Montana Cooperative Wildlife Research Unit

Report of Activities for the Coordinating Committee Meeting
April 2015

Cooperating Agencies
U. S. Geological Survey
Montana Fish, Wildlife and Parks
The University of Montana
Wildlife Management Institute
U. S. Fish and Wildlife Service

Project and fiscal information included in this report:
01 April 2014 through 31 March 2015

Montana Cooperative Wildlife Research Unit
The University of Montana
Natural Science Building – Room 205
Missoula, MT 59812
Ph: 406-243-5372
Fax: 406-243-6064
www.umt.edu/mcwru
mtcwru@umontana.edu

Table of Contents

Coordinating Committee Members

U. S. Geological Survey

F. Joseph Margraf
Supervisor Cooperative Research Units
U. S. Geological Survey
Box 25046 MS 406 DFC
Denver, CO 80225-0046

Wildlife Management Institute

Chris Smith
Wildlife Management Institute
5450 Tumbleweed Drive
Helena, MT 59602

U. S. Fish and Wildlife Service

Noreen Walsh, Regional Director
Mountain-Prairie Region
134 Union Boulevard
Lakewood, CO 80228

Jeffrey Warren
Wildlife Biologist
27650 B South Valley Rd
Lima, Montana 59739

Montana Fish, Wildlife and Parks

Ken McDonald
Wildlife Bureau Chief
Supervisor
P.O. Box 200701
Helena, MT 59620-0701

Justin Gude
Wildlife Research & Technical Services

1420 East 6th Avenue
Helena, MT 59620

The University of Montana

Scott Whittenburg, Vice President
Office of Research and Creative Scholarship
Main Hall 116
Missoula, MT 59812

Winsor Lowe, Program Director
Wildlife Biology Program
Forestry 311C
Missoula, MT 59812

Unit Staff

Mike Mitchell, Unit Leader
Thomas E. Martin, Assistant Unit Leader
Tina Anderson, Accounting Manager

Graduate Students Advised by Unit Faculty

Mike Mitchell

David Ausband, PhD Candidate
Sarah Bassing, MSc Candidate
Nathan Borg, MSc Candidate *
James Goerz, MSc Candidate
Charles Henderson, MSc Candidate *
Mark Hurley, PhD Candidate
Allison Keever, PhD Candidate
Sarah Sells, PhD Candidate
Jeff Stetz, PhD Candidate

Tom Martin

Andrew Boyce, MSc Candidate
Karolina Fierro-Calderon, MSc Candidate
Joseph LaManna, PhD Candidate
Adam Mitchell, MSc Candidate
James Mouton, MSc Candidate
Juan Carlos Oteyza, PhD Candidate
Riccardo Tom, PhD Candidate

Unit Faculty on Graduate Students' Committees

Mike Mitchell

Dan Eacker, MSc Candidate
Karolina Fierro, PhD Candidate
Jessie Golding, MSc Candidate
Charlie Henderson, PhD Candidate
Theresa Laverty, Ph. Candidate
Devin Landry, MSc Candidate
William Janousek, PhD Candidate
Anna Moeller, MSc Candidate
Juan Oteyza, MSc Candidate
Wesley Sarmento, MSc Candidate
Keith Slauson, PhD Candidate
Derek Spitz, PhD Candidate
Robin Steenweg, PhD Candidate
Tshering Tempa, PhD Candidate
Tshewang Wangchuk, PhD Candidate
Sara Williams, PhD Candidate

Tom Martin

David Ausband, PhD Candidate
Katie Baer, MSc Candidate
Sara Berk, PhD Candidate
Ryan Hegstad, PhD Candidate
Joseph Smith, PhD Candidate

Research Associates:

Connor Armstad
Julia Brandauer
Amy Macleod
James Nowak
Ahvi Potticary
Keith Slauson

Research Assistants:

Alissa Anderson
Janelle Badger
Kristin Barker
Allesandro Bartollo
Kelly Bartron
Stephen Brenner
Sam Case
Ellie Cosgrove
Cecily Costello
Olivia DaRugna
Taylor Dowell
Adam Fahnstock
Eliana Fierro-Calderon
Eric Fishel
Lila Fried
Sofia Haggberg
Alan Harrington
Sean Harris
Luke Hawk
Wieteke Holthuijzen
Maureen Hurd
Chelsea Hutton
James Klarevas-Irby
Sam Lane
Rabecca Lausch
Anna Lello-Smith
Randi Lesagonicz
Jon Linch
Taylor McDowell
William Medlicott
Thatcher Montgomery
Matthew Nordhagen
Alicia Omilid
Ryan Richards
Abigail Sage
Danielle Salganek
Toryn Schafer
John Schoen
Mary Schvatz
Casey Setash
Jillian Soller
Franklin Settler
Amber Swicegood
Thomas Thalhuber
Kyle VanAtta
Derek White
Ryan Wilbur
Ethan Young

Work-Study/Non-Work Study:

Kate Amsden
Abigail Asan
Emily Cohen
Nikita Cooley
Cayla Daly
Jeremy Deal
Julian Jamerson
Danielle Kelly
Josephine Kerrigan
Susan Keiser
Kaleah Mantanona
Evan Miller
Alexa Morris
Stephanie Parker
Christine Peterson
Brittani Radford
Kaitlyn Reintsma
Chris Lloyd
Skylar Sargent
Tayler Scherr
Dominique Slack
Hilary Turner
Callan Ward
Jeremy Welch
Kelsey Whitaker
Jennifer Youbles

DIRECTION STATEMENT

The Montana Cooperative Wildlife Research Unit performs research designed to address the needs of cooperators, bridging the gap between applied and basic wildlife science. Our studies provide new insights useful to management and conservation, based on understanding the ecological mechanisms that underlie habitat requirements and demography of individual and coexisting wildlife species. Research emphases within the Unit include ecology and management of carnivores, applied landscape ecology, management of large game, interactions between forest management and wildlife, environmental influences (predators, habitat, ungulates) on demography and diversity of birds, habitat requirements and community ecology of birds, and comparative demography and life history strategies of birds in differing environmental and geographical contexts. Other research topics are addressed as needed, in keeping with the Cooperative Research Program's mission to best meet the needs of the Cooperators by remaining flexible and open to new areas of inquiry. When Cooperator's needs occur outside Unit expertise, the assistance of appropriate University faculty will be recruited.

Unit staff will advance the training and education of graduate students at the University of Montana by teaching up to one graduate-level course per year in wildlife science, chairing graduate committees of Unit students, and serving on graduate committees of non-Unit students. Technical support and training will be provided to Cooperators and other agencies as the need exists.

Unit and Administrative Operating Funds

U.S.G.S. – Cooperative Research Units – Administrative Funds U of Ma		
Full-time Administrative Associate - Salary/Benefits	39,623	
SPABA – FY12 IDC returned to Unit in FY15	101,888	
Montana Fish, Wildlife and Parks Operating Funds	20,000	
Subtotal		**$ 161,511**

FY 2015 – Research Projects and Increase in Funding

T. Martin – PI		
New Funding:		
EPA Star Fellowship Award	42,000	
USGS – Climate and Habitat Change	100,000	
NSF – A New Theory of Clutch Size Evolution	536,534	
UM Research Administration – Graduate Support	46,000	
Subtotal		**$ 724,534**
Continued Funding:		
NSF – Graduate Research Fellowship	44,000	
USGS – Climate and Habitat Change	365,000	
The Bair Ranch Foundation – Aspen Study	100,000	
Colciencias Fullbright Scholarship	16,000	
NSF – Historical Influence/Biodiversity in Tropical Asia	1,326,915	
Subtotal		**$1,851,915**
M. Mitchell – PI or Co-PI		
New Funding:		
Computer Prog. Support – Mule Deer – Idaho Fish & Game	60,000	
Improving Ungulate Sampling – Mule Deer – Idaho Fish & Game	28,000	
Evaluating Occupancy – Mule Deer – Idaho Fish & Game	87,236	
Montana Wolf Monitoring – MTFWP	81,536	
Moose Demography – Washington Fish & Game	72,000	
MTFWP - Sage Grouse Research	88,523	
Bitterroot Elk Calf Modeling	13,145	
Subtotal		**$ 430,440**
Continued Funding:		
MTFWP – Big Horn Sheep	13,200	
NSF Fellowship	44,000	
NCDE Grizzly Bear Demographics	37,600	
Washington Fish & Game – Graduate student support	20,000	
Gift/UM Foundation Funding for Wolf Research	46,063	
National Park Service - Humboldt-Marten Prey	31,329	
U.S.G.S. – Migratory Birds	162,816	
Rocky Mountain Elk Study	45,000	
Waterton Biosphere - Test Monitoring Wolves	90,000	
Access Land-Use Migratory Birds	133,000	
Sage Grouse Genetics – Graduate student Support	21,500	
Subtotal		**$ 644,508**
Total Budget		**$3,812,908**

Completed Projects – 1 January 2014 – 31 December 2014

End Date	Principal Investigator	Funding Agency	Title
September 2014	Charlie Henderson	Washington Dept. of Fish & Wildlife	Linking resource selection with survival in female white-tailed deer
December 2014	Sarah Sells	MT Fish, Wildlife, & Parks	Proactive management of pneumonia epizootics in bighorn sheep in Montana

MTCWRU – Federal and State Vehicles

Description	Tag number	Odometer as of 3/31/2015
1999 Ford Truck, Extended Cab Pickup 4 x 2	FED 252524	100,131
2006 Ford F250 Crew Cab Pickup, 4 x 4	FED 430965	95,306
2010 Ford Expedition 4 x 4	FED 433441	34,285
2011 Ford F250 Crew Cab Pickup, 4 x 4	FED 433440	17,660
2011 Ford F250 Crew Cab Pickup, 4 x 4	FED 433610	17,060
2012 Dodge 1500 Crew Cab 4 x 4	FED 433621	19,153
1997 Chevy Suburban, 3/4 ton, 2wd	UM 7787	152,142
1998 Ford Taurus 4 Door Sedan	UM 7623	128,086
2005 Ford Explorer 4 x 4	UM 3787	126,875

BIRDS

Release of a Violet-Fronted Nuthatch

Fledglings – Photos by Juan Oteyza

The fight for space: Exploring the role of competition and physiological tolerance in limiting elevational distributions and structuring communities in tropical birds

Student: Andrew Boyce

Degree: PhD Candidate

Advisor: Tom Martin

UM Affiliation: Wildlife Biology Program
Montana Cooperative Wildlife Research Unit

Project Duration: 2011 – 2016

Funding Sources:

- National Science Foundation
- The University of Montana
- Montana Cooperative Wildlife Research Unit
- American Ornithologists Union

Objectives

I am conducting an observational and experimental study to investigate the importance of competition and physiology in limiting species distributions. Groups of closely-related species with abutting, non-overlapping elevational ranges are key components of biodiversity and endemism in the tropics and have been documented across taxa (Cadena et al. 2011). However, the mechanisms underlying this pattern are poorly understood. I will perform playback to determine the degree to which pairs of species compete and possible limit each other's ranges. I am also measuring physiological tolerance to temperature among closely-related species that exist at different elevations to determine if adaptation to a particular range of temperatures could limit the elevations at which a given species could persist. Additionally, I will be examining phylogenetic community structure across elevationally stratified bird communities. Phylogenetic community structure, or the degree to which species in a community are related to one another, is thought to reflect the relative importance of interspecific competition and environmental filtering in a given community (Losos 1996, Webb 2000, Graham 2009).

Progress and Status

I am currently in the midst of my fourth field season at Kinabalu Park on the island of Borneo. The bulk of my fieldwork at the moment is continuing to gather physiological data on a broad array of species in the lower reaches of the park after having completed similar work at high elevation. I am also continuing point counts and playback experiments around park headquarters to bolster those datasets. Two side-projects have also cropped up – 1) Working with Dr. Rob Fleischer and the Smithsonian Conservation Genetics lab to examine gene flow on both spatial and elevational gradients, and 2) Gathering metabolic data at a second field site (Arizona) to facilitate comparisons between metabolic rates of tropical and temperate birds.

Delineating greater sage-grouse conservation units to preserve genetic variation across a changing landscape

Obligated Funding: $165,094

Student: Todd Cross
Degree: PhD Candidate
Advisors: David Naugle & Michael Schwartz
Project Duration: 2011-2016
UM Affiliation: Wildlife Biology Program; MTCWRU
Funding sources: Bureau of Land Management
USDA NRCS – Sage Grouse Initiative
Montana Fish, Wildlife & Parks
U.S. Geological Survey – Research Work Order 99

Objectives

The greater sage-grouse (*Centrocercus urophasianus*) is a charismatic icon of the western sagebrush landscape, ranging across 11 Western states and 2 Canadian provinces. Sage-grouse rely on sagebrush habitat for food, nesting, and spring breeding congregations known as leks (the male lek display can be viewed here: http://goo.gl/KAuIPd). Sagebrush habitat is rapidly being fragmented and lost due to anthropogenic impacts including subdivision, agricultural tillage, energy development, and invasive species. Resultantly, sage-grouse currently occupy only 56% of potential pre-western settlement habitat but are warranted but precluded from the Endangered Species Act due to higher priority actions. Habitat loss and fragmentation and overall range contraction have heightened concerns regarding the risk of local population extinction due to the severing of genetic connectivity.

The conservation and management of sage grouse requires a detailed understanding of how landscape change influences gene flow, genetic dispersal, and genetic population structure. Therefore, my team of laboratory technicians and I are partnered with multiple state, federal, and non-governmental organizations to gain a more comprehensive understanding of greater sage-grouse genetic connectivity across the species' entire range. We are using non-invasive collecting techniques, and molecular genetics monitoring tools in a landscape genetics framework to:

1. Assess the relative importance of individual leks in the network of leks across the range.
2. Determine the importance of the persistence of individual leks to maintaining range-wide genetic connectivity.
3. Test multiple hypotheses about which landscape and environmental features are critical to maintain genetic connectivity, and which features hinder gene flow among leks.
4. Identify corridors of conservation priority to be included in updating resource management plans.
5. Model connectivity between and within the thirteen recently designated Montana Fish, Wildlife & Parks core breeding areas.

Progress and Status

To date, we have:

- analyzed DNA from 8861 genetic samples, collected from 837 leks across ID, MT, ND, and SD. From these 8861 samples we have identified 3972 individuals using a 21 locus microsatellite panel.
- used the microsatellite genotypes to identify genetic substructure across ID, MT, ND, and SD. We are currently confirming the robustness of our results, and have begun to identify the landscape and anthropogenic factors that may influence these patterns.
- applied network theory analyses to examine genetic connectivity of the population network across the range. These approaches are allowing us to identify the importance of each individual lek to maintaining range-wide genetic connectivity, and to examine the effects of different management scenarios on overall genetic network connectivity.
- developed an enrichment assay designed to target and capture genome-wide DNA sequence for over 80,000 single nucleotide polymorphisms (SNPs) associated with gene function. We have already begun using this assay to capture over 8.5 million base pairs of DNA sequence from each individual analyzed, from which we will learn a great deal about the greater sage-grouse genome and about functional variation (SNPs that affect gene function) across the species' range.

Understanding Variation in Habitat use Among Orange-Crowned Warblers "Oreothlypis celata" in Central Arizona, USA

Student: Karolina Fierro

Degree: PhD Candidate

Advisor: Thomas E. Martin

UM affiliation: Wildlife Biology Program
Montana Cooperative Wildlife Research Unit

Project duration: 2012 - 2016

Funding source:

- Montana Cooperative Wildlife Research Unit
- University of Montana
- Scholarship "Francisco Jose de Caldas" COLCIENCIAS and FULBRIGHT Colombia

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Objectives

Classic habitat selection theory predicts that individuals will choose habitats that confer higher fitness. Yet, we see cases where individuals use habitats associated with low reproductive success, even if highly suitable habitat is available. Using a 20-year dataset of Orange-crowned warblers (*Oreothlypis celata*) in Arizona, I will examine first what factors determine territory suitability. Furthermore, I propose two hypotheses that might explain variation in territory use. My hypotheses state that low-quality individuals may not always experience low reproductive success, as the Ideal Despotic Distribution affirms, but instead might increase their fitness, and therefore the territory suitability, via two strategies. These low-quality individuals may use territories with 1) higher variation in the survival probability of multiple nest sites, which will increase the cumulative survival probability of the territory, and 2) higher variation in the survival probability of eggs, nestlings and fledglings, which may increase territory suitability. Hence, I suggest that natural selection may favor different habitat selection strategies in both high- and low-quality individuals that allow them to achieve similar fitness.

Progress and Status

- I started my first field season at the Coconino National Forest, Arizona, on May 2012. During three months, I collected preliminary data about the distribution of territories, interspecific interactions, and foraging strategies of my four ground-nesting bird species.
- My research proposal was approved by my doctoral committee in December 2013. I have been collecting data on survival probability of fledglings and carrying out my experiment in order to determine the cumulative survival probability of multiple nest sites within the territories.
- I started a new experiment last summer 2014 in order to test the Public Information hypothesis and have more data to publish the first chapter of my dissertation.
- I passed my comprehensive written exams in the fall 2014 and I will finish all my classes in the spring 2015.

Assessing land use practices on the ecological characteristics of sagebrush ecosystems: multiple migratory bird responses

Obligated Funding: $477,620

Student: Jessie Golding

Degree: MSc Candidate

Principal Investigator: Mike Mitchell and Victoria Dreitz

Project Duration: 2012 – 2015

UM Affiliation: Wildlife Biology Program
Montana Cooperative Wildlife Research Unit

Funding source:

- US Fish and Wildlife Service – Plains and Prairie Pothole Landscape Conservation Cooperative ($417,620)
- Bureau of Land Management ($30,000)
- Montana Fish, Wildlife and Parks ($30,000)
- Stacie Ann DeWolf Memorial Scholarship, Wildlife Biology Program, University of Montana (03/2014) - $1,200
- Montana Fish Wildlife and Parks Nongame Program Grant, $10,000 (8/2013 and 8/2012)
- Hunting GPS Maps Equipment Grant, $1,000 (4/2013)
- Les Pengelly Scholarship, Wildlife Biology- University of Montana, $2,100 (03/2013)

Objectives

- Evaluate the impact of rest-rotational grazing on migratory songbird community structure in sagebrush landscapes.
- Determine the relationship between abundance of migratory songbirds and habitat quality in sagebrush landscapes.

Progress and Status

Migratory songbird populations, particularly those associated with sagebrush habitats, are in decline throughout most of their range in the US. Habitat loss and alteration are primary drivers of this decline. Livestock grazing is one of the most common land uses in the US and is known to alter habitat and associated wildlife communities. Recognizing this power, natural resource managers use grazing as a management tool to achieve conservation goals. Rest-rotation grazing is one such tool that is likely to enhance important components of sagebrush, shrubland, and grassland habitat for a wide range of species; however, little work has been done to evaluate impacts of rest-rotation grazing on migratory songbirds. Therefore the aim of my project is to determine how rest-rotation grazing affects migratory songbird communities and the relationship between songbird abundance and habitat quality.

I have completed a pilot season, 2012, and two years of songbird monitoring, 2013-2014. I developed a novel multispecies abundance model to assess the impact of rest-rotational grazing. Preliminary results indicate that rest-rotation grazing does significantly alter avian communities, although the impact varies by species. Final results will be available in Fall 2015.

Effects of aspen forest restoration on songbird distributions and reproductive success

Student: Joseph LaManna **Obligated funding: $382,000**

Degree: PhD Candidate

Advisor: Thomas E. Martin

Project Duration: 2009-2015

UM Affiliation: Wildlife Biology Program
Montana Cooperative Wildlife Research Unit

Funding Sources:

- The Bair Foundation
- Montana Fish, Wildlife and Parks
- Environmental Protection Agency – STAR Fellowship Program

Objectives

Understanding features that enhance bird diversity, sustain avian populations, and determine reproductive strategies and success is of great interest to science and conservation, especially in Aspen because these forests are declining across western North America. Aspen forests are biodiversity hotspots in North America, and conifer encroachment into aspen stands may be associated with population declines of a variety of organisms dependent on this community type, including many species of birds. Conifer trees have been removed from some aspen stands as one management treatment that can increase aspen survival and recruitment, and similar treatments are being planned and executed across western North America. However, the effects of such forest treatments on wildlife populations, such as breeding birds, are unknown. Conifer removal greatly alters predator communities and vegetation structure, which may strongly affect bird populations within the treated aspen stands. Therefore, I am interested in understanding how bird communities utilize aspen forests before and after treatments to improve management decisions and to test hypotheses regarding habitat selection and reproductive strategies. More specifically, we want to know how changes in predator and plant community assemblages influence songbird diversity, habitat selection, and reproductive strategies and success.

Progress and Status

Bird diversity, predator abundance, various measurements of reproductive success, and vegetation structure were surveyed during the 2009-2014 songbird breeding seasons. Bird diversity has been monitored each year with intensive point counts. A total of 2,697 nests from 45 songbird and woodpecker species were found and monitored during the six field seasons. Results indicate that nest predation risk of songbird species largely determines their distributions along natural aspen-conifer gradients and with experimental conifer removal. These results have been accepted for publication in the journal *Ecology* (to be published May 2015). I am also preparing for publication a global meta-analysis and review of the effects of logging on avian communities as well as a paper examining anti-predator responses of bird species to increased predation risk. I plan to defend my dissertation this May.

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

Obligated Funding: $915,015

Principal Investigator: Thomas E. Martin

Project Duration: 1985-ongoing

UM Affiliation: Montana Cooperative Wildlife Research Unit

Funding Source:

- U.S. Geological Survey – Research Work Order 92
- National Science Foundation

Objectives

Measure and examine: 1) annual variation in avian nest success and predation, adult survival, population size, habitat selection, parental care behaviors, and physiological metrics, 2) small mammal density and species composition, and 3) 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 for 32 bird species by affecting trophic levels below (plants) and above (predators) them based on study of their populations and >17,000 nests over the past 26 years. Winter snowfall has declined strongly across the 26 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 25 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 show a large effect on aspen recruitment and ground cover, and a slower but increasing effect on maple and locust recruitment; plant abundance and diversity (e.g., increased perennial flower diversity) have increased in the 6 years since fence establishment. In addition, several bird species 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 growth, and subsequent effects on higher trophic levels (birds, small mammals), as well as the interaction among these trophic groups. The results will have important implications for elk and ecosystem management in this vulnerable habitat type. This project also has a strong training component, training up to 20 students each year in a diversity of field techniques and conduct of hypothesis-testing science.

Historical and contemporary influences on elevational distributions and biodiversity tested in tropical Asia

Obligated funding: $1,325,620

Principal Investigator: Thomas E. Martin

Project Duration: 2013-2017

UM Affiliation: Montana Cooperative Wildlife Research Unit

Funding Sources:

- National Science Foundation

Objectives

This is a continuation of the previous Borneo project measuring demographic and life history strategies (clutch size, nest predation, development rates, parental care, adult survival rates) of bird species in montane Malaysian Borneo (Kinabalu Park) to compare with U.S. and tropical Venezuelan birds studied at similar elevations. This new grant adds new objectives related to measuring metabolic sensitivity of adults and offspring to temperature variation, possible role of competition in constraining elevational ranges, measuring dispersal through both capture/recapture and gene flow, and measuring genetic differentiation across elevations and among islands. Examine the relative importance of nest predation, food limitation, and adult mortality on variation in demography and life history strategies. This new project adds collaborations with scientists from Smithsonian to add population genetics, and from University of Kansas and Louisiana State University to add genetic differentiation at larger spatial scales.

Results

We are currently working on our third year of data collection in tropical Borneo because it retains large blocks of pristine forest at mid-elevation from 1450 to 1950 m elevation. In the past five seasons, 2,913 nests were found and monitored, nestling metabolism and nestling growth measured, parental care video-taped, and egg temperatures quantified. In addition, 3,189 new individuals were banded, and a total of 4,838 recapture/resight events were accrued to aid in estimating adult survival and renesting efforts. Nest predation rates show an elevational gradient where predation increases with elevation in the range we are working. Estimation of adult survival showed that survival rates were quite high, and adult survival explained variation in parental effort at keeping embryos warm to influence their development. Data collected on both adult and nestling metabolism shows that species vary strongly in their sensitivities to temperature, but we have not yet examined whether this can explain elevational distributions as more data are still needed. The importance of temperature suggests that global warming may be particularly important to long-term reproductive success of tropical birds. Work on genetic variations continues.

This work continues to include an important training component for young US and Malaysian scientists. The perception that reproduction cannot be studied in the field is corrected by training young scientists in the conduct of this field work. 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.

A new theory of clutch size evolution: Consequences of morphology at fledging on mobility and survival interacting with parental energy expenditure (FMR)

Obligated Funding: $536,534

Principal Investigator: Thomas E. Martin

Project Duration: 2014-2017

UM Affiliation: Montana Cooperative Wildlife Research Unit

Funding Source:

- National Science Foundation

Objectives

Measure and examine: 1) nest predation and nestling growth strategies, 2) fledgling mobility and survival of 7 species that differ in their developmental stage at fledging, and 3) parental effort during the nestling and fledgling stages in a high-elevation riparian ecosystem in north-central Arizona.

Progress and Status

This new work began in field season 2014 in the long-term Arizona system. It includes new work on fledgling survival, which can be a critical influence on overall demography but is poorly studied across species. It also includes measurement of adult energy expenditure across species for the first time, which can affect adult survival and, thereby, also have strong demographic effects that have not been tested across species. We are measuring fledgling flight mobility, spatial dispersion and rate of self-feeding as a function of age and morphology at fledging. I will examine the consequences of variation in these characters across species for parental energy expenditure per offspring, measured using doubly-labeled water, and fledgling mortality rates, measured using radio transmitters. I am conducting brood reduction experiments on all 7 species to separate and test alternative hypotheses. I am measuring parental energy expenditure during the late nestling and early fledgling stages across the 7 species to test: 1) whether energy demands are greatest during the fledgling stage and 2) that parental energy expenditure per offspring increases as fledgling mobility decreases and thereby limits the number of young (i.e., clutch size) raised.

This project will continue to have a strong training component, training up to 10 students each year in a diversity of field techniques and conduct of hypothesis-testing science.

Life history strategies of high elevation tropical birds

Student: **Adam Mitchell**

Degree: MSc – Wildlife Biology Candidate

Advisor: Thomas Martin

Project Duration: 2014 – 2016

UM Affiliation: Wildlife Biology Program
Montana Cooperative Wildlife Research Unit

Funding Sources:

- University of Montana
- Montana Cooperative Wildlife Research Unit
- National Science Foundation (NSF)

Project summary

Organisms have a wide range of life history strategies, both within and across species, and within and across geographic regions. These different strategies fall along a continuum from fast to slow, with fast species living short lives, having high annual reproductive output, and fast growth and development, while slow species often have the opposite traits. The mechanisms that cause these differences are still not thoroughly understood. One example that has received much attention is the pattern of life history strategies of animals across latitudinal gradients, such that tropical organisms lie on the slower end of the life history continuum and temperate organisms lie on the faster end. This has been widely studied in vertebrates, and particularly so in birds.

A much less studied gradient in life history strategies is along elevational gradients. Both within and across species, birds breeding at higher elevations lay fewer eggs and grow and develop slower than birds at lower elevations. I am testing a new hypothesis that the harsh abiotic conditions (e.g. temperatures, rainfall) proximately constrain the growth and development rates of high elevation birds.

Progress and status

I am one-third through my first season, and so far El Niño has created drought conditions at my field site. This has yielded heavy breeding from the birds, but not ideal conditions to try to experimentally mitigate harsh climate, as the climate has not been so harsh. In the meantime, I have been collecting a lot of samples for doubly-labeled water for warm/dry days. The next few months should bring significant rain, and I will begin experiments adding supplemental heat and rain covers to nests.

Plastic reproductive strategies in response to nest predation risk

Student: James C. Mouton

Degree: MSc Candidate

Advisor: Thomas E. Martin

Project Duration: 2013 – 2015

UM Affiliation: Division of Biological Sciences
Montana Cooperative Wildlife Research Unit

Funding Source:

- National Science Foundation
- Montana Cooperative Wildlife Research Unit
- The University of Montana

James in Arizona in 2012

Objectives

Life history theory predicts that organisms will allocate limited time and energy between current and future reproduction to maximize lifetime fitness. Age specific mortality can affect this allocation such that increased risk of offspring predation is expected to reduce reproductive value of current broods and decrease reproductive effort. Studies examining mortality patterns and evolved levels of reproductive effort across taxa support theory. Organisms may also plastically adjust overall reproductive effort and the expression of different life history traits (e.g. clutch size, food provisioning behaviors, growth and developmental rates) in response to variation in offspring mortality risk. Such plasticity can have important consequences for the rate of evolution and the persistence of populations in ecological time. However, we know little about plastic responses of life histories to changes in current brood reproductive value caused by offspring predation risk.

My research will examine how reduced brood value caused by nest predation risk affects reproductive effort expended by parents and growth and development in offspring in four songbird species. I will test the effect of nest predation risk on parental effort by manipulating the perceived level of risk and measuring parental energy expenditure. I will examine how nest predation risk affects offspring growth and development through the amount of food received by each nestling or prioritized development of traits required for nestlings to leave the nest and escape nest predation risk (i.e. endothermy and locomotor traits). Understanding the plastic responses of organisms to important sources of selection, such as offspring predation, is vital for a full understanding of life history evolution and can help explain ecological differences between populations.

Progress and Status

I will be manipulating the perceived level of predation risk at bird nests by playing recorded vocalizations from nest predators (i.e. Red Squirrels) and a songbird species that does not pose any threat to the study species. I will measure the daily energy expenditure of parents using doubly labeled water to examine the effect of nest predation risk on parental effort. I will also examine parental food provisioning strategies, nestling growth, and the age endothermy is achieved. I will began fieldwork in summer 2014 will continue work at least through the summer of 2015. All fieldwork will take place in the in high-elevation forested snowmelt drainages in the Coconino National Forest, AZ.

The influence of nest predation on parental and offspring strategies

Student: Juan C. Oteyza

Degree: PhD Candidate

Advisor: Thomas E. Martin

Project Duration: 2009 – 2015

UM Affiliation: Wildlife Biology Program
Montana Cooperative Wildlife Research Unit

Funding Source:

- National Science Foundation
- Montana Cooperative Wildlife Research Unit
- The University of Montana

Objectives

Predation is an important selective force which can have important consequences for prey populations. In addition to this direct effect, the perception of predation *risk* alone is itself powerful enough to affect wildlife population dynamics. Animals can assess predation risk and adjust their behaviors accordingly, thus making predation risk an important selective force that can have indirect consequences for populations. For example, predation on dependent offspring plays a central role in modulating avian life-histories. Specifically, nest predation can have important consequences on parental care (e.g. nestling feeding rates), nestling begging behavior, offspring growth strategies and, consequently, parent and offspring fitness.

Feeding rates may be sensitive to predation risk because activity at the nest (feeding trips) can attract visually oriented predators to the nest. Thus, proximately, when predation risk increases provisioning rates are expected to decrease, with negative consequences on energy available to offspring for growth. Yet, at an ultimate level increased predation risk should favor faster nestling growth and shorter development periods to reduce exposure to risk at the nest. This leads to an antagonistic interaction between the nestling's need to develop fast under constrained access to food resources.

Additionally, nest predation can be a selective force influencing nestling begging behaviors. Begging serves as a signal to solicit food which is thought to benefit young by leading to an increase in allocation of resources to the solicitor. However, begging can also incur a cost by attracting acoustically oriented predators to the nest. Nestling begging calls vary greatly in acoustic characteristics (e.g. frequency and amplitude) across species and theory predicts that offspring of species that are under high predation risk will evolve vocalizations that are harder to locate by predators.

Progress and Status

To better understand the relative importance of offspring predation risk as a selective pressure on parental care and nestling development strategies, I am experimentally manipulating the *perceived risk of nest predation* by broadcasting predator calls near nests. At these experimental nests I measure feeding and offspring development rates. During the 2012-2014 field season, predator playback experiments (and controls) were performed on nests of three species of passerine birds.

To test whether the structural characteristics of nestling begging calls correlate with nest predation rates, in 2012-2014 I recorded nestling begging calls at 138 nests of 22 species that show great variation in predation rates. Field work took place in the tropical montane forest of Kinabalu Park, in Malaysian Borneo. Data analysis and writing is currently underway.

Test of the Causes of Evolved Differences and Plasticity in Growth and Development Rates of Passerines Offspring Across Three Continents

Student: Riccardo Ton

Degree: PhD Candidate

Advisor: Thomas E. Martin

Project Duration: 2011 – 2015

UM Affiliation: Division of Biological Sciences –OBE
Montana Cooperative Wildlife
Research Unit

Funding Source:

- National Science Foundation
- The University of Montana

Objectives

The two overarching aims of my dissertation are: a) to test the role of temperature in causing the broad pattern of interspecific variation in development rates among ectothermic songbird embryos; b) to explore the role of interspecific variation in metabolism of endothermic offspring, potentially resulting from the differential selective pressure of predation, in contributing to interspecific variation in growth rate. To achieve these goals, I use an experimental and comparative approach among passerine species on three different continents.

Progress and Status

To achieve the above goals I spent three field seasons of data collection in a montane tropical forest in Borneo Malaysia, four seasons in a high altitude riparian system in Arizona, and one season of data collection in a third southern temperate field site in South Africa. I experimentally heated nests of 8 species covering a gradient of embryonic growth rates ranging from 12 to 25 days of incubation. I measured the metabolic rate of 104 embryos and 435 nestlings of these and other species. The field component of my research is now completed and I am focusing on data analysis and writing. I am currently submitting a paper that summarizes my result about the metabolic correlates of post-natal growth among species and latitudes. The scheduled date for the completion of my PhD is the fall of 2015.

Elk photo by Mark Hebblewhite

Wolf pup photo by S. Bassing

Effects of human-caused mortality on gray wolves

Research Associate: **David Ausband**

Project Duration: 2011 - 2015

UM Affiliation: Montana Cooperative Wildlife Research Unit

Funding Sources:

- Regina B. Frankenberg Foundation for Animal Welfare ($150,000)
- Leonard X. Bosack & Bette M. Kruger Foundation ($9,600)
- Bernice Barbour Foundation ($69,680)
- Eppley Foundation for Scientific Research ($24,000)
- Steven Leuthold Foundation ($31,000)
- Idaho Department of Fish and Game ($60,000)
- National Park Service ($7,500)
- U.S. Fish and Wildlife Service ($22,500)
- Alberta Conservation Assoc. ($5,000)
- Waterton Biosphere Reserve Association ($174,742)
- Shikar Safari Club International ($4,000)
- Coypu Foundation ($31,269)
- Alberta Environment and Sustainable Resource Development ($20,000)
- Nancy Carroll Draper Foundation ($10,000)
- Wesley M. Dixon Fellowship ($30,000)

Objectives

Wolves (*Canis lupus*) live in family groups comprising a breeding pair, their offspring, and several related helper wolves. Mortality, however, can affect this family group structure and result in smaller packs with adopted, unrelated individuals. Little is known about how characteristics of groups (i.e. size, composition, tenure) affect population growth. Furthermore, group characteristics may also affect individual behavior, group stability, and reproduction. States in the Rockies recently initiated public hunting and trapping seasons for gray wolves and our study is well-positioned to answer important questions about how that new source of mortality might affect gray wolf pack composition and reproduction.

Project and Status

Preliminary wolf population modeling shows that established packs (i.e., extant $\geq$ 3 years) have higher survival than nascent packs, particularly during periods characterized by high competition between packs. This lends support to our hypothesis that group stability may be important for wolf population growth. Full analyses and insights into the effects of wolf pack stability on population growth will be conducted once all of the data are compiled. We began genetically sampling wolves in Idaho in 2008 and currently have a multi-year dataset for packs in central Idaho that spans both before and after hunting and trapping began. We finished field surveys in summer 2014 in three focal study areas that encompass a range of human-caused mortality; Alberta, Idaho, And Yellowstone National Park. DNA analyses of collected samples are currently underway and will identify breeder, helper, and pup in every pack, i.e., a pack "pedigree." Tracking these pedigrees over time will allow us to examine how pack composition and recruitment change under the influence of human-caused mortality from hunting and trapping. Lastly, we have finished gathering wolf satellite-collar location data from multiple collaborators that can be used to answer questions about how wolf pack composition affects helping behavior in packs. Changes to pack composition may affect such helping behavior. We are currently preparing a manuscript that outlines the results of these analyses.

We have made substantial progress collecting the data necessary to adequately answer how packs affect population growth and how population management (i.e., hunting and trapping) might, in turn, affect packs. We plan to complete analyses and publish full study results in 2015.

Assessing gray wolf population dynamics under sustained harvest regimes in the Rocky Mountains

Obligated Funding: $230,000

Student: Sarah B. Bassing

Degree: MSc Candidate

Advisors: Mike Mitchell

Project Duration: 2014- 2016

UM Affiliation: Wildlife Biology Program
Montana Cooperative Wildlife Research Unit

Objectives

I began working for the Montana Cooperative Wildlife Research Unit in 2010 as a field technician and ran wolf rendezvous site crews in southwest Alberta for the past three years. Based on observations made in the field, genetic data, and wolf harvest data, wolf mortality appears to be particularly high in this region and few resident animals survive from one year to the next. Due to high harvest in southwest Alberta managers are unable to maintain radio collars in the wolf population and do not have current demographic estimates or a wolf monitoring program in place. Southwest Alberta is a working landscape; a mosaic of cattle grazing, oil and gas development, and outdoor recreation. Managers and local communities alike are keenly interested in the wolf population for management purposes but high turnover in the population makes long-term monitoring difficult. My objectives are to develop a wolf monitoring framework specific to the southwest Alberta region based on noninvasive monitoring methods and to better understand how current management practices are driving wolf population dynamics such as pack turnover and population growth.

Project

I began developing exploratory patch occupancy models to estimate wolf pack distribution and abundance in southwest Alberta prior to starting my graduate work in 2014. I plan to continue refining these models as part of my graduate research by testing additional covariates and finding innovative methods to address model assumptions in my study area. I will expand my models to a multi-season framework to estimate pack turnover rates through local colonization and extinction probabilities in an attempt to better understand this dynamic system. In addition, I will use the genetic data collected in southwest Alberta, as well as from concurrent work conducted in central Idaho, to better understand the impacts sustained, liberal harvest regimes have on wolf population growth. I am particularly interested in assessing source-sink dynamics in these two wolf populations and plan to use population model simulations and parentage-assignments to evaluate relatedness and immigration rates within these populations.

Habitat quality influences migratory strategy of female white-tailed deer

Obligated Funding: $70,000

Student: Charles R. Henderson, Jr.

Degree: MSc Candidate

Advisor: Mike Mitchell

Project Duration: 2011 – 2014

UM Affiliation: Wildlife Biology Program
Montana Cooperative Wildlife Research Unit

Funding Source:

- Washington Department of Fish and Wildlife

Objectives

The main goal of this project was to provide the Washington Department of Fish and Wildlife with the information necessary for a scientifically rigorous approach to the management of their white-tailed deer population. I also investigated the differences in survival and seasonal habitat use between resident and migrant deer. In order to accomplish this I identified what proportions of the deer population were residents and migrants, calculated seasonal survival rates, and quantified seasonal ranges using movement information. The information generated from the study resulted in area specific survival rates, a model that predicts individual migration strategy, and maps predicting the seasonal probability of use of specific habitat types. These maps are being used by Washington Department of Fish and Wildlife and other agencies to inform management decisions. I also provided information to managers identifying local migration patterns and corridors. On a broader scale, the resource use and survival information about two competing life history strategies added to the scientific knowledge about the effects of partial migration on this population. In addition, the model for predicting migration strategy increased the understanding of which winter range variables contribute to an individual's decision to migrate and allows managers to better predict white-tailed deer distribution throughout the year.

Progress and Status

Data gathering and analysis for this project was completed in 2014. My thesis based on this work was accepted and I was awarded a M.Sc. in Wildlife Biology in December 2014. I presented project results at the national conference of The Wildlife Society in October 2014. I also presented the results at the annual meeting of the Montana chapter of The Wildlife Society in February 2015 and received the award for best graduate student presentation. I will be submitting a paper about this project for publication in a peer reviewed journal in April 2015. I will also be presenting the results of this study at the Western states and Provinces Deer and Elk workshop in May 2015.

Linking resource selection to population dynamics of mule deer

Obligated Funding: $48,326

Student: Mark Hurley

Degree: PhD Candidate

Advisors: Mike Mitchell, Mark Hebblewhite

Project Duration: 2010 – 2014

UM Affiliation: Wildlife Biology, MTCWRU

Funding Source: Idaho Department of Fish and Game

Objectives

The broad goal of my Dissertation will be to answer the question: how does forage quality, predation risk and weather interact to determine habitat quality and, subsequently, how is habitat quality modified by mule deer behavior and local density to influence vital rates and population size? I will answer this question by investigating the interactive influence of weather patterns, resource selection, and predation risk on mule deer survival and population growth rate. I will integrate measures of population growth and fecundity with fine-scale resource selection and predator-caused mortality to estimate population dynamics and rank habitat components (vegetation type and quality, weather, density and predation) by their importance to population growth rate. These models will then enable wildlife managers to combine population data collected within climate and broad vegetation biomes with fine-scale habitat models to predict the potential mule deer population productivity in different habitats, weather patterns, and management regimes.

Progress and Status

This project will capitalize on mule deer research conducted by the IDFG research biologist and project staff in 52 fawn survival study sites and 8 permanent study sites across Idaho. From 1998 to date, >3,800 mule deer fawns and > 1800 adult females have been radio collared with VHF transmitters to monitor survival. Another 165 adult females were collared with GPS transmitters from 2003 to 2014 providing a total of 360,000 locations to estimate fine-scale resource selection. Of the 600 adult female were monitor annually, 250 adult female deer were selected to represent fawn rearing home ranges in all of the mule deer habitats across southern Idaho. Each of these deer was located 3-4 times during each summer for the past 2 seasons to estimate a coarse-scale use area. Through plant composition plots we will apply the fine-scale resource selection from GPS collars to the course-scale resource selection of the VHF collared females. The increase in sample will provide an avenue to link summer habitat quality to winter fawn survival in all of the southern Idaho Population Management Units (PMU).

In the summer of 2012, we installed 49 permanent plant phenology plots across southern Idaho. We repeatedly sampled vegetation plots throughout the 2012 and 2013 summers to measure the phenological stage and nutritional quality of vegetation within each of the major community types used by adult females during summer. These plots will be linked to bi-weekly measures of NDVI to track seasonally changing habitat quality. Plant composition of fawn rearing home ranges will link changing vegetation quality to satellite based measures of habitat quality for temporal estimation of nutrition across the landscape. We have completed 212 adult female plant composition plots in 2012-2013. We have also produced winter range models for each PMU from survey group locations that can vary annually by incorporating weather and vegetation phenology. From this data, I will produce annually varying estimate of habitat quality for each PMU with the intent of using the above nutritional relationships to estimate the influence of habitat quality on mule deer vital rates.

Improving estimation of wolf recruitment and abundance, and development of an adaptive harvest program for wolves in Montana

Obligated Funding: $362,976

Student: **Allison Keever & Sarah Sells**

Degree: PhD – Wildlife Biology Students

Advisor: Mike Mitchell

Project Duration: 2015 – 2020

UM Affiliation: Wildlife Biology Program
Montana Cooperative Wildlife Research Unit

Funding Sources:

- Montana Fish, Wildlife, and Parks
- Montana Cooperative Wildlife Research Unit

Objectives

Objective 1: Produce approach to estimate recruitment that is more tractable, cost effective, and biologically credible than the breeding pair metric. This will increase understanding of mechanisms driving recruitment, identify the best analytical approach to estimating recruitment, and thus further refine monitoring of factors relevant to recruitment.

Objective 2: Understand factors contributing to dynamics of territories to ensure accuracy of POM estimates into the future and more effectively manage wolf populations. We will collect and use location and observation data by deploying GPS collars throughout Montana to capture the range of variation in hypothesized environmental and anthropogenic predictors.

Objective 3: Develop framework for adaptive harvest management. This allows the formal assessment of harvest regimes and determination of underlying biological processes. Through monitoring, we will update these models to decrease uncertainty. By identifying appropriate models, we can more accurately forecast populations relative to proposed harvest levels.

Objective 4: Conduct sensitivity analyses and propose an efficient monitoring regime. We will use sensitivity analyses to understand the characteristics influencing estimates produced by our models. We will then identify factors that require monitoring to produce robust population estimates and reduce uncertainty associated with making harvest decisions.

Progress & Status

Wolves (*Canis lupus*) were reintroduced in the northern Rocky Mountains (NRM) in 1995, and after rapid population growth were delisted from the endangered species list in 2011. Since that time, states in the NRM have agreed to maintain populations and breeding pairs above established minimums (≥150 wolves and ≥15 breeding pairs within each state). Montana estimates population size every year using patch occupancy models (POM), however, these estimates are sensitive to pack size and territory size, and were developed pre-harvest. Reliability of future estimates based on POM will be contingent on accurate information on territory size, overlap, and pack size, which are expected to be strongly affected by harvest. Additionally, breeding pairs are estimated based on pack size, which has proven to be an ineffective measure of recruitment. Monitoring has become cumbersome and less effective since the population has grown. With the implementation of harvest, it is important to predict future populations to make informed management decisions regarding harvest and trapping quotas.

Western Elk Research Collaborative

Obligated Funding: $181,799

Principal Investigator: Paul M. Lukacs, Mike Mitchell

Project Duration: 2010 - 2015

UM Affiliation: College of Forestry and Conservation
Montana Cooperative Wildlife Research Unit

Funding Source:

- U.S. Geological Survey – Research Work Order 97
- Idaho Department of Fish and Game
- State of Colorado
- Rocky Mountain Elk Foundation

Objectives

The challenges facing elk management in Western landscapes are increasing at a rapid pace as modifications to predator communities; habitat and climate influence the demography and behavior of elk populations. Uncertainty about the influence of predation in the context of other limiting and regulating factors on elk populations initiated communication among wildlife researchers in the northwestern states of Idaho, Montana, Wyoming, Oregon, Washington, Utah, and Colorado about shared management challenges and research needs. Whereas individual states conduct their own research projects on how these factors influence elk, the collaborators recognize the benefits of a region-wide analysis for informing local ecological processes. A region-wide analysis allows collaborators to assess greater spatial and temporal variation in these drivers than could be achieved within any single study site or state, and gain a more general understanding of factors influencing elk populations to inform future management strategies (i.e., harvest, predator management, habitat management, etc.). Furthermore, collaborative analyses increase and add value to pre-existing local data sets, maximizing their utility in guiding elk and carnivore management beyond individual jurisdictions. Therefore, the Western Elk Research Collaborative (WERC) is pooling data on elk (and other covariates) from populations across the Northwest to assess the relative influence of predation, habitat quality, weather, and their interactions on elk demography.

Progress and Status

We completed the analysis of factors affecting the survival of adult female elk across seven western states, using one of the largest datasets analyzed for any large mammal. We collaboratively developed a manuscript that has been published in the Journal of Applied Ecology. We have also completed analysis of factors affecting recruitment across populations and submitted the completed work to the Journal of Applied Ecology.

Upon publication of the recruitment analysis, WERC will have explored adult female survival, calf survival, and recruitment over a broad temporal and spatial scale. Our next step will be to combine these components into an integrated population model to better understand cumulative population processes in elk. In addition, the population model provides a tool for state agencies to use in making decisions about elk management.

Grizzly bear population status in the Cabinet-Yaak ecosystem

Obligated Funding: $1,593,000

Principal Investigator: Mike Mitchell
Co P.I.: Kate Kendall

Project Duration: 2011 - 2015

UM Affiliation: Montana Cooperative Wildlife Research Unit

Funding Sources:

- Lincoln County
- U.S. D.A. Forest Service Northern Region
- Montana Fish, Wildlife and Parks

Objectives

This project will provide/identify:

- Baseline data on grizzly bear population size, density, distribution, and genetic structure
- An index of black bear relative density
- Genetic library of grizzly bears in region and further insight into their connection to neighboring populations/jurisdictions.
- Integrated relational database of grizzly bear spatial and genetic information from all sources in the ecosystem willing to share data

The goal of this project is to acquire precise and accurate data on the status of the endangered (listed as warranted but precluded) grizzly bear population in northern Montana and Idaho using noninvasive genetic sampling. Data generated will provide

- baseline information on total and local population abundance,
- evidence of gene flow within the ecosystem and with other recovery zones / Canada,
- insight to bear dispersal mechanisms,
- integrated database of grizzly bear spatial and genetic information.

Progress and Status

The results will provide information needed to design and assess a conservation strategy to recover and adaptively manage this population in the face of altered landscape conditions due to climate change, resource extraction, habitat manipulation designed to enhance bear habitat values, and expanding human presence. Data on grizzly bear abundance, distribution, and linkage with other populations will provide feedback on the effectiveness of population recovery efforts and will provide baseline data useful for monitoring population trend in the future.

Proactive management of pneumonia epizootics in bighorn sheep in Montana

Obligated Funding: $49,000

Student: Sarah Sells

Degree: MSc – Wildlife Biology
Advisor: Mike Mitchell

Project Duration: 2011 – 2014

UM Affiliation: Wildlife Biology Program
Montana Cooperative Wildlife Research Unit

Funding Sources:

- Montana Fish, Wildlife, and Parks
- Montana Cooperative Wildlife Research Unit

Abstract

Pneumonia epizootics are a major challenge for management of bighorn sheep (*Ovis canadensis*), often causing high mortality and subsequent long-term impacts that may continue for decades. There have been at least 22 epizootics in herds in Montana from 1979–2013, including 1 that led to a herd's extirpation, several that appear to be affecting herds up to 3 decades later, and 11 in the last 6 years. The disease is complex and associated risk factors are poorly understood. A lack of tools to help predict and proactively manage risk of pneumonia epizootics in attempt to prevent die-offs has led to reactive rather than proactive management. We developed risk and decision models to facilitate proactive management of pneumonia epizootics in bighorn sheep in Montana. Our risk model identifies risk factors and addresses biological questions about risk. We used Bayesian logistic regression with repeated measures to analyze 43 herds that experienced 22 epizootics out of 637 herd years from 1979–2013. Within an area of high risk for pathogen exposure (a herd's distribution plus a 14.5-km buffer), a herd's odds of a pneumonia epizootic increased >1.5 times per additional unit of private land, >3.3 times if domestic sheep or goats were used for weed control, and >10.2 times if the herd or its neighbors had a pneumonia epizootic since 1979. A herd at medium density compared to low had >5.2 times greater odds of a pneumonia epizootic, and at high density had nearly 15 times greater odds. Our decision model incorporates predictions from the risk model and uses a structured decision making approach to help make more proactive decisions about how to best manage herds, given herd-specific probabilities of pneumonia epizootics and management objectives. The model addresses uncertainty, risk tolerance, and the multi-objective nature of management of bighorn sheep while providing a consistent, transparent, and deliberative approach for making decisions. The risk and decision models are unique tools that will help wildlife agencies more proactively address pneumonia epizootics in bighorn sheep while providing a case study for developing similar tools for proactive management of other wildlife diseases.

Spatial and temporal scales of population performance in grizzly and black bears in the Northern Continental Divide Ecosystem, Montana

Obligated Funding: $56,230

Student: Jeff Stetz

Degree: PhD Candidate

Advisor: Mike Mitchell

Project Duration: 2009-2013

UM Affiliation: Wildlife Biology Program
Montana Cooperative Wildlife Research Unit

Funding Sources:

- U.S. Forest Service
- U.S. Geological Survey

Objectives

My primary interests are in investigating habitat selection and population performance across the sympatric grizzly and black bear populations in the Northern Continental Divide Ecosystem (NCDE) in the Northern Rocky Mountains of Montana. I am also interested in evaluating the ability of noninvasive genetic sampling (NGS) to detect fine-scale demographic processes in these populations. The specific questions that I am currently exploring include:

1. How does habitat selection vary in space and time for grizzly and black bears in this region? To answer this, I will use a combination of occupancy modeling and spatial interpolation methods using detection data from noninvasive genetic sampling projects.
2. How do habitat selection patterns vary between the sympatric grizzly and black bear populations in the NCDE? I will use the results of Question 1 to identify habitat factors that are shared versus specific to each species. This answer could inform grizzly bear reintroduction/augmentation programs if we determine that, for example, high black bear densities may lead to reduced grizzly bear density.
3. Why do we see such dramatic differences in capture probabilities of grizzly bears in certain NGS methods across populations? I will use detection data from 3-4 distinct populations to model capture probabilities in a meta-analysis framework. These results could be useful in designing future monitoring programs.
4. How can we use NGS method4 to detect fine scale population performance (i.e., population growth rates)? I will use simulations with spatially-explicit mark-recapture methods to explore the conditions under which intra-population (e.g., source-sink) dynamics can be identified.

Progress and Status

In 2012 I completed my required coursework and successfully completed my comprehensive exams. I have continued to work with biometricians to develop models for analyzing my data related to two of my proposed chapters. I have pursued a number of grants to aid in model development and acquire computing resources. I also was a teaching assistant in fall 2012, spring and fall 2013, and spring 2014 terms.

The bulk of the data to be used in my dissertation research was collected in 1998-2000 and 2004 during two distinct research projects. I have obtained access to datasets from the Russian Far East, Banff National Park, and Greece for Question 3. My efforts in 2013 focused on developing statistical code and assembling covariates (eg, landcover, sympatric species' density) for grizzly bear density models.

AWARDS AND RECOGNITIONS

Karolina Fierro-Calderon

- "PEO International Peace Scholarship" granted by International Chapter PEO Sisterhood for the academic period August 2014 to May 2015.
- Awarded Gladys Knowles International Peace Scholar for the 2014-2015 academic year.

Mark Hurley

- Outstanding Monograph Award – 2013 – The Wildlife Society

Joseph LaManna

- EPA Star Fellowship Award

Mike Mitchell

- Bob Watts Communication Award, Montana Chapter of The Wildlife Society
- Faculty Recognition Award for advising the Student Veterans Association, University of Montana

James Mouton

- Drollinger-Dial Foundation Travel Grant 2015 ($1000), Society for Integrative and Comparative Biology Meeting 2016 in Portland,OR (taking place Jan. 2016).
- Drollinger-Dial Foundation Travel Grant 2014 ($849), For travel to conduct laboratory work at the Duckworth lab (University of Arizona) and the Wolf lab (University of New Mexico).
- American Ornithologist Union Research Grant ($1000) For laboratory supplies needed to analyze the concentration of yolk hormones in the Duckworth lab (University of Arizona).
- NSF Graduate Research Fellowship (2013)

Juan C. Oteyza

- Wildlife Biology Program travel support to attend 26th International Ornithological Congress, Tokyo, Japan, 2014.

Sarah Sells

- Honorable Mention, Graduate Presentation, National TWS Conference, Pittsburgh 2014
- Cover article, Journal of Wildlife Management

Riccardo Ton

- Drollinger-Dial Research Travel Award
- Bertha Morton Scholarship

PRESENTATIONS AND POSTERS

A.J. Boyce, B.O. Wolf. and **T.E. Martin**. Divergent physiological tolerance in two allopatric species of White-eye (Zosteropidae) on a tropical elevational gradient. Oral Presentation to the AOU/COS/SCO Joint Meeting. September 2014. Estes Park, CO.

J. Golding and V.J. Dreitz, Assessing Land Use Practices in Sagebrush and Grassland Ecosystems: Multiple Migratory Bird Responses, 2014 North American Congress for Conservation Biology (7/2014)

J. Golding and V.J. Dreitz, Assessing Land Use Practices in Sagebrush and Grassland Ecosystems: Multiple Migratory Bird Responses, 4th Annual Matador Ranch Science and Land Management Symposium (6/2014)

Golding, J. and V.J. Dreitz, Poster Presentation, A Comparison of Avian Survey Methods and Implications for Conservation in Arid Environments, 2013 International Congress on Conservation Biology (7/2013)

Golding, J. and V.J. Dreitz, Poster Presentation, A Comparison of Avian Survey Methods in Arid Environments, 2013 Montana Chapter of the Society of Conservation Biology Research Symposium (11/2013)

Golding, J. and V.J. Dreitz, Assessing Land Use Practices in Sagebrush and Grassland Ecosystems: Multiple Migratory Bird Responses, 2013 Montana Chapter of the Society of Conservation Biology Research Symposium (11/2013)

Dreitz, V.J. and J. Golding, Webinar, Assessing land use practices in sagebrush and grassland ecosystems: multiple migratory bird responses, Sage Steppe Partner Forum (3/2014)

J. Golding Oral Presentation, Assessing land use practices in sagebrush and grassland ecosystems: multiple migratory bird responses, 2014 North American Congress for Conservation Biology (7/2014)

Martin, T.E. 2014. Direct and indirect effects of climate change on a high elevation riparian ecosystem. University of Florida, invited seminar (11/2014).

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Oteyza, J.C. and **T.E. Martin**. 2014. The effects of nest predation risk on parental investment and reproductive success. 26th International Ornithological Congress, Tokyo, Japan. August 2014 (oral).

Stetz, J.B. March 2014. *Invited speaker.* Black bear research and monitoring in northwestern Montana. Student Chapter of The Wildlife Society. University of Montana, Missoula, MT, USA.

SCIENTIFIC PAPERS AND REPORTS

Stansbury, C.R., **D.E. Ausband**, P. Zager, C.M. Mack, C.R. Miller, M.W. Pennell, L.P. Waits. 2014. A long-term population monitoring approach for a wide-ranging carnivore: noninvasive genetic sampling of gray wolf rendezvous sites in Idaho, USA. Journal of Wildlife Management 78:1040–1049.

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Martin, T. E. 2015. Consequences of habitat change and resource selection specialization for population limitation in cavity-nesting birds. Journal of Applied Ecology, in press.

Martin, T.E., J.C. Oteyza, A.J. Boyce, **R. Ton** & P. Lloyd. 2015. Adult and offspring mortality affect embryo development time through reproductive effort. American Naturalist. *In Press.*

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Robinson, H.S., R. DeSimone, C. Hartway, J.A. Gude, M.J. Thompson, **M.S. Mitchell** and M. Hebblewhite. 2014. A test of the compensatory mortality hypothesis in mountain lions: a management experiment in west-central Montana. Journal of Wildlife Management 78:791-807.

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