congress History of World Fisheries. A photographic essay for the Plenary Presentations at the 4th World Fisheries Congress; British Columbia. 2004.

Moffitt, C.M.. Plenary and Business Meeting Awards Ceremonies for Annual Meeting of the American Fisheries Society; Madison, Wisconsin. 2004.

Reports:

Congleton, J.L., T. Wagner, D. Jones, J. Evavold, J. Hafner, D. Fryer, B. Sun. 2004. *Evaluation of physiological differences in transported, in-river migrating, and multiple-bypassed juvenile salmon.* (DACW68-00-C-0031). Annual Report for 2002 to US Army Corps of Engineers, Walla Walla District. 56 pp.

Garrett, L., L. Svancara, T. Rodhouse, R.G. Wright. 2004. An inventory of the vertebrate species and plants in the parks of the Interior Columbia Basin Network. *Final Phase I Report, NPS*

Madison, E., T. Rodhouse, L. Garrett. 2003. *Mammal inventory for Craters of the Moon National Monument and Preserve*. Report for sub-agreement No. 20 for Cooperative Agreement No. CA9000-95-018.

Madison, E., K. Oelrich, T. Rodhouse, L. Garrett. 2003. *Mammal inventories City of Rocks National Reserve*. Report for Sub-agreement No. 20 for Cooperative Agreement No. CA9000-95-018.

Moffitt, C.M. 2004. *Bridging methods of analysis of tissues with erythromycin*, Submittal of Data to U.S. Food and Drug Administration.

Rachlow, J., L.K. Svancara. 2003. Pygmy rabbit habitat in Idaho. Project Completion Report, Bureau of Land Management, Boise, Id.

Strobl, C., L. Garrett, T. Rodhouse. 2003. *Mammal and herpetological inventories Nez Perce National Historical Park*. Report for Sub-agreement 20 for Cooperative Agreement No. CA9000-95-018.

Strobl, C., L. Garrett, L. and T. Rodhouse. 2003. *Mammal and herpetological inventories Big Hope National Battlefield*. Report for Sub-agreement No. 20 for Cooperative Agreement No. CA9000-95-018.

Stumph, B., R.G. Wright. 2004. *Sexual segregation in moose in willow communities at different elevation zones in Rocky Mountain NP*. Paper presented at annual ALCES meeting, Tordum, New Foundland.

Yanke, J.A., C.M. Moffitt, J.L. Congleton for W.P. Connor. 2004. *Effects of Water Temperature and Passive Integrated Transponder (PIT)-Tagging on the Survival, Growth, Physiology, and Health Status of Subyearling Fall Chinook Salmon*. Annual report for work order #109. Idaho Cooperative Fishery and Wildlife Research Unit.

Service:

James L. Congleton. Chair of search committee for new faculty member. Department of Fish and Wildlife Resources, University of Idaho; Moscow, ID.

Christine M. Moffitt. University Committees 2004-2005. Member at large, Athena Board. Advisor, Palouse Unit AFS.

Christine M. Moffitt. Fish Ecology Search Committee.

Christine M. Moffitt. Silver Creek Technical Advisory Committee, Idaho Nature Conservancy. 2004-2005.

Christine M. Moffitt. Potlatch Corporation Community Advisory Board 2002-2005.

Christine M. Moffitt. Department of Agriculture, CSREES Competitive Grants Program Review panel - Animal Protection. 2004.

Christine M. Moffitt. Journal Outreach Co-Editor, Journal of Aquatic Animal Health. 2004-2006.

Christine M. Moffitt. FWS Strategic Plan Evaluation Committee, appointed by Sport Fishing and Boating Partnership to Evaluate the USFWS Fisheries Program Progress toward their draft Strategic Plan. June 2004 – July 2005.

Christine M. Moffitt. Research Grade Evaualtion Panel. November 2003.

J. Michael Scott. Editorial board; *BioScience.*

J. Michael Scott. Board of Directors; American Institute of Biological Sciences. 2003-2004.

J. Michael Scott. Editorial board; *Biological Conservation.* 2003-2004.

J. Michael Scott. Chair; Edward T. LaRoe Award Committee, Society for Conservation Biology.

J. Michael Scott. Chair; Awards Committee, Natural Areas Association.

J. Michael Scott. Member; Scholarship Committee, National Fish and Wildlife Foundation.

J. Michael Scott. Member; Science Advisory Committee, Doris Duke Charitable Trust.

J. Michael Scott. Member; Science Advisory Board, Lava Lake Foundation for Science and Conservation.

J. Michael Scott, Nate Fisher. Co-chairs; Recovery management agreement workshop. Co-hosted by the University of Idaho and the National Cattlemens Assocation. Washington, D.C. July 2004.

J. Michael Scott, Dale D. Goble. Co-chairs; Conservation reliant species. U.S. Fish and Wildlife Service. Arlington, VA. June 2004.

R. Gerald Wright. Editor, *Natural Areas Journal.*

Jeffrey Yanke, Kara Anlauf, Mike Colvin. Coordination and participation of a stream habitat improvement project with the US Forest Service, North Idaho and Clearwater Flycasters of the Federation of Flyfishers.
Jeffrey Yanke, Kara Anlauf, Mike Colvin. Bull trout redd surveys on the St. Joe River with the US Forest Service, Fall 2003.

Teaching:

Kara Anlauf. (Teaching Assistant) Riparian and Floodplain Ecology. University of Idaho. Spring 2004.

James L. Congleton. (Guest Lecturer) Effects of physiological stress on fish health and performance. University of Idaho. February 2004.

Michael Colvin. (Teaching Assistant) Fish Health Management. University of Idaho. Spring 2004.

Christine M. Moffitt. FISH 504: Sustainable Aquaculture. University of Idaho. Fall 2004.

Christine M. Moffitt. FISH/WLF 501: Seminar. University of Idaho. Fall 2004.

J. Michael Scott. WLF 504/LAW 960: Graduate Seminar, Advocacy Science. University of Idaho. Fall 2004.

J. Michael Scott. WLF 504: Sustaining Ecological Integrity. University of Idaho. Spring 2004.

J. Michael Scott. WLF 504/LAW 960: Graduate Seminar, Endangered Species Act @ 30. University of Idaho. Fall 2003.

Leona K. Svancara, Eva Strand, Dr. Edward O. Garton. (Co-Instructors) Advanced GIS Applications in Natural Resources. University of Idaho. Spring 2003.

Leona K. Svancara, Gina Wilson. 4-H Natural Resource Identification Contest Latah County 4-H program, Moscow, ID. March 2003.

Gina Wilson. (Guest Lecturer) NR470: Interdisciplinary Planning. University of Idaho. Fall 2003.

Gina Wilson. (Guest Lecturer) Hands-on GIS. Troy Elementary School - 2nd Grade. Troy, Idaho. April 2003.

Publications:

Adams, J, L.P. Waits, B. Kelly. 2003. Using fecal DNA sampling and GIS to monitor hybridization between red wolves *(Canis rufus)* and coyotes *(Canis latrans) Molecular Ecology*12:2175-2186.

Adams, J., J. Leonard, L.P. Waits. 2003. Genetic evidence for introgression of domestic dog mitochondrial DNA into the wild coyote population. *Molecular Ecology* 12:541-546.
Belovsky, G.E., D.B. Botkin, T.A. Crowl, K.W. Cummins, J.F. Franklin, M.L. Hunter Jr., A. Joern, D.B. Lindenmayer, J.A. MacMahon, C.R. Margules, J.M. Scott. 2004. Ten suggestions to strengthen the science of ecology. *BioScience* 54: 345-351.
Cantu, C., R.G. Wright, J.M. Scott, E. Strand. 2003. Conservation assessment of current and proposed nature reserves of Tamaulipas State, Mexico. *Natural Areas Journal,* 23:220-228.

Cantu, C., R.G. Wright, J.M. Scott, E. Strand. 2003. Assessing biodiversity in Nuevo Leon, Mexico: Are nature reserves the answer? *Natural Areas Journal* 24(2).

Cantu, C., R.G. Wright, J.M. Scott, E. Strand. 2003. An assessment of current and proposed nature reserves in Mexico based on their capacity to protect geophysical features and biodiversity. *Biological Conservation* 114(1).

Congleton, J.L., P.R. Biga, B.C. Peterson. 2003. Plasma insulin-like growth factor-I concentrations in yearling Chinook salmon (*Oncorhynchus tshawytscha*) migrating from the Snake River Basin, USA. *Fish Physiology and Biochemistry*. 29:57-66.

Garner, A., J.L. Rachlow, L.P. Waits. *Genetic Diversity, Population Divergence, and Conservation of Idaho Ground Squirrels in Fragmented Habitats*. Conservation Genetics. *In press*.

Hubbs, A.H., T. Karles, R. Boonstra. 2000. Indices of Population Size for Burrowing Mammals. *Journals of Wildlife Management*, 64:296-301.

Jones, D., C.M. Moffitt. 2004. Swimming endurance of bull trout, lake trout, arctic char, and rainbow trout following challenge with *Renibacterium salmoninarum. Journal of Aquatic Animal Health* 16: 10-22.

Karl, J., J.M. Scott, E. Strand. 2005. An assessment of Idaho's Wildlife Management Areas for the protection of wildlife. *Natural Areas Journal* 23:36-45.

Miller, C.R., J.R. Adams, L.P. Waits. 2003. Pedigree based assignment tests for reversing coyote (*Canis latrans*) introgression into the wild red wolf (*Canis rufus*) population. *Molecular Ecology*, 12:3287-3301.

Moffitt, C.M., A.H. Haukenes, C.J. Williams. 2004. Evaluating and understanding fish health risks and their consequences in propagated and free-ranging fish populations. *American Fisheries Society Symposium* 44:529-537.

Moffitt, C.M. 2004. The implications of aquaculture production and development on sustainable fisheries. Fish in our future: perspectives on fisheries sustainability. American Fisheries Society Symposium 43:91-108.

Murphy, M., L.P. Waits, K. Kendall. 2003. Impact of diet on fecal DNA amplification and sex identification brown bears (*Ursus arctos*). *Molecular Ecology* 12:2261-2265. Murphy, M., L.P. Waits, K. Kendall, S. Wasser, J. Higbee, R. Bogden. 2002. An evaluation of long-term preservation methods for brown bear (*Ursus arctos*) fecal DNA samples. *Conservation Genetics* 3:435-440.

Peery, C.A., K.L. Kavenaugh, J. M. Scott. 2003. Pacific salmon: Setting ecologically defensible recovery goals. *Bioscience,* 52:622-623.

Rachlow, J., D.M. Sanchez, W.A. Estes-Zumpf. 2005. Natal burrows and nests of free-ranging pygmy rabbits (*Brachylagus idahoensis*). *Western North American Naturalist,* 65:136-139.

Ratti, J.T., M. Weinsteen, J.M. Scott, P.A. Wiseman, A.M. Gillesberg, C.A. Miller, M.M. Szepanskiand, L.K. Svancara. 2004. Feasibility of Wolf reintroduction to Olympic Peninsula Washington. *Northwest Science*, 78:1-76.

Roon D., L.P. Waits, K. Kendall. 2003. A quantitative evaluation of two methods for preserving hair samples. *Molecular Ecology Notes*, 3:163-166.

Scott, J.M. 2003. Hot spots, cold spots. *American Scientist*, 91:384-385.

Svancara, L.K., G. Servheen, W. Melquist, D. Davis, J.M. Scott. 2004. Habitat restoration across large areas: Assessing wildlife responses in the Clearwater Basin, Idaho. *Western Journal of Applied Forestry*, 19:123-132.

Wagner, T., J.L. Congleton. 2004. Blood-chemistry correlates of nutritional condition, tissue damage, and stress in migrating juvenile Chinook salmon *Oncorhynchus tshawytscha. Canadian Journal of Fisheries and Aquatic Sciences*, 61:1066-1074.

Wagner, T., J.L. Congleton, D.M. Marsh. 2004. Smolt-to-adult return rates of juvenile Chinook salmon transported through the Snake-Columbia River hydropower system, USA, in relation to densities of co-transported juvenile Steelhead. *Fisheries Research*, 68:259-270.

Welker, T.L., J.L. Congleton. 2004. Oxidative stress in juvenile Chinook salmon, *Oncorhynchus tshawytscha* (Walbaum). *Aquaculture Research*, 35:881-887.

Welker, T., J.L. Congleton. 2004. Relationship between dietary lipid source, oxidative stress, and the physiological response to stress in sub-yearling Chinook salmon (*Oncorhynchus tshawytsch*). *Fish Physiology and Biochemistry*, 29:1-11.

Theses and Dissertations:

Garner, Alisse. 2004. *Genetic Diversity and Divergence in Fragmented Populations of the Idaho Ground Squirrel (Spermophilus brunneus brunneus and s.b. endmicus)* M.S.

Gergely, Kevin. 2003. *A "New Institutional" Look at Comprehensive Conservation Planning in the National Wildlife Refuge System: Comparative Case Studies.* Ph.D.

Johnson, Eric. 2003. *Migration Depths of Adult Spring and Summer Chinook Salmon in the Lower Snake River and Columbia River in Relation to Dissolved Gas Supersaturation.* M.S.

Katzner, T. E. 1994. Winter Ecology of the Pygmy Rabbit (*Brachylagus idahoensis*) in Wyoming. *M.S. Thesis, University of Wyoming, Laramie.*

Koch, Toby. 2004. *Effects of Sedimentation and Water Velocity on White Sturgeon (Acipenser transmontanus) Embryo Survival.* M.S.

McGrath, Kathleen. 2003. *Size Variation and Fitness Consequences in Age 0 Westslope Cutthroat Trout.* Ph.D.

Peterson, Michael. 2004. *Naturally Occurring Hybridization and Introgression between Westslope Cutthroat (Oncorhynchus clarki lewisi) and Native Rainbow Trout (Oncorhynchus mykiss) within Three Tributaries of the Middle Fork Salmon River, Idaho.* M.S.

Roon, David. 2004. *Non-Invasive Genetic Sampling as a Population Assessment Tool for Brown Bears and Black Bears within the Greater Glacier Ecosystem.* Ph.D.

Santora, Maura. 2004. *Modeling the Effects of Myxobolus Cerebralis on the Population Dynamics of Its Hosts.* M.S.

Wilde, D. B. 1978. *A population analysis of the pygmy rabbit (Sylvilagus idahoensis) on the INEL site.* Ph.D. Dissertation, Idaho State University, Pocatello.

Outreach Education:

Christopher James. Participated in Idaho Public Television's Outdoor Idaho program, "War of the Weeds" This has aired several times on Public Television in 2004 and continues in 2005.

Jeffrey Yanke. Presentation on regional fish species and aquatic ecosystems to the 2nd and 4th grade classrooms at the Moscow Charter School, Moscow, ID. May 2004.
Kara Anlauf. 'Women in Science' Morphology and anatomy of fish for kids at the Palouse Discovery Science Center. March 2004.

Extended Abstracts and Others:

Anlauf, K.J., C.M. Moffitt, M.E. Colvin, B.R. Rieman. 2004. Understanding the ecology of whirling disease through modeling of *Tubifex* habitat. pp 15-16. in 10th Annual Whirling Disease Symposium. Salt Lake City. Whirling Disease Foundation, Bozeman, Montana.

Colvin, M.E., K. Anlauf, K. Johnson, C.M. Moffitt. 2004. Effects of fish distributions on whirling disease in the Pahsimeroi River drainage, Idaho. pp 13-14. in 10th Annual Whirling Disease Symposium. Salt Lake City. Whirling Disease Foundation, Bozeman, Montana.