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Ph.D., Fishery Resources

Annual Report

1 October 2000 — 30 September 2001

Idaho Cooperative Fish and Wildlife Research Unit

Samantha Cooney
Dept. of Fish & Wildlife Resources



Cooperating Agencies:

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

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**U.S. Geological Survey
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Moscow, ID 83844-1141**

Unit Cooperators

**U.S. Geological Survey
Idaho Department of Fish and Game
University of Idaho
Wildlife Management Institute**

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Cooperating University of Idaho Faculty

The following College of Natural Resources Faculty and Researchers are cooperating on projects with the Idaho Cooperative Fish and Wildlife Research Unit. They are also involved in teaching and other research projects in their respective departments.

David Bennett - Fishery Resources
Michael Falter - Fishery Resources
Oz Garton - Wildlife Resources
Christine Moffitt – Fishery Resources
Dennis Murray – Wildlife Resources
Janet Rachlow-Wildlife Resources
Jim Peek - Wildlife Resources
John Ratti - Wildlife Resources
Kerry Paul Reese - Wildlife Resources
Dennis Scarnecchia - Fishery Resources
Lisette Waits-Wildlife Resources

Graduate Students on Unit-Assisted Projects

Student	Discipline	Advisor
Jocelyn Aycrigg	Ph.D. Wildlife Resources	E. O. Garton/J.M. Scott
Peter Bloom	Ph.D. Fishery Resources	J.M. Scott
Billy Connor	Ph.D. Fishery Resources	T. C. Bjornn
Patrick Crist	Ph.D. Wildlife Resources	J. M. Scott
LeeAnne Eareckson	M.S. Wildlife Resources	R. G. Wright
Derek Fryer	M.S. Fishery Resources	J. L. Congleton
Kevin Gergely	Ph.D. Wildlife Resources	J. M. Scott
Tom Goniea	M.S. Fishery Resources	T.C. Bjornn
Lorrie Haley	M.S. Fishery Resources	J. L. Congleton
Brett High	M.S. Fishery Resources	T.C. Bjornn
Eric Johnson	M.S. Fishery Resources	T.C. Bjornn
Toby Kock	M.S. Fishery Resources	J.L. Congleton
Kathy McGrath	Ph.D. Fishery Resources	J. M. Scott
Stephen Mosher	M.S. Wildlife Resources	J.M. Scott
Dave Robertson	M.S. Fishery Resources	J. L. Congleton
Scott Patterson	M.S. Fishery Resources	J. L. Congleton/D. Scarnecchia
Anna Pidgorna	M.S. Environmental Science	J.M. Scott
K. Roongadulpisan	M.S. Wildlife Resources	J.M. Scott
David Stannish	M.S. Environmental Science	J.M. Scott
Leona Svancara	Ph.D. Wildlife Res/Geography	J.M. Scott
Tom Welker	Ph.D. Fishery Resources	J. L. Congleton
Jim Wilder	M.S. Wildlife Resources	R. G. Wright
Don Zaroban	Ph.D. Fishery Resources .	J.M. Scott

Unit Affiliated Students

Student	Discipline	Advisor
Lydia Allen	M.S. Wildlife Resources	J. M. Peek
Rachel Ash Cook	M.S. Wildlife Resources	D. Murray
Leona Bomar	M.S. Wildlife Resources	E. O. Garton/J.M. Scott
Nathan Burkepile	Ph.D. Wildlife Resources	K. P. Reese
Christopher Claire	M.S. Fishery Resources	G. LaBar
Lance Clarke	M.S. Fishery Resources	D. H. Bennett
Darin Jones	M.S. Fishery Resources	C. M. Moffitt
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Derek Fryer	M.S. Fishery Resources	J. Congleton
John Guidice	Ph.D. Wildlife Resources	J. T. Ratti
Lorrie Haley	M.S. Fishery Resources	J. Congleton
Ben Herman	M.S. Wildlife Resources	K.P. Reese
Monica Hiner	M.S. Fishery Resources	C. M. Moffitt
Scott Host	M.S. Fishery Resources	G. LaBar
Chris Karchesky	M.S. Fishery Resources	D. H. Bennett
Michelle Kissling	M.S. Wildlife Resources	E. O. Garton
Toby Koch	M.S. Fishery Resources	J. Congleton
Gretchen Kruse	M.S. Fishery Resources	D. Scarnecchia
Susan Loper	M.S. Wildlife Resources	K. L. Lohman
Matt Lucia	M.S. Wildlife Resources	K. P. Reese
Hollie Miyasaki	M.S. Wildlife Resources	K.P. Reese
Melanie Murphy	M.S. Wildlife Resources	L. Waits
Marilyn K. Nielsen	M.S. Wildlife Resources	K. L. Lohman
Hollie Miyasaki	M.S. Wildlife Resources	K. P. Reese
John Quintella	M.S. Fisheries Resources	G. LaBar
Susan Roberts	M.S. Wildlife Resources	E. O. Garton
David Roon	Ph.D. Wildlife Resources.	L. Waits
Danielle Schiff	M.S. Fisheries Resources	G. LaBar
Dan Schill	Ph.D. Fisheries Resources	G. LaBar
Jay Shepherd	Ph.D. Wildlife Resources	K.P. Reese
Todd Steury	M.S. Wildlife Resources	D. Murray
Katherine Strickler	Ph.D. Wildlife Resources	J.M. Scott
Jake Venard	M.S. Fishery Resources	D. Scarnecchia
Dimitri Videgar	M.S. Fishery Resources	D. H. Bennett
Tyler Wagner	M.S. Fishery Resources	C. M. Falter
Tim Welker	Ph.D. Fishery Resources	D. Scarnecchia
Josh Whiting	M.S. Fishery Resources	D. H. Bennett
Paul Wik	M.S. Wildlife Resources	K. P. Reese
Aaron Wirsing	M.S. Wildlife Resources	D. Murray
Don Zaroban	Ph.D. Fisheries	G.LaBar/M.Scott

David

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 in many states 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, and the Wildlife Management Institute. The U.S. Fish and Wildlife Service supported and coordinated the unit from its founding until 1993.

Program Direction

The Unit works toward the following basic objectives: (1) conduct research on fish and wildlife problems of state, regional, and national interest, (2) train graduate students for careers in the fish and wildlife professions, and (3) provide technical assistance to state and federal managers and researchers. The Unit emphasizes research to (1) help find solutions to problems affecting anadromous fish passage in the Snake River basin; (2) evaluate methods of establishing new animal populations or augmenting existing populations; (3) improve estimators of animal abundance; (4) evaluate effectiveness of existing reserve and management areas in the Pacific Northwest; (5) study the basic biology of aquatic and terrestrial animals; and (6) 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 and Idaho Department of Fish and Game personnel. Research studies are conducted primarily within Idaho, although some work is done in adjoining states, as well as Hawaii, Federated States of Micronesia and Alaska.

Unit research is supported by the State contribution and by contracts from the USGS/Biological Resources Division, the 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 thesis advisors for graduate students, and participate in a variety of professional activities. Cooperating faculty at the University of Idaho and Idaho State University serve as thesis advisors for additional graduate students.

J. Michael Scott - Unit Leader and Professor of Wildlife Resources – Recent research activities include studies on the: limiting factors in endangered species; reserve identification, selection, and design in North America; use of translocation as a tool for establishing or augmenting animal populations; and Gap Analysis. Areas of interest include animal ecology, conservation biology, estimating animal numbers. Specialty course: FW-504 Advanced Topics in Conservation Biology.

Ted C. Bjornn - Assistant Unit Leader and Professor of Fishery Resources - Recent research activities include studies on: Wild trout ecology and management; effects of small hydro on stream carrying capacity; habitat features that affect carrying capacity; anadromous fish production in the Tucannon River; role of stress and BKD in salmon smolt losses; viability of hatchery versus wild steelhead; survival of salmonid embryos in relation to sediment; supplementation of wild salmon and steelhead; juvenile chinook salmon-brook trout interactions; passage of adult salmon and steelhead at dams. Areas of interest include management and ecology of wild and hatchery salmonids, and radio-telemetry. Specialty course: F510 - Advanced Fish Management.

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; stress response of chinook salmon smolts collected and transported from Snake River dams; natural defenses against IHN virus. Areas of interest include mechanisms of disease resistance in fish and stress physiology. Specialty courses: F511 - Fish Physiology, F514 - Fish Population Ecology.

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; natural resource data management and geographic information systems. Specialty courses include Human Dimensions of Wildlife Management.

Ongoing Projects - Fisheries Resources

David H. Bennett - Principal Investigator

- Evaluation of adult chinook salmon passage and squawfish distribution at Lower Granite dam during testing of surface bypass and collection prototype-smolt predation
- Effects of increased winter water levels in Lake Pend Oreille on kokanee survival, predation, food abundance, and aquatic macrophytes
- Effects of higher winter lake levels on warmwater fishes in the Pend Oreille River
- Monitoring water temperatures in the lower Snake River Reservoirs
- Evaluate temperature and dissolved gas exposure on passage rates and routes for adult salmon and steelhead in the Columbia and Snake Rivers

Theodore C. Bjornn - Principal Investigator

- Evaluation of adult salmon, steelhead, and lamprey migration past dams and through reservoirs in the Lower Columbia River and into tributaries
- Studies of fishways modifications and temperature, spill deflectors, and patterns at lower Snake River dams
- Synthesis of information on Snake River salmon and wild trout management
- Monitoring and evaluation of fall chinook salmon supplementation in the Snake River

James L. Congleton - Principal Investigator

- Evaluation of the effects of multiple dam passage on physiological condition of migrating juvenile salmon
- Development of design criteria to reduce delay of fish in areas of accelerating flows and to enhance separator performance
- Development of methods of control of infectious hematopoietic necrosis virus (IHNV) in commercially reared salmonid fishes

C. Michael Falter – Principal Investigator

- Effects of increased winter water levels in lake Pend Oreille on kokanee survival, predation, food abundance, and aquatic macrophytes

Christine M. Moffitt - Principal Investigator

- Susceptibility of bull trout, *Salvelinus confluentus*, to infection by *Reinbacterium salmoninarum*, causative agent of bacterial kidney disease

Dennis Scarnecchia - Principal Investigator

- Determination of the effects of contaminants on white sturgeon reproduction in the Kootenai River
- Bull trout studies, East Fork, South Fork Salmon River
- Habitat use and population dynamics of benthic fishes along the Missouri River
- Exotic species control in Upper Priest Lake, Idaho

J. Michael Scott - Principal Investigator

- Conservation of diversity in cutthroat trout systems
- Distribution and abundance of the fishes of Idaho

EVALUATION OF ADULT CHINOOK SALMON PASSAGE AND SQUAWFISH DISTRIBUTION AT LOWER GRANITE DAM DURING TESTING OF SURFACE BYPASS AND COLLECTION PROTOTYPE-SMOLT PREDATION

Principal Investigator: D. H. Bennett
Funding Agency: U.S. Army Corps of Engineers
Completion Date: 12/31/01

Objectives: 1) To estimate abundance of smallmouth bass and northern squawfish in the trailrace and forebay of Lower Granite Dam during operation of the Surface Bypass and Collection prototype (SBC); and 2) To estimate predation on chinook salmon by northern squawfish and smallmouth bass in the trailrace and forebay of Lower Granite Dam during operation of the SBC.

Progress: Northern pikeminnow *Ptychocheilus oregonensis* and smallmouth bass *Micropterus dolomieu*, the more abundant juvenile salmonid predators in Lower Granite Reservoir were sampled from April through August 1998. Nighttime electrofishing was conducted in the Forebay, Forebay, BRZ (boat restricted zone), Tailwater, tailwater BRZ and at random locations in the Snake River Arm of Lower Granite Reservoir. Statistical comparisons of abundance indicated that highest catch rates (no./minute) for smallmouth bass < 70 mm in the Forebay were not different ($P>0.05$) than those from the Forebay BRZ and Tailrace and Upper Reservoir. Smallmouth 70-174 mm were collected in highest abundance from the Forebay BRZ and Tailrace, both of which were statistically higher in abundance than in the Forebay and other locations. Abundance of larger smallmouth bass was higher in either the Forebay or Forebay BRZ but few statistical differences were found among locations. Northern pikeminnow (<200 mm) abundance was statistically highest in the Forebay overall for all months.

Dietary examination indicated that the presence of salmonid smolts was low in both species of predators. Crayfish and nonsalmonid fishes were the predominant food items of both predators. The presence of salmonids was seasonal and generally lower than in previous years.

Bioenergetic modeling is currently being conducted to estimate the number of juvenile salmonids consumed and the overall importance of salmonids in the diet of predators. A final report is being prepared.

EFFECTS OF INCREASED WINTER WATER LEVELS IN LAKE PEND OREILLE ON KOKANEE SURVIVAL, PREDATION, FOOD ABUNDANCE, AND AQUATIC MACROPHYTES

Principal Investigator: D. H. Bennett
Student Investigators: Lance Clark
Dimitri Vidergar
Funding Agency: Idaho Department of Fish and Game
Completion Date: 12/31/01

Objectives: 1) To evaluate growth and survival of age 0 kokanee in Lake Pend Oreille; 2) To evaluate the spatial and temporal zooplankton abundance in Lake Pend Oreille during the growth season for kokanee; and 3) To evaluate the abundance of potential predators and assess their consumption of kokanee in Lake Pend Oreille.

Progress: The initial stages of this project have been completed and have resulted in completion of two Master of Science theses and one Ph.D. dissertation:

Clarke, L. 1999. Juvenile kokanee diet and growth, and zooplankton community dynamics in Lake Pend Oreille, Idaho. M.S. thesis. University of Idaho, Moscow.

Vidregar, D. T. 2000. Population estimates, food habits, and estimates of consumption of selected predatory fishes in Lake Pend Oreille, Idaho. M.S. thesis. University of Idaho, Moscow.

Chipps, S.R. 1997. *Mysis relicta* in Lake Pend Oreille: Seasonal energy requirements and implications for mysid-cladoceran interactions. Ph.D. dissertation. University of Idaho, Moscow.

In addition studies have been conducted to test the hypothesis that emerging kokanee *Oncorhynchus nerka* need food immediately or mortality will ensue. Dietary studies of emerging kokanee showed strong selection for copepods, especially *Cyclops bicuspidatus thomasi* although *Bosmina longirostris*, a reported important dietary zooplankton, was present in zooplankton samples. *Mysis relicta*, opossum shrimp, appeared in stomachs of age 0 kokanee in net pen studies showed no differences in kokanee growth and survival between kokanee maintained at ambient food levels and those considered high for the lake. Initial findings are that food is not limiting survival of recently emerging kokanee in Lake Pend Oreille.

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

Principal Investigator:	T. C. Bjornn
Student Investigators:	Brett High Tom Gonica
Funding Agency:	U.S. Army Corps of Engineers
Completion Date:	12/31/01

Objectives: 1) Prepare final work plan for field work to be conducted in 2000; 2) Complete maintenance and installation of telemetry receiver and antenna equipment at dams, reservoir and tributary sites in Lower Columbia and Snake rivers and tributaries; 3) Collect and outfit adult chinook salmon and steelhead with radio transmitters for release and tracking through Columbia and Snake rivers hydrosystem, and into tributaries; 4) Process telemetry data and begin evaluation of fish movements and passage conditions for data summaries and project reports.

Progress: In 2001, we collected and radio-tagged over 3,500 adult salmon and steelhead, to evaluate various aspects of their upstream migration through the Columbia and Snake rivers. This was the fourth year of data collection for this project since 1996 (fish were not tagged in 1999). Radio-tagged fish were monitored at four hydroelectric dams and reservoirs in the lower Columbia River, and four dams in the mid-Columbia River in cooperation with two public utility districts, and at all major tributary rivers between Bonneville and Priest Rapids dams. Radio-tagged fish were also intensively monitored by truck and boat in areas of interest, such as in the tailrace of Bonneville Dam and at the confluence of the Columbia and Snake rivers, where detailed information on fish movements and behavior was desired. Specific objectives for studies in 2000 included an evaluation of high spill levels at dams on passage and fallback of adult salmon in the lower Columbia River, to determine exposure to high dissolved gas (spring) and water temperatures (summer) levels, evaluate effects of closing orifice gates at powerhouses on

passage, investigate homing and straying rates of salmon with differing migration histories, and to investigate potential sources of loss and determine reach-specific survival rates for adult salmon and steelhead migrating upstream to spawning areas. We are currently processing data and starting analysis for project reports.

Associated with the salmon and steelhead project we are conducting a study using radio telemetry to evaluate passage for Pacific lamprey in the lower Columbia River. In 2001, we collected and radio-tagged 349 adult lamprey at Bonneville Dam. Studies were also conducted using an experimental flume to evaluate swimming performance and behavior of adult lamprey under conditions similar to those existing in fishways at Bonneville Dam. A total of 21 different test treatments were performed to evaluate passage of lamprey during both day and nighttime (fish were taped during tests using infrared lights) under various passage scenarios. Results of tests will be used to recommend modifications to fishways to improve passage for adult lamprey at dams.

STUDIES OF FISHWAY MODIFICATIONS AND TEMPERATURE, SPILL DEFLECTORS, AND PATTERNS AT LOWER SNAKE RIVER DAMS

Principal Investigators:	T. C. Bjornn
Student Investigator:	Eric Johnson
Funding Agency:	U.S. Army Corps of Engineers
Completion Date:	12/31/01

Objectives: 1) Install and maintain radio receivers and antennas at four lower Snake River dams, in their reservoirs, and at the mouths of the major tributaries in the Snake River basin; 2) Monitor passage of radio-tagged adult spring, summer, and fall chinook salmon and steelhead (fish tagged and released at Bonneville Dam on lower Columbia River for related studies) at the four lower Snake River dams and through their reservoirs; 3) Evaluate dissolved gas and temperature exposure of adult salmon; 4) Investigate survival rates, migration timing, and final distribution of adult salmon and steelhead in the Snake River basin in relation to time of passage at Bonneville Dam in the lower Columbia River; 5) Process data and begin preparing project reports.

Progress: Adult salmon and steelhead were monitored as they passed the four lower Snake River dams to evaluate passage conditions in and around fishways and through reservoirs. Fish with transmitters were intensively tracked in the tailrace of Ice Harbor Dam and at the Snake-Clearwater rivers confluence to determine temperature and dissolved gas exposure levels. A test was performed to evaluate effectiveness of weir modifications to improve passage of adult salmon and steelhead in the transition pool at Lower Granite Dam. Extensive tracking surveys have been conducted by truck to locate fish in tributaries as they approach and reach spawning areas and hatcheries. We are currently monitoring steelhead movements in the system and have started processing chinook salmon data in preparation of analysis and preparing project reports.

SYNTHESIS OF INFORMATION ON SNAKE RIVER SALMON AND WILD TROUT MANAGEMENT

Principal Investigator: T. C. Bjornn
Funding Agency: U.S. Geological Survey
Completion Date: 9/30/01

Objectives: 1) To prepare a book-length manuscript on the biology, management, and history of Snake River salmon and steelhead; and, 2) To prepare a book-length manuscript on the biology, population dynamics, and management of wild trout in the Pacific Northwest.

Progress: Data compilation is nearly complete, and writing has been started on each of the major drainages in the Snake River basin. Information on hatchery fish produced and released in the various drainages, redds counted, and counts of the various runs into the Snake River have been updated. The basis for projecting run sizes has been established, and the analysis of long-term trends is underway.

MONITORING AND EVALUATION OF FALL CHINOOK SALMON SUPPLEMENTATION IN THE SNAKE RIVER

Principal Investigator: T. C. Bjornn
Student Investigator: William Connor
Funding Agency: U.S. Fish and Wildlife Service
Completion Date: 12/31/01

Objectives: 1) Assess timing of emergence and migration of natural fall chinook salmon as related to survival to the tailrace at Lower Granite Dam; 2) Assess the residualism of natural and hatchery fall chinook salmon in the Snake and Clearwater rivers; and 3) Assess the attributes of hatchery fall chinook salmon following release into the Snake River and their survival to Lower Granite Dam.

Progress: During FY2001, William P. Connor passed his written and oral qualifying examinations to become a candidate for a doctoral degree. We revised the scope of Connor's project to focus entirely on the ecology of wild subyearling chinook salmon. Connor's dissertation outline was revised to include five papers. These papers will cover: the run composition and early life history attributes of wild subyearling chinook salmon in the Snake River; the role of rapid growth on age at seaward migration by wild spring chinook salmon; fall chinook salmon early life history as affected by dams; factors affecting downstream migration rate of subyearling chinook salmon; and factors affecting survival of subyearling chinook salmon. During FY2001, Connor completed two papers: the run composition paper was published in Northwest Science, and the rapid growth paper will be published in Transactions of the American Society in 2001.

EVALUATION OF THE EFFECTS OF MULTIPLE DAM PASSAGE ON PHYSIOLOGICAL CONDITION OF MIGRATING JUVENILE SALMON

Principal Investigator: J. L. Congleton
Student Investigators: Tom Welker and Lorrie Haley
Funding Agency: U.S. Army Corps of Engineers
Completion Date: 12/31/02

Objectives: 1) Sample spring chinook smolts of wild and hatchery origin to determine and compare physiological responses to barge transportation; 2) Analyze blood and tissue samples; provide blood and tissue samples to other investigators; 3) Determine if significant differences exist between wild and hatchery chinook salmon such that they might have different survivorship following collection, bypass, or transportation; and 4) Determine the cumulative effects of dam passage on stress indices, energy stores, and “tissue damage” enzymes in migrating chinook salmon.

Progress: In 1998, 1999, 2000 and 2001, PIT-tagged spring/summer 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 concentrations and total quantities were determined so that the rate of use of energy reserves could be estimated as the fish migrated downstream to, and then through, the hydropower system. Plasma triglyceride, cholesterol, and total protein concentrations and alkaline phosphatase activity were measured as indices of nutritional status. Plasma activities of the enzymes alanine aminotransferase, aspartate aminotransferase, lactate dehydrogenase, and creatine kinase were measured as indices of metabolic status.

The lipid, protein, and caloric reserves of juvenile chinook salmon originating from three Idaho hatcheries decreased (–65 –30, and –40% on a length-standardized basis relative to mean prerelease values; $P < 0.0001$ for each analysis) as the fish migrated 116 to 283 km downstream to Lower Granite Dam on the Snake River. Lipid, protein, and caloric reserves continued to decline (–40, –12, and –16% relative to mean values at Lower Granite Dam; $P < 0.0001$) as the fish migrated an additional 348 km downstream, through five dams and reservoirs, to John Day Dam on the Columbia River. Changes in mean fork lengths were small (0 to 4 mm). Standardized lipid content was negatively correlated with travel time to the dams ($P = 0.01$). The lipid content of fish sampled at John Day Dam and at Bonneville Dam was low—1 to 2.5% of body weight—and would provide little reserve energy if the fish experienced poor feeding conditions during the first few weeks of marine life.

Plasma triglyceride, cholesterol, and total protein concentrations and alkaline phosphatase activities decreased significantly as the fish migrated to Lower Granite Dam, and continued to decrease as the fish migrated to John Day Dam. These results indicate that the energetic deficit in migrating fish is in part due to a low rate of food intake.

Plasma activities of the gluconeogenic enzymes ALT and AST increased as the fish migrated from release points to Lower Granite Dam and to Little Goose Dam, but subsequently declined as the fish continued migrating to John Day Dam. Activities of creatine kinase and lactate dehydrogenase also declined significantly as the fish migrated from Lower Granite Dam to John Day 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.

Fish reared at Dworshak National Fish Hatchery were smaller than fish reared at McCall and Rapid River hatcheries and were less robust, with only one-half the lipid content. The marine survival rates for fish from the three hatcheries will be compared in future years and tested for correlations with physiological condition during the smolt migration.

DEVELOPMENT OF DESIGN CRITERIA TO REDUCE DELAY OF FISH IN AREAS OF ACCELERATING FLOWS AND TO ENHANCE SEPARATOR PERFORMANCE

Principal Investigator: J. L. Congleton
Funding Agency: U.S. Army Corps of Engineers
Completion Date: 03/31/02

Objective: Evaluate the potential of secondary separation for incrementally improving total project separation efficiency at fish collection facilities with two-stage separators. Secondary separation methods to be evaluated include in-flume separation and secondary separation within raceways and barge holds.

Progress: Results from earlier years were summarized and a completion report prepared. The light-weight, portable fish separators tested at Lower Granite Dam in 1997 and 1998 performed reasonably well, separating fish smaller than 180 mm fork length (primarily chinook salmon) from fish larger than 180 mm (primarily steelhead) with efficiencies ranging from 40 to 80%. These separators clogged rapidly with debris, however, so that engineering solutions would be needed to improve debris removal before the portable fish separators could be used.

The feasibility of letting mixed-species groups of fish collected from bypass systems “volitionally” separate into upstream and downstream sections of raceways was tested at McNary Dam. A vertical bar array was placed in the middle portion of the raceway and test fish were introduced into the downstream end. Separation of fish into the upstream and downstream raceway sections after overnight exposure to various attraction flows (flows introduced into the upstream end of the raceways) were compared. In general, more fish of each species moved into the upstream section of the raceway at the lowest attraction velocity tested (valve opening of 25 percent = V25). However, the difference was only significant for sockeye salmon (68.1 versus 34.1 percent; $P = 0.04$). Separation of steelhead was, as expected, much lower than for the other, smaller species, and was similar at higher (valve fully open, V100) and lower (V25) attraction flows.

When all species were combined in the analysis, significantly more fish of all species smaller than 180 mm separated into the sanctuary section at V25 than at V100 (54.3 versus 34.1 percent; $P = 0.01$) indicating that the lower attraction velocity resulted in better size separation and that increasing attraction velocity did not increase separation efficiency. Further, while separation at V25 was higher than at V100, it was generally close to 50 percent, which is too low to be useful for separation of larger from smaller fish.

Because the efficiency of small fish/large fish separation at Little Goose Dam declined after a roof was installed over the separator, we carried out trials to see if increasing the intensity of artificial light over the separator would improve separation. We found a greater separation of species (almost significant, $P = 0.06$) and a significantly greater separation of fish by size class (52.4 versus 46.3 percent; $P = 0.02$) with the artificial lights on. These results indicate that facility-wide separation by species and size was better with the lights on. However, the magnitude of the difference was small (6.1%).

DEVELOPMENT OF METHODS OF CONTROL OF INFECTIOUS HEMATOPOIETIC NECROSIS (IHN) VIRUS IN COMMERCIALY REARED SALMONID FISHES

Principal Investigator: J. L. Congleton
Funding Agency: Western Regional Aquaculture Consortium
Completion Date: 12/31/02

Objectives: 1) Develop model challenge protocols that mimic the etiology of mixed IHNV/*Flexibacter psychrophilus* infections; 2) Determine effects of IHNV and *F. psychrophilus* on the immune response of rainbow trout; and 3) Determine histopathological changes in various tissues from fish exposed to mixed IHNV/*F. psychrophilus* infections.

Progress: Work on this project focused on objectives 2 and 3. Development of an ELISA (enzyme-linked immunosorbence assay) method for measurement of the humoral immune response against *Flexibacter* was successful. Methods were also developed for dual staining of IHN virus and *Flexibacter* antigens in tissue sections. These methods are currently being applied to the study of histopathological changes in rainbow trout with mixed IHNV/*Flexibacter* infections.

SUSCEPTIBILITY OF BULL TROUT, *SALVELINUS CONFLUENTUS*, TO INFECTION BY *REINBACTERIUM SALMONINARUM*, CAUSATIVE AGENT OF BACTERIAL KIDNEY DISEASE

Principal Investigator: C. M. Moffitt
Student Investigator: Darin Jones
Funding Agency: U.S. Fish and Wildlife Service
Completion Date: 6/30/02

Objectives: 1) Determine the susceptibility of bull trout to bacterial kidney disease (BKD), caused by *Renibacterium salmoninarum*; 2) Compare the susceptibility of bull trout to BKD with that of other salmonid species, for which there are more data; and 3) to provide information and analysis about the risks of infections of *R. salmoninarum* to managers involved with bull trout recovery.

Progress: This year we repeated laboratory tests to determine the median lethal dose of *Renibacterium salmoninarum* for bull trout at 9 and 15 °C. We pooled data from both trials and estimated an LD₅₀ for *R. salmoninarum* = 7.48 x 10⁸ cells/g for fish held at 9°C and 2.8 x 10⁸ cells/g for fish held at 15°. We began a second trial to compare the relative susceptibility of four salmonid species to one dose of *R. salmoninarum*. In this comparison study, responses of chinook salmon *Oncorhynchus tshawytscha*, lake trout *Salvelinus namaycush*, and arctic char *Salvelinus alpinus* were compared with bull trout *Salvelinus confluentus*. All species comparison trials will continue through December and early January. At the termination of the study, fish will be tested to measure the time for fish to reach exhaustion after swimming in a flume of water at velocity of 6 body lengths per second. After testing, fish will be killed and examined by necropsy to assess clinical signs of disease and hematocrit. From our preliminary analyses, arctic char appear most susceptible to *R. salmoninarum* infection.

CONSERVATION OF DIVERSITY IN CUTTHROAT TROUT SYSTEMS

Principal Investigator: J. M. Scott
Student Investigator: Kathy McGrath
Funding Agency: U.S. Forest Service
Completion Date: 12/31/01

Objectives: 1) Analyze existing data to describe associations between the structural composition of cutthroat trout populations and select environmental characteristics. The analysis will include but is not limited to area and contextual variables. The analysis will also consider sampling issues that may confound or limit the interpretation of length frequency data; 2) Conduct a review of the literature on strategies for the conservation of biological diversity across the scales and levels of organization relevant to interior native fishes. Consider specifically the prioritization of watershed conservation and restoration efforts based on the range of potentially conflicting and complimentary diversity measures.

Progress: Third year of fieldwork has been completed. Preliminary data analysis for years 1 & 2 completed and that for year 3 has been initiated. Original project objectives have been completed; required products were delivered to the U.S. Forest Service on or prior to April 30, 2000. Additional objectives have been added to the project:

3. Conduct fieldwork on up to 12 stream systems in each of the Panhandle and Selway-Bitterroot National Forests, collecting spawning westslope cutthroat trout by angling, electroshocking, and/or weirs; collecting resident westslope cutthroat trout by electroshocking; collecting stream habitat data.
4. Collect from agencies such as the U.S. Forest Service, Idaho Department of Fish and Game, and University of Montana, existing westslope cutthroat trout community data including size structure, genetic, age/growth, life history, species diversity, and stream habitat information.
5. Conduct scale and genetic tissue (microsatellite DNA) analyses to describe age and growth and genetic structuring of the sampled cutthroat trout populations.
6. Characterize sample sites using basin and channel diversity measurements.
7. Obtain all necessary access authorization and collection permits, coordinate as necessary with Idaho Department of Fish and Game and appropriate U.S. Forest Service Forest and Ranger Districts.
8. Describe the variation in growth and size of young of the year cutthroat trout within and among streams included in existing work plans. Provide a subsample of at least 25 fish for analysis of parental origin by life history type in streams that overlap with RMRS [funding agency] objectives.

Additional funding has been received in support of these objectives. Significant progress has been made on the new objectives. Fieldwork was conducted during 1999, 2000 and 2001 on 20 streams in the Panhandle National Forest and four streams in the Selway-Bitterroot National Forest, collecting resident westslope cutthroat trout and stream habitat data. Collection of spawning cutthroat trout was attempted during spring, 1999 but was unsuccessful. No additional collection of spawners will be attempted. Information on genetic structuring and life history of

westslope cutthroat trout has been collected from various agencies; this objective has not yet been completed. Scale and genetic tissue analyses have not yet been completed. Sample sites have been characterized by in-field measurements, additional information available from topographic maps remains to be obtained. All access and collector's permits were obtained as required. A minimum of 30 fish were collected from each of 16 streams during 2000, in cooperation with or on behalf of the funding agency.

DISTRIBUTION AND ABUNDANCE OF THE FISHES OF IDAHO

Principal Investigators:	George LaBar/J. Michael Scott
Student Investigator:	Don Zaroban
Funding Agency:	Dept. of Environmental Quality
Completion Date:	07/01/05

Objectives:

- 1) compile records of occurrence for non-game fish species in Idaho, geo-reference the collection events, publish occurrence information via the proposed Field Guide to Native Fishes of Idaho; make occurrence information available through the Idaho Digital Atlas, Idaho GAP, Orma J. Smith Museum of Natural History;
- 2) create and field test a species occurrence prediction model for Wood River sculpin and shorthead sculpin to address bias associated with occurrence only data set and to delimit the range of the species, publish model and results in peer reviewed/refereed journal;
- 3) compile records of fish introductions (native and alien species), geo-reference the introduction events, append results to existing IDFG fish stocking database, publish process and results in peer reviewed/refereed journal; and
- 4) assess status of Wood River sculpin population and potential for conflicting fishery management goals in the Wood River drainage created by stocking native and alien salmonids for recreational purposes in waters containing Wood River sculpin (an endemic species listed as a species of special concern, publish results of status and management conflict assessment as separate articles in peer reviewed/refereed journal.

Progress: Dissertation project objectives are drafted and reviewed by primary advisors, comprehensive literature search being conducted for each objective, project proposal being drafted, anticipate presentation of project proposal to the department during the graduate seminar during fall 2002 semester.

Completed Projects - Fisheries Resources

Dennis Scarnecchia – Principal Investigator

- Determination of the effects of contaminants on white sturgeon reproduction in the Kootenai River
- Bull trout studies, East Fork, South Fork Salmon River
- Habitat use and population dynamics of benthic fishes along the Missouri River
- Exotic species control in Upper Priest Lake, Idaho

DETERMINATION OF THE EFFECTS OF CONTAMINANTS ON WHITE STURGEON REPRODUCTION IN THE KOOTENAI RIVER

Principal Investigator: D. Scarnecchia
Student Investigator: Gretchen Kruse
Funding Agency: Idaho Department of Fish and Game
Completion Date: 12/31/00

Objective: To determine if contaminants (PCBs, pesticides and heavy metals) in gonad, egg, and larval tissue of Kootenai River white sturgeon are limiting survival of sturgeon eggs and larvae.

Results: This study used biomarkers to evaluate the effects of environmental levels of organochlorine, organophosphate, organonitrate, and carbamate pesticides, polychlorinated biphenyls (PCBs) and metals in the aquatic system on Kootenai River white sturgeon, *Acipenser transmontanus*. The biomarkers that were used include tissue residue analysis, plasma steroid production and egg size in adult sturgeon, survival and contaminant uptake during incubation in embryos, red blood cell chromosome content and variability, liver histology, tissue residue analysis and acetylcholinesterase inhibition in juvenile sturgeon. Chemical residues were assessed in ovarian tissue from mature adult females, in wholebody tissue from juveniles, in incubated embryos, and in water and sediment samples from the river. Contaminant residues in ovarian tissue and river-bottom sediment (collected between 1997 and 1999) were compared with residues detected in samples collected between 1989 and 1991. Incubating white sturgeon embryos were exposed to different rearing media (water, sediment and suspended solids collected directly from the Kootenai River) to determine mortality rate and uptake of environmental contaminants. Blood samples were collected from adult and juvenile sturgeon to determine plasma steroid (testosterone, 11-ketotestosterone, and estradiol) levels, cholinesterase inhibition and chromosomal DNA variability. Results from chemical residue analysis indicated that copper, zinc, iron and the PCB Aroclor 1260 were at levels that could adversely affect sturgeon reproduction as well as other aquatic organisms and overall system productivity. Plasma steroid concentrations in Kootenai River sturgeon were comparable to those reported for their species of sturgeon. However, the significant negative correlations between testosterone production and bioaccumulated aroclor 1260 (Spearman; $r = -0.753$) and zinc (Spearman; $r = -0.652$) suggest that males may experience decreased sperm production if they have bioaccumulated these contaminants at levels similar to those found in females. The significant positive between the

female hormone estradiol and DDT (Spearman; $r = 0.893$) also suggests potential feminization of male sturgeon that bioaccumulate DDT levels similar to those found in females. Zinc that resides in sturgeon ovarian tissue was significantly (Mann-Whitney U test; $P < 0.05$) higher than in samples taken between 1989 and 1991. River bottom sediments were found to be a significant source of metal and PCB exposure for incubating white sturgeon embryos. Environmental levels of copper and PCB Aroclor 1260 in the rearing media were associated with increased mortality (Spearman; $r = 0.568$) and decreased incubation time of sturgeon embryos. Results from cholinesterase and DNA analyses in juveniles suggest that juvenile sturgeon could potentially experience inhibition of cholinesterase or increased mutation of DNA from low-level exposure to chromium, lead, aluminum and iron. Liver histology results indicate low-level effects that could potentially result from contaminant exposure; however, further research on older fish is needed to assess long-term effects. The biomarkers used in this study indicate effects and are not a measure of definite cause. Therefore, it was concluded that embryonic, juvenile and adult life stages are potentially experiencing sub-lethal effects from contaminants in the Kootenai River. In addition to other problems and habitat alterations in the system, these effects could be creating additional stress on the white sturgeon population. In order to determine the extent of effects that contaminants may actually be having on the sturgeon, new research technology should be applied as it becomes available and monitoring should continue to develop trend data for contaminants over a longer time period.

Final report has been prepared and accepted by the funding agency.

BULL TROUT STUDIES EAST AND SOUTH FORK SALMON RIVER

Principal Investigator:	D. Scarnecchia
Student Investigator:	David Hogen
Funding Agency:	Idaho Department of Fish and Game
Completion Date:	6/30/00

Objective: To determine spatial and temporal distribution of bull trout in the upper East Fork, South Fork Salmon River and its tributaries.

Results: The study investigated the spatial and temporal distribution of bull trout in the upper East Fork South Salmon River (EFSFSR) and its tributaries in 1999 and 2000. The objectives of this study were to determine if the bull trout were resident or migratory, investigate if environmental parameters affect bull trout locations, and delineate spawning, migration corridors, and overwintering habitat. Radio transmitters were implanted in sixty-five bull trout (>385 mm FL) in the EFSFSR to study these objectives. Bull trout group movement by year was determined to exhibit non-random movement (nonparametric runs test, $p = 0.01$). All radio-tagged fish were migratory. Streamflow was determined to be a significant environmental factor in predicting bull trout location (autoregression, $p = 0.0001$). Bull trout spawned in Quartz, Profile, Tamarack, and Sugar Creeks and their tributaries from August 28 to September 15. An adfluvial population of bull trout was identified in the Glory Hole near Stibnite, Idaho. Fluvial bull trout overwintering habitat included both the lower SFSR (Sheep Creek confluence downstream to mouth) and Salmon River (Elkhorn Creek confluence upstream to Big Mallard Creek confluence).

Paper was completed and accepted by funding agency.

HABITAT USE AND POPULATION DYNAMICS OF BENTHIC FISHES ALONG THE MISSOURI RIVER

Principal Investigator: D. Scarnecchia
Student Investigator: Tim Welker
Funding Agency: U.S. Army Corps of Engineers
Completion Date: 7/31/01

Objectives: The goal of the overall study is to gain information to assist in planning a broader study that will help the COE in complying with the Endangered Species Act. 1) Describe and evaluate recruitment, growth, size structure, body condition, and relative abundance of selected benthic fishes in the Missouri River between the Yellowstone River-Missouri River confluence and the headwaters of Lake Sakakawea, North Dakota, and between Garrison Dam and the headwater of Lake Oake; 2) Describe the use of six dominant habitats (main channel, outside bend, inside bend, tributary mouth, connected secondary channel, nonconnected secondary channel), and 3) Measure hydrological (e.g. velocity), physical (e.g. bottom type), and water quality (e.g. turbidity, temperature) features where fish are collected.

Results: Paper was completed and accepted by funding agency.

EXOTIC SPECIES CONTROL IN UPPER PRIEST LAKE, IDAHO

Principal Investigator: D. Scarnecchia
Funding Agency: Idaho Department of Fish and Game
Completion Date: 6/30/01

Objectives: 1) To determine diel and seasonal migration patterns of lake trout, bull trout and cutthroat trout between Upper Priest Lake and Priest Lake; and 2) compare the migration patterns of lake trout, bull trout, and cutthroat trout between Upper Priest Lake and Priest Lake in relation to physical habitat parameters such as lake water temperatures and water clarity, and Thorofare water temperature, depth and discharge.

Results: Paper was completed and accepted by funding agency.

Ongoing Projects - Wildlife Resources

E. O. Garton - Principal Investigator

- Point Reyes National Seashore Tule elk populations
- Beach buffer effectiveness project
- Meta population dynamics of elk in Idaho

Dennis Murray – Principal Investigator

- Predator-prey relationship of Canada Lynx and snowshoe hares on the Clearwater National Forest and surrounding areas
- Evaluating factors potentially affecting red wolf demography and population recovery

Kerry P. Reese - Principal Investigator

- Sage Grouse Ecology
- Owyhee Sage Grouse Ecology
- Sage Grouse Chick Ecology
- Sharp-tailed Grouse Ecology
- Mountain Quail Natural History
- Game Bird Research
- Blue Grouse Ecology
- Jarbridge Sage Grouse Ecology

J. Michael Scott - Principal Investigator

- Large Area Mapping of Biodiversity
- Idaho Partners in Flight Program
- Optimum nature reserve design for North America
- Conservation assessment of Idaho biodiversity
- GAP Analysis of Ukraine
- Recovery of endangered species

Lisette Waits - Principal Investigator

- Using DNA to monitor grizzly bear population trends
- Red wolf genetics

R. Gerald Wright- Principal Investigator

- A survey of amphibian activity in ponds in the Palouse grasslands of Idaho
- Understanding the range of historical variability in Snake River Plain plant communities
- Bear conflicts along the McCarthy Road corridor in the Wrangell St. Elias National Park and Preserve
- Breeding bird and raptor inventories, Nez Perce National Historical Park
- Natural resource bibliographic database project

- Synthesis of scientific information – Voyageurs National Park, Minnesota
- Interpretive training

BEACH BUFFER EFFECTIVENESS PROJECT

Principal Investigator: E. O. Garton
Student Investigator: Michelle Kissling
Funding Agency: U.S. Fish and Wildlife Service
Completion Date: 6/30/02

Objectives: 1) Design an approach for determining the effectiveness of beach buffers for perching and movement; 2) Evaluate the adequacy of the beach buffers for maintaining quality of habitat.

Progress: Preliminary analysis has revealed that fieldwork will be necessary to reduce variability and produce more meaningful results. A proposal describing field methods is currently being refined. Methods will include an assessment of edge effects of migratory and resident birds, including bald eagles. This approach has been, and continues to be, peer-reviewed. Field research will be conducted to investigate avian composition, abundance, and distribution in maritime-influenced forests in the Tongass National Forest. The evaluation of the beach buffers has not yet been addressed, and will be a result of Objective 1 efforts.

PREDATOR-PREY RELATIONSHIP OF CANADA LYNX AND SNOWSHORE HARES ON THE CLEARWATER NATIONAL FOREST AND SURROUNDING AREAS

Principal Investigator: D. Murray
Graduate Investigators: Todd Steury
 Aaron Wirsing
Funding Agency: Idaho Department of Fish and Game
Completion Date: 6/30/01

Objectives: 1) To evaluate the likelihood of a successful release of lynx in Idaho using mathematical models of lynx-snowshoe hare population dynamics; 2) To estimate the biomass of snowshoe hare and red squirrels available on the Clearwater National Forest; and 3) To describe the population dynamics of hares and squirrels in Idaho.

Progress: Field operations for this project were completed in May 2000. One paper was published looking at the geographic differences among snowshoe hare populations. One manuscript was submitted to *Conservation Biology* on the likelihood of a successful release of lynx to Idaho and elsewhere along the southern distribution. In addition, 5 presentations related to this effort were given at various meetings. The two students funded by this project currently are completing laboratory work and are in the process of writing their theses and preparing manuscripts for submission.

EVALUATING FACTORS POTENTIALLY AFFECTING RED WOLF DEMOGRAPHY AND POPULATION RECOVERY

Principal Investigator: D. Murray
Funding Agency: U.S. Fish and Wildlife Service
Completion Date: 9/30/02

Objectives: Formulate and parameterize a simple model depicting the potential effects of coyotes on a recovering red wolf population. This model will include a basic sensitivity analysis of each parameter, and will explore scenarios ranging from those created by an actively reproducing vs. completely sterile coyote population.

Progress: One presentation related to this work was given at the Society for Conservation Biology meeting and one is to be given later this month at the Carnivores 2000 meeting. The literature review for this project was completed last spring, and we are in the process of completing the model that will serve as the focus of this project.

SAGE GROUSE ECOLOGY

Principal Investigator: K. P. Reese
Student Investigator: Matthew B. Lucia
Funding Agency: Idaho Department of Fish and Game
Completion Date: 12/31/01

Objective: To determine cause- and age-specific mortality of juvenile sage grouse.

Progress: Fieldwork was conducted during summer and fall of 1997 and 1998. One hundred eighty-four sage grouse were captured by night-lighting on summer ranges. In 1997, we equipped 26 10-week old juveniles with radio-transmitters and in 1998 we radioed 33 juveniles. Predation is the most common cause of death of juvenile sage grouse and avian predators killed more grouse than did mammalian predators. Hunters killed 0 radioed birds in 1997 and only 1 was harvested in 1998. Analysis of juvenile survival and movement patterns in relation to those of adults is underway

OWYHEE SAGE GROUSE ECOLOGY

Principal Investigator: K. P. Reese
Student Investigator: Paul Wik
Funding Agency: Idaho Department of Fish and Game
Completion Date: 6/30/02

Objectives: 1) Determine the physical characteristics female sage grouse are selecting in nest sites and brood-rearing areas of Owyhee County, Idaho, 2) determine if present grazing regimes prevent selected characteristics from being available across the landscape, 3) determine hen reproductive success and mortality rates, and to determine if these rates differ by grazing intensities, 4) determine the timing and seasonal movements and the general seasonal ranges of male and female sage grouse in Owyhee County study area, and 5) determine if construction of

emitter sites and use of "no-drop" zones influence habitat use by sage grouse before and after the planned construction during spring 2000.

Progress: Fieldwork began during early March 2000. Twenty-eight hens and 13 male sage grouse were radio-marked. Twenty-three hens were followed through the nesting season; 19 nested. Eight hens successfully hatched clutches (hen success = 42%), 2 hens attempted a second nest after the first was depredated (nest success = 38%). Of the 8 hens producing young, 3 raised chicks to 12 weeks of age. Another hen raised 1 chick to 9 weeks when radio contact was lost. Five hens and 4 males died during the field season (78% survival for sexes combined, 82% survival for hens, 69% for males) from mid-March to mid-August. Vegetation was measured at 23 nests and 23 random locations, and brood vegetation variables were measured at 25 brood and 25 random locations. These data have not been analyzed. Seasonal movement data will be analyzed in a GIS program in the next 6 months, as will other data collected this past field season. A second season of data collection will begin in March 2001.

SAGE GROUSE CHICK ECOLOGY

Principal Investigator:	K. P. Reese
Student Investigator:	Nathan Burkepile
Funding Agency:	Idaho Department of Fish and Game
Completion Date:	6/30/02

Objectives: To determine the cause- and age-specific mortality of day-old sage grouse chicks.

Progress: We initiated a preliminary project in 1999 in southeastern Idaho. During 2000, we completed the second field season using techniques similar to those of 1999. We monitored radio-marked hens through the nesting season. Thirty hens nested with a nest success of 57%. Most hens nested under sagebrush (n=23), but some nested under rabbitbrush (n=6) and 1 nested under a clump of grass. The major cause of nest failure was predation, but 1 hen abandoned her nest after 400 head of cattle moved into the area and 1 incubating hen was depredated. We radio-marked 44 sage grouse chicks from 15 broods and monitored their survival. The average age of death for sage grouse chicks was 8.9 (\pm 1.2) days and mortalities occurred at 1 to 32 days of age. All deaths were due to predation. Chick survival to 8 weeks was 22%. Along with monitoring mortalities, we observed 5 inter-brood movements, a behavior not before documented in sage grouse.

SHARP TAILED GROUSE ECOLOGY

Principal Investigator:	K. P. Reese
Funding Agency:	Idaho Department of Fish and Game
Completion Date:	6/30/02

Objective: To determine reproductive success of newly released and formerly released Columbian sharp-tailed grouse translocated into the Shoshone Basin.

Progress: This continuing project has documented successful reproduction of Columbian sharp-tailed grouse following translocation into the Shoshone Basin of south-central Idaho since 1992. Former graduate student S. Gardner, MS 1997, has continued to analyze monitoring data from

1997-2000, and is completing a manuscript for publication. There currently are at least 4 active leks in the basin, the population is reproducing and survival of radio-marked grouse is high. We will continue to monitor the population over the next few years.

MOUNTAIN QUAIL NATURAL HISTORY

Principal Investigator: K. P. Reese
Funding Agency: Idaho Department of Fish and Game
Completion Date: 6/30/01

Objectives: 1) describe characteristics of habitat use by mountain quail in fall and winter, 2) determine daily and seasonal movements and home range size of mountain quail during fall and winter, 3) determine survival rates of mountain quail over the fall and winter, 4) determine mountain quail productivity, 5) describe the physical and vegetal characteristics of spring and summer habitat used by mountain quail, focusing on nest site and brood-rearing habitats, and 6) determine the spring and summer home range and survival of mountain quail

Progress: The spring and summer portion of the work is in progress. We have captured over 300 mountain quail, have collected over 2250 radio-locations and completed over 200 detailed habitat plots at nest, brood and random sites. Expected completion is January 2001.

GAME BIRD RESEARCH

Principal Investigator: K. P. Reese
Funding Agency: Idaho Department of Fish and Game
Completion Date: 6/30/01

Objectives: to provide funds to hire a research associate to assist in conducting research on sage grouse in southern Idaho. Specific duties were to assist in fieldwork and to assemble a statewide database on sage grouse leks, nesting and wintering ranges.

Progress: Research associate was hired for 8 months until IDFG reorganized their efforts and wished to terminate this contract so that the employee could be hired directly by IDFG. Project is completed.

BLUE GROUSE ECOLOGY

Principal Investigator: K.P. Reese
Student Investigator: Hollie Miyasaki
Funding Agency: Idaho Department of Fish and Game
Completion Date: 6/30/01

Objectives: 1) To determine the productivity of blue grouse populations on grazed and lightly grazed sites using clutch size, nest success, and chick survival as measures of productivity, 2) to determine the age ratio of the fall harvest and compare it with observed pre-harvest age ratios, 3) to determine survival rates of radio-marked hens and chicks during brooding, post-brooding, and

wintering periods, and 4) to formulate an elasticity model and substitute data from this study for specific life stages in the model.

Progress: During spring and summer of 1996 and 1997, blue grouse were captured in the Cuddy Mountains and West Mountains of southwestern Idaho. Adults and chicks over 200 grams were fitted with leg bands. Hens, some males and chicks weighing at least 500 grams were marked with necklace-attached radios weighing 16 grams. Radioed birds were monitored every 2 weeks to determine habitat use, movements and survival. Harvest data was collected from hunter check stations and from wing barrels in both years. Results indicate that harvest information is a credible approach to estimate productivity, but that wing barrel data were more variable in comparison to check station data. Data analysis is continuing.

LARGE AREA MAPPING OF BIODIVERSITY

Principal Investigator: J. M. Scott
Funding Agency: USGS/Biological Resources Division
Completion Date: 12/31/02

Objectives: 1) Test three basic tenets of reserve design. a. Capturing 12% of a species range captures the full geographical and ecological expression of the species; b. Protecting umbrella species across the full range of their ecological and geographical expression captures 90% of all biodiversity; and c. The current set of conservation areas in the western United States captures the full spectrum of vegetation types. 2) Translate research protocols for Gap Analysis into Spanish; and 3) Create thematically seamless land cover and land use maps for the 10 western states.

Progress: Translation of research protocols for GAP were translated into Spanish. A seamless vegetation map was completed for the 10 contiguous Western states, exclusive of California. Manuscript based on this map was published in *Biological Conservation*. Conservation assessment found that only cover types % met conservation goal of 10%. A map analysis of the vegetation types in that data set was completed.

The first found that when full geographical range of four widespread Western vegetation types were analyzed, minimal conservation targets were met in less than 50% of the latitude, longitude elevation cells. Similar results were obtained for three other vegetation types and examination of the occurrence of nature reserves in geophysical space found that their occurrence was strongly biased toward high elevations and poor soils. Those areas least represented in nature reserves were in better soils at lowest elevations and were overwhelmingly in private ownership. Thus completion of a comprehensive nature reserve system in the United States must involve private lands.

Manuscripts

Wright, R. G., J. M. Scott, M. Murray and S. Mann. 2001. Identification of underprotected and potentially at risk plant communities in the Western United States. *Biological Conservation* 98.

Scott, J. M., R. Abbitt, and C. Groves. 2001. What are we protecting! The United States Conservation portfolio. *Conservation Biology in Practice* 1 (2).

- Scott, J. M. and M. D. Jennings. 1998 Large area mapping of biodiversity. *Annals Missouri Botanical Society* 81:34-47.
- Scott, J. M., E. Norse, H. Arita, A. Dobson, J. Estes, et al. 1999. Considering scale in the identification selection and design of biological reserves. Pp. 19-38 *in* M. Soule and J. Terborgh (eds.), *Continental Conservation at multiple scales: Implications for conservation planning*. *Landscape and Urban Planning* 43:49-63.
- Scott, J. M. 2000. Owning up to our responsibilities. Pp. 275-300 *in* B. A. Stein, L. S. Kutner and J. S. Adams (eds). *Precious Heritage The Biodiversity of the United States*. Oxford University Press, New York. (nature reserves, endangered species, gap analysis)
- Scott, J. M., F. Davis, et al. 2001. Nature reserves: Do They Capture the full range of biodiversity. *Ecological Applications*.

PARTNERS IN FLIGHT

Principal Investigator: Sharon Ritter
Funding Agency: Idaho Fish and Game
Completion Date: 6/30/01

The Idaho Department of Fish and Game hired Sharon Ritter as the Idaho Partners in Flight (Idaho PIF) Coordinator on 1 July 1995. Dan Svingen, Nez Perce National Forest, replaced Sharon as Coordinator from July through mid-October 1997. Sharon then returned to the position. Contributors to Idaho Partners in Flight in FY01 included a wide variety of federal, state and private organizations and agencies. This project serves as a clearinghouse and coordinating point for all research and management activities on neotropical migrant birds in Idaho.

CAN THE METAPOPOPULATION CONCEPT BE USED TO EXPLAIN THE SPATIAL AND TEMPORAL POPULATION DYNAMICS OF ELK POPULATIONS IN IDAHO?

Principal Investigators: E.O. Garton/J. M. Scott
Student Investigator: Jocelyn Aycrigg
Funding Agency: Idaho Department of Fish and Game
Completion Date: 6/30/02

Commonly the metapopulation concept is applied to rare and threatened species, however it could be useful when studying more common and widespread species. A regularly harvested population, such as the Rocky Mountain elk (*Cervus elaphus nelsoni*), could potentially fit a metapopulation model because its spatial dynamics are influenced by harvest as well as environmental and habitat factors. The Rocky Mountain elk, a highly charismatic and sought after game species, is important in Idaho because of its economic benefits, recreational opportunities, and intrinsic value. A long-lived species, such as elk, require extensive data to examine population dynamics over time and space.

Historically elk populations in northern and central Idaho were low in the 1800's, but they

benefited from wildfires that occurred in the early 1900's. These fires provided extensive seral brushfields with abundant forage for elk. Since about 1940, fire suppression techniques and plant succession have reduced the amount of available forage. In the late 1960's elk populations appeared to be decreasing in some areas and more strict hunting regulations were invoked. By the mid-1970's the elk populations were increasing again and the increase continued through the mid-1980's.

Currently elk populations in central Idaho have been decreasing while in other areas of the state they are increasing (Idaho Department of Fish and Game 1999). The factors causing these changes could include habitat quality and quantity, movement of individuals between populations, harvest levels, density dependence response, predator abundance, weather, or low levels of vital minerals, such as selenium. Furthermore, the long-term spatial population dynamics of elk populations are influenced by the patterns and density of roads throughout the state (Rowland et al. 2000, Idaho Department of Fish and Game 1999, Black et al. 1976). Elk populations are influenced by all these factors and they should be taken into consideration when planning and implementing management objectives and practices.

Objectives:

1. To examine demographic and physical factors that explain the observed patterns of spatial and temporal population dynamics of elk, including habitat change, movement of individuals between populations, harvest levels, population response to density dependence, predation, weather, road patterns or density, fire patterns, and nutritional requirements.
2. To examine these factors at multiple spatial extents, including subunits of game management units (GMU), groups of subunits, game management units, elk zones, data analysis units, and potentially a multi-state region.
3. To determine which factor(s) best explain the observed patterns of elk population dynamics both temporally and spatially.

Progress: Data has been obtained from Idaho Department of Fish and Game on population abundance and harvest levels. Elk tissue samples for genetic analysis have been obtained from the Wildlife Health Laboratory. Spatial databases including summer and winter elk ranges, game management subunits, and roads are being evaluated for applicability and completeness. Furthermore, satellite imagery both classified and unclassified are being evaluated for its usefulness.

GUIDELINES FOR COMPREHENSIVE CONSERVATION ASSESSMENTS

Principal Investigators: J. Michael Scott/Leona Svancara
Funding Agency: U.S. Geological Survey
Completion Date: 09/30/02

Objective: With increasing human populations and a national policy of sustainable growth dependent on increased rates of consumption of natural resources, extinction threatens any species not adapted to anthropogenic environments and ecosystem not found in areas managed for the long-term maintenance of biodiversity. While efforts to protect landscapes have increased, the prioritization of land and creation of new reserves often operate without a comprehensive plan in mind, resulting in an opportunistic and uncoordinated attempt at protection. Our objectives are to a) identify a complimentary network of conservation

opportunity areas that captures all under-protected, native species and cover types of Idaho in areas sufficient in size and connectivity to ensure viable populations and integrity of ecological processes, b) more fully document the capabilities and limitations of GAP data sets in the identification, selection, and design of reserves, and c) provide a protocol for others to create similar products in a user friendly format for policy makers, land managers and others making land use decisions.

Progress: To date, we have identified 317 native, non-anthropogenic terrestrial species that regularly breed in Idaho. Of these, 38.8% currently have <10% of their predicted habitat in areas managed for the long-term maintenance of biodiversity. This includes 61 bird species, 38 mammals, 16 reptiles, and 8 amphibians. Of the 317 total species, an average of 184.6 species were predicted to occur per hexagon (standard deviation = 39.8, range = 80-254). While areas of highest species richness (> 233 species) occurred in southern Idaho along the Snake River Plain, the sub alpine and alpine areas of northern and central Idaho, the shrub-steppe habitats of Owyhee County, and the largely non-vegetated lava fields of southern Idaho had the lowest richness values. Although species richness is lower in these regions, they provide unique habitats to some species that are found nowhere else in the state (e.g., northern bog lemming [*Synaptomys borealis*] in northern Idaho, Rock squirrel [*Spermophilus variegates*] in Owyhee County). This highlights just one of the shortcomings of prioritizing lands solely on species richness.

We are currently developing priorities and creating selection algorithms that incorporate the principles of representation, redundancy resiliency, complementarity and irreplaceability. Due to limited population size and/or distribution, we are considering threatened and endangered populations separately, using established guidelines for identifying size and distribution of conservation areas for these species and cover types. To assess the number of individuals and populations possible in protected areas, home range requirements for each species have been obtained from the literature and, where empirical data was lacking, estimates made using body size. The final step will be to assess potential conservation areas for primary threats (i.e., economic development, urbanization, road density), costs of land acquisition, and constraints to upgrading management status for those on public land.

GAP ANALYSIS OF UKRAINE

Principal Investigator: J. M. Scott
Student Investigator: Anna Pidgorna
Funding Agency: The George Soros Fund Open Society Institute

Objectives: Determine representation of biological and geophysical features of Ukraine in existing nature reserves. From this analysis identify gaps in protective network of nature reserves.

Progress: Information on geophysical and biological features of the Ukraine have been obtained in digital form, study plan written and location of nature reserves digitized.

OPTIMUM NATURE RESERVE DESIGN FOR NORTH AMERICA

Principal Investigator: J. Michael Scott
Completion Date: 07/01/02
Funding Agency: U.S. Geological Survey

Objectives: Assess cost of system of nature reserves that would capture full range of America's biodiversity.

Progress: Data has been collected. Met with collaborators on several occasions, manuscript written, peer reviewed, submitted for publication. Published Summer 2001. Two others submitted and accepted for publication in Fall 2002. Extent nature reserves comprise slightly more than 5% of coterminous United States. These areas are biased in their occurrences towards higher elevations and poorer soils. These are the areas with fewer species, lower elevations and more productive soils are underrepresented, less than 10%, in nature reserves. These areas are overwhelmingly in private ownership.

ENDANGERED SPECIES ACT: RETROSPECTIVE ON 30 YEARS OF POLICY, LAW, SCIENCE AND SOCIETAL RESPONSE

Principal Investigator: J. Michael Scott
Student Investigators: David Stanish, Robbyn Abbitt & Julie Miller
Funding Agency: U.S. Geological Survey &
Idaho Dept of Fish and Game

Objectives: 1) Determine factors correlated with successful recovery of species. 2) Contrast conservation efforts for successfully recovered species with those that have failed to recover. 3) Determine relationship between dollars spent and recovery success.

Progress: Data to answer first generation questions associated with objectives 1, 2 & 3. Data analyzed, manuscript written, peer reviewed, submitted for publication and published. Findings: Median level of funding for recovery actions was 18% of identified costs in recovery plans. Funding levels varied with taxonomic group with median level of funding being 49% for birds, amphibians 45%, fish 35%, mammals 30%, reptiles 26%, invertebrates 19% and plants 11%. Recovery status was positively correlated with funding levels. Interestingly, those species plants and invertebrates that comprise 68% of all threatened and endangered species received the least funding. Effectiveness of recovery expenditures varied with the threat. Species at risk because of non-native species, dams, drainage, and diversions or alterations of disturbance regimes were the least responsive to recovery actions. Doubling the number of "recovered species" could be achieved with expenditure of 300 million more per year than is currently being spent.

Comparison of those species listed prior to 1988 that have been proposed or formally delisted or downlisted with those listed in the same period and are declining found differences in threats, and in some cases, scale of management actions.

A symposium in which participants will examine the 30 year record of legal, biological, economic and responses to those actions will be convened and co-hosted by the Coop Unite in November 2003. An outline has been completed, steering committee created, partial funding obtained and speaker commitments obtained. Final products: graduate class, book, and media. Two policy briefings.

USING DNA TO MONITOR GRIZZLY BEAR POPULATION TRENDS

Principal Investigator:	L. Waits
Student Investigators:	David Roon, Melanie Murphy
Funding Agency:	U.S. Geological Survey
Completion Date:	5/30/02

Objectives: 1) Develop annual minimum grizzly bear population counts for three years. Develop a genetic database; 2) Based on the amount of sign variation found during surveys conducted over three years, estimate the power of these data to detect grizzly bear population declines; 3) Estimate the proportion of the total Glacier National Park bear population not detected by sign surveys, and adjust survey design to improve efficiency; 4) Evaluate the power of passive hair collection to detect population trends; 5) Adapt the techniques used to extract DNA from fecal samples to process large number of samples; and 6) Estimate the relative size of the black bear population from the ratio of black to grizzly bear sign found on survey routes.

Progress: DNA analysis was completed on 4000 hair samples collected in 1998, 500 scat samples collected in 1998, and 1200 scat samples collected in 1999. Currently, we are extracting DNA from 4000 rub tree samples and 500 additional scat samples from 1999. Based on results from 2440 hairs collected on traps in 1998, we have found 35% brown bears, 65% black bears. Success rates for species ID are 95%. Brown bear samples were analyzed to individual and 147 individuals were identified. 45% were male and 55 % were female. Success rates for individual ID were 80%. From the 1998 rub trees hairs, 81% were brown bears, and 19% were black bears. 78 brown bears were observed and 53 of these were not detected in the hair traps. The sex ratio was 68% male and 32% female. These data were used to obtain a mark-recapture population estimate of 350 – 550 brown bears. The scat samples from 1998 and 1999 were only identified to species due to the lower success rate and high cost of individual ID. In 1998, 60% were brown, 40% were black and success rates were 60%. In 1999, 55% were brown, 45% were black and success rates were 85%.

For hair analysis, we have also been using computer modeling to evaluate the impact of genotyping error rates on minimum and mark-recapture population estimation. We have also run experiments to determine that individual ID success rates drop 15 – 20% when samples are stored for more than 6 months before extraction. For fecal analysis, we have run experiments to evaluate the impact of preservation method, diet, time and conditions in the field, storage time and DNA extraction method on success rates. We have determined that 90% ethanol is the optimal storage method and that DNA does not degrade during 6 months of storage at room temperature. We have fed captive bears restricted diets of salmon, deer, grass, alfalfa, carrots, and blueberries and tested fecal samples for DNA amplification success. Individual ID success rates were significantly lower for salmon scat but no other differences were detected. In a different experiment, we also determined that DNA amplification success rates drop most rapidly when fecal samples are in wet climates. The greatest drop in success rates occurred between 1 and 3 days in the field, but DNA could be obtained even after two months in the field.

RED WOLF GENETICS

Principal Investigator: L. Waits
Student Investigator: Jennifer Adams
Funding Agency: U.S. Fish and Wildlife Service
Completion Date: 12/31/02

Objectives: 1) Design a genetic approach for discriminating between red wolves, coyotes, and domestic/feral dogs inhabiting the red wolf recovery area in northeastern North Carolina; 2) Evaluate the genetic characteristics of hybrids between these species and develop a rapid diagnostic method using genetic markers to detect hybrids; and 3) Develop a non-invasive genetic sampling method.

Progress: We developed a genetic test to differentiate fecal samples for red wolves, coyotes, dogs, red fox, grey fox, bear and bobcat. In the spring of 2000, we collected fecal samples on all roads in Alligator River National Wildlife Refuge, and obtained 400 samples with GIS coordinates for each sample. DNA has been extracted from all 400 samples and we are currently completing species ID on these samples. Success rates for species ID are 85%. To date, we have detected 60 red wolf samples, 25 bobcat samples, and 2 dog samples.

We have collected and extracted DNA from over 150 coyote samples from Virginia, NC, Texas, Kentucky and California to use as comparisons to red wolf genetic samples. We have collected and extracted DNA from over 50 samples of red wolves from the captive population. We have also optimized microsatellite primers for 15 loci and will be using these in a genetic diagnostic for differentiating red wolves, coyotes and hybrids. We completed mtDNA sequencing for 16 known hybrid samples and determined that 8 of these samples contained red wolf DNA. This indicates that breeding is occurring between red wolf females and coyote or hybrid males more frequently than previously suspected.

A SURVEY OF AMPHIBIAN ACTIVITY IN PONDS IN THE PALOUSE GRASSLANDS OF IDAHO

Principal Investigator: R. G. Wright
Funding Agency: National Park Service
Completion Date: 12/15/01

Objectives: 1) To describe and map amphibian species occurrences and abundance in ponds of the Idaho Palouse; and 2) to characterize these ponds as to age, depth, surrounding habitat, and other ecological characteristics.

Progress: This project has been expanded in several ways. The geographic area now encompasses the Palouse bioregion as defined by Bailey and therefore includes portions of eastern Washington. The scope of the project has been expanded to identify and map all features of conservation importance within this region, particularly unique habitats that are unprotected and/or are at risk from development or land-use change.

Progress to date:

A vegetation cover map for the study area has been produced from 1999 Landsat 7 and ancillary data and incorporated into an ARC-INFO GIS coverage. We have mapped and are currently digitizing all wetland areas, ponds, and riparian zones. We have initiated an effort to obtain and map all agricultural lands in Latah County contained in the CRP program. A general land status map, identifying public, state, federal, and corporate ownership is also being developed. We have held consultations with Idaho Dept. of Fish & Game and the Latah County planning and zoning commission about what they would like to see in this project.

UNDERSTANDING THE RANGE OF HISTORICAL VARIABILITY IN SNAKE RIVER PLAIN PLANT COMMUNITIES

Principal Investigator: R. G. Wright
Funding Agency: U.S. Geological Survey
Completion Date: 03/15/03

Objectives: 1) Illustrate how environments in the Snake River Plain have change or not changed over the course of the past 10 decades; 2) Attempt to identify the reasons for the changes or lack of changes and the consequences of these changes.

Progress: This project, which was funded this year, has not yet been started.

BEAR CONFLICTS ALONG THE MCCARTHY ROAD CORRIDOR IN THE WRANGELL ST. ELIAS NATIONAL PARK AND PRESERVE

Principal Investigator: R. G. Wright
Funding Agency: U.S. Geological Survey
Completion Date: 03/03/02

Objectives: 1) Gain a better understand of the type of bear/human conflicts that current exist or may develop as a consequence of increased visitor use and facility development; 2) Document the general biological and behavioral characteristics of the bear population in the study area and contrast those with the specific characteristics of those bears involved in conflicts with humans.

Progress: Fieldwork on this project began in May 2000, directed by graduate student James Wilder and assisted part-time by an NPS intern. Prior to starting fieldwork in the Wrangells, Jim spent a week at Glacier NP observing the protocols being used there on a similar bear hair-trapping study. He also spent some time in Denali NP observing bear handling and tagging protocols used there. Project activities to date have been to more accurately delineate the study area on the ground, establish hair-traps for bears in appropriate areas, collect hair samples, investigate instances in the Chitina River Valley of bear/human conflicts, and collect data from bears that have been killed as a result of conflicts with humans. To date, 204 hair samples have been collected. These were sent to the UI genetic lab for DNA extraction. The success rate for species ID from these samples was 75%. This is lower than on the study underway in Glacier NP, but about the same as hair trapping projects conducted in British Columbia. Of the known IDs,

136 were black bears, 11 were brown bears, and 5 contained DNA of both species. At least three bears involved in conflicts with humans were killed this past summer, all by valley residents. Data from these bears will be compared to samples from the hair traps. In September, James Wilder spent two weeks at Katmai National Park observing the bear management plan in use around Brooks Camp. He will attend the bear/humans conflicts symposium in British Columbia in October.

BREEDING BIRD AND RAPTOR INVENTORIES, NEZ PERCE NATIONAL HISTORICAL PARK

Principal Investigator: R. G. Wright
Funding Agency: National Park Service
Completion Date: 12/30/01

Progress: The second year of field work on this project was completed this summer under the direction of Rita Dixon. All areas of the Nez Perce NHS extending from sites in eastern Oregon to Big Hole Battlefield and Bear Paw in Montana were thoroughly sampled for breeding birds, raptors, owls, woodpeckers, and waterfowl. A long-term monitoring protocol has been developed for the park based on the sampling methods used. This protocol provides basis for second generation set of research questions regarding reasons for distribution and abundance of park vertebrates. The project was also extended to include breeding bird surveys of Whitman Mission NHS in Washington. It is anticipated that a final report on the project will be produced this winter.

NATURAL RESOURCE BIBLIOGRAPHIC DATABASE PROJECT

Principal Investigator: R. G. Wright
Funding Agency: National Park Service
Completion Date: 12/30/01

Progress: This project is nearing completion with the final editing of several park bibliographic databases from the National Park Service units in the southeastern US. Projects associated with NPS Midwest, Western, Northwest, and Southwest regions have been completed under the direction of Lisa Garrett. A draft final report has been prepared for the Southeast work. Currently, as a result of this project, over 100,000 records of park-specific resource studies have been entered into our electronic bibliographic databases. This study provides reference database for all future efforts in the park. We are now working with the National Park Service to implement access to these databases from a web site.

SYNTHESIS OF SCIENTIFIC INFORMATION – VOYAGUERS NATIONAL PARK, MINNESOTA

Principal Investigator: R. G. Wright
Funding Agency: National Park Service
Completion Date: 12/30/01

Progress: This project is currently underway. The principal investigator has made one trip to Voyageurs National Park to get a better understanding of the ecological characteristics of the parklands. During that trip he used the Voyageurs NRBIB database to search the park library and resource management files for appropriate information to be used in the synthesis and brought that material back to the UI. Since then work has been progressing on synthesizing information about the various resource components of the park using tropic levels and ecological processes as a basis for organizing information. Sections on herbivores, primarily, beaver, moose, and white-tailed deer have been completed and well as the role of fire on parklands.

INTERPRETIVE TRAINING

Principal Investigator:	R. G. Wright
Funding Agency:	National Park Service
Completion Date:	12/30/01

Progress: Under the direction of Lisa Garrett, we are compiling information on the distribution, impacts, control measures, and restoration techniques for exotic plant species on national park lands throughout the US. These materials are to be compiled into course materials for a workshop to be given to park interpreters and educators about the role of exotic plant species in parks. Originally this workshop was to be organized in the early fall of 2000. However, the intense involvement of National Park Service contacts on the project with fires in the parks has delayed this until at least the early winter of 2000-2001.

Completed Projects - Wildlife Resources

Dennis Murray - Principal Investigator

- Elk condition and reproductive physiology

Kerry P. Reese - Principal Investigator

- Curlew Valley Habitat Mapping

Edward O. Garton/J. Michael Scott - Principal Investigators

- Broad-Scale Patterns of Elk Recruitment in Idaho

R. Gerald Wright – Principal Investigator

- Axis deer ecology and distribution: Kaluapapa National Historic Park, Hawaii

ELK CONDITION AND REPRODUCTIVE PHYSIOLOGY

Principal Investigator: D. Murray
Funding Agency: Idaho Department of Fish and Game
Completion Date: 6/30/00

Objectives: To evaluate the role of nutritional state of captive female elk on 1) reproductive physiology and 2) body condition and nutritional assays.

Results: We assessed and calibrated indices of nutritional condition for live and dead Rocky Mountain elk (*Cervus elaphus nelsonii*). Live animal indices included serum and urine chemistry, a body condition score (BCS), ultrasonography of subcutaneous fat and muscle, bioelectrical impedance analysis (BIA), and body mass. Dead animal indices included marrow fat, kidney fat, and several carcass scoring methods. Forty-three captive-raised cows (1.5 to 7-years old) were divided into 3 seasonal groups (September, December, and March) and were maintained on different nutritional levels to induce a wide range of condition. All were placed on identical diets 7 days prior to sampling to eliminate short-term nutritional effects. Cows were euthanized and homogenized for chemical analysis of fat, protein, water, and ash content. Estimates of fat and gross energy (GE) were compared to each of the condition indicators using regression analysis, with age and season covariates. Thyroxine (T₄) and insulin-like growth factor (IGF-1) exhibited significant seasonal effects and mandible marrow fat had a significant age effect. Nearly all serum and urine indices, bone marrow indices and BIA were either poorly correlated with condition or exhibited highly non-linear relations, restricting their value to a narrow range of condition. In contrast, BCS and subcutaneous fat depth were the best predictors of fat and GE for live animals ($r^2 > 0.87$, $P < 0.001$); kidney fat and carcass/muscle scores were the best predictors for dead animals ($r^2 > 0.77$, $P < 0.001$); and IGF-1 and T₄ were the only useful serum and urine predictors ($r^2 > 0.54$, $P < 0.001$). Six wild cows were used to assess suitability of condition-index models for free-ranging elk. Although the range of condition for wild elk was limited, there was no difference in the ability of models to predict fat and GE between wild and captive cows. These results will enhance assessment of nutritional condition of free-ranging elk using practical and affordable techniques that were previously untested in elk.

CURLEW VALLEY MAPPING

Principal Investigator: K. P. Reese
Funding Agency: Idaho Department of Fish and Game
Completion Date: 6/30/00

Objectives: To ground truth vegetation maps of the Curlew Valley in southern Idaho which were created previously through GIS application of remotely sensed data.

Results: Project completed in January 2000. Data on 900 vegetation transects were collected during the summer of 1999 near the Curlew Valley National Grasslands. Copies of all data were sent to the Bureau of Land Management, Idaho Department of Fish and Game, and Utah State University. Completion report filed as Commons, M.L. 2000. Curlew Valley Vegetation Mapping Project: Summer 1999. Final Report to BLM, IDFG, Utah State U., and University of Idaho.

BROAD-SCALE PATTERNS OF ELK RECRUITMENT IN IDAHO:

Principal Investigator: J. M. Scott
Funding Agency: Idaho Fish and Game
Completion Date: 6/30/01

Summary: To investigate relationships between environmental variables and broad-scale patterns of elk population dynamics in Idaho, we analyzed 12 years (1987 - 1998) of aerial survey data collected in Idaho Department of Fish and Game Game Management Units (GMUs) across the state. Average elk recruitment during the study period was greatest in areas not on the Idaho batholith, with low forest productivity and high mature bull (≥ 5 points on each antler) densities ($r^2 = 0.31$, $P < 0.05$). Higher values of forest productivity occurred in areas with increased precipitation and net primary productivity, indicating potentially high vegetative growth rates and dense overstory. We proposed that lower elk recruitment in these areas may be due in part to reduced ground and shrub layer production, and therefore decreased forage quantity, quality, or both. One of the primary challenges in spatial analysis is the sensitivity of statistical results to the definition of spatial units over which data are collected. In the geographical literature, this sensitivity is known as the modifiable areal unit problem (MAUP) and results have been shown to vary with both the level (the scaling problem) and the configuration (the zonation problem) of aggregation. We explored the effect of the MAUP on statistical relationships between elk (*Cervus elaphus*) recruitment and 3 independent variables when GMUs were aggregated to 3 different levels in 3 configurations. Changes in variances, correlation coefficients, regression parameters, and model fit were inconsistent across aggregations and as dependent on the particular variable of interest as on the level or configuration of aggregation. While this appears to be one of the first research efforts demonstrating effects of the MAUP in wildlife survey data, more studies are likely to be challenged by the MAUP due to the significant increase in broad-scale research and regional management. We pose questions that must be considered before conducting spatial analyses of aggregated data.

Results: The first manuscript on broadscale relationships has been accepted as a chapter in the book, *Perspectives of scale in ungulate ecology and management* edited by E. Merrill & L. Irwin. The second manuscript on the effects of the MAUP has been submitted to and accepted by the Journal of Wildlife Management.

AXIS DEER ECOLOGY AND DISTRIBUTION: KALUAPAPA NATIONAL HISTORIC PARK, HAWAII

Principal Investigator: R. G. Wright
Funding Agency: National Park Service
Completion Date: 12/30/00

Progress: This project was terminated following six months of fieldwork. The termination was the result of actions by the Kaluapapa NHP resource manager to begin a fencing program that would bisect the Kaluapapa Peninsula, essentially dividing the study area, and to undertake a substantial control program that would eliminate axis deer within the fenced area. We anticipated that many of the deer that had been marked and radio-collared would be trapped within the fenced area and therefore eliminated. We considered that these actions compromised the integrity of the study and by mutual agreement it was terminated. Andrew Yost directed the field study while it was active. The protocols developed for immobilizing and handling the deer were done under the

supervision of Maui veterinarian Alan Kaufman, who has provided consultation on a similar project at Haleacola NP. During the brief study, 20 deer were immobilized and fitted with radio collars and followed for up to 5 months. All relocations were placed into an ARCVIEW GIS file.

We collected all rumens that were available from deer harvested by local residents within the park (n=137). It was our intention to have the contents of these rumens analyzed for dietary components. This data could then be compared with visual and radio locations of deer within specific habitats on the peninsula. This part of the study was not completed because of its termination. A final report on the study and its management implications was produced:

Yost, A. and R. G. Wright. 1999. A preliminary study of axis deer distribution, movements, and food habits at Kalaupapa National Historic Park.

Summary of Activities

Honors and Awards Received by Unit Staff and Students and Associated Faculty and Students

Jennifer Adams – University of Idaho Travel Grant

Lisette Waits, David Roon, Melanie Murphy – Best Paper Award at International Bear Association Meetings

Darin Jones, masters' student (major professor C. Moffitt) was awarded several scholarships this year:

- Matthew Clow Scholarship to attend and participate in the 6th Annual Whirling Disease meeting in Salt Lake City in February 2001.
- S. F. Snieszko Student Travel Award to attend and present a paper at the American Fisheries Society Fish Health Section meeting in Victoria British Columbia, June 2001. This was a society wide competition.
- Eugene Maughan Western Division Student Scholarship awarded to graduate students in the Western Division. His research proposal, community and professional society activities were are considered in this award.
- University of Idaho Idaho-AFS scholarship for graduate students in the Department of Fish and Wildlife Resources.

J. Michael Scott:

Honorary Member, Cooper Ornithological Society, 2001. For career long contributions to knowledge of Hawaiian forest birds, pioneering work in development and improvement of census techniques for birds, development of Gap Analysis Program and ability to work effectively at the science/policy interface.

Star Award, June 2001. For publication of "Evolution, Ecology and Management of Hawaiian Birds: A Vanishing Avifauna".

Ted Bjornn:

University of Idaho Alumni Hall of Fame Award - for outstanding contributions in teaching and fisheries and training of two generations of fisheries biologists.

American Fisheries Society Lifetime Achievement Award - for excellence in research and influencing fish management policy.

Publications and Professional Papers presented - Unit Staff and Students:

Professional Papers

- Effects of Spill on Fallback and Passage of Adult Chinook salmon at Bonneville Dam, 2000. C. Peery and T. Bjornn. Corps Research Review, Nov 2000.
- Migration Behavior of Steelhead During Summer and Fall in Relation to Spill and Temperature. Brett High and T. Bjornn. Corps Research Review, Nov 2000.
- Migratory Patterns of Adult Chinook Salmon and Steelhead in the Lower Snake river and Columbia river in Relation to Dissolved Gas. Eric Johnson and T. Bjornn. Corps Research Review, Nov 2000.
- Adult Sockeye Tagging at Lower Granite Dame and Tracking to Redfish Lake. Megan Heinrich and T. Bjornn. Corps Research Review, Nov. 2000.
- Studies of Pacific Lamprey Passage in the Test Fishway at Bonneville Dam. C. Peery, T. Bjornn, D. Ogden, M. Moser, and W. Cavender. Corp Research Review, Nov 2000.
- Background Information for 2000 Adult Passage Program: Fish Tagged, Timing of Runs, Flows, Spills, and Temperatures. A. Matter. Corps Research Review, Nov 2000.
- Effects of Orifice Gate Closures on Radio-tagged Spring and Summer Chinook Salmon Behavior at Bonneville, The Dalles, Lower Monumental and Little Goose Dams. M. Jepson and T. Bjornn. Corps Research Review, Nov 2000.
- Migration Routes of Salmon and Steelhead Released on the Oregon Shore in the Forebay of Bonneville Dam, 2000. T. Bjornn, R. Ringe, S. Lee, K. Tolotti, D. Josten. Corps Research Review, Nov 2000.
- Depth and Temperature Profiles of Salmon and Steelhead While They Migrated from Bonneville to Lower Granite Dams with RDST tags. T. Reischel, and T. Bjornn. Corps Research Review, Nov 2000.
- Migration Behavior of Steelhead During Summer and Fall in Relation to Spill and Temperature. B. High and T. Bjornn. Corps Research Review, Nov 2000.
- Migration Behavior of Fall Chinook in Relation to Spill and Temperature in 2000. T. Goniea and T. Bjornn. Corps Research Review, Nov 2000.
- Fallback, Escapement and Reach Survival of Radio-Tagged Adult Salmon and Steelhead through the Columbia River Hydrosystem. M. Keefer and T. Bjornn. Corps Research Review, Nov 2000.
- Distribution of Adult Spring and Summer Chinook Salmon in Columbia and Snake river Tributaries as Assessed with Radio Telemetry in 2000. G. Naughton and T. Bjornn. Corps Research Review, Nov 2000.
- Discrepancies in Counts of Spring Chinook Salmon and Steelhead at John Day, McNary, Ice Harbor, and Priest Rapids dams in 2000 versus Passage of Fish with Transmitters. T. Bjornn and M. Jepson. Corps Research Review, Nov 2000.

Passage of Adult Salmon and Steelhead through Juvenile Bypass Systems at Bonneville, John Day, McNary and Ice Harbor Dams as Assessed with Radio Telemetry. M. Jepson and T. Bjornn. Corps Research Review, Nov 2000.

Effects of Weir Modifications on Passage of Chinook Salmon Through the Transition Pool at Lower Granite Dam, Spring 2000. C. Peery, T. Bjornn, T. Reischel, and M. Morasch. Corps Research Review, Nov 2000.

An Evaluations of cool Water Releases from Dworshak Dam on Adult Migration Through Lower Granite Pool. T. Reischel and T. Bjornn. Corps Research Review, Nov 2000.

Survival of adult chinook salmon and steelhead migrating up the Columbia and Snake Rivers. A. Matter, M. Keefer, and T. Bjornn. Survival Workshop, Seattle, Nov 2000.

Physiological studies on in-river migrating and barge-transported juvenile salmonids. J. Congleton. Corps Research Review, Nov 2000.

Tagging of adult sockeye salmon at Lower Granite Dam and their migration to Redfish Lake. M. Heinrich, and T. Bjornn. Idaho Chapter AFS meeting, March 2001.

What do we know about adult salmon and steelhead migrations in the Columbia basin? T. Bjornn. Corps Biologist Workshop, Feb 2001.

Salmon and steelhead survival rates in the Columbia River. Guest lecture, Wildlife 541, Feb 2001

Habitat in Columbia-Snake rivers migration corridor and behavior of adult salmon and steelhead. T. Bjornn. WSU-UI joint seminar series. Feb 2001.

Publications:

Sykes, P., A.K. Kepler, C. B. Kepler, and J. M. Scott. 2000. The Melaphagids. *In* The Birds of North America No. 535 (A. Poole and F. Gill, Editors). Philadelphia: The Birds of North America, Inc., Washington, D.C. *

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Scott, J.M., R.J.F. Abbitt and C.R. Groves. 2001. The United States Conservation Portfolio: What are we protecting? *Conservation Biology in Practice* 2:18-19.

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Papers Presented:

Jones, D. and C. M. Moffitt. June, 2001. Susceptibility of bull trout, *Salvelinus confluentus*, to infection by *Renibacterium salmoninarum*, the causative agent of bacterial kidney disease. Annual Meeting of the American Fisheries Society Fish Health Section. Victoria, British Columbia, CANADA.

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Murphy, Melanie. 2001. Non-invasive genetic sampling of the brown bear (*Ursus arctos*) using fecal samples: method optimization in the Glacier National Park Ecosystem

Welker, Tim. 2000. Ecology and structure of fish communities in the Missouri and Lower Yellowstone Rivers.

Roberts, Susan. 2000. Foraging ecology of tule elk at Point Reyes, California.

Kazfkay, Joe. 2000. The ecology of Age-0 and Age-1 paddlefish in Upper Fort Peck Lake, Montana.

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Wagner, Tyler. 2000. Response of an aquatic macrophyte community to fluctuating water levels in an oligotrophic lake.

Comer, Matthew. 2000. Elk population characteristics and habitat use in southeaster Idaho.

Giudice, John H. 2000. Visibility bias in waterfowl brood surveys and population ecology of dabbling ducks in central Washington.

Papers Presented:

L. Waits, K. Kendall, M. Murphy, D. Roon, J. Adams, 11/00, Non-invasive genetic sampling: promise and pitfalls. *Carnivores 2000*, Denver, CO.

J. Adams, L. Waits, B. Kelly. 11/00, Non-invasive genetic sampling of red wolf population on

Alligator River National Wildlife Refuge, Carnivores 2000, Denver, CO.

Roon, D., K. Kendall, and L. Waits 10/00. Tracking bear demography in the Greater Glacier Area of the U.S.A. through non-invasive DNA sampling, Managing for Bears in Forested Environments, Revelstoke, BC.

L. Waits, 10/00, Taxonomic placement of the giant panda based on molecular data. Panda 2000, San Diego Zoo. (Invited talk)

L. Waits, 5/01, Non-invasive genetic sampling of bear populations: promise and pitfalls. International Bear Association meetings, JacksonHole WY

Roon, D., L. Waits, and K. Kendall, 5/01, The effectiveness of filtering non-invasive genetic data: a case study from Glacier National Park. International Bear Association meetings, JacksonHole WY

Murphy, M., L. Waits, and K. Kendall, 5/01, Brown bear fecal DNA analysis: Technique optimization and application to Glacier National Park, International Bear Association meetings, JacksonHole WY

Kendall, K., L. Waits, D. Roon, M. Murphy, J. Stetz, 5/01, Biases associated with sampling bears with hair traps, rub trees, and scat surveys. International Bear Association meetings, JacksonHole WY (Best paper award)

Kendall, K., L. Waits, D. Roon, M. Murphy, and J. Stetz. 06/01. Biases associated sampling bears with hair traps, rub trees and scat surveys. American Society of Mammalogists, Missoula, MT

Adams, J., B. Kelly, and L. Waits, 7/01 Monitoring for genetic introgression into an island population: the Red Wolf as a case study, Society for Conservation Biology, Hilo, HI

Luikart, G., S. Manel, and L. Waits, 7/01. Wildlife forensic applications of DNA typing: empirical evaluations and guidelines, Society for Conservation Biology, Hilo, HI

Cegelski, C., L. Waits, and N. Anderson, 7/01, Mitochondrial DNA and microsatellite DNA analysis of wolverine population structure in Montana, Society for Conservation Biology, Hilo, HI

Waits, L. 8/01, Molecular Genetic Tools for the Conservation and Management of Natural Populations, Animal Genomics Symposium, NC State University (Invited talk)

Adams, J. L. Waits, and A. Beyer, 9/01, Faecal DNA sampling to detect the presence of coyotes and hybrids in the Red Wolf Recovery Zone, Canid Biology and Conservation Conference, Oxford, England

L. Waits, J. Adams, C. Miller, William Waddell, and A. Beyer, 9/01, Detecting coyote introgression into the wild Red Wolf populations, Canid Biology and Conservation Conference, Oxford, England

Waits, L., K. Kendall, D. Roon, and M. Murphy, 9/01, Non-Invasive Genetic Sampling of Bears at an Ecosystem Scale Using Multiple Collection Methods, Conservation Genetics Meeting, Lausanne, Switzerland

Roon, D, L. Waits, and K. Kendall, 9/01, Trail travails: The impact of human presence on the Non-invasive genetic sampling of brown bears (*Ursus arctos*) and black bears (*Ursus americanus*) within a protected landscape, Conservation Genetics Meeting, Lausanne, Switzerland

Edelmann, F.B., K.P. Reese, and P. Zager. 2000. Microhabitat use by Merriam's turkey broods in west-central Idaho. Proceedings of the National Wild Turkey Symposium.

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