

Wildlife and Fisheries Research

Annual Report
October 2008

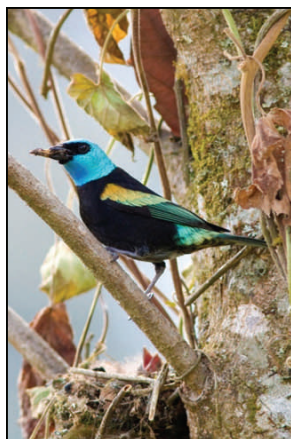
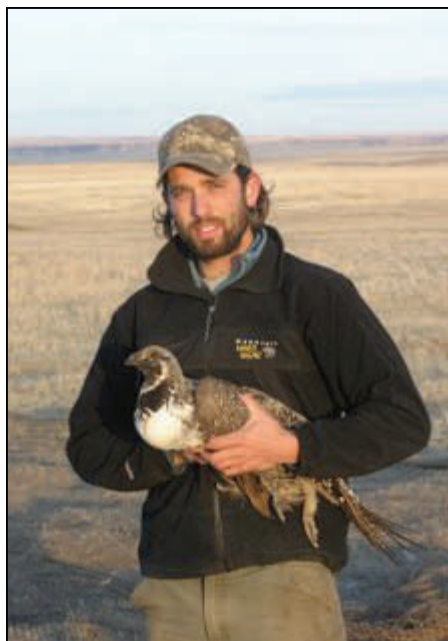


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FACULTY INVOLVED IN WILDLIFE AND FISHERIES RESEARCH AT THE UNIVERSITY OF MONTANA

Wildlife and Fisheries Research projects at The University of Montana are supervised by faculty members associated with the Wildlife Biology Program (WBIO). This Program represents a joint endeavor among the College of Forestry and Conservation (CFC), the Division of Biological Science (DBS) in the College of Arts and Sciences, and the Montana Cooperative Wildlife Research Unit (MTCWRU).

[Allendorf, Fred](#) - Professor of Biological Sciences and Wildlife Biology. Genetics and management of natural populations. (DBS)

[Berger, Joel](#) – John J. Craighead Chair and Professor of Wildlife Biology. (DBS)

[Breuner, Creagh](#) - Assistant Professor of Biological Sciences and Wildlife Biology. Avian behavioral and physiological changes to unpredictable events (stressors). (DBS)

[Callaway, Ragan](#) - Professor of Biological Sciences and Wildlife Biology. Competitive and facilitative interactions among plants and how these interactions affect plant community organization and dynamics. (DBS)

[Elizabeth Crone](#) - Associate Professor of Quantitative Wildlife Ecology. (CFC)

[Eby, Lisa](#) - Associate Professor of Aquatic Vertebrate Ecology. (CFC)

[Ezenwa, Vanessa](#) - Assistant Professor of Biological Sciences and Wildlife Biology. Wildlife disease and behavioral ecology. (DBS)

[Foresman, Kerry R.](#) - Professor of Biological Sciences and Wildlife Biology. Reproductive biology of mammals. (DBS)

[Greene, Erick](#) - Professor of Zoology and Wildlife Biology. Animal behavior, population biology, and conservation biology. (DBS)

[Harris, Richard](#) – Adjunct Research Professor of Wildlife Conservation. (CFC)

[Hebblewhite, Mark](#) - Assistant Professor of Ungulate Habitat Ecology. Large herbivores and how they balance the costs of predation with benefits of foraging. (CFC)

[Hutto, Richard](#) - Professor of Biological Sciences and Wildlife Biology. Ultimate factors that determine habitat choice in birds. (DBS)

[Krausman, Paul](#) – Boone and Crockett, Professor of Wildlife Conservation. (CFC)

[Lowe, Winsor](#) - Assistant Professor of Biological Sciences and Wildlife Biology. Aquatic and evolutionary ecology. (DBS)

[Maron, John L.](#) - Associate Professor of Biological Sciences and Wildlife Biology. Plant distribution and abundance. (DBS)

[Martin, Thomas](#) - Assistant Leader, Montana Cooperative Wildlife Research Unit. Avian ecology, predator-prey interaction, life history theory, and evolutionary ecology. (MTCWRU/DBS/CFC)

[Mills, L. Scott](#) - Professor of Wildlife Population Ecology. (CFC)

[Mitchell, Mike](#) - Leader, Montana Cooperative Wildlife Research Unit. Ecology and management of carnivores, applied landscape ecology. (MTCWRU/CFC)

[Naugle, David](#) - Associate Professor of Large Scale Wildlife Ecology. (CFC)

[Patterson, Michael](#) - Associate Professor of Wildlife/Recreation Management, Chair of Society & Conservation Department. (CFC)

[Pletscher, Daniel H.](#) - Director of Wildlife Biology Program and Professor of Wildlife Biology. (CFC)

[Schwartz, Michael](#) – Adjunct Research Professor of Wildlife Conservation, conservation genetics. (CFC)

[Servheen, Chris](#) - Adjunct Associate Professor of Wildlife Conservation, Grizzly Recovery Coordinator. (USFWS).



Do sagebrush density and vegetation condition affect demography of Brewer's Sparrows nesting in the Blackfoot Valley?

Student: Masa Abe

Degree: M. Sc. Wildlife Biology

Advisor: Jeffrey Marks

Funding Source(s):
US Fish and Wildlife Service
Bureau of Land Management
Montana Audubon

Project Duration: 2003 - 2007

UM Project Affiliation:
WBIO - MTCWRU

Abstract:

Vegetation condition can influence habitat quality by altering food abundance, predator abundance and species composition, and microclimate. In some habitats, livestock grazing alters vegetation condition in ways that affect the breeding success of passerines. Most sagebrush-dominated habitats have been heavily grazed by livestock, and the total area of sagebrush has declined substantially. Owing to this habitat loss and change, numbers of various sagebrush-obligate birds have declined, the Brewer's Sparrow among them. I examined the effects of cattle grazing on Brewer's Sparrow reproduction. Grazed plots, at the study-site scale, were characterized by higher potential nest-sagebrush density, and canopy cover, a higher number of exotic grass species, greater bare/rock ground cover, and lower grass/forb ground cover, compared with ungrazed plots. Trends in the characteristics of vegetation at the nest-patch scale were the same as those at the study-site scale. Reproductive performance was similar between grazed and ungrazed plots. Nestlings raised on ungrazed plots were larger than those on grazed plots in 2004, but not in other years. The numbers of breeding pairs were, however, higher in grazed plots than in ungrazed plots.

Vegetation condition also influences nest-site selection of organisms. Many studies assume that this selection is adaptive; however, it does not necessarily increase the fecundity of organisms. Vegetation condition becomes one of the important cues to select nest sites because organisms use vegetation as nest hiding cover, thermal cover, foraging sites, and display sites. I examined two questions, using model selection analysis: (1) does vegetation condition affect nest survival of Brewer's Sparrows? and (2) does vegetation condition affect nestling size? There was no one best-approximating model to explain the correlation between vegetation features and nest survival, but all high-ranking models included nest-patch variables. In nestling-size models, nest-shrub size was positively correlated, and nest cover was negatively correlated, with nestling mass. Contrary to nest-survival models, nestling mass was strongly associated with nest-shrub variables rather than with nest-patch or understory-layer variables.

Master's defended December 2007

What explains differences among species in parent and offspring responses to brood size variation?

Student: Daniel Barton

Degree: Ph.D. Organismal Biology and Ecology Program

Advisor: Thomas E. Martin

Funding Source(s):
National Science Foundation
NSF EPSCoR
US Geological Survey
US Department of Agriculture

Project Duration: 2005-2010

UM Project Affiliation:
DBS-OBE and MTWCRU



Objectives:

Life history theory explains variation in age-specific fecundity and mortality, which is enigmatically arranged along a 'slow-fast' gradient. Species at the 'slow' end express long life span, low fecundity, and low reproductive effort, while species at the 'fast' end express the converse. Despite the nearly universal nature of this pattern and its critical connections to evolutionary biology and population biology, we do not know what selective (environmental) factors create and maintain this variation. Food limitation, age-specific mortality, and offspring quality are advanced as alternative explanations. Comparative studies of these alternatives have classically either ignored or confounded phenotypic plasticity in life history traits with among-species variation in mean trait expression, limiting the power of these tests. We integrate life history theory with phenotypic plasticity theory to generate predictions for how plasticity in traits should vary among life histories under each alternative. For example, rate of feeding offspring is a key life history trait. It varies substantially among species and incurs both energetic costs to parents (reproductive effort) and benefits to offspring (e.g. increased growth, survival). Thus, the reaction norm of parental feeding rates integrates two key life history tradeoffs, between current and future reproduction and number and quality of offspring, and represents a key component of life history. Predictions for the evolution of within- and among-species variation in reaction norms are generated under alternative hypotheses and we test them using natural and experimentally induced variation in brood size.

Progress and Status:

We tested whether food limitation or age-specific mortality explain variation in parental feeding behavior over natural brood size variation among 29 songbird species from Arizona, Argentina, South Africa, and Venezuela. Our results supported the age-specific mortality hypothesis and suggested species with high adult mortality increase feeding rate proportionately with increasing brood size, while species with low adult mortality do not. In contrast, food limitation theory predicts proportional adjustment of feeding rate across species and this hypothesis was rejected. This suggests an important role for adult mortality in the evolution of provisioning strategies, which are a key component of life histories. However, alternatives remain and experimentally induced variation in brood size will provide stronger inference. Experimental brood size manipulations began in 2007 and are ongoing. We manipulated clutch size and measured parental and offspring responses at 180 nests of 20 species in Arizona and Venezuela. Behavioral data summary and analysis are underway.

Does nest size constrain clutch size in tropical birds? Nest attentiveness and food limitation in tropical birds.

Student: Atilio L Biancucci

Degree: M.Sc. Wildlife Biology

Advisor: Thomas E. Martin

Funding Source(s):
National Science Foundation

Project Duration: 2007-2008

UM Project Affiliation:
WBIO – MTCWRU



Objectives:

The study of reproductive strategies is a central topic in the development of life history theory. Passerine birds show a wide range of reproductive strategies, which makes them a useful group to test hypotheses about life histories. Latitudinal variation in life history strategies along slow tropical-fast north temperate gradient has been well described, yet, it largely unexplained pattern. Small clutch size and low nest attentiveness are typical traits of slow-tropical strategies, and they are also unexplained. I focus on testing explanatory hypotheses for the latitudinal variation in those two traits. I specifically tested the hypotheses

- 1) that high nest predation rate in the tropics favors smaller nest sizes, which constrains clutch size, and
- 2) that food limitation constrains nest attentiveness in tropical birds.

Progress and Status:

To test predictions of the first hypothesis I compared predation rates, nest sizes (controlling for body mass), and clutch sizes among 14 north temperate (Arizona) and 22 tropical (Venezuela) bird species. I further conducted an experiment to test if nest predation increases with nest size in tropical birds. I found a positive relationship between nest predation rate and nest size. I experimentally demonstrated that nest predation increases with nest size, through 282 position swaps of old nests of 5 species with different nest sizes. Given that nest size was not related with clutch size, and that nest size did not change between latitudes, I rejected the hypothesis of clutch size reduction due to nest size in tropical birds.

To test predictions of the food limitation hypothesis I carried out a food supplementation experiment in Venezuela. I supplemented food at nest of two bird species during the incubation period. I filmed these nest and controls, every other day to test if nest attentiveness increase with food availability. I am currently processing these data.

Interspecific variation in growth strategy among coexisting passerines

Student: Yi-Ru Cheng

Degree: M.Sc. Wildlife Biology

Advisor: Thomas E. Martin

Funding Source(s):
US Geological Survey
US Department of Agriculture

Project Duration: 2006-2008

UM Project Affiliation:
WBIO - MTCWRU



Objectives:

Understanding why growth strategies differ among species is a critical question in evolutionary biology. Many studies focused on the variation in the growth rates of body mass. Yet, the variation of growth strategy cannot be fully captured without understanding the relative growth rates of different body components. Different body components may compete for resources during growth and results in differential growth rates. Life history theory predicts that growth strategy as a whole should be optimized in different environments. Therefore, species should prioritize their resources to the growth of components that has functional priority (e.g. locomotor). Altricial birds hatch relatively undeveloped and provide a system to study the variation of growth strategy. I answered these two questions with a series of altricial species that coexist in a north temperate habitat in northern Arizona:

1. Do the growth and development rates of different components trade off?
2. Can nest predation and foraging behavior explain the variation of differential growth strategies?

Specifically, I am interested in three morphological components (mass, tarsus and wing chord) and one intrinsic component, endothermy. I tested the ability of nest predation risk and foraging behavior to explain the differential growth strategies among species. Nest predation should favor faster development of components that have advantages for leaving the nest earlier. Alternatively, the growth and development of different morphological components may be favored based on specific foraging behavior (e.g. tarsus in ground foragers).

Progress and Status:

I finished three field seasons in Coconino National Forest in Arizona from 2006 to 2008. In total, I collected data from 12 species and 309 nestlings in 76 nests. Preliminary analysis showed that species with higher nest predation have faster growth and development rates in all components. Foraging behavior may explain the prioritized growth of tarsus in ground foragers. At this stage, I am finishing up my thesis.

Flammulated Owl Citizen Monitoring – 2008 mini-report

Supervisor: Amy Cilimburg

Funding Source(s):
Montana Fish, Wildlife and Parks

Project Duration: 2007-2008

UM Project Affiliation:
UM Avian Science Center - MTCWRU

Progress and Status:

In 2008, the Avian Science Center continued a Flammulated Owl citizen monitoring program initiated the previous year. This project was funded by Montana Fish Wildlife and Parks with in-kind support from the Avian Science Center and the Helena National Forest.

We continued to survey routes around the greater Missoula area, and volunteers were once again primarily Five Valleys Audubon Society (FVAS) volunteers. We advertised in the FVAS newsletter, contacted all the 2007 volunteers, and held one training session. We had 12 observers participate in the Missoula area; they surveyed 7 transects at least once and detected 6 owls. As we look to expand the program, we will likely need additional outreach efforts both within FVAS and elsewhere in the community.

We also initiated a new citizen monitoring effort in the Helena area. We did this with significant assistance from Denise Pengeroth of the Helena National Forest and the Helena Birds and Beasleys store (where the equipment boxes were housed), and with great enthusiasm from the Last Change Audubon Society. We held one extensive training session at the HNF office and over 20 participants attended. In all, 18 volunteers surveyed 11 transects at least once and detected 15 owls. We are in the process of sending out a questionnaire to these volunteers in order to assess ways to improve the program.

The primary challenge with this 2008 season was the cool and wet weather that made early season surveys impossible and likely affected our June detection rates. Overall results may be “off” from other years based on the potential for missed detections from observers or late or failed breeding attempts by the owls.

At the Avian Science Center, Amy Cilimburg spearheaded all efforts. She is now working with Montana Audubon and hopes to collaborate with the ASC in order to continue and expand the program. Kristina Smucker is now the ASC lead and is collating the data and updating our website, including the Flammulated Owl mapping site. See http://avianscience.dbs.umt.edu/research_landbird_flam.htm for more of the story. We will also be presenting our citizen monitoring program, together with efforts done in conjunction with five National Forests in our region, September 25, 2008 at the Raptor Conference in Missoula.

Pilot study of the prediction of heart rot in apparently sound western larch for snag retention and management

Student: Angela Daenzer

Degree: M. Sc. Wildlife Biology

Advisor: Jack Ward Thomas

Funding Source(s):

US Forest Service Health Protection,
Missoula Field Office

Flathead National Forest

Bitterroot National Forest

Disney Corporation

National Fish and Wildlife Foundation

Duration of Project: 2003 – 2007

UM Project Affiliation:

WBIO - CFC

Abstract:

Since many cavity-excavating birds require trees with heart rot, managers routinely emphasize decayed trees in their snag retention prescriptions. Where too few trees are present with obvious indicators of decay, apparently sound trees are left to meet retention objectives. These trees may also contain decay, and may offer advantages in longevity and protection over more extensively decayed trees. Better information regarding conditions and heartwood decay-causing fungi important to heart rot in apparently sound trees would aid in retention decisions. We combined data from the 2003 Westside Reservoir and Roberts Fire burns with data from the USFS Forest Health Protection's 10-year western larch (*Larix occidentalis*) merchantability study on the 2001 Moose Fire burn, all collected on the Flathead National Forest. We used dissection data from 284 apparently defect-free fire-killed western larch to predict the probability of heart rot related to tree age, diameter at breast height (dbh), elevation, aspect, habitat type, and sapwood-to-heartwood ratio. Fungi were isolated from trees with heart rot and identified through DNA analysis. We isolated *Stereum sanguinolentum*, *Echinodontium tinctorium*, *Sistotrema brinkmannii*, *Antrodia serialis*, *Phellinus chrysoloma*, and *Fomitopsis cajanderi* from trees in the three burn areas. All variables tested except elevation and slope were significantly associated with probability of heart rot ($\alpha=0.05$), with sapwood-to-heartwood ratio and dbh showing the highest predictive power through CART analysis. These findings support large tree diameter as a critical characteristic in retaining trees most useable to wildlife, as well as retaining heart rot-causing fungi, which have undergone marked declines in other parts of the world.

Completed Degree Fall 2007

Mallard nesting ecology in the Great Lakes states

Student: Jonas Davis

Degree: M. Sc. Wildlife Biology

Advisor: Dave Naugle

Duration of Project: 2001 – 2008

UM Project Affiliation:
WBIO – CFC

Abstract:

Understanding how habitat features influence vital rates that drive population growth is fundamental for delivery of effective conservation programs. Past decisions in management of Great Lakes mallard (*Anas platyrhynchos*) populations were based largely on paradigms established in the mid-continent because regional data were lacking. Recent sensitivity analyses from the Great Lakes Mallard Study show that population growth (i.e., λ) is most sensitive to changes in nest success (16%) and duckling survival (32%).

In spring of 2001 to 2003, as part of the Great Lakes Mallard Study, 536 mallards were radio-marked at nine sites in four states (Michigan, Ohio, Wisconsin, and Indiana). I tested a set of *a priori* candidate models to evaluate the relative influence of habitat variables on survival rate of mallard nests (DSR) at local and landscape-level scales (2 m and 2-, 5-, and 10-km radii from nest). Nest success (0.156 ± 1.420) varied regionally from a low of 0.101 in Wisconsin to a high of 0.247 in Michigan, and was higher in forested landscapes (21.7 - 24.7%) than in agricultural environments (10.1 – 16.5%). Mallard nest survival was higher for older females than for second-year birds, and probability of hatching increased with nest age. Concealment within 2 m of a nest increased nest DSR, and amount of tillage agriculture within 5-km of a nest was inversely related to survival.

Models that combined variables at multiple spatial scales explained nest DSR better than any combination of variables that were measured at a single spatial scale. Mallard populations in the Great Lakes states are likely to expand further as forested lands are cleared for agricultural production, and mallards begin to pioneer newly created habitats. Because nest success and duckling survival are the most influential vital rates, we recommend that managers conserve and restore wetlands to increase brood survival in higher forested landscapes where small inclusions of agricultural tillage provide habitat without affecting nest success.

Completed Degree Fall 2007

A demographic and landscape analysis for common loons in Northwest Montana

Student: Christopher Hammond

Degree: M. Sc. Wildlife Biology

Advisor: Mike Mitchell

Funding Source(s):
Montana Fish, Wildlife, and Parks,
State Wildlife Grant

Project Duration: 2005-2008

UM Project Affiliation:
WBIO - MTCWRU



Objectives:

Since I was interested in protecting resources that contribute to the longevity of common loons, it was logical to address long-term management needs by investigating both demographic and landscape relationships responsible for current population levels and distribution. My research was designed to 1) address how population dynamics (i.e. fecundity, occupancy, and stability) were linked to territory distribution and abundance, 2) address how population dynamics were related to habitat, disturbance, and intraspecific competition, 3) address how population dynamics were related to lake and landscape scales effects, and 4) estimate occupancy, colonization, and abandonment rates of lakes.

Progress and Status:

I designed my research to evaluate the relationships between disturbance (as measured by the number of houses, resorts, and campgrounds in relation to lake size), habitat, intraspecific interactions and territory occupancy and reproduction. I used occupancy models to explore the dynamics underlying occupancy of potential lakes. I observed that landscape scale effects were important to occupancy of loon territories. The abundance of feeding lakes and the number of territorial pairs within 10 km were equally important for explaining probabilities of occupancy. I suggest managers protect both occupied, as well as, unoccupied lakes, especially when in close proximity to clusters of territorial pairs and feeding lakes. I observed that lake scale effects were more important to reproductive potential than landscape scale effects. I found a significant negative relationship with islands and a significant positive relationship with shoreline complexity on reproduction. Shoreline disturbance did not appear important when compared to other factors, but there are factors associated with Montana's outreach and education program that probably affected this result. For increasing reproduction I suggest managers continue current management activities, but include a greater focus on protecting nesting habitat on lakes without islands. I also suggest managers continue to mitigate for disturbance while exploring other ways to evaluate the effects of disturbance on occupancy and reproduction.

The student presented results of his research at the Joint Meeting of the Montana Chapter of The Wildlife Society and Society for Vertebrate Biology and received the Best Masters Paper Award. The student received his degree and submitted a paper titled "Territory Occupancy by Common Loons in Response to Disturbance, Habitat, and Intraspecific Relationships" that is currently under review with the Journal of Wildlife Management. This research has also led to a new conservation plan for common loons in Montana which will be submitted to the United State Fish and Wildlife Services March of 2009 as required by the funding grant.

Graduated May 2008

Assessment of aspen habitats for enhancing songbird utilization and reproductive success

Student: Amy Johnson

Degree: M.Sc.
Organismal Biology and Ecology.

Advisor: Thomas E. Martin

Funding Source(s):
Montana Fish, Wildlife, and Parks

Project Duration: 2008-2010

UM Project Affiliation
DBS - MTCWRU



Objectives:

Habitat selection and use is dependent upon landscape features, such as patch size and landscape context. Species diversity and richness vary among differing landscapes. In the north temperate United States, deciduous forests have high species diversity. However, many of these forests are being reduced and fragmented. Aspen stands, in particular, are significantly changing due to natural and anthropogenic influences. Previous studies have focused on how forest fragmentation in the Eastern United States negatively affects avian populations, but few studies have been conducted in the West. Results of western studies have not been consistent in whether or not fragmentation and landscape context have a negative effect on avian populations. Local landscape features, such as patch size, conifer encroachment, or agriculture encroachment, may greatly affect avian populations by limiting nest-site selection, altering predator habitat and abundance, or limiting food resources. In the Western United States, aspen stands provide nesting and foraging sites for many Passerines. As a result, bird abundance and diversity could be greatly affected by the reduction of aspen or the change in landscape context of aspen stands. I am interested in how landscape features associated with changing aspen populations, such as patch size and landscape context, affect the breeding biology of Passerines in western Montana.

Progress and Status:

This fall I will be working towards identifying key topics and issues that will contribute to the development of my research proposal. A study area will be chosen in Western Montana, and the first field season will begin Summer 2009.

Do parasites play an important role in life history trait evolution?

Student: Ania Majewska

Degree: Ph.D. Wildlife Biology

Advisor: Thomas E. Martin

Funding Source(s):
National Science Foundation

Project Duration: 2008-2013

UM Project Affiliation:
WBIO - MTCWRU - M-EID



Objectives:

Life history traits are arranged along a 'slow-fast' gradient. For example, passerine birds in tropical regions are typified by slow development and 'slow' life history strategies (i.e. low fecundity, high adult survival) whereas birds of North temperate regions exhibit the opposite traits. The causes of this broad variation in life history strategies are poorly understood. A possible explanation may be selection for high offspring quality. In 'slow' tropical species, resources allocated to development may be reduced and instead shunted to enhancing the immune function essential for high quality offspring and high adult survival. Indeed, longer developmental periods are correlated with increased adult survival across passerine species, and with reduced parasite prevalence, suggesting enhanced disease resistance. Thus, 'slow' life history strategies of tropical passerines may reflect a need for better immune function due to the presumed larger impact of parasites on hosts in tropics compared to north temperate region. Lack of seasonality in the tropics may result in the maintenance of high levels of parasite abundance year round and may result in higher selection pressure on the host. However, whether geographic variation in parasite abundance and/or virulence exists and whether tropical vs. temperate hosts invest differentially in immune function, remains unclear. To determine whether parasites play an important role in life history trait evolution, I plan to examine parasite diversity, abundance and virulence as well as host's immune function in a comparative study using phylogenetically and ecologically similar passerine species from North temperate Arizona and tropical Borneo.

Progress and Status:

Field work for this project will begin in summer 2009.

Effect of climate change and elk browsing on population trajectories and trophic interactions in a high elevation riparian ecosystem

Principal Investigator:
Thomas E Martin

Funding Source(s):
US Geological Survey
US Department of Agriculture

Project Duration: 1985-ongoing

UM Project Affiliation:
MTCWRU



Objectives:

Measure and examine annual variation in avian nest success and predation, adult survival, population size, habitat selection, small mammal density and species composition, vegetation density and species composition in a high-elevation riparian ecosystem in north-central Arizona relative to climate variation and elk browsing.

Progress and Status:

Climate has had large consequences over the past 22 years for seven bird species and 6000 nests by affecting trophic levels below (plants) and above (predators) them. Winter snowfall has declined strongly across the 22 years of study, as typical throughout western North America, which has increased over-winter densities of elk in the study area. This decline in snowfall and increase in overwinter elk was strongly associated with the loss of deciduous vegetation (aspen, canyon maple, New Mexican locust) that represents preferred bird habitat, and birds have declined in abundance associated with the decline in preferred habitat. In addition, summer precipitation has also declined over the 22 years of study and drier summers have yielded greater predation on offspring.

The direct effects of climate on differing trophic levels together with indirect effects arising from altered interactions among trophic levels substantially change ecosystem structure. An exclosure experiment was initiated in the fall of 2004 to test the effects of elk and winter snow on plant, bird and small mammal communities. Three large (10 ha) exclosures were established on three different canyons. Results through 2008 already show a large effect on aspen recruitment and ground cover, and a slower effect on maple and locust recruitment; plant abundance and diversity (e.g., increased perennial flower diversity) have increased in the 4 years since fence establishment. In addition, several bird species have already increased in abundance compared with adjacent controls. Small mammal species also show responses, with some species (deer mice, wood rats) increasing and others (chipmunks) decreasing on fenced areas compared with controls.

Continuation of this project will help to differentiate the interacting effects of elk browsing and climate on plant reproduction, and subsequent effects on higher trophic levels (birds, small mammals).

Ecological determinants of variation in life history strategies between related tropical and temperate birds

Principal Investigator:
Thomas E. Martin

Funding Source(s):
National Science Foundation

Project Duration: 2001-2008

UM Project Affiliation:
MTCWRU



Objectives:

Measure demographic and life history strategies (clutch size, nest predation, development rates, parental care, adult survival rates) of bird species in montane Venezuela (Yacambu National Park) to compare with related bird species in the long-term Arizona study. Examine the relative importance of nest predation, food limitation, and adult mortality on variation in demography and life history strategies.

Progress and Status:

Life history strategies are comprised of age-specific fecundity and mortality, plus parental care behaviors and developmental rates influencing these fitness components. Altogether these traits determine demography of populations in ecological time and influence evolution of phenotypes to provide critical insight into environmental selection pressures. By examining geographic variation in life history strategies and the selection pressures favoring differing strategies, new insights are gained into the environmental influences on population regulation. Particularly strong insight is gained by comparing phylogenetic relatives in different geographic regions because it allows examination of differing historical pressures on populations and species.

We located and monitored nearly 4,500 nests in tropical Venezuela. The results to date show that adult mortality can be of greater importance in the longer-lived tropical birds than temperate birds and explain large regional differences such as smaller clutch sizes, lower parental effort, slower development and cooler embryo temperatures. This has led to discovery of broad patterns that have never been recognized previously. For example, we documented for the first time that there is a general world-wide pattern of parents exhibiting lower nest attentiveness (less time on the nest) during incubation than north temperate birds. This then explains long incubation periods in a way never before considered. Nest predation can influence strategies within each region, but does not explain differences among regions. Finally, we netted and banded more than 4,000 birds to allow examination of adult survival.

This work includes an important training component for young Latin American scientists. The perception that reproduction cannot be studied in the field is corrected by training young scientists in the conduct of this field work and 5-6 young Latin American scientists are included on the field crew each year. In addition, the most motivated are invited to the lab in Montana where they are taught to write their first publications on the life history of some species that is previously undescribed.

Influence of embryonic metabolic rate and incubation temperature on incubation length variation in neotropical passerines

Student: Alina Niklison

Degree: M.Sc. Wildlife

Advisor: Thomas E. Martin

Funding Source(s):
National Science Foundation
University of Montana

Project Duration: 2005 - 2008

UM Project Affiliation:
WBIO – MTCWRU



Objectives:

Test the role of species-specific embryo metabolism and sensitivity of metabolism to temperature as explanations of interspecific variation in length of embryonic development (i.e., incubation) periods.

Progress and Status:

Causes of interspecific variation in the length of embryonic developmental periods are poorly understood. Incubation temperature can explain some variation in developmental periods, but substantial variation remains unexplained. Here we examine two previously untested alternatives. Adult metabolic rates differ among species and similar differences among embryos may explain some variation in embryonic development rates; higher metabolism may allow faster cellular proliferation. Alternatively, metabolic rates are temperature dependent, and metabolic rates might respond differentially to temperature among species and compensate for differing incubation temperatures. These alternatives are untested across any taxa. Therefore, we examined them in tropical Venezuela by measuring embryonic metabolism at four temperatures in 15 passerine species with incubation periods ranging from 12 to 27 days. Embryonic metabolic rates responses to temperature were different among species even at constant embryonic age. Furthermore, species with lower average daily incubation temperature are less sensitive to changes in temperature than species with higher average incubation temperatures. Differences in embryonic mass specific metabolic rate among species explained a significant amount of variation in incubation periods after correcting for incubation temperature. Thus, differences in the “rate of living” as manifested through metabolism can influence developmental trajectories.

Defended Thesis May 2008.

A landscape approach to grassland bird conservation in the Prairie Pothole Region of the Northern Great Plains

Student: Frank Quamen

Degree: Ph.D. Wildlife Biology

Advisor: Dave Naugle

Funding Source(s):

US Fish and Wildlife Service

US Geological Survey

US Department of Agriculture

Iowa Department of Natural Resources

Minnesota Department of Natural Resources

Montana Fish, Wildlife and Parks

North Dakota Game and Fish

South Dakota Game, Fish and Parks

The Nature Conservancy

Duration of Project: 2000– 2007

UM Project Affiliation:

WBIO – CFC

Abstract:

Prairie is one of the most imperiled ecosystems, and grassland birds have experienced steeper and more consistent declines than any other group of birds in North America. Habitat-based planning tools are a cornerstone of conservation in forested ecosystems, but remain a novel approach in grasslands. In Chapter 2, I develop spatially-explicit habitat models as decision support tools for conservation. I survey birds, measure local vegetation and quantify landscape features at 952 sites in western Minnesota and northwest Iowa. Findings indicate that cropland provides little habitat for grassland songbirds and that hayland does not compensate for loss of grasslands. Multiscale models show that conservation actions that integrate management at local and landscape scales have the greatest chance of success. At landscape scales, conserving and creating grasslands, removing trees from the landscape, or both, increase songbird density. Density of many species is positively related to amount of grassland at the smallest scale evaluated (0.5km²), but large grasslands are vital for others whose density is related to grassland abundance at large scales (32km²). At local scales, managing for a mosaic of vegetation that varies in structure and composition increases bird diversity. Model validation shows that planning maps can be used reliably ($r^2 \geq 0.90$) to establish a regional conservation strategy. I used spatially-explicit maps to identify five landscapes capable of attracting the highest densities of the greatest number of songbirds, and show that most of this habitat is unprotected from risk of conversion to other land uses. Models in Chapter 2 confirm that woody edges exacerbate effects of habitat loss, so in Chapter 3 I test whether birds use otherwise suitable habitats by experimentally removing trees in a before-after/control-impact design. This is the first study to experimentally show that songbirds avoid woody edges in otherwise suitable habitat. Avoidance of trees is apparent as far away from woody edges as surveys were conducted (240m). The spring following tree removal, the four most common species redistributed themselves ubiquitously in grasslands where trees were removed. I recommend that managers remove trees from grasslands and avoid planting trees in grasslands where conservation of songbirds is the management goal.

Completed Degree Fall 2007

Sex-specific investment in incubation and the reproductive biology of two tropical antbirds

Student: Brian Schwartz

Degree: M.Sc. Wildlife Biology

Advisor: Thomas E. Martin

Funding Source(s):
National Science Foundation
US Geological Survey

Project Duration: 2006-2008

UM Project Affiliation:
WBIO - MTCWRU



Objectives:

Empirical studies of bi-parental incubation, which have focused on north temperate species, demonstrated that males are less effective than females in time spent incubating the clutch and maintaining proper egg temperatures. Life history strategies of tropical birds have features that should more often promote the evolution of equal sex roles in parental care duties. Time and energy contributions of males that participate in incubation might then be particularly large in tropical compared with temperate species.

The objective of our research was to investigate allocations of time and energy between males and females in tropical passerines that exhibit bi-parental incubation. For two related and ecologically similar species, Slaty Antwren (*Myrmotherula schisticolor*) and Plain Antvireo (*Dysithamnus mentalis*), we asked four questions with respect to sex-specific parental effort and incubation effectiveness:

- 1) Do males and females share nest attentiveness equally?
- 2) Do temperatures experienced by developing embryos differ between male and female parents?
- 3) Do these two related and ecologically similar species exhibit similar patterns of sex-specific parental effort? and
- 4) Does sex-specific parental effort change with age of the embryo?

Progress and Status:

We measured sex differences in nest attentiveness and egg temperatures during 2006 and 2007 in a tropical, cloud forest in northern Venezuela. We found sexes were similar in their daytime nest attentiveness in Slaty Antwrens, but males invested greater time than females in Plain Antvireos. Despite being equally capable at re-warming cold eggs, males in both species incubated clutches at cooler temperatures than females but at different stages of embryonic development. For the first time in two nidicolous species, we demonstrated that males and females physiologically increase the amount of heat delivered to embryos as eggs approach hatching independent of parental time spent on the nest. Our results suggest that males may benefit embryonic development by minimizing time eggs experience cold temperatures during female absences, and concurrently benefit female physiological condition for future nesting efforts. I defended my thesis February 2008 and accepted a Ph.D. position with Dr. Hubert Schwabl at Washington State University investigating hormonal mechanisms for variation in developmental life history.

Graduated May 2008.

Patterns of nest success and migratory refueling performance in relation to cottonwood riparian habitat structure.

Student: Ty Smucker

Degree: M.Sc. Wildlife Biology

Advisor: Richard Hutto

Funding Source(s):
PPL Montana

Duration of Project: 2002– 2007

UM Project Affiliation:

WBIO – DBS, Avian Science Center

Abstract:

Despite an increasing awareness of the ecological significance of riparian areas, these habitats continue to disappear at a rapid rate. In the Rocky Mountains and Great Plains regions, 90-95% of cottonwood-willow riparian ecosystems have been eliminated. Information on how vegetation structure affects the quality of riparian habitat for breeding birds is limited. I explored mechanisms by which bird abundance and nest success during the breeding season are influenced by the structure of riparian vegetation, particularly understory vegetation. I also measured refueling performance of songbirds during migration in relation to density of riparian vegetation in cottonwood (*Populus trichocarpa*) habitat occurring along the Madison and Missouri rivers in Montana. I used a plasma lipid metabolite profile technique to estimate rate of mass gain, a surrogate measure of fitness, by migrant Wilson's Warblers (*Wilsonia pusilla*) during stopover.

Initial classification of nest plots into three categories – sparse, moderate, and dense – based on vegetation density was validated by extracting five non-correlated and biologically meaningful components that characterized the structural complexity of vegetation. Point counts and constant effort mist-netting efforts revealed that bird diversity was slightly greater on the dense plots. Yellow Warbler was the most frequently encountered bird species in the study area; however, its relative abundance did not differ among plot types. Proportional nest success for all species was highest on dense plots (54%) and lowest on sparse plots (39%), and this pattern held for Yellow Warbler, where daily nest survival rates were significantly higher (43% vs. 20%) on dense than on sparse plots. Nest parasitism showed the opposite trend, being lowest on dense plots. Differences between nest and random sites were also lowest on dense sites.

For autumn migrating Wilson's Warbler, mass, fat score, and plasma triglyceride level were all positively correlated with time of day, indicating that birds were gaining mass while foraging in riparian habitat. Triglyceride levels were highest on sites with dense vegetation, indicating that refueling performance by migratory songbirds increases with structural complexity of riparian vegetation. However, the habitat condition effect was confounded with time of day and date.

Completed Degree Fall 2007

Stress physiology during life history transitions in Laysan Albatross

Student: Rachel S. Sprague

Degree: Ph.D. Wildlife Biology

Advisor: Creagh W. Breuner

Funding Source(s):

National Science Foundation
U.S. Fish & Wildlife Service
(Kauai National Wildlife Refuge Complex
and Midway Atoll National Wildlife
Refuge)
Kilauea Point Natural History Association
Society for Integrative and Comparative
Biology
Five Valleys Audubon Society
Sigma Xi
American Ornithological Union
University of Texas at Austin

Project Duration: 2004-2008

UM Project Affiliation:
WBIO



Objectives:

I am interested in the role of glucocorticoid (GC) hormones as a proximate mechanism mediating life-history transitions. Specifically, I am investigating the action of GC hormones in a long-lived seabird with an extreme life-history strategy, the Laysan Albatross (*Phoebastria immutabilis*):

1. How do GC hormones and binding proteins change during long (2-3 week) incubation fasts?
2. How does the GC stress response change with age?
3. How do age, body condition, GC physiology, or environment affect parental behavior?

Progress and Status:

- All sample collection from birds in the field and data analysis of samples in the lab is completed. We have found exciting relationships between age/experience, stress physiology, and behavior in adult albatross provisioning their chicks. Glucocorticoid hormones tend to promote self-maintenance activities (e.g. nest abandonment) at the expense of reproduction and usually rise in situations of food deprivation, social stress, or unpredictable environmental events (to name a few).
- We have found that generally, stress hormones rise when body condition declines. Binding proteins (CBG) bind GC hormones in the blood and may restrict access of those hormones to receptors in tissue. Surprisingly, binding proteins also rise during incubation fasts as birds lose mass (generally thought to decline when body mass falls). This may help protect adults from the negative effects of elevated GC hormones on reproduction.
- In this long-lived species, age appears to be an important factor influencing both physiology and behavior. Older parents appear to have a lower GC stress response, possibly making them less likely to abandon their current reproductive effort than younger birds. In 2007, older birds and birds in good body condition made foraging trips that resulted in heavier chicks. Interestingly, the types of trips they made were not predicted based on previous research from the Southern Hemisphere. These Northern Hemisphere birds may face ocean conditions that lead them to different foraging strategies than their southern counterparts.

Habitat use, movements, and survival of Greater Sage-Grouse (*Centrocercus urophasianus*) in the Milk River Basin of northeastern Montana and southwestern Saskatchewan.

Student: Jason Tack

Degree: M.Sc. Wildlife Biology

Advisor: Dave Naugle

Funding Source(s):
Bureau of Land Management
Parks Canada
World Wildlife Fund

Project Duration: 2006 - present

UM Project Affiliation:
WBIO - CFC



Objectives:

Sage-grouse populations have declined by 66-92% on the northern periphery of their range over the past 35 years. Despite little change to recent land practices, populations continue to decline annually. With the threat of energy development, conversion of rangeland to agriculture, and mortality due to West Nile virus, an emerging infectious disease for sage-grouse range-wide, we believe it is increasingly important to delineate critical habitat for sage-grouse. Specifically, we are interested in

- 1) determining seasonal movements of sage-grouse in the northern fringe of their range,
- 2) examining habitat selection at patch and landscape scales to identify areas critical to the viability of sage-grouse populations,
- 3) estimate survival and productivity of breeding females and their broods, and
- 4) measure the impact that West Nile virus has on this declining population of sage-grouse.

Progress and Status:

We have completed two field seasons of intensive monitoring via radio-telemetry from March through September, and have conducted five winter flights to determine the migratory status of this population. We recently discovered that sage-grouse from Saskatchewan, a federally endangered population, make long-distance winter movements across a national border to use sagebrush habitats in northeastern Montana. We are currently working with resource managers from Saskatchewan and Montana to develop trans-boundary conservation initiatives to ensure the protection of this unique population.

Greater sage-grouse response to coal-bed natural gas development and West Nile Virus in the Powder River Basin, Montana and Wyoming, USA

Student: Brett Walker

Degree: Ph.D. Wildlife Biology

Advisor: David Naugle

Funding Source(s):

Bureau of Land Management
Montana Fish, Wildlife and Parks
Wyoming Game and Fish Department
National Fish and Wildlife Foundation
Petroleum Association of Wyoming
Wolf Creek Charitable Foundation
Anheuser-Busch Companies, Inc.

Duration of Project: 2003– 2007

UM Project Affiliation:

WBIO – CFC

Abstract:

Understanding how population dynamics respond to landscape-scale disturbance and disease are crucial for effective wildlife management and conservation. Two new potential stressors on greater sage-grouse (*Centrocercus urophasianus*) populations in the Powder River Basin of Montana and Wyoming are coal-bed natural gas (CBNG) development and West Nile virus (WNV). I first examined how CBNG development, habitat, and other landscape features influenced trends in the abundance of displaying males and the status of sage-grouse leks. Second, I used rates of WNV-induced mortality and seroprevalence from radio-marked birds to estimate rates of WNV infection. Third, I studied the influence of female characteristics, season, and environmental variables on nest, brood, and female survival. I then used population models to estimate potential impacts of WNV on population growth. From 2001-2005, numbers of males on leks in CBNG fields declined more rapidly than leks outside CBNG. Of leks active in 1997 or later, only 38% within CBNG remained active by 2004-2005, compared to 84% of leks outside CBNG. By 2005, leks in CBNG had 46% fewer males per active lek than leks outside CBNG. Persistence of 110 leks was positively influenced by proportion sagebrush habitat within 6.4 km of the lek and negatively affected by CBNG development at multiple scales. Prohibiting CBNG development within 0.4 km of sage-grouse leks is inadequate to ensure lek persistence. From 2003-2005, minimum WNV-related mortality rates from 1 July – 15 September ranged from 2.4-13.3% and maximum possible rates ranged from 8.2-28.9%. In spring 2005 and 2006, 10.3% and 1.8% respectively, of newly-captured females tested seropositive for neutralizing antibodies to WNV. Annual WNV infection rates were lower in habitats without CBNG development. Summer mortality from WNV occurred every year, decreased annual female survival rates by 0-27% per year, and reduced estimates of population growth by 7-10% per year. Changes in epizootiology of WNV and in distribution and management of surface water from CBNG development will play an important role in long-term impacts of WNV on greater sage-grouse populations in the Powder River Basin. Management should focus on eliminating man-made water sources that support breeding mosquitoes known to vector the virus.

Completed Degree Spring 2008

Population structure and dispersal of black-backed woodpeckers, a disturbance-dependent species

Student: Jennifer C. Woolf

Degree: Ph.D. Wildlife Biology

Advisors:

Fred W. Allendorf

Michael K. Schwartz

Funding Source(s):

Montana Fish Wildlife and Parks
McIntire-Stennis Cooperative Forestry
Research Program

US Forest Service, Region 1

Bureau of Land Management Glacier

National Park, The Glacier Fund

American Association of University

Women P.E.O.

Northwest Scientific Association

Danny On Memorial Scholarship

Bertha Morton Scholarship

Yellowstone to Yukon and

Wilburforce Foundation

National Center for Fire Analysis Five

Valleys Audubon

National Science Foundation

Project Duration: 2003 - 2009

UM Project Affiliation:

WBIO - DBS - MTCWRU

Objectives:

My primary objective is to describe the dispersal dynamics of black-backed woodpeckers to better inform the management of this disturbance-dependent species.

Progress and Status:

We completed field collection of genetic samples from 275 black-backed woodpeckers and 97 hairy woodpeckers in six regions of the northwestern U.S., Alberta and Quebec. I have completed genetic lab analyses and I am currently writing my dissertation with an expected completion in spring 2009. In black-backed woodpeckers, we found substantial genetic differentiation between woodpeckers in Oregon, South Dakota, yet little evidence of genetic differentiation within the Rocky Mountains or between the Rocky Mountain region and Quebec. This pattern may be explained by generally contiguous forest between these regions which may allow gene flow over large distances. In contrast, Oregon and South Dakota are much closer to the Rocky Mountains, yet are separated by areas of non-forested habitat. Male black-backed woodpeckers cross these gaps in forested habitat at higher rates than females. Hairy woodpeckers show a similar pattern, however, they are much less genetically differentiated than black-backed woodpeckers at the same spatial scales.

Bird monitoring surveys in Southeastern Montana

Researcher: Jock Young

Funding Source(s):
Montana Fish, Wildlife and Parks
Bureau of Land Management

Project Duration: 2007 - 2008

UM Project Affiliation:
Avian Science Center – DBS
MTCWRU

Progress and Status:

With additional cooperation and funding from the Bureau of Land Management (thanks to Gayle Sitter) and the Custer National Forest (thanks to Tom Whitford), we hired, trained, and supervised four field technicians for bird surveys in two targeted areas of southeastern Montana.

We re-visited point-count transects surveyed in 2007 and added a few more, for a total of 10 transects in the Decker/Tongue River region (mostly in Big Horn County), and 14 transects in the Willow Creek anticline near Baker (mostly Fallon and Wibaux counties, but extended this year into North Dakota). The anticline transects were surveyed twice, and the Decker transects once, between May 21 and July 5.

We also implemented a new survey method this year. We conducted area searches in places of interest, as an alternative method to address our twin goals of species inventory and long-term monitoring. Area searches were approximately an hour long and covered 40 acres or more. The technicians experimented with the best ways to detect the most species diversity while still conducting a repeatable survey. We will compare the sampling efficiency of the two methods.

FISH AND AMPHIBIANS



Evaluating effects of small dams on the fish community and developing conceptual guidelines to assess removal

Student: Aubree Benson

Degree: M.Sc. Wildlife Biology

Advisor: Lisa Eby

Funding Source(s):
Northwestern Energy
US Forest Service
Montana Fish, Wildlife and Parks

Project Duration: 2006 - 2008

UM Project Affiliation:
WBIO – MTCWRU



Objectives:

The main objectives are to:

- 1) determine the impacts of two small dams in the Clearwater River on native migratory bull trout spawning populations within the river basin,
- 2) determine the distribution of exotic species, and
- 3) use these data to develop conceptual guidelines to explore tradeoffs of demographic impacts to native populations versus allow for the expansion of exotic fishes to help decide if these dams should be removed to benefit the native fish community.

Progress and Status:

For two years, we have captured migratory bull trout below both dams, implanted radio transmitters, and passed them over the dams to monitor their movements throughout the year. We are now aware of 5 potential bull trout spawning areas in the Clearwater River Drainage. Several of these populations are impacted by individuals passing downstream over the dam and not being able to return to spawn. The effects of these losses to the potential spawning are being quantified with a population model. To determine the distribution of fish species throughout the basin, we have completed basin-wide electrofishing surveys, snorkeled below the dams and in the spawning tributaries and operated a fish ladder at the larger dam. The final field work will be completed in fall 2008. Given the discovered impacts to several migratory bull trout spawning population and the limited potential for expansion of exotic species present in the area, Montana Fish, Wildlife and Parks is moving forward with the necessary ecological assessments and anticipates removal of the larger dam within the next two years. The smaller dam will be modified to select against passage of exotic species, but allow for passage of bull trout.

Behavioral and demographic consequences of introgressive hybridization: Implications for Westslope Cutthroat Trout ecology and management

Student: Matthew P. Corsi

Degree: Ph. D. Wildlife Biology

Advisor: Lisa Eby

Funding Source(s):
Confederated Salish and Kootenai Tribes
Montana Water Center

Project Duration: 2005-2008

UM Project Affiliation:
WBIO



Objectives:

The goal of this project is to assess some of the ecological and evolutionary consequences of hybridization between native westslope cutthroat trout and introduced rainbow trout. I am also describing the current and historical distributions of native westslope cutthroat trout, introduced rainbow trout, and westslope-rainbow hybrids in the Jocko River Basin, Montana in order to assist with the development of management strategies for the protection of remaining pure populations of westslope cutthroat trout.

Progress and Status:

During the summers of 2005 and 2006, I collected demographic information and tissue samples from trout throughout the Jocko River Basin in collaboration with CSKT Fisheries biologist, Craig Barfoot. In 2008 I will complete analysis of distribution of rainbow and hybrid trout in the Jocko River Basin. We have also been collecting juvenile and adult migratory fish to establish the role, if any, of hybridity for determining migration timing, growth, and fecundity. I have been working on the development of a model to simulate demographic outcomes of various hybrid management strategies. Future versions of this model will incorporate genetic information to simulate the spread of hybridization under various management scenarios. I have also been working with collaborators to develop a conceptual framework for managing hybrid trout based on weighing competing management values and identifying assumptions about the evolutionary and ecological consequences of allowing hybridization versus isolation or other management actions.

Spatial population dynamics of western painted turtles in a wetland ecosystem in northwestern Montana

Student: Kathleen Griffin

Degree: Ph.D. Wildlife Biology

Advisor: Dan Pletscher

Funding Source(s):
Montana Department of
Transportation
Confederated Salish and Kootenai
Tribes, Western Montana

Duration of Project: 2000– 2007

UM Project Affiliation:
WBIO – CFC - MTCWRU

Abstract:

Population dynamics are driven by the interplay between the positive forces of births and immigration and the negative forces of deaths and emigration. Understanding dynamics at the local and metapopulation level is key in wildlife conservation. Although data on turtle survival and movement rates are available, few studies use rigorous statistical analyses and none include examination of stage-specific seasonal survival simultaneous with movement estimates.

I used capture-mark-recapture methods to estimate apparent survival rates and movement probabilities of adult and juvenile western painted turtles (*Chrysemys pictabellii*) across space and time in a wetland ecosystem in northwestern Montana. All wetlands within five complexes were sampled during three primary sessions a year from fall 2002 to spring 2005. I captured 1,072 individual adults 5,050 times and 442 individual juveniles 3,078 times. Although both juvenile and adult apparent survival rates were influenced by pond, seasons, and year, I found very different patterns spatially and seasonally between age classes. Apparent annual survival was lowest for adults in shallow ponds and lowest for juveniles in deep ponds. This variation could be due to mobility of adults which allows them to seek refugia habitats during drought conditions. Juveniles were less mobile and less likely to leave ponds. Movement probabilities of adults were influenced by distance between ponds and depth of originating pond. Only two juveniles were observed to move between complexes. Although the highest interpopulation movement probability was 3.8%, the probability for most interpopulation movements was very low (< 1%). Temporary emigration estimates were higher than estimates of interpopulation movement indicating the importance of refugia habitat. I examined the potential impacts of road mortality on both the overall population size and population structure via sex and stage class ratios of this population. Road mortality averaged 185 individuals/year. Annual road mortalities ranged widely depending on pond characteristics but in general were higher than the 2-3% mortality suggested by other research to likely affect long-term viability in turtle populations. No highway induced sex-bias occurred in this population. Population growth rates were negatively influenced by the presence of roads and positively influenced by movements.

Completed Degree Fall 2007

The influence of beaver ponds on fish invasions and terrestrial nutrient dynamics in southwestern Montana.

Student: Magnus McCaffery

Degree: Ph. D. Wildlife Biology

Advisor: Lisa Eby

Funding Source(s):
US Fish and Wildlife Service
The Montana Water Center
Grizzly Riders International
Bureau of Land Management

Project Duration: 2003 - 2008

UM Project Affiliation:
WBIO



Objectives:

The aim of this project is to enhance our understanding of how beaver influence ecological processes on the landscape, focusing on: (i) the effects of beaver ponds on fish invasion ecology, and the consequences for native fish species (ii) the influence of beaver impoundments on aquatic/terrestrial nutrient dynamics.

Progress and Status:

This project will determine how beaver affect ecosystem processes relevant to invasion and community ecology, which are important issues in the western United States where this ubiquitous species is in some cases removed as a pest, and in others introduced as a watershed restoration tool.

My research suggests that beaver impounded areas export greater quantities of organic matter to the local terrestrial system, leading to higher relative abundances of terrestrial organisms. In addition, beaver-induced stream warming has profound effects on stream distributions of both invasive brook trout and native cutthroat trout in western Montana. In beaver-influenced systems, brook trout occur higher in watersheds, whilst cutthroat trout occur at lower elevations, thus increasing the degree of overlap between the two species relative to non-beaver systems. Beaver ponds also allow cutthroat trout to achieve higher individual growth rates in the presence of brook trout relative to non-beaver systems. This effect is size-dependent with smaller cutthroat trout size-classes benefiting most from beaver presence.

The field component of this research was completed in August 2008, and I have one draft chapter of my dissertation completed. I am currently modeling trout population growth rates with three years of mark-recapture data to ascertain the viability and growth rates of these populations. I aim to defend my dissertation and graduate in December 2008.

Population dynamics of the Columbia spotted frog in western Montana

Student: Rebecca McCaffery

Degree: Ph. D. *Wildlife Biology*

Advisor: Elizabeth Crone and Lisa Eby

Funding Source(s):

NSF - EPSCoR

U.S. Geological Survey

Montana Natural Heritage Program

Project Duration: 2004-2009

UM Project Affiliation:

WBIO



Objectives:

1. Continue long-term demographic monitoring a population of Columbia spotted frogs in the Little Rock Creek basin of the Bitterroot Mountains.
2. Use demographic information to study the role of different sources of variability on long-term population dynamics.
3. Compare traditional methodologies for analyzing demographic data with a hierarchical Bayesian approach.
4. Examine how predictions from demographic data on amphibians change with varying years of data collection and different data types.
5. Examine the population dynamics and behavior of predaceous garter snake in relation to the Columbia spotted frog.

Progress and Status:

This project will contribute to our understanding of long-term population dynamics in amphibians, which is a pressing issue in light of concern over global amphibian declines. In addition, it will help guide the way in which we conduct amphibian monitoring, and will contribute to how we interpret demographic data in wildlife systems. For the last 4 years, I have collected extensive demographic data on a population of Columbia spotted frogs in the Little Rock Creek drainage in the Bitterroot Mountains of Montana, in continuation of work conducted by a previous graduate student. This year was the final year of mark-recapture field work in the Little Rock Creek drainage. I began analyses to determine the influence of snowpack variation on frog survival, which I presented at a national meeting. In addition, I continued collection of mark-recapture data on seasonal and spatial garter snake distribution and abundance in the system. In the upcoming year, I will collaborate with mathematicians to build Bayesian statistical models for my demographic data, which I will compare to more traditional approaches. I will also begin analyses to examine the influence of study duration on our estimates of population growth and viability in the species.

Demography and landscape ecology of the Columbia spotted frog and other amphibians in western Montana: effects of spatial arrangement of seasonal habitats and introduced fish

Principal Investigator:
Bryce A. Maxell

Degree Ph.D. Wildlife Biology

Advisors:
Lisa Eby and Andrew Sheldon

Funding Source(s):
Region 1 U.S. Forest Service
US Geological Survey
Montana Fish, Wildlife and Parks
Bureau of Land Management
Montana Department of
Environmental Quality
EPA
IUCN Declining Amphibians Population
Task Force

Project Duration: 2000-2008

UM Project Affiliation:
WBIO – FOR – DBS/MTCWRU –
MT Natural Heritage Program



Objectives:

The project links an extensive landscape inventory for several amphibian and reptile species to intensive population dynamics studies of a single amphibian species. First, all standing water bodies in randomly selected watersheds across western Montana are being surveyed for amphibians and aquatic reptiles in order to:

- 1) assess the current status of these species in relation to a variety of land use practices;
- (2) establish a baseline of presence/non detection information that can be used to monitor these species' status over time; and
- 3) improve our understanding of the geographic distribution of these species. Second, intensive demographic studies of the Columbia spotted frog are being conducted in 6 watersheds across western Montana in order to assess the local and landscape population dynamics of this species in relation to the introduction of exotic salmonid fishes.

Progress and Status:

Through the 2008 field season, 571 watersheds and more than 8,650 water bodies have been inventoried. This has resulted in >10,373 species records with numerous extensions of known geographic ranges and maximum elevations. The presence of the Idaho Giant Salamander (*Dicamptodon aterrimus*) has been confirmed in Montana for the first time with hundreds of individuals found in 15 tributaries of 4 watersheds in Mineral County. Western toads have been found breeding at less than 3% of sites surveyed and the deadly chytrid fungus (*Batrachochytrium dendrobatidis*) has been detected across Montana, suggesting it may be the cause of declines observed in both western toads and northern leopard frogs. Mass mortalities of Tiger Salamanders have also been found across eastern Montana, suggesting the widespread presence of *Ambystoma tigrinum* virus. This inventory information is being continually updated in statewide conservation plans for amphibians and reptiles as part of Montana's Comprehensive Fish, and Wildlife Conservation Planning process. To-date, the focal demographic study has resulted in the marking of more than 12,000 Columbia spotted frogs and more than 30,000 individual captures. The study has documented growth rates, survival rates, movement rates, and age structures in watersheds with and without introduced salmonids. This project has also involved 3 undergraduate thesis projects investigating diet and breeding behavior of Columbia spotted frogs and the abundance and diet of their gartersnake predators.

MAMMALS



Wolf monitoring protocols

Research Associate: David Ausband

Funding Source(s):

Nez Perce Tribe – Idaho

Idaho Department of Fish and Game

Defenders of Wildlife

Wolf Recovery Foundation, Inc.

Department of National Resource
Council

The Oregon Zoo Foundation

The Mountaineers Foundation

Project Duration: 2006 - 2011

UM Project Affiliation:

MTCWRU



Objectives:

The U.S. Fish and Wildlife Service recently proposed removing Endangered Species Act protections for wolves in the Northern Rockies. As Endangered Species Act protections are removed so too are federal monitoring dollars used to gauge overall wolf population health. States and tribes in the Northern Rockies are now faced with the task of monitoring wolf populations, specifically Breeding Pairs, to ensure their conservation with much limited budgets. Radiotelemetry has been the primary tool for monitoring wolves in the Northern Rockies, requiring intensive trapping and handling of wolves. Maintaining radiocollared wolves dispersed widely across the landscape is an expensive and logistically difficult monitoring approach and its efficacy as the sole method for monitoring will wane as federal funding declines. Recently, the Nez Perce Tribe, Idaho Fish and Game, and the Montana Cooperative Wildlife Research Unit began a research project to develop cost effective yet accurate methods for monitoring wolves in Idaho.

We used logistic regression and data collected from wolves in the Northern Rockies over the last 20 years to estimate the probability a pack of a given size contains a Breeding Pair. Our results indicate that if pack size is known then the probability that the pack contains a Breeding Pair can be accurately estimated. In addition, to test new monitoring methods we identified 4 study areas based on wolf density ranging from low to high (2 low, 2 high). We have VHF and GPS collared wolves in the study areas to determine wolf density and to allow comparisons of wolf abundance estimates from new methods to estimates obtained from radiotelemetry. In the summer of 2007, we surveyed 478 predicted rendezvous sites and without the aid of radiotelemetry, collected over 250 genetic samples and in 2008 we collected over 1,950 genetic samples to use for population estimation in our study areas. We also surveyed 2,000 hunters in 2007 & 2008 in our 4 study areas to ascertain the accuracy of their wolf observations. Preliminary results show the public is largely truthful in their reporting and that public observations may be one tool for monitoring wolves in the future. For use in roadless areas, we have developed an automated tool called a "howlbox" which can remotely survey an area by broadcasting a wolf howl, recording responses, and then shutting down until the next scheduled broadcast.

Using models to address uncertainty in management of black and brown bears

Student: Julie Beston

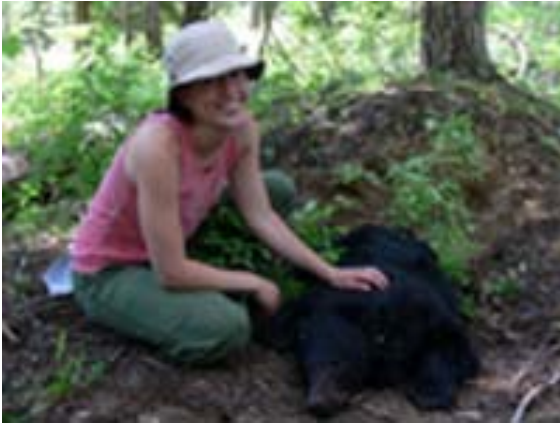
Degree: Ph. D. Wildlife Biology

Advisor: Elizabeth Crone

Funding Source(s):
NSF EPSCoR
Montana Fish, Wildlife and Parks
The Nature Conservancy

Project Duration: 2005-current

UM Project Affiliation:
WBIO – MTCWRU



Objectives:

1. Use statewide harvest data to estimate harvest rates and demographic structure of Montana black bears.
2. Conduct meta-analyses of black bear and grizzly bear demography using published and unpublished research findings from North America.
3. Compare models of black bear harvest strategies to determine their value in maintaining populations and establish, if possible, management criteria from harvest data.
4. Model the effects of salmon fishing strategies on grizzly bear population viability.

Progress and Status:

Bears are important members of their ecosystems and carry cultural and recreational importance to humans. Managers must make decisions that impact bear populations. Bears are solitary and long-lived, and it is difficult and expensive to collect data needed to make the best decisions. Through my work, I incorporate knowledge from previous studies and examine the consequences of uncertainty through mathematical models to guide management. This reduces costs for managers and can focus future studies on gaps in understanding.

To date, I found that the female segment of the Montana black bear population is being harvested at an annual rate of about 10%, and there are indications that the population may be declining.

I have also created a suite of population models for grizzly bears in British Columbia. Simulations show that serious (>50%) declines in salmon escapement will jeopardize population viability, regardless of which model best represents reality.

Research addressing other projects is in progress.

Patterns and causes of spatial population synchrony in snowshoe hares

Student: Ellen Cheng

Degree: Ph.D. Wildlife Biology

Advisor: L. Scott Mills

Funding Source(s):
National Science Foundation
National Park Service
Animal Welfare Institute
UM Graduate Council
Bertha Morton Scholarship

Project Duration: 2007-2009

UM Project Affiliation:
WBIO

Objectives:

My dissertation addresses the long-standing question of what drives regional population dynamics of snowshoe hares. In particular, what are the mechanisms generating spatial synchrony of snowshoe hare population cycles across their northern range—Canada and Alaska—and why are these regional dynamics apparently diminished in their southern range, southern Canada and the contiguous United States? This study combines long-term time series, genetic data and simulation modeling in a quantitative analysis of the patterns and causes of snowshoe hare spatial population synchrony.

In a related side project I am developing and evaluating a non-invasive genetic alternative to live-trapping for mark-recapture estimation of snowshoe hare abundance.

Progress and Status:

For my dissertation research I have thus far compiled snowshoe hare time series data from 59 sources (primarily other hare researchers and agency biologists) distributed across 8 Canadian provinces and 14 of the 28 U.S. states that support snowshoe hare populations. I have received approximately 400 hare tissue samples donated from 23 sources distributed across 2 Canadian provinces and 11 U.S. states. In summer 2008 I collected snowshoe hare tissue samples via live-trapping from an additional 2 U.S. states (California and Oregon). Genetic analysis of 158 hare tissue samples (11 U.S. states) revealed snowshoe hare populations are fragmented in parts of the western U.S. Although other mechanisms still have to be explored, these preliminary findings are consistent with the hypothesis that reduced dispersal among southern hare populations may contribute to their reduced population synchrony.

For my side project, preliminary results suggest non-invasive genetic methods can generate mark-recapture abundance estimates comparable to live-trapping snowshoe hares. Non-invasive genetic methods are a cost-effective alternative when hare densities are relatively low and study sites are difficult to access.

Behavioral and population implications of human hunting for elk in the wildland-urban interface

Student: Shawn Cleveland

Degree: M.Sc. Wildlife Biology

Advisor: Mark Hebblewhite

Funding Source(s):

Montana Fish, Wildlife and Parks
Rocky Mountain Elk Foundation
Living With Wildlife
Transboundary Research Award Hellgate
Hunters and Anglers
Safari Club International
The University of Montana

Project Duration:2007-2009

UM Project Affiliation:
WBIO



Objectives:

I want to determine the mechanisms influencing elk population growth in the WUI, the direct and indirect effects of human hunting on elk populations in the WUI, assess the mechanisms of habituation as a function of time spent with humans, and to determine influences of land management practices on elk resource selection.

Progress and Status:

Urban elk research began in January of 2007 to address concerns surrounding a growing elk population in the North Hills outside of Missoula, MT. A total of 21 adult female elk were outfitted with radio collars, 10 with global positioning system (GPS) and 11 with very high frequency (VHF) collars during the winters of 2006-2007 and 2008-2009. In the winter of 2008, one GPS collar was redeployed and five VHF collars deployed on adult female elk. Data acquired from the collared elk has shown a change in winter range use from solely using the winter range east of Butler Creek Road in 2007 to expanding use to west of Butler Creek Road in 2008. Preliminary elk resource selection results were presented at the 2008 Montana Chapter of The Wildlife Society's annual meeting held in Missoula, MT. Vigilance and approach trials began in the spring of 2008 to determine the duration of perceived predation risk of humans by elk following hunting season and will continue in the fall of 2008 thru spring of 2009. These trials will also be conducted in areas around Gardiner, MT starting in September 2008. In addition, I have mentored an undergraduate student to develop a senior thesis project examining the relationship between elk density and knapweed colonization, and written and received a grant from the Rocky Mountain Elk Foundation and the Transboundary Research Award. My thesis proposal was accepted by committee members in May, 2008.

Wolf-caribou dynamics and population ecology in the Canadian Rockies

Student: Nick DeCesare

Degree: Ph. D. Wildlife Biology

Advisor: Mark Hebblewhite

Funding Source(s):

Canadian Association of Petroleum Producers

Shell Canada, Ltd.

Weyerhaeuser Company

Parks Canada

Alberta Fish and Wildlife Division

British Columbia Ministry of Environment

Alberta Conservation Association

Endangered Species Recovery Fund

Project Duration: 2007–2011

UM Project Affiliation:

WBIO



Objectives:

I will be conducting research on woodland caribou, wolves, and other ungulate prey to answer the following research questions:

- 1) What habitat features best predict the regional and local distributions of woodland caribou?
- 2) How do gradients in forest stand age and structure affect prey densities, wolf densities, and wolf predation levels?
- 3) Do seismic lines increase predator efficiency and hence kill-rates?
- 4) Are current monitoring protocols sufficient to detect population change in all forms?
- 5) What do spatially-explicit population projections tell us about conserving caribou populations in west-central Alberta?

Progress and Status:

Existing Data: Through data sharing agreements with collaborating provincial, federal, and industry biologists, we have assembled a database of >500,000 GPS locations documenting caribou movements within the study area since 1999.

Data Collection:

We have coordinated the capture and monitoring of 29 wolves within the study area to document spatially-explicit predation rates across a land-use gradient from complete protection to heavily exploited by forestry and oil and gas industries. We continue to monitor caribou with GPS collared individuals in each herd.

We are also in collaboration with the GIS lab of Dr. Greg McDermid at the University of Calgary, where we have finalized a remote-sensing based raster data set of landcover information for the entire study area, as well as an in-progress vector data set of current roads, seismic lines, pipelines, and other sources of human disturbance.

Timeline: During year 2 of this degree, I plan to continue coursework, defend a final proposal for my PhD research, complete my comprehensive exams, continue field work documenting wolf predation across the study area, and conduct initial analyses towards objectives 1 and 4 above.

Analysis of gray wolf diets in northwestern Montana using scat and stable isotopes.

Student: Jonathan Derbridge

Degree: M.Sc. Wildlife Biology

Advisor: Paul R. Krausman

Funding Source(s):
Boone & Crockett Program in Wildlife
Conservation
Montana Fish, Wildlife & Parks

Project Duration - 2-3 years

UM Project Affiliation:
WBIO – Boone and Crockett

Objectives:

To analyze gray wolf diets using scat and stable isotopes. To compare methods. To examine the importance of moose to wolf diets.

Progress and Status:

Wolf hairs and scat have been collected from June 2008 to the present. Hair and scat collection continues. Scat and hair will begin during the current semester.

Current and historic roles of fire in Sierra Nevada bighorn sheep habitat

Student: Lacey Greene

Degree: M. Sc. Wildlife Biology

Advisor: Mark Hebblewhite

Funding Source(s):

California Department of Fish and Game
White Mountain Research Station
Sierra Nevada Bighorn Sheep Foundation

Project Duration: 2008 - 2010

UM Project Affiliation:

California Department of Fish and Game



Objectives:

Quantify forage quality and quantity changes in response to the Seven Oaks fire.

Quantify Sierra Nevada bighorn sheep response to the Seven Oaks Fire.

Quantify historic habitat changes using aerial photos and ground photo analysis.

Progress and Status:

Wrote and defended my Masters thesis proposal.

Presented thesis proposal at wildlife biology seminar and for the wilderness society undergraduate club.

Captured and put GPS collars on 5 Sierra Nevada bighorn sheep that have access to burned areas.

Completed my first round of field work this spring to get a post fire estimate of biomass by species in both burned and unburned areas . This included 54 plots visited three times each throughout the growing season.

Located and purchased aerial photos for historic treeline analysis and finished a preliminary search for ground photos in the target area.

Demography and ecology of a declining endemic: The Olympic marmot

Student: Suzanne Griffin

Degree: M. Sc. Wildlife Biology

Advisor: L. Scott Mills and Mark Taper

Funding Source(s):

UM-EPSCor

Environmental Protection Agency

National Science Foundation

Olympic National Park

Anheuser-Busch Companies, Inc.

Canon

Northwest Scientific Association

Mazama

American Society of Mammalogists

American Museum of Natural History

Duration of Project: 2002– 2007

UM Project Affiliation:

WBIO - CFC

Abstract:

Protected areas serve to conserve species, habitats, and ecological processes. However, biological systems within even large parks are increasingly affected by outside perturbations.

The Olympic marmots (*Marmota olympus*) are ground-dwelling squirrel that inhabit high-elevation meadows almost exclusively within Olympic National Park. Despite this protection, anecdotal reports in the 1990's of disappearances from historically occupied locations suggested that the species was in decline. I used demographic monitoring, habitat surveys, and non-invasive genetic sampling to evaluate population status of the species and consider the effects of several possible stressors. Olympic marmots disappeared from ~50% of well-studied colonies, and abandoned burrow complexes were common throughout the park. Estimated annual abundances at intensively studied sites indicated a currently declining population, as did population projections based on measured demographic rates. Low dispersal rates and the spatial distribution of the abandoned sites were inconsistent with etapopulation dynamics as the cause of the declines. There was no evidence that disturbance by tourists was responsible – although marmot behavior differed between remote and regularly-visited sites, there was no corresponding difference in birth or death rates. Likewise, 100% overwinter survival of adults and normal reproductive and juvenile survival rates provide no support for the hypothesis that changes in forage quality or thermal conditions within hibernacula associated with low snowpack were causing the decline. In fact, consecutive year breeding by females during years of early snowmelt suggests a possible positive effect of climate warming. Adult female annual survival was only 0.69, all mortality appeared to be due to predation with coyotes the most common predator, and even moderate changes in adult female mortality rates translated to large changes in projected population growth rates, so it is likely that coyotes are the primary driver of local Olympic marmot declines. Given that marmot populations appear depressed throughout Olympic National Park and that marmots constitute a considerable portion of coyotes diet in many parts of the park (Witczuk 2007), it is likely that this non-native, generalist carnivore is threatening the marmot's existence throughout its range. As parks become increasingly isolated and surrounded by human perturbations, it will be ever more important to monitor species of special interest within these areas; and when a threat is suspected, to consider more than just the most obvious candidates.

Wild ungulate survey, spring 2008. Dulan International Hunting Area, Qinghai, China

Principal Investigator:
Richard B. Harris

Funding Source(s):
Foundation for North American
Wild Sheep
Robert M. Lee Foundation

Project Duration: 2008

UM Project Affiliation:
MTCWRU



Objectives:

Objectives of the Dulan International Hunting Area (DIHA) staff were to obtain approximate counts of important large mammals species in areas in which they conduct hunts. Principle species of interest were blue sheep, argali, and white-lipped deer, although other species were to be observed and recorded. Although some government officials in Dulan wished to know the total numbers for selected species within the county, DIHA staff did not expect or require a population estimate. Rather, rough counts were considered useful in their own right.

Objectives of personnel from the University of Montana, in addition to assisting with field work, were to:

- 1) understand survey methods previously used by DIHA staff,
- 2) make suggestions for improvement to these methods where it was clear that such improvements could easily be adopted, and
- 3) improve documentation and facilitate dissemination of survey results.

Progress and Status:

We used vehicles, horses, and foot travel to access remote mountain areas, searching for animals visually, inspecting animals groups using spotting scopes, plotting locations of animal groups using 1:40,000 satellite imagery and GPS units, and recording the number of animals using hand-held tally meters. In total, we observed from 6,392 to 6,688 blue sheep (depending on assumptions regarding duplicate counts of individuals) during 16 days of actual field survey. An additional 205 argali were documented in the surveyed areas, as were 55 white-lipped deer, 23 red deer, and an undocumented number of Tibetan gazelles (as well as additional blue sheep, observed while traveling between survey areas but not recorded). We cannot estimate the true number of animals present within surveyed areas, but 2 replicated surveys on different days resulted in similar counts. At present, we have no good method to estimate the total number of blue sheep (or argali, or other species) present within the hunting area, because we do not know if sampled areas were representative. We are currently working on ways to estimate the amount of area effectively sampled in this steep terrain, and have plans to work toward models that would allow estimation of true abundance under the sampling constraints we faced.

Relationships between plateau Tibetan foxes (*Vulpes ferrilata*) and plateau pikas (*Ochotona curzoniae*)

Principal Investigator:
Richard B. Harris

Funding Source(s):
Robert M. Lee Foundation
Denver Zoological Foundation

Cooperators:
East China Normal University
Qinghai Province Wildlife
Management Bureau
Dulan International Hunting
Area

Project Duration: 2006-2008

UM Project Affiliation:
MTCWRU

Objectives:

Quantify correlates of habitat use of Tibetan foxes, focusing on their movements, den-site selection, and home range location relative to the distribution and density of plateau pikas.
Quantify food habits of Tibetan foxes via analysis of verified fox scats.

Progress and Status:

The Chinese Ph.D. student at East China Normal University (Liu Qunxiu) has completed field work and is now analyzing data and writing papers. One paper (on home range patterns of the first 3 collared foxes) has been published in *Acta Theriologica Sinica* (in Chinese). A short report on biological aspects of *Vulpes ferrilata* as been published online by the IUCN Canid Specialist Group. Mammalian Species account of *Vulpes ferrilata*, of which Harris is a co-author, is forthcoming.



Multiscale effects of roads on Black Bears

Student: Ben Jimenez

Degree: M.Sc. Wildlife Biology

Advisor: Mike Mitchell

Funding Source(s):
Idaho Fish and Game, MTCWRU

Project Duration: 2007 - 2009

UM Project Affiliation:
WBIO-MTCWRU



Objectives:

Black bears (*Ursus americanus*), are a highly adaptable landscape species with few natural predators. With high road densities and increasing traffic volumes throughout much of their range however, the potential effects of roads on bears as well as the habitat which they rely upon are of growing concern (IUCN Bear Specialist Group 2007). The black bear population within the Coeur d'Alene (CDA) river watershed of Northern Idaho is exposed to high road densities and moderately high hunting pressure. Hunting regulations allow for the use of bait and dogs in both spring and fall hunting seasons, and dogs are permitted for non-lethal pursuit during the summer pursuit season. In an effort to better understand the effects of these pressures on black bears, the objectives of this study are as follows:

1. Provide a fine scale analysis of habitat selection of black bears (2nd and 3rd order habitat selection).
2. Assess the effects of road density and traffic volume on this multi-scale habitat selection.
3. Assess alterations to daily activity patterns due to seasonal shifts in traffic volumes.
4. Evaluate potential functional habitat loss for black bears within the area.

Progress and Status:

Between June 1, 2007, and July 25, 2008, we captured 43 black bears, and instrumented 28 adults with Global Positioning Systems (GPS) collars. Collars are set to acquire positions at 20 minute intervals from April 10 - November 10. Thus far, 3 collars retrieved during the fall of 2007, plus 11 collected from dens in the winter of 2008 have yielded a total of 75,772 locations. Analysis of this data is currently underway. The remaining 20 collars will be collected from dens this fall and winter.

Escaping the Extinction Vortex: Identifying factors affecting population performance and recovery in endangered Sierra Nevada bighorn sheep

Student: Heather Johnson

Degree: Ph.D. Wildlife Biology

Advisor: L. Scott Mills

Funding Source(s):
California Dept. Fish and Game
Canon National Parks Science
Scholars Program
National Fish and Wildlife
Foundation for North American Wild
Sheep

Project Duration: 2005-2009

UM Project Affiliation:
WBIO

Objectives:

While endangered species conservation is a key issue in natural resource management, most of these species are still in decline or remain at precariously low numbers. A growing body of evidence suggests that difficulties with endangered species recovery are due to an "extinction vortex," where demographic, environmental, and genetic stochasticity interact with each other and with deterministic factors, such as habitat loss, to mutually reinforce and accelerate the extinction of small populations. To investigate how these factors individually and synergistically drive the dynamics of small populations I will simultaneously track demography, resource use and availability, and genetic variation in Sierra Nevada bighorn sheep (*Ovis Canadensis sierrae*; SNBS), a federally endangered subspecies. SNBS are the rarest of mountain sheep in North America, with isolated populations comprising approximately 350 individuals. For my dissertation, I will employ a combination of demographic, habitat, genetic, and modeling techniques to:

- 1) identify vital rates most critical to SNBS populations and the stochastic and deterministic factors driving those rates,
- 2) determine habitat characteristics being selected by SNBS and how selection decisions confer fitness traits,
- 3) ascertain whether genetic factors are limiting SNBS recovery and the need for genetic management, and
- 4) quantify the relative effects of demographic, habitat, and genetic factors on the dynamics of SNBS and their cumulative impacts on population viability, and
- 5) specify management actions that should be taken to reduce extinction risk and promote subspecies recovery.

Progress and Status:

This past year my crew and I obtained detailed demographic and habitat data, population estimates, and genetic information from 3 SNBS populations; this data collection will continue into the spring of 2009. We also finished the lab analysis of both neutral and candidate adaptive genetic markers in 120 individually marked bighorn sheep.

Out of the field, I have just finished analyzing 25 years of SNBS demographic data, identifying vital rates most critical to SNBS and simulating the potential effects of different management scenarios on population recovery. This fall I will continue analyzing this time series data to determine specific deterministic and stochastic factors impacting each bighorn herd. Additionally, I will quantify genetic structure within and between herds and determine whether inbreeding depression may be inhibiting subspecies recovery.

Results from this study will elucidate critical aspects of SNBS ecology and provide a recovery strategy for California Dept. of Fish and Game, US Fish and Wildlife Service, the National Park Service, and the US Forest Service. More importantly, it will pioneer new approaches for quantifying and alleviating extinction vortices that will be widely applicable to other endangered species recovery programs.

Geographic structure of Marco Polo sheep in the Pamir Region of Afghanistan, China, Pakistan, and Tajikistan

Principal Investigators:
Gordon Luikart and Richard Harris

Funding Source(s):
Wildlife Conservation Society

Project Duration: 2008

UM Project Affiliation:
DBS

Objectives:

We are addressing issues of connectivity, corridors, isolation, loss of genetic diversity, and possible barriers to movement among sub-populations of Marco Polo argali (*Ovis ammon poli*) throughout the 4 country transboundary region (Tajikistan, Afghanistan, China, Pakistan). We will use non-invasive sampling (primarily of feces) to provide data on the genetic structure of this meta-population because: the region is extremely remote and difficult to access; capturing large numbers of argali for research in this area is impractical, and; simply observing them during surveys does not provide the information we need.

By understanding the relative similarity of haplotypes (from mtDNA) and genotypes (from microsatellite markers) of individuals from various geographic locations within the overall range, we can address a number of questions related to conservation and land use policy. Are there identifiable sub-populations? If so, do any have levels of genetic diversity low enough to arouse concern for their future viability? Can we estimate the magnitude of gene-flow among groups of argali that appear to be geographically separate? If so, are there identifiable natural barriers or man-made barriers to gene-flow? Can we identify geographic regions that appear important in maintaining connectivity among demographically disparate populations? Is there sex biased gene flow such that females move far less than males?

Progress and Status

We have now collected < 500 fecal pellet samples (many of which will be used only for population estimation. In addition to the < 300 samples from the Big Pamir, we have approximately 80 samples from the Little Pamir, 30 from the Pamirs of Tajikistan, 48 from the Tashkorgan area of adjacent Xinjiang, China, and 35 from the Shimshal Valley of Northern Pakistan. Of the Tajik samples, 21 yielded good or very good PCR products, suggesting that individual genotyping using microsatellites will be possible. Of the China samples, 25 seem likely high enough quality to yield individual genotypes. Unfortunately, preliminary analyses suggest the Pakistan samples were too degraded to yield useful DNA. Based on initial testing, we have indentified at least 9 microsatellite loci that appear to be identifiable from most samples (and have an additional 8-10 candidate loci), and that show sufficient variability to be useful. We appear to be on track to be able to characterize populations in the Big Pamir of Afghanistan, the Little Pamir of Afghanistan, the Wakhjir Valley of Afghanistan, the Tajik Pamirs, and the Chinese Pamirs based on both mtDNA and microsatellites with sample sizes sufficient to make valid inference.

Habitat selection of the North American Porcupine (*Erethizon dorsatum*) in Western Montana

Student: Katie Mally

Degree: M.Sc. Wildlife Biology

Advisor: Kerry R. Foresman

Funding Source(s):
Montana Fish Wildlife & Parks
Montana Audubon

Project Duration: 2006 - 2008

UM Project Affiliation:
WBIO - MTCWRU

Objectives:

Assess resource selection of porcupine at the second and third order with the use of resource selection functions, quantify home range, and collect demographic information (mortalities and reproduction)

Progress and Status:

Surveys requesting reports of porcupine sightings were distributed throughout Montana Fish Wildlife and Parks regions 1, 2, & 3 during the summer of 2006. Surveys were distributed to groups thought to potentially have knowledge of porcupine locations; these groups included biologists, trail crews, veterinarians, outfitters, as well as many others. One hundred and eight two surveys were returned and used to model selection using resource selection functions in a used versus available framework. With this method porcupine sightings were used points and randomly generated points within the study area were available points. To account for the influence of human density on the survey a covariate distance to roads was generated and included in the model. The idea was that more surveys would be returned in areas with higher human density and that as distance from roads increases human densities decrease. Our model showed the lack of conifer species to have the largest influence on porcupine selection at the second order followed by elevation, and the occurrence of broadleaf and shrub species in order of greatest influence.

Porcupines in the Bitterroot Valley were radio-collared in the summer of 2007 to begin to quantify habitat selection at the third (within home range) order. Seven individuals were live trapped and radio-collared along the Bitterroot River on Lee Metcalf National Wildlife Refuge, Teller Wildlife Refuge, and a privately owned ranch. Five individuals were collared during the summer of 2008 bringing the total to twelve, five males and seven females. Individuals were located during both the day and night beginning in May and running through August. At each location a suite of habitat variables were recorded at both the individual's location as well as at a random location. There have been 327 locations to date. These locations will be used to again model habitat selection this time at the third order using resource selection functions in a used versus available framework.

Each collar has a mortality switch allowing us to perform necropsies on all mortalities. There have been three mortalities to date; two were attributed to starvation and one to pest control. When females are located a search of the area is formed to attempt to locate offspring and confirm reproduction.

Further analysis will be continued into the fall. A thesis defense is scheduled for December of this year.

Wolf recolonization in the western Alps: Effects of habitat loss and fragmentation

Student: Francesca Marucco

Degree: Ph.D. Wildlife Biology

Advisor: Dan Pletscher

Funding Source(s):
Interreg II Italy France and Regione
Piemonte (Italy)

Project Duration: 2003-2008

UM Project Affiliation:
WBIO - CFC

Objectives:

The primary goal of my research is to gain a landscape-level understanding of the wolf recolonization process in the south-western Alps, which have important ecological and management implications. We are using a combination of occupancy analysis, non-invasive genetic capture-mark-recapture (CMR) analysis, GIS, modeling, and computer simulations to estimate abundance, trend in population size, and apparent survival of wolves using genetic mark-recapture techniques, as well as a predictive occupancy map. We will finally develop a spatially explicit, individual-based model that incorporates information obtained in the above objectives for analyzing the natural expansion of wolves under current conditions and under different predictions of future landscape changes to investigate the effects of habitat loss and fragmentation on an ongoing decolonization process.

Progress and Status:

I am currently writing the dissertation, and the date planned for defense is March 2009.

Effects of biological sources of variation on mark-recapture estimates for black bears based on non-invasive genetic sampling

Student: Barb McCall

Degree: M.S. Wildlife Biology

Advisor: Mike Mitchell

Funding Source(s):
Idaho Department of Fish and Game

Project Duration: 2006-2009

UM Project Affiliation:
WBIO/MTCWRU



Objectives:

1. Explore biological causes of variations in capture probability and closure violation of black bears by modeling apparent survival (ϕ), recruitment (f), and recapture probability (p) by year as a function of:
 - a. Sex
 - b. Season
 - c. Movement rates
 - d. Average home range size
 - e. Distance captured from grid edge
2. Determine the biological causes of yearly variations in black bear vital rates by modeling apparent survival (ϕ), recruitment (f), recapture probability (p), and population growth rate (λ) of all years as a function of:
 - a. Huckleberry production
 - b. Buffaloberry production
 - c. Serviceberry production
 - d. Mountain ash production
3. Determine the population growth rate (λ), apparent survival (ϕ), recruitment rate (f), and the recapture probability (p) of black bears in the Purcell Mountains of Idaho (2003-2006)

Progress and Status:

Currently analyzing mark-recapture data through program MARK using the Pradel model.

Conducted a field season during June-August 2008 to collect bear DNA in the Coeur d'Alene Mountains, Idaho. This project geographically and spatially overlapped with GPS collared black bears. Information gained will be used to determine encounter rates of GPS collared bears to hair snares and to estimate abundance of black bears in the Coeur d'Alene Mountains.

Ecology and behavior of urban black bears, Missoula, Montana and public attitudes about management

Student: Jerod A. Merkle

Degree: M.Sc. Wildlife Biology

Advisor: Paul R. Krausman

Funding Source(s):

Harry Longwell Foundation
Boone and Crockett Wildlife
Conservation Program

Project Duration: 2008 – 2010

UM Project Affiliation:
WBIO

Objectives:

The project will provide information to wildlife management agencies on black bears, humans, and human-black bear conflicts to help minimize future conflicts. There are three phases to the project. The first will be to help Montana Fish, Wildlife and Parks analyze data on sightings in the Missoula Valley. Second, a public survey will be administered to residents of Missoula. Results will provide information on human behaviors and attitudes with respect to black bears, and quantify the success of education efforts. Third, 10 female black bears will be captured and marked with global positioning radio collars. Bears will be monitored to determine movement patterns and habitat selection with respect to Missoula's wildland-urban interface.

Progress and Status:

The project is completely underway. The analysis of the sightings database began summer of 2008, and will continue through summer of 2009. The public survey was sent out at the end of August 2008, and residents are currently returning completed surveys. Three culvert traps, located in Missoula's periphery, were set at the beginning of September. However, no black bears eligible for a radio collar have been captured to date. Trapping will continue through fall 2008.

Predicting occupancy, pack size, and breeding pair status for wolves in the Northern Rocky Mountain Ecosystem

Student: Alison Mynsberge

Degree: Ph.D. Wildlife Biology

Advisor: Mike Mitchell

Funding Source(s):
Montana Fish, Wildlife and Parks
Nez Perce Tribe
Idaho Fish and Game

Project Duration: 2008-2012

UM Project Affiliation:
MTCWRU

Objectives:

The removal of wolves from the Endangered Species Act will affect wolf monitoring in the Northern Rocky Mountain Ecosystem. The number of wolves and the number of breeding pairs must continue to be estimated in Montana, Idaho, and Wyoming to ensure continued recovery and to prevent relisting, and population estimates will also be necessary for creating harvest guidelines. However, funding available for wolf monitoring will decrease as states assume management of wolves. The goal of this project is to develop methods that will allow states in the Northern Rocky Mountain Ecosystem to efficiently monitor wolves after delisting. Specifically, this research will use patch occupancy modeling to derive estimates of important population parameters while reducing monitoring costs.

Progress and Status:

Current efforts include compiling data on wolf packs in the Northern Rocky Mountain Ecosystem and developing databases of variables that may influence wolf demographics. Researchers conducting related projects have placed GPS collars on several wolves in both Idaho and Montana, and we will use home ranges determined from the movements of these wolves to set the patch size for occupancy modeling.



Dispersal characteristics and habitat use of dispersing Puma

Student: Jesse Newby

Degree: M.Sc. Wildlife Biology

Advisor: L. Scott Mills

Funding Source(s):
Panthera: Partners In Wild Cat
Research
Montana Fish, Wildlife and Parks

Project Duration: 2005-2009

UM Project Affiliation:
WBIO - MTCWRU

Objectives:

Interpopulation movements play a critical role in the genetic and demographic maintenance of large carnivore populations making landscape connectivity essential to conservation. Puma populations naturally rely on immigration supplied by young dispersing animals. Puma research to date has focused on small areas and barely addressed dispersal. The strength of our research is built upon collaboration with four long-term research projects in the Greater Yellowstone Area and Central Montana. We are incorporating results of these studies into a common framework to examine puma dispersal. In addition, this data is being used to examine other population parameters and develop monitoring methodologies. Using VHF and GPS locations obtained on known dispersing individuals we are attempting to meet the following objectives:

1. Develop and test a priori models of the potential landscape characteristics and anthropogenic factors influencing dispersal movements within each system.
2. Compare the relationship between disperser and adult cat habitat use.
3. Compare habitat models across systems to develop a robust model depicting areas likely to constrain or facilitate interpopulation connectivity. The resulting model is to be used in the management of puma populations at a landscape level.
4. Supply testable predictions and potential new directions for ongoing research into puma dispersal.

Research findings are expected to play a significant role in future puma management by supplying an empirically based understanding of population processes, and habitat characteristics that strongly influence population connectivity.

Progress and Status:

Over the past year our work has included:

1. Collaborating with other puma researchers to determine and prioritize information needs and incorporating data from across studies to meet them. The collaboration brings together research conducted by The Hornocker Wildlife Institute, Wildlife Conservation Society, and Montana Fish Wildlife and Parks. In addition we are working with Beringia South's ongoing puma research in Wyoming. In this area we deployed 2 GPS/Satellite collars on dispersing males last year and intend to deploy 1-2 more this winter.
2. We have incorporated life history and location data from all of these studies into a final database. Additionally, location data from MTFWP Garnet Mountain study has been attributed with habitat variables and is being analyzed to assess population vital rates and characterize habitat use.
3. We have developed a priori models of landscape and anthropogenic variables which may influence dispersal movements, as well as how these may differ between adult and dispersing pumas. These models are being tested using Generalized Linear Mixed Models both within and between study areas. The goal is to find a robust model depicting habitat use of dispersing pumas that can be used in gaining insights into dispersal ecology and on the ground management.

Effects of Rocky Mountain Elk on small mammals and nutrient cycling

Student: Elliott W.R. Parsons

Degree: Ph.D. DBS.

Advisor: John Maron

Funding Source(s):
US Department of Agriculture

Project Duration: 2006-2009

UM Project Affiliation:
WBIO - DBS - MTCWRU

Objectives:

My research examines how impacts of Rocky Mountain elk on plant community structure indirectly affect both small mammal populations and nutrient cycling. Specifically, we are 1) quantifying how elk influence small mammal populations and habitat structure, and 2) determining how elk influence plant community structure and how this in turn affects leaf litter biomass, decomposition, nutrient availability, and plant germination and growth.

Progress and Status:

Paired elk enclosure and control plots are employed to determine how elk impacts on vegetation influence small mammal populations and nutrient cycling. Summer 2008 was our 4th year of small mammal trapping. Trapping efforts to date show strong impacts of elk exclusion on rodent abundance and community structure. Leaf litter collected from 144 leaf litter traps deployed during 2007 show that gains in the number of deciduous stems that occurs in the absence of elk browsing results in greater amounts of deciduous leaf litter. We are using estimates of how elk exclusion influences the quality and quantity of litter to determine how elk influence nutrient cycling through changes in vegetation. In addition, concurrent work is revealing that litter decomposition rates for aspen, maple, and white fir leaves differ. Between August 2007 and May 2008, on average, aspen litter bags lost 66%, maple lost 50% and white fir lost 18% of their mass. These differences in rates of decomposition were unaffected by underlying differences in soil temperature where measurements were obtained.

Cause specific mortality of desert bighorn sheep lambs in the Fra Cristobal Mountains, New Mexico, USA

Student: Zachary Parsons

Degree: M.Sc. Wildlife Biology

Advisor: Dan Pletscher

Funding Source(s):
Turner Endangered Species Fund

Duration of Project: 2000– 2007

UM Project Affiliation:
WBIO – CFC

Abstract:

Desert bighorn sheep (*Ovis canadensis mexicana*) are an endangered species in New Mexico. Many of the small, isolated populations of desert bighorn are declining, and factors affecting their growth rates include low lamb recruitment and high mortality of adults due to cougar predation. No one has previously reported cause-specific mortality rates for desert bighorn lambs. My objectives were to determine the causes, extent, and timing of lamb mortality in the Fra Cristobal Mountains, New Mexico, USA. I tested 3 capture techniques during 2001 and 2002: approaching lambs on foot and restraining them by hand; jumping from a helicopter and restraining them by hand; and firing a net-gun from a helicopter. I captured 6 lambs by hand on the ground, 4 lambs by hand from the helicopter, and 11 lambs from the helicopter with a shoulder-mounted and skid-mounted net-gun. No injuries occurred to lambs or capture personnel. The hand capture technique allowed me to capture very young lambs. I then monitored lambs for mortality, and examined carcass and site characteristics to determine cause. I found that the primary proximate cause of lamb mortality was cougar predation, followed by golden eagle predation. Coyotes and bobcats did not kill lambs. Although 1 lamb died from pneumonia, disease was not a critical factor affecting lamb recruitment. I measured habitat characteristics at sites where adults and lambs were killed by cougars and paired control sites, and derived habitat characteristics at predation sites, relocation sites representing used areas, and random sites representing available areas. Visibility was lower at predation than control sites, while slope, elevation, and ruggedness were lower at predation than relocation sites, and predation sites were closer to water and roads than random sites. I suggest selective cougar control of habitual sheep killers over the short term may be an appropriate management strategy to enhance the recovery of desert bighorn populations, while recognizing the importance of carnivore populations to ecosystem health. Wildlife managers may consider prescribed burning to reduce vegetation encroachment and increase visibility and forage quantity and quality. Additionally, assessment of desert bighorn and cougar use of artificial water developments would be beneficial.

Completed Degree December 2007

Understanding territory size to improve estimates of wolf pack abundance and distribution

Student: Lindsey Rich

Degree: M.Sc. Wildlife

Advisor: Mike Mitchell

Funding Source(s):
Montana Fish, Wildlife, and Parks

Project Duration: 2008 - 2010

UM Project Affiliation:
WBIO – MTCWRU



Objectives:

1: Estimate average wolf territory size for Montana and determine if this size varies significantly throughout the state, annually, seasonally, or between nocturnal and diurnal periods.

2: Explore causes for the variation in size, shape, and distribution of wolf territories in Montana by modeling territory size as a function of:

- a. Human and road density
- b. Type of prey and prey density
- c. Land cover and land ownership
- d. Collared pack size and longevity
- e. Presence, longevity, and size of surrounding packs
- f. Livestock density and control actions as a result of depredations
- g. Slope and Elevation

3: Explore if wolves' have core areas of use and if they do, determine if these core areas can be modeled as a function of:

- a. Human and road density
- b. Type of prey and prey density
- c. Land cover and land ownership
- d. Livestock density and control actions as a result of depredations
- e. Slope and elevation
- f. Distance to territory edge
- g. Reproductive status of the pack

4: Determine if a patch occupancy model using hunter surveys can accurately (within $\pm 20\%$ of MFWP's minimum wolf pack count) estimate wolf pack abundance and distribution in Montana by modeling hunter detection probability of wolves as a function of:

- a. Hunter Density
- b. Road Density
- c. Land Cover

Progress and Status:

In my first semester I successfully put together my graduate committee consisting of my advisor, Mike Mitchell, as well as Dan Pletchser and Mark Hebblewhite and had them sign off on my course work. I have been working on my research proposal and will have it completed by the end of this semester.

In the spring we purchased 15 GPS7000 collars with Argos capabilities from Lotek Wireless. Over the course of the summer 8 of these collars have been deployed by Montana Fish, Wildlife, and Parks wolf specialists. Packs targeted for GPS collars have 4+ wolves, an established territory, are located in Montana, and serve as a representative sample of the variables I will be modeling in relationship to territory size. Only one wolf per pack is collared with a GPS collar. Trapping will continue until all of the collars are deployed or until weather no longer permits.

Blackfoot watershed cougar survival analysis and population modeling

Student: Hugh Robinson

Post Doc Researcher

Advisor:
Mike Mitchell and Mark Hebblewhite

Funding Source(s):
Montana Fish Wildlife and Parks

Project Duration: 3 Months

UM Project Affiliation:
MTCWRU - WBIO

Objectives:

The University of Montana was approached to provide a population model based on radio telemetry data collected by MFWP, that would provide insight into the population effects of hunting, and a baseline population trend for comparison to other population indices. In the absence of an annual complete census (something extremely rare in wildlife biology), stage based matrix models based on radio-collar data provide ecologists with an accurate and versatile tool to assess population growth. The goal of this report was to estimate vital rates (i.e. survival, maternity, and fecundity) from the radio collar data collected by MFWP, and then use these rates to produce a stage based matrix model to estimate population growth against which various population indices could be compared.

Progress and Status

Proportional hazard modeling of population components is complete, and survival rates have been calculated. We are currently awaiting further data from MFWP regarding immigration, emigration, and maternity rates. Once these final population parameters are quantified, population models will be completed.

Relationships between fire, caribou, wolves, elk and moose to aid prescribed fire and caribou recovery

Student: Hugh Robinson

Post Doc Researcher

Principal Investigator:
Mark Hebblewhite

Funding Source(s):
Parks Canada

Project Duration: 2008-1010

UM Project Affiliation:
WBIO

Objectives:

Woodland Caribou (*Rangifer tarundus caribou*) are listed as threatened within Alberta under the Wildlife Act and nationally under the Species at Risk Act (SARA). Banff and Jasper National Parks maintain populations of woodland caribou, although numbers in both parks have declined since the 1980s. Caribou declines outside of the national parks are thought to be related to habitat loss and increased mortality associated with resource extraction industries. For instance, forestry reduces habitat directly by cutting mature timber stands favored by caribou, while linear features (i.e. seismic lines and roads) associated with the oil and gas industry increase their exposure to predation. The cause of declines within the national parks, where resource extraction does not occur is less clear, however may also be related to predation and habitat loss.

Fire can influence caribou directly by altering habitat quality, and indirectly by influencing habitat use and movement patterns of other ungulates species and predators. The goal of this project is to provide Parks Canada with guidelines to optimize benefits from fire (e.g., providing habitat for grizzly bear, reducing mountain pine beetle attack risk) while minimizing negative effects on woodland caribou.

Progress and Status:

Year 1 of the project is complete. Field work over the past year included an aerial survey of ungulate populations in Jasper National Park and the capture and collaring of 20 female elk. Monitoring has accumulated approximately 200 telemetry locations and cause specific mortality of 5 collared animals (3 predation, 1 highway, 1 unknown). Other work has focused on the accumulation and construction of GIS baselayers for use in the construction of resource selection functions (RSFs) for each of the four focal species.

Preliminary results will be presented at the '88 Fires: Yellowstone and Beyond conference in Jackson, Wyoming, September 2008.

Monitoring grizzly bear populations with bear rub tree surveys

Student: Jeff Stetz

Degree: M.Sc. Wildlife Biology

Advisor: Christopher Servheen

Funding Source(s):
US Geological Survey
US Forest Service

Project Duration: 2002-2008

UM Project Affiliation:
WBIO



Objectives:

To develop a long term population monitoring program for grizzly bears in the NCDE using non-invasive genetic sampling. Recent research has suggested that the natural rubbing behavior of bears provides an opportunity to sufficiently sample a population to detect trends in the population size. These surveys also monitor distribution of bears in extremely remote locations where other methods are not feasible without extensive collaring and radio tracking.

Progress and Status:

During the 2004 field season we had approximately 210 field technicians working throughout the Northern Continental Divide Ecosystem (NCDE) collecting bear hair from both baited hair traps and unbaited bear rubs. Nearly 2,600 hair traps were established that season from which we collected 20,785 hair samples. We also surveyed 4,795 bear rubs 18,021 times. These surveys yielded 12,956 hair samples for genetic analyses.

Final genetic results were received late in 2006. We are continuing to present posters, papers, and workshops at various outlets including The Wildlife Society, the NCDE managers subcommittee of Interagency Grizzly Bear Committee (IGBC) meetings, and the International Association of Bear Managers and Researchers. We had one paper come out this spring, two papers accepted this summer, and will submit at least one more paper this fall. We have also made significant progress on analyzing grizzly bear density patterns across the NCDE, we received funding to expand our long-term monitoring work, and we are completing black bear hair sample analyses.

Currently, I am enrolled in two graduate seminar courses which will complete my required credits. My thesis is in its final review stage and I am scheduled to defend in October. I also continue to work full-time in West Glacier as a research associate with the USGS.

Population genetics of fisher in the Sierra Nevada

Student: Jody Tucker

Degree: Ph.D. Wildlife Biology

Advisor:
Mike Schwartz and Fred Allendorf

Funding Source(s):
U.S. Forest Service Pacific Southwest
Region
U.S. Fish and Wildlife Service
National Fish and Wildlife Foundation.

Project Duration: 2006-2009

UM Project Affiliation:
WBIO



Objectives:

Hair samples obtained by non-invasive sampling are being used to analyze genetic diversity and connectivity in the Sierra Nevada fisher population. A landscape genetic analysis is being conducted to identify landscape features influencing dispersal and migration. Historic genetic samples obtained from museum specimens are being used to evaluate past connectivity in the California population prior to a severe population decline in the early 1900's. Specific objectives are:

- 1.) Describe the population genetic structure and test the effects of prominent landscape features on gene flow.
- 2.) Estimate the population size.
- 3.) Evaluate historic population connectivity using ancient DNA.

Progress and Status:

In 2006-2007, 262 fisher hair samples were collected from the Sierra and Sequoia National Forest, and Yosemite and Sequoia-Kings Canyon National Parks. Samples have been genotyped at 10 microsatellite loci. Out of 262 fisher samples collected, 164 contained sufficient DNA to obtain individual genotypes (~62.5% success). 81 individuals have been identified with a low recapture rate between years. 2008 field work and genotyping is ongoing.

16 historic fisher DNA samples have been collected from the Smithsonian Museum of Natural History and permits have been issued to collect an additional 25 samples from the Museum of Vertebrate Biology in Berkeley, CA in September 2008.

Using non-invasive genetics to monitor snow leopard (*Uncia uncia*) in Bhutan and across its range.

Student: Tshewang Wangchuk

Degree: Ph.D. Wildlife Biology

Advisor: L. Scott Mills

Funding Source(s):

Nature Conservation Division, Bhutan
World Wildlife Fund – Bhutan
Programme

International Snow Leopard Trust
Snow Leopard Network
McArthur Foundation

Project Duration: 2008-2009

UM Project Affiliation:
WBIO

Objectives:

My ultimate research goal is to use non-invasive genetics to monitor snow leopard populations in Bhutan and across its range. To achieve this goal, I will address 4 specific research objectives:

1. Determine occupancy and distribution of snow leopards in Jigme Dorji National Park in Bhutan.
2. Determine presence or absence of structure among snow leopard populations in Bhutan and across its range.
3. Determine the possible causes of livestock depredation by snow leopard and seek ways to curb them.
4. Set up a conservation program that brings benefits to local communities while ensuring snow leopard survival.

Progress and Status:

The pre-proposal was approved by my dissertation committee. Funding for field work was secured from MacArthur Foundation, The National Geographic Society (Waitt Grant) and the International Snow Leopard Trust.

I attended the International Conference on Snow Leopard Conservation in Beijing, China, organized by WCS, ISLT and Panthera Foundation where my proposed research was discussed with several other snow leopard biologists from several range countries and international experts.

In Bhutan, three preliminary surveys have already been completed with good results. I've collected over 70 scat samples during the preliminary surveys which also provided me with crucial information for further survey planning. A survey and planning workshop will be conducted in the first week of September 2008 followed by field surveys in Jigme Dorji National Park and across Bhutan (September-October).

Other additional information:

I have been actively advocating government action on important conservation issues in Bhutan. One such issue involved the fragmentation of migratory pathways for Bhutan's national animal, the Bhutan takin (*Budorcas taxicolor whitei*). As a result of my initiative a ministerial team is to visit the site to explore alternatives. Another issue involves the up-coming Punatsangchhu hydropower megaproject. I am working through the media to initiate dialogue on this project to ensure ecological and social considerations are incorporated in its execution.

Factors leading to limited distribution of Marco Polo argali (*Ovis ammon poli*) in the Big Pamir region.

Post Doc Researcher: John Winnie

Principal Investigator:
Richard Harris

Funding Source(s):
Wildlife Conservation Society

Project Duration: 2008

UM Project Affiliation:
DECS



Objectives:

Preliminary information suggests that the argali population in the Big Pamir of Afghanistan is self-sustaining, at least in the near term, but that it is restricted to a very small area. In the long-term, this raises conservation concerns. Hypotheses that explain this limited distribution include hunting, grassland degradation, displacement by livestock, and natural (e.g., bio-climatic) factors. At present, however, there are few reliable data to support various hypotheses over others.

This project will use presence and relative abundance data obtained primarily from fecal samples (supplemented by direct observations during both summer and winter seasons) as the dependent variable in a suite of models that explore the level of support enjoyed by the various hypotheses. Independent variables will include information on vegetation condition and livestock distribution (obtained by direct field work and use of GPS data-loggers), hunting pressure (obtained from interviews), and various geographic factors (obtained via remote sensing and interpreted through GIS analyses). We will also estimate the size of the Big Pamir sub-population using mark-recapture methods based on DNA microsatellites obtained from argali feces.

Progress and Status:

During January-March 2008, our efforts were centered on a winter field expedition to the Big Pamir region of the Wakhan Corridor (following up our previous expedition of November/December 2007), and on acquiring, and preparing data for analyses and entry into a Geographic Information System (GIS). During summer 2008, we conducted additional field work in the Big Pamirs, concentrating on vegetation sampling in areas where we observed argali groups. We also collected additional fecal samples for food habits analyses, to be conducted by Zalmay Moheb, and Afghan M.S. student at Aligarh Muslim University in India. We have now collected over 300 fecal samples for DNA extraction, and have begun genotyping. One overflight of the area was contracted, which resulted in few argali being seen, but in some areas be identified as useful for further searching. The last field expedition, this one into the Little Pamir section near the Chinese border, was initiated in September 2008.

Monitoring program and assessment of coyote predation for Olympic marmots

Student: Julie Witczuk

Degree: M.Sc Wildlife Biology

Advisor: L. Scott Mills

Funding Source(s):
National Science Foundation
Olympic National Park

Duration of Project: 2005– 2007

UM Project Affiliation:
WBIO – CFC

Abstract:

The Olympic marmot (*Marmota olympus*) is an endemic species to the Olympic Peninsula, Washington State. Although nearly all of its range is enclosed within Olympic National Park, declines and local extirpations of the species have been documented. The most plausible driver of the decline appears to be an increase in predator pressure. My thesis had two main objectives. First, I investigated the role of non-native coyotes (*Canis latrans*) in causing marmot mortality. Through park-wide carnivore scat analysis I determined the spatial extent of coyote predation on Olympic marmots and the magnitude of coyote predation relative to other carnivore species. I used mtDNA analysis of scats to determine carnivore species and microsatellite markers for individual coyote identification. Out of 958 carnivore scats collected, 84% came from coyotes and 10.3% contained marmots. The proportion of scats containing marmots was highly variable across studied regions, ranging from 3% to 34%. Among 79 scats with marmot remains for which predator species identification with mtDNA was successful, 85% arose from coyote, 10% from bobcat (*Lynx rufus*) and 5% from cougar (*Puma concolor*). Twelve out of 13 coyote individuals identified with genetic markers included marmots in their diet. Overall, occurrence of marmot remains in coyote scats observed could be considered high, especially if relatively low marmot densities are taken into account, supporting the potential for coyote predation to be the main driving factor of the observed marmot declines and extinctions. For my second objective, I designed a large scale, long-term monitoring program for marmot populations in Olympic National Park accounting for financial constraints. The monitoring program is designed to reflect extinction recolonization dynamics via park-wide occupancy sampling. The sampling design is based on annual surveys of a set of at least 25 randomly selected clusters (closely located groups of polygons with record of current or historical occupancy by marmots), and 15 additional polygons to test for recolonizations.

Completed Degree Fall 2007.

Twice the mice: Indirect effects of fire on forest dynamics?

Student: Rafal Zwolak

Degree: Ph. D. Wildlife Biology

Advisor: Elizabeth E. Crone

Funding Source(s):
RJVA, McIntire-Stennis Grant

Project Duration: 2003-2008

UM Project Affiliation:
DBS-OBE

Collaborators:
Dean E. Pearson (FS RMRS)
Yvette K. Ortega (FS RMRS)

Objectives:

After fires, deer mouse populations often increase more than twofold. We tested whether this increase is due to changes in food availability, particularly conifer seeds, and whether elevated seed predation alters conifer recruitment, addressing basic questions about interactions between mammals and trees, and applied questions about whether mice warrant management as pests in regenerating forests.

Specifically, we have:

1. Evaluated whether changes in food could dramatically elevate mouse populations.
2. Quantified the seed removal by deer mice in burned and unburned forest.
3. Determined whether deer mice exhibit preference for ponderosa pine over Douglas-fir seeds.
4. Evaluated the effect of deer mouse seed predation on recruitment of ponderosa pine and Douglas-fir seedlings

Progress and Status:

Our project is in the final stages of data analysis. Our preliminary conclusions are as follows:

1. Food resources (seeds and/or insects) are NOT elevated in burned areas. However, experimental data on deer mouse foraging suggests that post-fire simplification of habitat may improve mouse foraging success.
2. In seed predation trials, overnight seed removal in burned forest reached 88.8%, whereas in unburned forest equaled only 40.6%.
3. Deer mice demonstrated only slight preference for ponderosa pine seeds over Douglas-fir seeds, removing on average 67.4% of the former and 62.1% of the later.
4. In closed germination cages (rodents excluded), seedling emergence was low in unburned areas (2.3% for ponderosa pine and 11.7% for Douglas-fir) but considerably higher in burned forest (20.0% for ponderosa pine and 56.0% for Douglas-fir). Emergence in cages with openings that allowed access by deer mice was extremely rare (0.0% in burned forest and 0.9% in unburned forest) and did not differ between tree species.

Our study demonstrates that fire creates favorable conditions for seedling emergence but seed predation by deer mice obliterates this advantage.

NON-THESIS PROJECTS



Conservation and status of Markhor (*Capra falconeri*) in the northern parts of North West Frontier Province, Pakistan

Student: Sajjad Ali

Degree: M.Sc. Wildlife Biology

Advisor: Dan Pletscher

Funding Source(s):
Shikari Safari Club International
Foundation

Project Duration: 2006 - 2008

UM Project Affiliation:
WBIO – MTCWRU



Objectives:

Pakistan is blessed with a great variety of wild flora and fauna, including a rich diversity of wild Caprinae (sheep and goats) represented by 7 species divided into 12 subspecies. These animals are found in Balochistan and Sindh in the south and the North West Frontier Province (NWFP) and Northern Areas in the north. Markhor is a wild goat which belongs to the family Bovidae and sub family Caprinae. In 1992, it was transferred from Appendix II to Appendix I of the Convention on International Trade in Endangered Species of Wild Flora and Fauna (CITES). The inclusion of markhor in Appendix I brought an end to the trophy hunting program for markhor which was initiated by the North West Frontier Province Wildlife Department (NWFP WD) in 1983. In 1993, the NWFP WD involved local communities in conservation of wildlife through notifying Community Game Reserve Rules under the Wildlife Act of 1975. In 1997, with special approval of CITES, the NWFP WD launched the community-based markhor trophy hunting program in the Province. Eighty percent of the permit fee is deposited in a Village Conservation Fund (VCF) as an incentive to encourage involvement of local communities in conservation of markhor and other associated wildlife species. This has resulted in a positive change in the attitudes of local people towards wildlife which led to an increase in the population of markhor in community managed conservation areas (CMCA). The markhor conservation program in CMCA was as effective as in government managed protected areas. Credit for this achievement goes to the NWFP WD for involvement of the local community in conservation of natural resources. In NWFP, markhor face a number of threats that include habitat fragmentation, dependence of local communities on natural resources, unawareness, poaching, and lack of conservation funds making conservation of markhor a challenging task both for the government and local communities. The community-based markhor conservation program in NWFP succeeds due to the economic incentive. Uncertainty prevails about the sustainability of this program because a complete ban on markhor trophy hunting by government and/or non-government conservation organizations could occur. For the long term sustainability of the markhor conservation program, it is essential to explore alternative means of income and to build the capacity of local communities in the field of conservation.

Progress and Status:

Completed non-thesis degree May 2008.

Management effectiveness of Chitral Gol National Park, North West Frontier Province, Pakistan

Student: Mohammad Ayaz Khan

Degree: M.Sc. Wildlife Biology

Advisor: Dan Pletscher

Funding Source(s):
Shikari Safari Club International
Foundation
Bart O'Gara Memorial Fund

Project Duration: 2006 - 2008

UM Project Affiliation:
WBIO – MTCWRU



Objectives:

Protected areas are instrumental in conservation of biological diversity, providing a continuous sustainable flow of goods and services to people, and maintaining balance in ecosystems. However, the range and quality of environmental, social, and economic benefits realized from protected areas depends upon their effective management. Protected area managers, donors, and other conservation organizations are struggling to enhance management effectiveness of protected areas to achieve the desired objectives. Management assessment is the door way to improved management which includes assessment of inputs, processes, strategies, implementation, results, and gap identification. Management assessment not only helps managers learn about past management, but also provides a base for future planning. I assessed the management effectiveness of Chitral Gol National Park in the NWFP of Pakistan since its establishment (1984). I used three different approaches: analysis of Markhor (*Capra falconeri*) populations; the WWF/World Bank tracking tool; and socio-economic data. However, Markhor as a management indicator makes the crux of the report due to the availability of 18 years (1989 to 2006) data on the Markhor population. The results show the management of the Park is effective in achieving the objective of its establishment. There is a pressing need to establish a comprehensive database covering all aspects of management (biological, social, and administrative) for comprehensive assessment. I also recommended focusing on education and awareness of local communities living around the Park. Research by students, establishment of PA website, PA conferences at national and provincial levels, establishment of a wildlife institute, provision of equipment, and capacity building of the protected area manager are imperative for enhancing the management effectiveness of protected areas in the country. I also conclude that a network of contiguous protected areas is more effective than a single isolated protected area. Trans-boundary management of Chitral Gol with Afghanistan will help conserve flagship and keystone species like Markhor, Snow leopard (*Uncia uncia*) and other associated wildlife on a larger landscape.

Progress and Status:

Completed non-thesis degree May 2008.

Aspects of Environmental Education in North West Frontier Province, Pakistan

Student: Mohammad Niaz

Degree: M.Sc. Wildlife Biology

Advisor: Dan Pletscher

Funding Source(s):
Shikari Safari Club International
Foundation
Bart O'Gara Memorial Fund

Project Duration: 2006 - 2008

UM Project Affiliation:
WBIO – MTCWRU



Objectives:

With the increase in human population and technological development, environment-related problems have grown complex and challenging. Human activities have resulted in deterioration of landscapes, forests, wetlands, rangelands, wilderness, wildlife, and natural areas. Major international conferences in 1970s focused on improvement of environmental quality through environmental education programs. Environmental education, a lifelong process, focuses on different target groups for developing positive and responsible environmental behavior through experiential learning. I focused on different aspects of Environmental Education (EE) in the North West Frontier Province of Pakistan. Because EE deals with developing a positive change in attitude, I focused on three target groups including teachers, students, and the public because of their indispensable role and inter-relationship with the environment. I examined relevant documents such as policies, plans, and strategies of governmental and non-governmental, environment-based organizations and agencies in NWFP. All the documents and developmental interventions highlight approaches to EE but lack practical implementation and a proper assessment mechanism. Therefore, EE programs occur in less than one per cent of the total schools in the province due to the fact that it is not prioritized and infused into the curricula. I not only identified existing gaps in approaches and implementation process of the EE programs but also provided guidelines for effective awareness and education programs. There is a dire need for development of an EE database, coordination among environment-based organizations, experiential learning, infusion of EE into existing curricula, and capacity building of teachers in conducting meaningful EE programs. Schools and local communities both in urban and rural areas need extensive and intensive focus to effect a behavioral change. I conclude that long-term, conservation-based projects as well as informal and proactive approaches to promoting EE would help encourage environmental awareness and participation of different target groups. Traditional teaching methods through formalistic lecturing should be replaced with enquiry-based and environment-based learning.

Progress and Status:

Completed non-thesis degree May 2008.

Wildlife Biology

Student: Tshering Tempa

Degree M.Sc. Wildlife Biology
(Professional Paper)

Advisor: L. Scott Mills

Funding Source(s):
Bhutan Trust Fund for
Environmental Conservation

Project Duration: 2006-2009

UM Project Affiliation:
WBIO

Objectives:

To developed Wildlife Biology Curriculum and teaching Modules for Wildlife Conservation and Management in Bhutan

Progress and Status:

Developed curriculum for Basic Ecology and Wildlife management to be taught at Ugyen Wangchuck Environment and Forestry Institute in Bhutan. This will be the first college-level wildlife biology course to be taught in Bhutan. I will finish my Professional Paper M.S. this September and then start teaching in the spring.

Conservation of pheasants in North West Frontier Province (NWFP), Pakistan

Student: Iftikhar Zaman

Degree: M.Sc. Wildlife Biology

Advisor: Dan Pletscher

Funding Source(s):
Shikari Safari Club International
Foundation
Bart O'Gara Memorial Fund

Project Duration: 2006 - 2008

UM Project Affiliation:
WBIO – MTCWRU



Objectives:

Pheasants belong to the avian order Galliformes and are important environmental indicators. Among 49 species of pheasants in the world, 5 of them are endemic to Pakistan with distribution in the Himalaya and remote northern parts of the country. Due to increase in human population, encroachment, poaching, and habitat disturbance pheasants are threatened and vulnerable. Besides ecological importance of pheasants they have also aesthetic values which mainly contribute to their decline in population in wake of poaching in their native local habitat. Because cheer pheasant was extirpated locally and other pheasants were declared endangered or threatened by the IUCN, the NWFP wildlife department started a captive breeding program in early 1980s for these pheasants and their subsequent re-introduction into suitable habitat in the province. I focused on different initiative, interventions, and relevant documents to compile a comprehensive report on conservation of pheasants in the NWFP. Established in early 19980s, captive breeding program in Dhodial Pheasantry in district Mansehra has served not only as an ex-situ conservation tool but also as a platform for reintroduction of pheasants. Awareness and public education programs are also being implemented in different areas as a tool for conservation of pheasant at a larger scale. The Wildlife Department involved local communities in effective conservation of wildlife resources on sustainable basis. Review of documents and interventions of different conservation-based organization has shown that pheasants' surveys are not conducted in a proper, systematic, and consistent manner. There is a lack of in-depth research, effective survey protocols, and database on the basis of which estimate of wild population cannot be ascertained. There is a lack of coordination and networking among conservation-based organizations and the NWFP Wildlife Department has to struggle for finances and support. I recommend that regular pheasant survey must be ensured and international organizations must implement projects in core zones of these valuable birds. Database should be developed and properly maintained for effective assessment and implementation of projects in the future. Poaching and lack of public awareness about these birds are also main contributing factors. For education and awareness, intensive and extensive programs must be carried out to sensitize people about importance of these birds: and for discouraging poaching there is a dire need to strictly implement existing rules and regulations.

Progress and Status:

Completed non-thesis degree May 2008.



High country citizens science training

Student: Jami Belt

Degree: M.Sc. Wildlife Biology

Advisor: Paul Krausman

Funding Source(s):

Glacier National Park Fund
National Park Service

Project Duration: 2008- 2009

UM Project Affiliation
WBIO – Boone and Crockett



Objectives:

1. Use observational data gathered at least 3 times per season during 1 hour surveys by volunteers (citizen scientists) to develop an estimate of abundance and distribution of mountain goats in Glacier National Park.
2. Conduct a temporal population count ("mountain goat days") in mid- August at all survey sites to determine the efficacy of this approach as an annual population index. This will be done in conjunction with aerial mountain goat surveys to compare detectability of goats during ground and aerial methods.
3. Enlist volunteers to conduct surveys at known talus habitat sites and to identify additional pika habitat to assess detectability of pikas.
4. Develop sampling protocols for volunteer- based long-term monitoring of mountain goats and pikas to detect potential climate change impacts.
5. Assess efficacy of observational data from volunteers as a means of developing population and distribution estimates.

Progress and Status:

I have mapped 36 mountain goat and 20 pika survey sites. I have trained 74 volunteers and 12 Glacier National Park employees as citizen scientists to survey mountain goats and pikas. To date citizen scientists have complete 134 mountain goat surveys (including at least one survey at 31 of the 36 mountain goat surveys sites during July/early August and one survey at 35 of the 36 mountain goat survey sites during "mountain goat days". I am aiming to have each site surveyed at least once more this season. I am developing a GIS-based view shed analysis of each site to determine the portion of suitable potential mountain goat habitat that is visible .

Surveys have been conducted 34 surveys at 13 of the 20 pika sites, but many of the pika sites have not been accessible until recently due to persistent snow covering their talus habitats. Citizen scientists have surveyed and documented 12 additional pika sites.

Population dynamics of an invasive plant: Direct and indirect effects are influenced by environmental context

Student: Kim Crider

Degree: Ph. D. Wildlife Biology

Advisor: Elizabeth Crone

Funding Source(s):
USDA Forest Service Student Career
Experience Program
McIntire Stennis

Project Duration: 2004-2008

UM Project Affiliation:
WBIO

Objectives:

The goal of this study was to determine the effects of a native predator (carpenter ants) and herbivory by a biological control agent, *Tyria jacobea* (cinnabar moth) on the population dynamics of its host plant, *Senecio jacobaea*, a noxious, invasive plant in Northwest Montana.

The following objectives were set to meet this goal:

1. Determine the effects of herbivory by the cinnabar moth on the population dynamics of tansy ragwort using herbivore addition and exclusion experiments to construct stage structured matrix models to quantify the population dynamics of tansy ragwort in different environments.
2. Determine the effects of predation by native ants on the survival and subsequent efficacy of cinnabar moth larvae as biological control agents for controlling tansy ragwort.

Progress and Status

The field work for this research was completed in 2007 and this project is currently in the data analysis and writing phase. Preliminary results suggest the potential control of tansy ragwort by the cinnabar moth is influenced by the environmental context of the site. At dry sites, the cinnabar moth is more effective at reducing the population growth rate of tansy ragwort. However, dry sites also harbor a higher abundance of native carpenter ants, common predators of cinnabar moth larvae. The presence of ants at these sites effectively reduced the effects of cinnabar moth larvae as folivores of tansy ragwort. This pattern was reflected in plant fitness, as larvae survived and consumed more flowers and seeds on plants from which ants were excluded, compared to plants that were accessible to ants. In general, this work emphasizes the importance of environmental context in influencing plant insect interactions, and the importance of monitoring to determine causes and consequences of biological control programs.

Transient dynamics in population modeling

Student: Martha M. Ellis

Degree Ph.D. Wildlife Biology

Advisor: Elizabeth Crone

Funding Source(s):
National Science Foundation

Project Duration: 2006-2011

UM Project Affiliation:
WBIO



Objectives:

Demographic population models play an essential role in informing management decisions by condensing a wide variety of information on a species' biology into a few key statistics. The validity of these models and their analyses rely on many assumptions, that are often violated in real populations. For example, model analyses are based on long-term population dynamics to guide management, even though we are often interested in the short-term fate of a population. While theoretical ecologists have demonstrated the potential for important differences between long and short-term (transient) dynamics, it is unclear whether the actual differences that occur are large enough to affect model interpretations.

I am developing general framework for deciding if or when it will be necessary to consider transient responses in model applications. I am using a survey of published models to develop a baseline of how frequently large differences in short- and long-term dynamics occur and simulating these models to determine whether the differences that actually occur in these populations are large enough to affect commonly used statistics. Secondly, I will apply these analyses in a case study on the interactions of invasive plants, herbicide, and population dynamics of a native plant species, Arrow leafed balsamroot, to investigate whether transient dynamics influence model interpretations in a larger management framework.

Progress and Status:

Currently, I am working on developing a database of studies to use in my baseline analysis. This fall, I will use 3-5 of these studies to begin developing programming code to conduct transient analyses across studies. Population monitoring for Arrowleafed balsamroot continued this summer, and we are considering reapplying management treatments.

A risk assessment framework for defining scientifically-defensible recovery goals for listed species

Post-Doc Researcher:

Cynthia Hartway

Principal Investigator: L. Scott Mills

Funding Source(s):

SERDP Department of Defense

US Geological Survey

Project Duration: 2006 - 2008

UM Project Affiliation:

WBIO - MTCWRU

Objectives:

Our objective is to develop and test tools to improve management of listed species on Department of Defense (DoD) installations. This project is collaborative with the Wildlife Co-op units at University of Idaho and University of Wyoming. The primary goal of the UM portion of this project is to develop guidelines for prioritizing management actions for species of concern for which little data exists. We combine a systematic review of the effects of management actions on key life history attributes for well-studied species (for example, the effect of predator removal programs on bird nest success) with a demographic modeling approach to determine how alternate management actions should translate to changes in population growth for data-poor species. We will disseminate this information to land managers in a helpful way to guide on the ground decision making.

Progress and Status:

We have completed our extensive review and meta-analyses on the effects of common management actions on vital rates. In sum, we have quantitative information on the effect of 5 common management actions (controlled burns, grazing/mowing, predator removal, contaminant removal and herbivore removal) on survival and reproductive rates for 169 species from 5 taxonomic groups (amphibians, birds, mammals, plants and reptiles). To determine the effect of these management actions on potential population growth of data-poor species, we have developed a population modeling approach that requires only basic life history information (e.g., age at reproductive maturity, maximum lifespan and reproductive output, etc.). Tailoring these models to the life history of specific species of concern, we can map the parameter space for which population growth is positive, negative or stable. We combine these results with our review data regarding which vital rates can be altered and by how much by management actions to formulate broad guidelines on the efficacy of alternate management options. Our results will also be pertinent to prioritizing research or data collection efforts. We are in the process of developing a website that displays these results in an easy-to-use graphical format.

A secondary objective of our project evaluates existing methods for determining population trend from count data. We developed a trend estimation method that works well even with multiple observations missing from the time series. Because the status quo in monitoring programs for most agencies is to strive to obtain an unbroken time series, even if funding or logistic constraints lead to poor abundance estimates, our finding is revolutionary: we argue that that trend estimates may be improved by diverting effort away from annual monitoring and towards increasing time series length or improving precision of the abundance estimates for years that data are collected.

Scientific Papers and Reports

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- Wilson, R. R., and **P. R. Krausman**. 2008. Possibility of heart-related mortality in desert ungulates. *Arizona-Nevada Academy of Science* 40: 12-15.
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- Woolf, J. C.**, and **F. W. Allendorf**. 2008. Population structure and dispersal of black backed woodpeckers, a disturbance-dependent species. Unpublished report to the Bureau of Land Management, Missoula, MT.
- Woolf, J. C.**, and **F. W. Allendorf**. 2008. Population structure and dispersal of black backed woodpeckers, a disturbance-dependent species. Unpublished report to Montana Fish Wildlife and Parks, Helena, MT.
- Woolf, J. C.**, and **F. W. Allendorf**. 2007. Population structure and dispersal of black backed woodpeckers, a disturbance-dependent species. Investigator Annual Report to Glacier National Park, West Glacier, MT.
- Zwolak, R.**, and **K. R. Foresman**. 2008. Deer mouse demography in burned and unburned forest: no evidence for source-sink dynamics. *Canadian Journal of Zoology* 86: 83-91.

Zwolak, R. 2008. Ogniu, kroc za mna: ekologia i polityka pozarow lasow Ameryki Polnocnej. [Fire walk with me: Ecology and politics of forest fires in North America] *Wiadomosci Ekologiczne* 53: 191-200. - with English summary.

Presentations and Posters

- Ausband, D. E., M. S. Mitchell,** C. Mack, M. S. Nadeau, and P. Zager. 2007. Developing a monitoring framework for wolves in Idaho. Annual Meeting, Montana Chapter, The Wildlife Society, Missoula, MT.
- Barton, D. C.** 2008. Does food limitation, nest predation, or adult mortality explain variation among species in within-species reaction norms of provisioning rate to brood size? AOU/COS/SCO Joint Meeting, Portland, OR.
- Benson, A.** December 2007. Life history and ecology of bull trout in the Clearwater River Basin. Clearwater Resource Council meeting, Seeley Lake, MT - December 2007.
- Benson, A., L. A. Eby,** L. Knotek, and J. Thabes. February, 2008. Evaluating effects of small dams on migratory bull trout in the Clearwater River Drainage, Montana. Montana Chapter of the American Fisheries Society, Billings MT.
- Benson, A., L. A. Eby,** L. Knotek, and J. Thabes. October, 2008. Evaluating effects of small dams on migratory bull trout in the Clearwater River Drainage, Montana. Montana Chapter of the Society for Conservation Biology meeting, Missoula, MT.
- Biancucci, L., and T. E. Martin.** 2008. Does Nest Predation Favor Smaller Nests In The Tropics To Explain Smaller Clutch Sizes? The Lill-Snow Hypothesis Tested. 126th Stated Meeting of the American Ornithologists' Union, Portland, Oregon.
- Bush, K.L., C.L. Aldridge, **A. Battazzo,** J. Carpenter, **K. Doherty,** B. Moynahan, H. Sauls, **J. Tack, B. Walker, D.E. Naugle,** C.A. Paszkowki, and D. Coltman. 2007. Genetic diversity analysis of the Northern Montana sage-grouse population and in Alberta. Alberta Wildlife Society Conference. Canmore, AZ.
- Bush, K.L., C.L. Aldridge, **A. Battazzo,** J. Carpenter, **K. Doherty,** B. Moynahan, H. Sauls, **J. Tack, B. Walker, D.E. Naugle,** C.A. Paszkowki, and D. Coltman. 2007. Genetic diversity analysis of the Northern Montana sage-grouse population: consequences for the management of the endangered Canadian sub-populations. 8th Prairie Conservation and Endangered Species Workshop. Regina, Saskatchewan.
- Cheng, E., L.S. Mills** and K.E. Hodges. 2008. A comparison of non-invasive genetic and traditional approaches to estimating animal abundance. Doñana National Park, Seville, Spain (*Invited*).
- Cheng, E., L.S. Mills** and K.E. Hodges. 2008. A comparison of non-invasive genetic and traditional approaches to estimating animal abundance. Northwest Section of The Wildlife Society Annual Meeting. Spokane, WA.
- Cheng, E., L.S. Mills** and K.E. Hodges. 2008. A comparison of non-invasive genetic and traditional approaches to estimating animal abundance. Montana Chapter of The Wildlife Society Annual Meeting. Missoula, MT.
- Cheng, Y., and T. E. Martin.** 2008. The effect of nest predation and foraging behavior on differential growth strategies of passerines. 126th American Ornithological Union meeting, Portland, Oregon.

- Cleveland, S.**, M. Thompson, and **M. Hebblewhite**. 2008. Habituation, Hunting, and Recreation: Understanding Human Influences on Elk Behavior in the Wildland-Urban Interface. Montana Chapter of the Wildlife Society Annual Meeting, Missoula, MT.
- Corsi, M. P., P. Spruell**, and C. E. Corsi. 2008. Managing Hybrids: Explicit Recognition of Assumptions. Annual Meeting of the American Fisheries Society, Ottawa, ON.
- Crider, K. K.** 2008 Direct and indirect effects of predation on weed biological control. Ecological Society of America – 2008 Annual Meeting, Milwaukee, WI.
- Crone, E. E.** and P. Lesica. 2007. Rare plant monitoring in Glacier National Park. Glacier NP Science and Natural History Day, Montana. (*Invited*)
- Crone, E. E.** 2007. Managing invasive plants and weeds in the American West. American Voices Seminar, University of Turku, Turku Finland (*Invited*).
- Crone, E. E.** 2007. Synchronous flowering and pollen limitation in a perennial wildflower. University of Helsinki, Helsinki, Finland (*Invited*).
- Crone, E. E.** 2007. Spatial ecology and conservation of the Fender’s blue butterfly. University of Alberta, Edmonton, Alberta, Canada (*Invited*).
- Crone, E. E.** 2008. Spatial ecology and conservation of the Fender’s blue butterfly. Stockholm University, Stockholm, Sweden
- Crone, E. E., E. Miller** and A. Sala. 2007. Mast-seeding in a perennial wildflower: testing the pollen coupling hypothesis, poster presented at the Ecological Society of America Annual Meeting.
- Crone, E. E.** 2008. Synchronous flowering and pollen limitation in a perennial wildflower. University of Queensland, Brisbane Australia (*Invited*).
- Crone, E. E.** 2008. Synchronous flowering and pollen limitation in a perennial wildflower. University of Oslo, Oslo, Norway (*Invited*).
- Crone, E. E.** 2008. Is bad habitat good? Response of the Fender’s blue butterfly to partial habitat restoration. Future of Butterflies in Europe Symposium, Wageningen, The Netherlands
- DeCesare, N. J.** November 2007. What drives caribou population growth? West-central Alberta Caribou Research Workshop, Calgary, Alberta, Canada.
- DeCesare, N. J., J. R. Squires, J. A. Kolbe,** and L. F. Ruggiero. February 2008. Hierarchical den selection of Canada lynx in western Montana. Annual Meeting of the Montana Chapter of The Wildlife Society, Missoula, MT.
- DeCesare, N.J.** April 2008. Canada lynx and the Endangered Species Act. Guest lecture: Forestry 275 – Wildlife Conservation, University of Montana, Missoula. MT.
- Dennis, B., J-Y Humbert, **L. S. Mills** and J. S. Horne. 2008. Estimating ecological trend: which model should I use? Society for Conservation Biology, Chattanooga, TN.

- Hammond, C. A. M., M. S. Mitchell,** and G. Bissell. 2008. Estimating territory occupancy, colonization, and extinction rates for common loons in northwest Montana. Annual Meeting, Montana Chapter, The Wildlife Society, Missoula, MT.
- Harris, R.B.** 2008. Moving toward a modern wildlife conservation system in China. The Nature Conservancy, Beijing office, China.
- Harris, R.B.** 2008. Wildlife conservation in China. Laguna Woods reform temple association, Laguna Woods, California.
- Hartway, C., L.S. Mills,** and M. Kauffman. 2008. Generalizations developed from existing data can be used to guide management for data-poor species. Society for Conservation Biology, Chattanooga, TN.
- Hartway, C., L.S. Mills,** and M. Kauffman. 2007. New tools for prioritizing management actions for species of concern on Department of Defense lands. Partners in Environmental Technology Technical Symposium, Washington, D.C. (*Invited*).
- Hopping, K., E. Miller, E. E. Crone** and A. Sala. August 2007. Do these cones make me look fat? Unexpected patterns of resource allocation in whitebark pine, poster presented at the Ecological Society of America Annual Meeting.
- Krausman, P. R.** 2007. Wildlife on the edge: crossing to the other side. Plenary presentation (Leopold Award Presentation), 14th Annual meeting of The Wildlife Society, Tucson, Arizona.
- Krausman, P. R.** 2007. Society's responsibility to consider cumulative effects on wildlife resources. 14th Annual meeting of The Wildlife Society, Tucson, Arizona.
- Loya, T. M., D. E. Ausband, M. S. Mitchell,** and C. M. Mack. 2008. A novel, automated remote sensing tool for detecting wolves. Annual Meeting, Montana Chapter, The Wildlife Society, Missoula, MT.
- Martin, T.E.,** American Fisheries Society – 2007 – Climate change consequences for trophic structure and interactions of a high elevation riparian system (*Invited*)
- McCaffery, M.** 2008. Influence of beaver on brook trout invasion and native westslope cutthroat trout displacement in southwest Montana. Society for Conservation Biology. Chattanooga, TN.
- McCaffery, M.** 2008. Influence of beaver on growth and distribution of two fish species. The Wildlife Society, Montana Chapter. Missoula, MT.
- McCaffery, M.** 2008. The influence of beaver on brook trout invasion and native westslope cutthroat trout displacement. American Fisheries Society, Montana Chapter. Billings, MT.
- McCaffery, M.** 2007. Impacts of beaver activity on invasive brook trout and native westslope cutthroat trout in southwestern Montana. The Wild Trout Symposium. West Yellowstone, MT.
- McCaffery, R.** and B. A. Maxell. 2008. Dynamics of Columbia spotted frog populations in three mountain basins. Society for Conservation Biology Annual Meeting, Chattanooga, TN.
- McCaffery, R.** and B. A. Maxell. 2008. Patterns and consequences of size at metamorphosis in the Columbia spotted frog. Montana Chapter of The Wildlife Society annual Meeting, Missoula, MT.

- Merkle, J.** 2008. Interactions between gray wolves and coyotes in Yellowstone National Park. Montana Chapter of The Wildlife Society, Missoula, Montana.
- Mills, L. S.,** J-Y Humbert, J. S. Horne and B. Dennis. 2008. Is my population recovering, decreasing, or stationary? Improving the status quo for estimating exponential trend from count data. Society for Conservation Biology, Chattanooga, TN.
- Naugle, D. E., K. E. Doherty, B. L. Walker,** M. J. Holloran, and H. E. Copeland. 2008. Greater sage-grouse and energy development in western North America. 26th Western Agencies Sage and Columbian Sharp-Tailed Grouse Workshop, Mammoth Lakes, CA.
- Naugle, D. E.** 2008. Cumulative impacts of energy development on wildlife resources. Invited speaker, Symposium on Our Changing Landscape: Oil and Gas Development: Impacts to Wildlife, Hunting and Angling. Montana Wildlife Federation, Great Falls, MT.
- Naugle, D. E.** 2008. Wildlife and energy development. Ecology Seminar Series, Montana State University, Bozeman, MT. (*Invited*)
- Naugle, D. E.,** and **F. R. Quamen.** 2008. Conservation planning for grassland birds in Minnesota and Iowa. Crossing the Medicine Line Network Spring Forum, sponsored by Parks Canada and The Nature Conservancy, Elkwater, AB, Canada. (*Invited*)
- Robinson, H. S, M. Hebblewhite,** M. Musiani, and C. White. 2008. Caribou-Fire Relationships in the Canadian Rockies National Parks. Montane Ecosystem Science Workshop. Banff National Park, Banff, AB. (*Invited*)
- Robinson, H. S, M. Hebblewhite,** M. Musiani, and C. White. 2008. Caribou-Fire Relationships in the Canadian Rockies National Parks. Canadian Parks for Tomorrow. University of Calgary, Calgary, AB.
- Robinson, H. S.,** R. B. Wielgus, H. S. Cooley, and S. W. Cooley. 2008. Sink populations in carnivore management: cougar demography and immigration in a hunted population. 9th Mountain Lion Workshop. Sun Valley, ID.
- Sprague, R.S.,** B.J. Zaun, and **C.W. Breuner.** 2008. Effects of glucocorticoid physiology, age, and environment on parental behavior in albatross. American Ornithological Union Annual Meeting: Portland, OR.
- Sprague, R.S.,** B.J. Zaun, and **C.W. Breuner.** 2008. Parental behavior in albatross: integrating glucocorticoid physiology, age, and environment. International Symposium on Avian Endocrinology: Leuven, Belgium.
- Sprague, R.S.,** B.J. Zaun, and **C.W. Breuner.** 2008. Re-evaluating parental investment strategies in albatross: a physiological perspective. Pacific Seabird Group Annual Meeting: Blaine, WA.
- Sprague, R.S.,** B.J. Zaun, and **C.W. Breuner.** 2008. Re-evaluating parental investment strategies in albatross: a physiological perspective. Society for Integrative and Comparative Biology Annual Meeting: San Antonio, TX.
- Stenglein, J., C. Mack, **D. E. Ausband, M. S. Mitchell,** P. Zager, and L. Waits. 2008. Evaluating the use of noninvasive genetic sampling for monitoring gray wolves in Idaho. Annual Meeting, Idaho Chapter, The Wildlife Society.

- Tack, J.D.**, and D.E. Naugle. 2008. Habitat Use by sage-grouse in the milk river basin. Rangeland Diversity Workshop, Glasgow, MT.
- Tack, J.D.** and **D.E. Naugle**. 2008. Life on the edge: conservation of a trans-boundary sage-grouse population. 26th Western Agencies Sage and Columbian Sharp-tailed Grouse Workshop. Mammoth Lakes, CA.
- Tack, J.D.** 2007. Habitat-Use by Sage-Grouse: Examining Limiting Resources for a Northern, Endangered Population. The Montana Student Chapter of the Wildlife Society, Missoula, MT.
- Tack, J. D.** 2007. Sage-grouse research in the Milk River Basin: an update of findings and future directions. Glasgow Sage-Grouse Local Working Group Meeting. Glasgow, Montana.
- Tucker, J.M.**, Allendorf, F.W., Schwartz, M.K., and R.L. Truex. February 2008. Landscape genetics of fisher in the Sierra Nevada. Montana Chapter of the Wildlife Society. Missoula, MT.
- Walker, B.L., **D.E. Naugle**, and **J.D. Tack**. 2008. West Nile virus: ecology and impacts on greater sage-grouse populations. 26th Western Agencies Sage and Columbian Sharp-tailed Grouse Workshop. Mammoth Lakes, CA.
- Woolf, J.C.** 2008. Population structure and dispersal of black backed woodpeckers, a disturbance-dependent species. Otago University, Dunedin, New Zealand.
- Woolf, J.C.** 2008. Population structure and dispersal of black backed woodpeckers, a disturbance-dependent species. Victoria University, Wellington, New Zealand.
- Woolf, J. C., F. W. Allendorf, and M. K. Schwartz.** 2008. Large scale genetic structure of black-backed woodpeckers. AOU/COS/SCO Annual Meeting. Portland, OR.
- Woolf, J. C., F. W. Allendorf, and M. K. Schwartz.** 2008. Contrasting patterns of mitochondrial and nuclear genetic structure in black-backed woodpeckers. Evolution. Minneapolis, MN.
- Woolf, J. C., F. W. Allendorf, and M. K. Schwartz.** 2007. Large scale genetic structure of black-backed woodpeckers. The 14th Annual Conference of The Wildlife Society. Tucson, AZ, September 22-26, 2007.
- Zwolak, R.** 2008. Effects of wildfire and forest harvest on North American small mammals - a metaanalysis. American Society of Mammalogists, Brookings, SD.

Honors and Awards

Daniel Barton

NSF Graduate Research Fellowship, 2007-2010

Frances F. Roberts Award for Outstanding Student Presentation, Cooper Ornithological Society, 2008

Aubree Benson

George E. Bright Memorial Fellowship, 2007

George and Mildred Cirica Scholarship, 2007

Ellen Cheng

University of Montana Diversity Advisory Council Student Achievement Award, 2008

University of Montana International Leadership Recognition, 2008

Bertha Morton Scholarship, 2008

National Science Foundation Doctoral Dissertation Improvement Grant, 2008

Christine Stevens Wildlife Award, 2008

Best Student Presentation (PhD), Montana TWS conference, 2008

University of Montana Graduate Council Dissertation Award, 2008

Yi-Ru Cheng

Taiwan MOE Study Abroad Scholarship 2005-2008

Matt Corsi

Montana Water Center Fellowship, 2008

Elizabeth Crone

Fulbright Fellowship, 2007-2008 (Lecturing & Research at the University of Helsinki)

Chris Hammond

Best Student Presentation (MS), Montana TWS Conference, 2008

Heather Johnson

Canon National Parks Science Scholar, 2008

Tom Martin

Promoted to Senior Scientist, US Geological Survey

Magnus McCaffery

Bertha Morton Scholarship, University of Montana, 2008

Rebecca McCaffery

Bertha Morton Scholarship, University of Montana, 2008

Elliott Parsons

George and Mildred Cirica Scholarship, 2008

Brian Schwartz

ARCS Center for Reproductive Biology Fellowship, Washington State University, 2008.

Rachel Sprague

National Science Foundation Doctoral Dissertation Improvement Grant, 2008/09

Outstanding Teaching Award, College of Forestry and Conservation, UM, 2008

American Ornithological Union Student Travel Award, 2008

Jody Tucker

Cirica Family Scholarship, 2008

Jenny Woolf

American Association of University Women American Fellowship, 2008

Rafal Zwolak

Bertha Morton Scholarship, University of Montana, 2008