Montana Cooperative Wildlife Research Unit

Report of Activities for the Coordinating Committee Meeting
April 2014

Cooperating Agencies
U. S. Geological Survey, Biological Resources Division
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 2013 through 31 March 2014

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
P.O. Box 200701
Helena, MT 59620-0701

Justin Gude
Wildlife Research & Technical Services Supervisor
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, Administrative Associate IV

Graduate Students Advised by Unit Faculty

Mike Mitchell

David Ausband, Ph.D. Candidate
Nathan Borg, M.Sc. Candidate
Charles Henderson, M. Sc. Candidate
Mark Hurley, Ph.D. Candidate
Sarah Sells, M.Sc. Candidate
Jeff Stetz, Ph.D. Candidate

Tom Martin

Andrew Boyce, M.Sc. Candidate
Karolina Fierro-Calderon, M.Sc. Candidate
Joseph LaManna, Ph.D. Candidate
James Mouton, M.Sc .Candidate
Juan Carlos Oteyza, Ph.D. Candidate
Riccardo Ton, Ph.D. Candidate

Unit Faculty on Graduate Students' Committees

Mike Mitchell

Daniella Dekalaita , M.Sc. Candidate *
Dan Eacker, M.Sc. Candidate
Karolina Fierro, Ph.D. Candidate
Jessie Golding, M.Sc. Candidate
Theresa Laverty, Ph.D. Candidate
Juan Oteyza, M.Sc. Candidate
Wesley Sarmento, M.Sc. Candidate
Keith Slauson, Ph.D. Candidate
Derek Spitz, Ph.D. Candidate
Robin Steenweg, Ph.D. Candidate
Tshering Tempa, Ph.D. Candidate
Tshewang Wangchuk, Ph.D. Candidate
Sara Williams, Ph.D. Candidate
Marketa Zimova, M.Sc. Candidate *

Tom Martin

David Ausband, Ph.D. Candidate
Katie Baer, M.S. Candidate
Sara Berk, Ph.D. Candidate
Ashley Heers, Ph. D. Candidate *
Margaret Riordan, M. S. Candidate *
Joseph Smith, Ph. D. Candidate

* Graduated

Research Associates:

Julia Brandauer	Amy Macleod	James Nowak
Ahva Potticary		

Research Assistants:

Armando Aispuro	Chelsea DeMarco	Matthew Nordhagen
Kate Amsden	Lerry Dominic	Katie Oelrich
Logan Anderson	Adam Fahnestock	Andrew Orlando
Conor Armstad	Eliana Fierro-Calderon	Rachel Panning
Derek Arnold	Holly Garrod	Amanda Reininger
Sarah Bassing	Chad Gaspard	Kaitlyn Reintsma
Jordan Boersma	Joshua Goldberg	Jessica Ruebesam
Carley Benda	Raoul Gobbo	Taylor Scherr
Seth Bergman	Dan Gusset	Rebekah Schimp
Lindsey Bischoff	Sofia Haggberg	Robert Schorr
Kaydee Borchers	Ian Hamilton	Jennifer Smith
Carly Boyce	Jennifer Hernandez	Matthew Smith
Justin Broderick	Benjamin Hawkins	Rebecca Smith
Eric Cannizaro	Tia Hunter	Jillian Soller
Samuel Case	Chelsea Hutton	Charl Stafleu
Ed Conrad	Ashley Jensen	Ryan Steiner
Emily Cohen	Randi Lesagonicz	Rose Swift
Joel Contreras	Carrie Lowe	Torreya Swift
Eleanor Cosgrove	Garrett MacDonald	Andrew Thornton
Stephanie Couture	Adam Mitchell	Antoinette Taylor-Salisbury
Audra Diemer	Adam Mohr	Philip Turner
Christopher Davidson	Seamus Murphy	Katherine Welch
Hanna Davis		

Work-Study and Non-Work Study Students:

Kate Amsden	Brittani Johnson	Kaitlyn Reintsma
Logan Anderson	Erik Karolik	Abraham Salois
Kesley Bare	Danielle Kelly	Taylor Scherr
Rudy Baum	Josie Kerrigan	John Schoen
Tyler Clark	Margaret Kincaid	Tim Schwartz
Eric Clewis	Courtney Kratz	Kelly Shank
Emily Cohen	Morgan LaPointe	Sarah Stanick-Woods
Nikita Cooley	Caleb Matthew	Hilary Turner
Colton Crismore	Alan Marr	Sarah Washko
Steven Cross	Joseph Murphy	Jeremy Welch
Jeremy Deal	Mikaela Pederson	Kelsey Whitaker
Mathew Erickson	Amanda Perdue	Robert Wilson
Chelsea Hutton	Britney Radford	Sarah Zielke

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	0	
University of Montana		
Full-time Administrative Associate - Salary/Benefits	39,623	
SPABA – FY11 IDC returned to Unit in FY13	87,656	
Subtotal		**$ 127,279**
FY 2013 – Research Projects and Increase in Funding		
Montana Fish, Wildlife and Parks		
Operating Funds		**$ 20,000**
T. Martin – PI		
New Funding:		
NSF – Graduate Research Fellowship	44,000	
USGS – Climate and Habitat Change	365,433	
NSF – A New Theory of Clutch Size Evolution	536,534	
UM Research Administration – Graduate Support	46,000	
Subtotal		**$ 991,967**
Continued Funding:		
EPA Star Award – Graduate Support	42,000	
The Bair Ranch Foundation – Aspen Study	100,000	
Colciencias Fullbright Scholarship	16,000	
NSF – Historical & Contemporary Influence/Biodiversity in Tropical Asia	1,326,915	
Subtotal		**$1,484,915**
M. Mitchell – PI or Co-PI		
New Funding:		
Idaho Fish & Game – Mule Deer Research, Ungulate Ecology	39,000	
Panthera – Development of decision making tool/MT. Lions In Montana Year 3	36,000	
National Park Service - Humboldt-Marten Prey	70,740	
U.S. Forest Service – Grizzly Bear DNA Study	100,000	
U.S.G.S. – Migratory Birds	162,816	
MTFWP - Sage Grouse Research	85,962	
MTFWP – Big Horn Sheep	13,200	
MTFWP – Grassland Birds	5,000	
Kootenai River Development – Grizzly Bear Populations	25,000	
Gift/UM Foundation Funding for Wolf Research	91,260	
Subtotal		**$ 628,978**
Continued Funding:		
Washington Fish & Game – Graduate student support	20,000	
Rocky Mountain Elk Study	45,000	
Waterton Biosphere - Test Monitoring Wolves	90,000	
Access Land-Use Migratory Birds	133,000	
Sage Grouse Stepping Stones	5,500	
Sage Grouse Genetics – Graduate student Support	55,700	
Subtotal		**$ 349,200**
Total Budget		**$3,602,339**

Completed Projects – 1 January 2013 – 31 December 2013

End Date	Principal Investigator	Funding Agency	Title
December 2013	Nathan Borg	Idaho Department of fish & Game	Movements, gene flow, and relatedness of Bighorn Sheep in central Idaho
December 2013	Tom Martin	NSF	Understanding the environmental causes of a major global divergence in life history strategies of tropical birds
December 2013	Ross Crandall	Craighead Beringia South	Determining the influence of landscape change on a breeding Golden Eagle population: 1962-present
December 2013	Maggie Riordan	State of Colorado	Factors influencing survival of mountain plover chicks in Eastern Colorado

MTCWRU – Federal and State Vehicles

Description	Tag number	Odometer as of 3/31/2014
1999 Ford Truck, Extended Cab Pickup 4 x 2	FED 252524	100,131
2003 Chevy Suburban 1500	FED 430256	86,301
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

Bornean Forktail – 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: Ph.D. 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

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 experiments at congener interaction zones 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 completed comprehensive exams this past Fall and I am currently gathering data during my third field season at Kinabalu National Park, Sabah, Malaysia. I have outlined elevational ranges for all species at the park, and am collecting both competition data (playback experiments) and physiological data (metabolic experiments) for my second consecutive field season. I will be working with Dr. Blair Wolf and Bill Talbot from the University of New Mexico in collecting this physiological data and greatly appreciate their generosity with both equipment and expertise.

Determining the influence of landscape change on a breeding Golden Eagle population: 1962-Present

Student: Ross Crandall **Obligated funding: $35,484**

Degree: M.Sc. Candidate

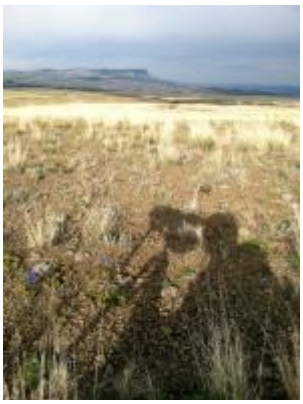
Advisors: Tom Martin
Erick Greene

UM Affiliation: Wildlife Biology Program
Montana Cooperative Wildlife Research Unit

Project Duration: 2011 – 2013 (Completed)

Funding Source:

- Craighead Beringia South



Glassing a golden eagle territory, looking for breeding adults

Objectives

Declining populations of native plant and animal species is a major problem threatening global biodiversity. Causes for declining populations have primarily been attributed to human-related impacts. Predicting and mitigating impacts is often a primary goal of conservation biologists and applied ecological research. My project examines the influence of landscape change on a breeding population of an apex avian predator, the golden eagle (*Aquila chyrsaetos*). Golden eagles are thought to be declining in the Western U.S. and future threats are a concern. Breeding golden eagles in my study area have increased roughly 50% in the last 50 years, an anomaly among other intensively monitored populations. I am interested in determining the landscape and environmental factors necessary to support the current population and testing differences in identified factors between both time periods. This information will shed light on the role that landscape change has on ecosystem processes, provide information on factors influencing a species of conservation concern and provide tools managers can use to effectively create plans and implement guidelines or management action based on sound scientific evidence.

Progress and Status

The 2013 nesting season marked the fourth year of data collection on breeding golden eagles in the study area. I collected information on territory occupancy rates, nest initiation rates, productivity and tracked 18 adults and 9 nestlings with GPS and PTT transmitters. After completing my analysis, I successfully defended my thesis in November of 2013. I found breeding golden eagles were selecting for prey habitat and topography at the territory and within territory scale. In addition, birds were more likely to use the aspect which promoted uplift at the within territory scale. My results showed the amount of available prey habitat has increased since the 1960's but was unlikely responsible for the increase in the number of breeding eagles in the study area. Instead, my results suggest human disturbance may have been responsible for the lower documented breeding population in the 1960's. A copy of my thesis is available online and hard copies are available in the Wildlife Biology Office at the University of Montana as well as the Montana Cooperative Wildlife Research Unit Office.

Greater Sage-Grouse genetic connectivity across the species' eastern range

Obligated Funds: $165,094

Student: Todd Cross

Degree: Ph. D. Candidate

Advisors: David Naugle & Michael Schwartz

Project Duration: 2011-2016

UM Affiliation: Wildlife Biology Program
Montana Cooperative Wildlife Research Unit

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 are sagebrush obligates. They 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. Sage-grouse currently occupy only 56% of potential pre-western settlement habitat and 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. Therefore, the conservation and management of sage grouse requires a detailed understanding of how landscape change influences gene flow, genetic dispersal, and genetic population structure.

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. Partners include: Bureau of Land Management; California Department of Fish and Game; Colorado Division of Wildlife; Great Northern Landscape Conservation Cooperative; Idaho Department of Fish and Game; Intermountain West Joint Venture; Montana Audubon; Montana Fish, Wildlife and Parks; Nevada Department of Wildlife; North Dakota Game and Fish Department; Natural Resource Conservation Service - Sage Grouse Initiative; Oregon Department of Fish and Wildlife; South Dakota Game, Fish, and Parks; University of Montana; USDA Forest Service; US Geological Survey; Utah Division of Wildlife Resources; Western Association of Fish and Wildlife Agencies; Washington Department of Fish and Wildlife; and Wyoming Game and Fish Department. 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:

- extracted DNA from over 6800 genetic samples, representing over 800 leks across Idaho, Montana, North Dakota, and South Dakota. From these 6800 samples we have identified over 2200 individuals using a 21 locus microsatellite panel. As we continue analyzing the remaining samples, the number of individuals identified will continue to grow.

- applied network theory analyses to examine genetic connectivity of the population network across the range. These approaches will allow 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.

- used the microsatellite genotypes to identify genetic substructure across Idaho, Montana, North Dakota, and South Dakota. We are currently testing the robustness of our results, and will soon begin identifying the landscape and anthropogenic factors that influence these patterns.

- collaborated with researchers at the University of Denver to use the genetic data to identify the optimal remaining sampling locations to collect from this spring for our final year of feather collection. This year's sampling effort should optimize coverage and resolution across Idaho, Montana, North Dakota, and South Dakota.

- developed an enrichment assay designed to target and capture sequence for over 80,000 single nucleotide polymorphisms (SNPs) associated with gene function. We will soon begin using this assay to capture over 8.5 million base pairs of DNA sequence 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: Ph.D. Student

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

---

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. Hence, the next two summers I will collect data on survival probability of fledglings and carry out my experiment in order to determine the cumulative survival probability of multiple nest sites within the territories.
- The spring 2014 I will take my comprehensive exams and have almost ready for publication the first chapter of my thesis about the historical territorial distribution of Orange-crowned warblers in Arizona.

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

Obligated Funds: $477,620

Student: Jessie Golding

Degree: M. Sc. 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)
- Montana Fish Wildlife and Parks Nongame Program Grant, $5,000 (8/2013)
- Hunting GPS Maps Equipment Grant, $1,000 (4/2013)
- College of Forestry and Conservation Les Pengelly Scholarship, $2,100 (03/2013)
- Montana Fish Wildlife and Parks Nongame Program Grant, $5,000 (8/2012)

Objectives

- To evaluate the impact of rest-rotational grazing management on migratory bird species associated with sagebrush landscapes.
- To provide information to ensure the persistence of multiple sagebrush-obligate bird species and assist in developing natural resource policies

This project is in year 3 of a three-year project and will inform natural resource managers and private landowners of the impacts of conservation-oriented livestock grazing practices in sagebrush ecosystems.

Progress and Status

This research study is designed to evaluate responses of migratory birds to rest-rotation grazing management in sagebrush system. Rest-rotation grazing management is likely to enhance important components of sagebrush, shrubland, and grassland habitat for a wide range of species, but little work has been done to evaluate impacts of prescribed rest-rotation grazing on birds. The scale and magnitude of benefits for avian species remains unclear. In 2012, we initiated a research project building off of the existing US Department of Agriculture - Natural Resource Conservation Service's Sage-Grouse Initiative infrastructure in eastern Montana to evaluate the impact of conservation managed rest-rotational grazing on migratory birds. Results from the 2012 pilot season were primarily used in determining sampling scheme and methods for 2013 field efforts. The 2013 field efforts expanded from the pilot year, which only included BLM land with traditional grazing systems, including private lands enrolled in SGI with rest-rotation grazing. From these two years I have identified a set of potential focal species for the region: Brewer's sparrow (Spizella breweri), vesper sparrow (*Pooecetes gramineus*), western meadowlark (*Sturnella neglecta*), McCown's longspur (*Rhynchophanes mccownii*), and horned lark (*Eremophila alpestris*). In addition, in 2013 I began efforts to monitor nests. I am interested in nest success because habitat quality is one of the main drivers of nest success, and grazing causes a known change in habitat quality, so I anticipate that grazing management will have an effect on nest success. Preliminary results from 2013 indicate little difference in avian communities (e.g, observed abundance, mean species richness) between rest-rotation and traditional grazing regimes. I will conduct the final field data collection for this project in the summer of 2014.

Effects of aspen forest restoration on songbird diversity, habitat selection, and reproductive strategies and success

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

Degree: Ph.D. Candidate

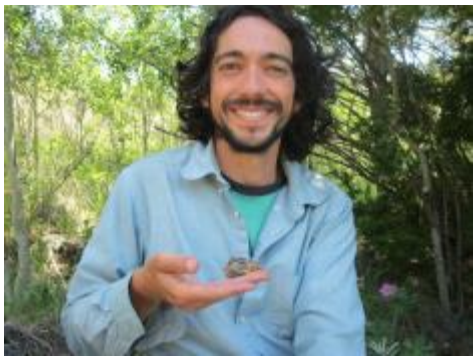
Advisor: Thomas E. Martin

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



Montana field site measuring Dusky Flycatcher

Objectives

Understanding features that enhance bird diversity 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 are being 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, 2010, 2011, and 2012 songbird breeding seasons. Bird diversity has been monitored each year with intensive point counts. A total of 1,676 nests from 43 songbird and woodpecker species were found and monitored during the four field seasons. Reproductive success data will be used in conjunction with vegetation surveys and the conifer removal treatment to examine bird community and reproductive responses to changing habitat conditions. Systematic vegetation survey points in each aspen stand will be used to answer questions about habitat preferences for nest placement, availability of nest sites, and overall aspen stand structure. Preliminary results indicate that songbird diversity declines and predator densities increase with conifer encroachment. As a result, nest predation increases with conifer encroachment for many species. Data analyses are underway and a dissertation proposal will be completed and defended in April 2013. Fieldwork begins again in May 2013.

Understanding the environmental causes of a major global divergence in life history strategies of tropical birds

Obligated funding: $600,000

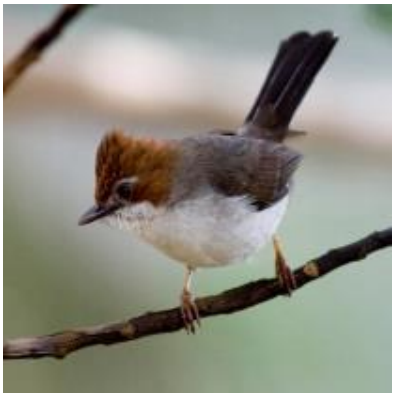
Principal Investigator: Thomas E. Martin

Project Duration: 2009-2013 (Completed)

UM Affiliation: Montana Cooperative Wildlife Research Unit

Funding Sources:

- National Science Foundation



Objectives

Measure 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. Examine the relative importance of nest predation, food limitation, and adult mortality on variation in demography and life history strategies.

Results

Life history strategies are comprised of age-specific fecundity and mortality, plus parental care behaviors and developmental rates. 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.

We completed four years 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 four seasons, 2,340 nests were found and monitored (the largest sample size ever accrued for tropical Asia), embryo metabolism and nestling growth measured, parental care video-taped, and egg temperatures quantified. In addition, 2,204 new individuals were banded, and a total of 3,626 recapture/resight events were accrued to aid in estimating adult survival and renesting efforts. Nest predation rates are high, as common in many tropical areas, but show an elevational gradient where predation increases with elevation in the range we are working. Recapture rates of birds are reasonable, and higher than any other tropical locale that I have worked. Embryo metabolism explained variation in embryo development rates once embryonic temperatures were taken into account. 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. The importance of temperature suggests that global warming may be particularly important to long-term reproductive success of tropical birds.

This work includes 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 were taught to write their first publications on the life history of some species that is previously undescribed.

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

Obligated funding: $1,325,620

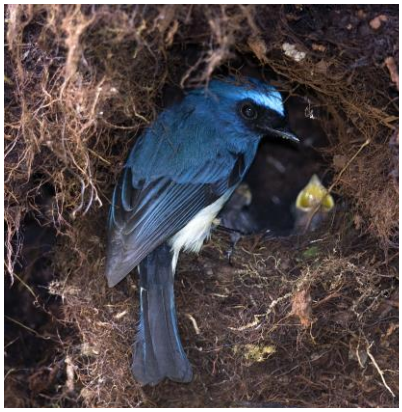
Principal Investigator: Thomas E. Martin

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 second 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 genetics in development.

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.

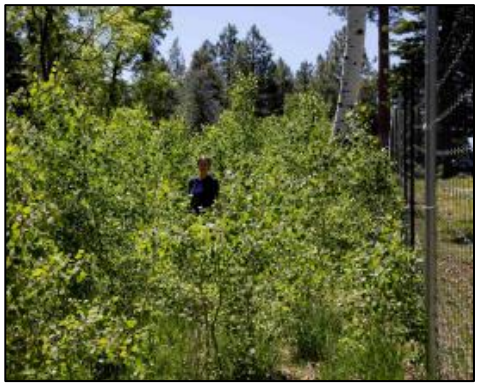
Effect of climate change and elk browsing on population trajectories and trophic interactions in a high elevation riparian ecosystem

Obligated Funds: $365,433

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 102

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, and 2) 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 29 years. Winter snowfall has declined strongly across the 29 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. Cavity-nesting woodpeckers that depend on aspen for nesting have shown particularly strong population declines over the nearly 3 decades.

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 2013 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.

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

Obligated Funds: $536,534

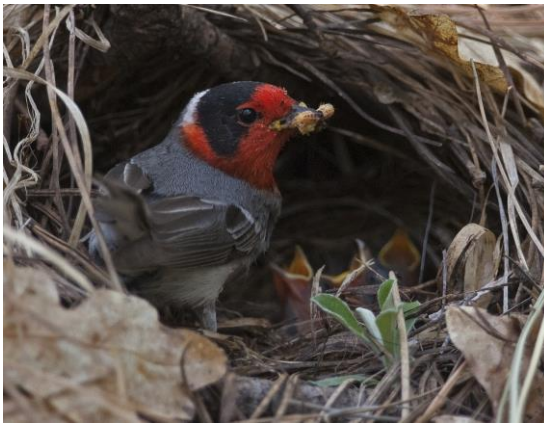
Principal Investigator: Thomas E. Martin

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 will begin this field season 2014 in the long-term Arizona system. It will include new work on fledgling survival, which can be a critical influence on overall demography but is poorly studied across species. It will also measure 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. I will measure 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 will conduct brood reduction experiments on all 7 species to separate and test alternative hypotheses. I will measure 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.

The influence of nest predation on parental and offspring strategies

Student: Juan C. Oteyza

Degree: Ph.D. Candidate

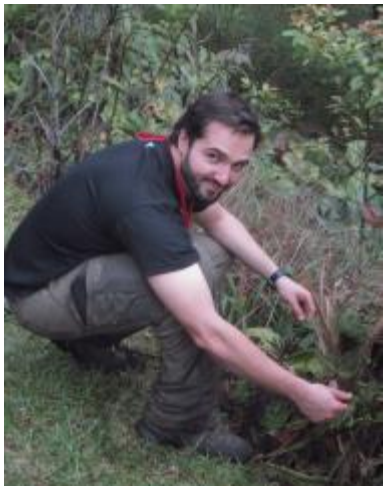
Advisor: Thomas E. Martin

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



Juan hiding a camera – field site, Borneo

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 of life-history strategies. For example, predation on dependent offspring plays a central role in modulating avian life-histories. Specifically, nest predation can have important consequences on nestling feeding rates, nestling begging behavior, offspring growth strategies and, consequently, offspring fitness.

Feeding rates may be sensitive to predation risk because activity at the nest (feeding trips) may 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 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 field season, predator playback experiments (and controls) were performed on nests of three species of passerine birds.

To test whether nestling begging calls correlate with nest predation rates, in 2012 I recorded nestling begging calls at 72 nests of 18 species that show great variation in predation rates. Additional data will be collected during the 2013 and 2014 field seasons. Filed work takes place in the tropical montane forest of Kinabalu National Park, in Malaysian Borneo.

Factors influencing survival of mountain plover chicks in Eastern Colorado

Obligated Funds: $90,110

Student: Maggie Riordan

Degree: M. Sc. Candidate

Principal Investigators: Mike Mitchell and Victoria Dreitz

Project Duration: 2011 – 2013 (Completed)

UM Affiliation: Wildlife Biology Program
Montana Cooperative Wildlife Research Unit

Funding source:

- State of Colorado

Abstract

Skewed sex ratios can have negative implications for population growth or persistence if not congruous for a species system. A skewed tertiary sex ratio (2.3 males per female) has been detected in the breeding population of a grassland shorebird experiencing population declines, the mountain plover (*Charadrius montanus*). To evaluate the ontogeny of the observed male skew this study examined the early life stages, from laying to fledging, of mountain plover young during their breeding season from 2010 – 2012 in eastern Colorado. The life stages between laying and fledging that allows for differentiation between production and survival of males and females. Early stages encompass the primary (eggs produced) ratio which allows for evaluation of applied sex allocation theory, the secondary sex ratio (successfully hatched chicks) which determines if a sex specific mortality is occurring pre-hatching, and the chick stage which determines if a sex specific mortality is occurring post-hatching. Mountain plovers are a sexually monomorphic species at all stages therefore DNA samples were used to determine the sex of individuals. The primary sex ratio was 1.01 (± 0.01) males per females. The secondary sex ratio consisted of 1.1 (± 0.02) males per female. Neither the primary nor secondary sex ratio was able to account for the magnitude of the skew observed later in this species adult population. Radio telemetry was used to evaluate the next stage of life, survival of male and female chicks from hatching until fledging. Using a multi-state mark recapture analysis, the top model for predicting chick survival rates estimates differed between males (0.55 ± 0.13) and females (0.47 ± 0.15). The estimated survival difference between the sexes during the chick stage can drive a population with equal survival rates at all other life stages to a ~2.1 :1 adult sex ratio. Results from this study suggest survival difference between males and females at the chick stage is possibly contributing to a male skewed population.

Test of the Causes of Evolved Differences and Plasticity in Growth and Development Rates of Passerines Offspring Across 3 Continents

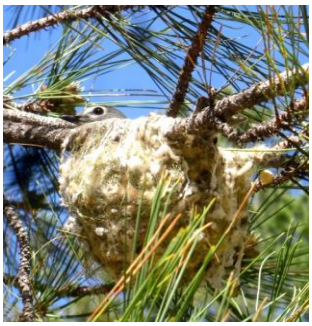
Student: Riccardo Ton

Degree: Ph. D. 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 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 and three seasons in a high altitude riparian system in Arizona. Moreover I have obtained funding to support one season of data collection in a third southern temperate field site in South Africa starting in September 2014. 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 82 embryos and 235 nestlings of these and other species. I'm currently submitting a paper that summarizes the result for the Arizona field site.

Grizzly Bear Family
Kananaskis, Alberta, Canada
Photo by D. Ausband

Wolf yearling silhouette – Lamar Valley, Yellowstone Park. 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 ($18,000)
- Idaho Department of Fish and Game ($40,000)
- 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 ($30,000)
- Alberta Environment and Sustainable Resource Development ($20,000)

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. In 2013, we completed genotyping samples from wolf packs collected during 2010-2012 in Idaho and 2012 in Alberta and Yellowstone National Park. We continued field surveys in summer 2013 in these three focal study areas. We surveyed 435 potential wolf rendezvous sites between the three study areas and collected 1,885 fecal samples for DNA analysis in 2013. We detected 14 litters between the three study areas. 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. Preliminary analyses using data from Idaho wolves indicate that female and male helper wolves differ in the amount of time they spend guarding pups. Changes to pack

composition may affect such helping behavior. We will conduct full analyses exploring the effects of group size and genetic relatedness, as well as prey and predator abundance, once all of the data are compiled.

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 continue field sampling through 2014 and complete analyses and publish full study results in 2015.

Wolf monitoring in Alberta

Research Associate: **David Ausband**

Project Duration: 2010 - 2012

UM Affiliation: Montana Cooperative Wildlife Research Unit

Funding Sources:

- Regina B. Frankenberg Foundation for Animal Welfare ($150,000)
- Eppley Foundation for Scientific Research ($24,000)
- Alberta Conservation Assoc. ($5,000)
- Waterton Biosphere Reserve Association ($174,742)
- Shikar Safari Club International ($4,000)
- Alberta Environment and Sustainable Resource Development ($20,000)
- Coypu Foundation ($30,000)

Objectives

Gray wolf populations can be difficult to monitor due to logistical and budgetary challenges. Building on work we conducted in Idaho and Montana, USA we began testing wolf monitoring techniques in southwest Alberta in 2012. Data from our survey methods (i.e., hunter and rendezvous site surveys) can populate an occupancy model which provides estimates of wolf abundance and distribution across the region.

Project and Status

Our study area ranges from the international border north to Highway 1 and is bordered on the east by Highways 6 and 22, except for the Porcupine Hills which are included in our study area. No wolf packs are currently radio marked in this area. We surveyed Alberta big game hunters for wolf sightings after the 2012 hunting season. We received 2,227 completed surveys and 161 hunters reported seeing $\geq$2 live wolves in our study area during the 2012 big game hunting season. To target wolf survey efforts and increase our ability to find and sample wolf packs in the field we developed a habitat model that predicts suitable wolf pack rendezvous site habitat. In summer 2012, we surveyed 420 potential wolf rendezvous sites between the international border and the Highwood River (including Porcupine Hills) and collected 439 genetic samples that yielded 45 individual wolf genotypes. This represents a minimum count of wolves in that area at that time and should not be interpreted as a population estimate. We resumed surveying in summer 2013 at 301 predicted rendezvous sites across the entire study area from the international border to Highway 1 and detected 4 litters of pups. DNA analysis of the 415 genetic samples collected during these surveys is currently underway at the University of Idaho.

As a response to community feedback we sent letters to >300 grazing leaseholders and included refrigerator magnets with our contact information in an attempt to gain more public input and sightings of wolves in the study area. We gave multiple public outreach presentations in January and July throughout the study area and contacted members of the South Country Trappers Association to gain information about wolf activity in the study area. We also conducted multiple interviews about our project with media in the region over the last 12 months.

Immediately after the 2013 big game hunting season, we will survey hunters in our study area for observations of live wolves once again. The resulting data, coupled with the 2012 hunter surveys and rendezvous site survey data from summers 2012 and 2013, will feed an occupancy model and provide preliminary estimates of wolf pack abundance and distribution in the study area. We plan to continue rendezvous site, DNA, and hunter surveys in 2014. Our goal by early 2015 is to have developed and tested a monitoring framework based on patch occupancy modeling that uses data from a variety of sampling techniques to provide reliable estimates of wolf population size in southwest Alberta annually.

Movements, gene flow, and relatedness of Bighorn Sheep in Central Idaho

Obligated Funds: $108,517

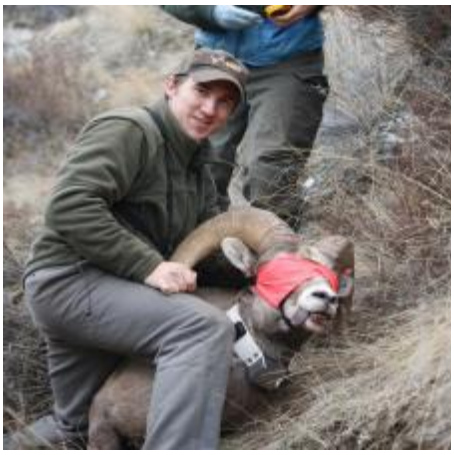
Student: Nathan Borg

Degree: M. Sc. Candidate

Advisor: Mike Mitchell

Project Duration: 2010-2013 (Completed)

UM Affiliation: Wildlife Biology Program
Montana Cooperative Wildlife Research Unit



Funding Source:

- Idaho Department of Fish and Game

Objectives

The primary objective of my research is to assess the level of connectivity between bighorn sheep populations across central Idaho in order to understand the potential for disease transmission between these populations. I am using genetic techniques to measure sex-specific levels of gene flow between populations and to identify landscape features that may regulate bighorn population connectivity. To understand connectivity at a local scale, I am combining radio-location and genetic data to assess bighorn social organization and spatial structuring, as well as to quantify interactions between social groups. Finally, I am measuring both nuclear and mitochondrial genetic diversity in bighorn populations to determine if there is a relationship between genetic diversity and variable levels of lamb recruitment observed across Idaho. This research will help managers identify populations with high levels of connectivity and a high potential for disease transmission should an outbreak occur. In addition, it will also provide an improved understanding of bighorn movements and allow possible insights into directional migration, source/sink dynamics, and social organization and interactions of bighorn sheep.

Progress and Status

In December 2011, we captured and radio-collared 3 rams and 9 ewes; of these, 6 ewes were marked with GPS collars. Total number of radio-collared bighorns at the beginning of 2012 was 31. An additional 135 fecal samples were collected during the 2nd field season for use in genetic connectivity analyses. Collection efforts focused on filling gaps in the sampling distribution across central Idaho and on re-sampling several radio-collared individuals. 40 blood and tissue samples collected during bighorn capture efforts in 2012 and 2013 have also been extracted and are included in the dataset. Currently, there are 403 nuclear DNA samples genotyped to individual. Landscape level Bayesian analysis is underway. Location data from 56 radio-collared bighorn sheep have been assembled. Data includes 25,100 GPS and VHF locations collected from 2007-2012 in GMUs 14, 19, and 20; cluster analysis is complete and fine-scale movement/space use analyses are progressing.

Linking resource selection with survival in female white-tailed deer

Obligated Funds: $70,000

Student: Charles R. Henderson, Jr.

Degree: M.Sc. Candidate

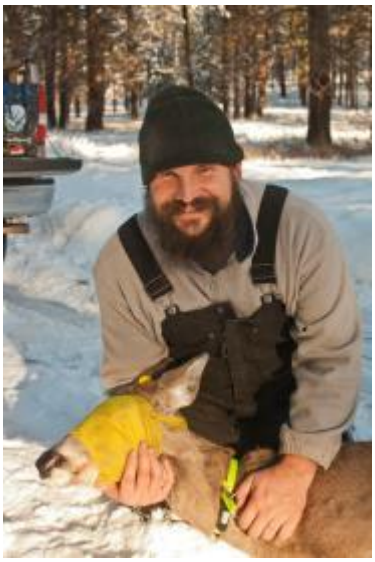
Advisor: Mike Mitchell

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 is 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. In addition, I will investigate the differences in survival and seasonal habitat use between resident and migrant deer. In order to accomplish this I will identify what proportions of the deer population are residents and migrants, calculate seasonal survival rates, identify and quantify seasonal ranges using movement and survival information. The information generated from the study will result in maps that combine seasonal resource use and survival data. These maps will allow agency personnel to more effectively manage the white-tailed deer population in this region. I will also provide information to managers that will increase the accuracy of local population estimates and identify local migration patterns and corridors. On a broader scale, the resource use and survival information about two competing life history strategies will increase scientific knowledge about the effects of partial migration on this population and white-tailed deer in general. Also, it will increase overall understanding of how the strategy of partial migration affects the habitat use and survival in other species.

Progress and Status

In February 2014, we completed the data collection process. As of March 2013, we had captured a total of 128 deer and of those 81 have active radio telemetry devices, 30 of which are GPS equipped. I presented a poster of preliminary results at the western states and provinces deer and elk workshop in May 2013. Currently, analysis on the complete data set is ongoing and I will begin writing up the results and my thesis in April 2014.

Linking resource selection to population dynamics of mule deer

Obligated Funds: $48,326

Student: Mark Hurley

Degree: Ph. D. Candidate

Advisors: Mike Mitchell
Mark Hebblewhite

Project Duration: 2010 – 2014

UM Affiliation: Wildlife Biology
Montana Cooperative Wildlife Research Unit

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.

We developed a new method to visualize the plant phenology curve using NDVI, a satellite-based measure of plant growth, to estimate annual and spatial differences in vegetation quality. With this method we are able to predict weight gain until December and when coupled with winter severity, estimate winter survival and recruitment of young. I have completed all of the coursework, teaching, proposal, and comprehensive exam requirements for the Ph.D. program as of December, 2012. This season, we will complete the remaining plant composition and quality of fawn rearing home ranges and analyze nutritional quality results.

Western elk research collaborative

Obligated Funds: $181,799

Principal Investigator: Paul M. Lukacs, Mike Mitchell

Data Technician: Matthew Nordhagen

Project Duration: 2010 - 2014

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.

Representatives from the collaborating states and universities met in Missoula in June 2013 to begin analyzing the entire recruitment data set. We are examining the combined effects of predation and environmental conditions on elk recruitment. We anticipate completing the analyses during the fall of 2013 and submitting a manuscript for publication shortly thereafter.

Upon completion 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 Funds: $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

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

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.

Ungulate ecology in Idaho: Understanding predator/prey interactions

Obligated Funds- $149,745

Principal Investigator: Mike Mitchell

Project Duration: 2010 – 2013

Fund Source:

- Idaho Department of Fish and Game

Project summary

In 2005, we launched the Ungulate Ecology Project. An important initial objective was to simply take a demographic and ecological "snapshot" of representative mule deer and elk populations in 12 study areas across Idaho. Results have provided wildlife managers with important background information, including adult female survival rates and cause-specific mortality, pregnancy rates, body condition, and general movement patterns.

More recently, the emphasis has shifted to 2 contrasting focal areas (Lowman, GMUs 33, 34, 35; and North Fork, GMUs 10, 12) where the objective is to understand the dynamics and mechanics of the elk/ wolf system. The goal is to develop predictive models to estimate elk populations based on elk/wolf ratios and covariates such as topography, habitat, alternate prey species and density, and weather. These models will reduce the need for intensive radio-collaring and monitoring efforts in each GMU of interest, resulting in significant efficiencies. This project requires intensively monitoring elk, moose, and wolves in study areas, investigating mortalities, and significant data management challenges.

Furthermore, there is a strong link between the Ungulate Ecology Project and the Wolf Monitoring Project (Nez Perce Tribe is an additional collaborator). The primary initial funding for the Wolf Monitoring Project was provided through the Nez Perce Tribe, though UM has played a leadership role in that research effort via the Coop Unit. Results and techniques from this work are integrated into the Ungulate Ecology Project and management programs as they become available. The UEP provides logistical support and continual feedback.

These projects will provide decision tools to wildlife managers that strive to balance natural processes with social and economic realities.

Proactive management of pneumonia epizootics in bighorn sheep in Montana

Obligated Funds: $49,000

Student: **Sarah Sells**

Degree: M.Sc. – Wildlife Biology Candidate

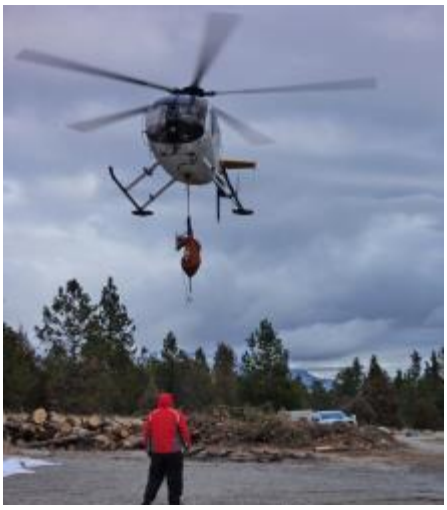
Advisor: Mike Mitchell

Project Duration: 2011 – 2013

UM Affiliation: Wildlife Biology Program
Montana Cooperative Wildlife Research Unit

Funding Sources:

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



Preparing to Receive Ewe – Yellowstone National Park

Objectives

Pneumonia epizootics are a major challenge for management of bighorn sheep (*Ovis canadensis*). Half of the 50 populations in Montana have suffered die-offs since 1980, most due to pneumonia and rarely with <50% mortality. The result may ultimately be extirpation due to direct pneumonia mortality and other stochastic and density-related factors. Many studies have investigated the cause of these epizootics, and pathogen transmission from domestic to bighorn sheep is the only supported hypothesis in experimental trials (Wehausen et al. 2011). Yet disease processes are often influenced by complex environmental interactions. Various stressors may influence health and immune response, but it is unknown what stressors influence pneumonia in bighorn sheep. Ultimately, poor understanding of wildlife diseases usually results in reactive crisis management. In contrast, proactive management would integrate health management with day-to-day wildlife management, reducing need for reactive crisis response.

Our goal is to use pneumonia epizootics as a case study for development and application of risk and decision models for statewide, proactive programs so that wildlife health can be managed as an integral facet of general wildlife management. A set of models that identify risk of pneumonia epizootic and the best management decisions given that risk would be of great value for proactive management of pneumonia in bighorn sheep. Thus, our objectives are to:

- **Design a risk model** to predict risk of pneumonia epizootics for herds in Montana through statistical analyses of hypothesized risk factors.
- **Design a proactive decision model** for management of pneumonia epizootics that incorporates estimates of pneumonia risk using Structured Decision Making (SDM; Figure 1; Runge et al. 2011) to help evaluate costs and benefits of alternative actions appropriate to risk estimates.

The resulting models will help MFWP predict risk of pneumonia under various management alternatives and evaluate relative efficacy of management alternatives in reducing the effect of pneumonia in bighorn sheep herds. The models will thus be a complete toolset for proactive management of pneumonia epizootics in Montana. Ultimately, this project will also demonstrate development and application of risk and decision models 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 Funds: $56,230

Student: Jeff Stetz

Degree: Ph.D. 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 2013 to May 2014.
- Colciencias Fullbright Scholarship

Mark Hurley

- Outstanding Monograph Award – 2013 – The Wildlife Society

Joseph LaManna

- EPA Star Fellowship Award

James Mouton

- NSF Graduate Research Fellowship
- Dial-Drollinger Research Travel Grant

Juan Oteyza

- Student Travel Grant ($1000), 26th International Ornithological Congress, Tokyo, Japan (taking place Aug. 2014).
- Student Travel Fund Award ($362), Office of the Provost, University of Montana. To attend the 26th International Ornithological Congress, Tokyo, Japan.
- Wildlife Biology Program travel support ($750) to attend the Gordon Research Conference on Predator Prey Interactions in Ventura, California, January 2014.

Jeff Stetz

- Consultant, Forest Carnivores Monitoring Initiative. Lolo, Helena, and Flathead National Forests, leads.
- Member, Great Bear Foundation board of directors [501(c)3]

Riccardo Ton

- Office of the Provost Travel award, University of Montana (2013)
- Drollinger-Dial Research Travel Award, (2014)

PRESENTATIONS AND POSTERS

Ausband, D.E. March 2013; Idaho chapter of The Wildlife Society Annual Conference, Coeur D'Alene, Idaho

Ausband, D.E. November, 2013; Montana Chapter of The Wildlife Society Annual Conference, Whitefish, Montana

Mitchell, A., J. Boersma, **A.J. Boyce**, and **T.E. Martin**. Life-history strategies of high elevation tropical birds. Poster presentation to the AOU/COS 2013 Joint Meeting. August 2013. Chicago, IL.

A.J. Boyce. Studying and conserving the birds of Kinabalu Park. Keynote presentation at the 2013 Borneo Bird Festival. June 2013, Sandakan, Sabah, Malaysia.

Crandall, Ross Master's Thesis Presentation – "Identifying Environmental Factors Influencing Golden Eagle Presence and Reproductive Success"

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)

Charlie Henderson, 10th Biennial Western States and Provinces Deer and Elk Workshop entitled "Survival and Resource selection in partially migratory White-tailed deer

LaManna, J. A. and **T. E. Martin**. 2014. Cost of fear: predation risk affects reproductive traits and success across species. Predator-Prey Interactions Gordon Conference, Ventura, CA, USA

Arriero, E., A. Majewska, and **T. E. Martin**. 2013. Ontogeny of constitutive immunity: maternal vs endogenous influences. Functional Ecology 27: 472–478.

Ghalambor, C. K., S. I. Peluc, and **T. E. Martin**. 2013. Plasticity of parental care under the risk of predation: how much should parents reduce care? Biology Letters 9: 20130154.

Martin, T. E. 2014. A conceptual framework for clutch size evolution in songbirds. American Naturalist 183: 313-324.

Lloyd, P., F. Abadi, R. Altwegg, and **T. E. Martin**. 2014. South-temperate birds have higher apparent adult survival than tropical birds in Africa. Journal of Avian Biology, in press

Oteyza, Juan C. and **Thomas E. Martin**. 2014. The effects of nest predation risk on parental investment and reproductive success. Gordon Research Conference on Predator-Prey Interactions. Ventura, California, January 2014 (poster).

Sells, Sarah March, 2014; A risk model for proactive management of pneumonia epizootics in bighorn sheep in Montana", Montana Chapter of The Wildlife Society Meeting

Stetz, Jeff Invited speaker, 21st Eastern Black Bear Workshop, Millinocket, Maine

Stetz, Jeff, Invited speaker, 11th Western Black Bear Workshop , Coeur d'Alene, Idaho

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.

Henderson, M.M**.**, M. Hebblewhite, **J. Stetz,** M. Mitchell, K. Kendall, R. Carlson. February 2014. A model of bear rub locations using landscape covariates in the Cabinet-Yaak region of Northwest Montana. Poster. Washington State Chapter of The Wildlife Society Annual Conference. Pasco, WA, USA

Stetz, J.B. January 2014. *Invited speaker.* Grizzly bear research and monitoring in northwestern Montana. WILD 470, Population Ecology. University of Montana, Missoula, MT, USA.

Stetz, J.B. January 2014. *Invited speaker*. Review of noninvasive sampling methods in wildlife research. WILD 472, Wildlife handling and immobilization. University of Montana, Missoula, MT, USA.

Stetz, J.B. July 2013. *Invited speaker.* Grizzly bear research and monitoring in northwestern Montana. ConGen. Flathead Lake Biological Stations, Polson, MT, USA.

Stetz, J.B. May 2013. Bear biology, research, and management. Two day education event through Great Bear Foundation and the Lolo National Forest. Frenchtown, MT, USA.

Stetz, J.B., M.A. Sawaya, F. van Manen, and J. Clark. April 2013. *Invited speaker*. Black bear research and monitoring options in the Northeast.21st Eastern Black Bear Workshop, Millinocket, Maine, USA

SCIENTIFIC PAPERS AND REPORTS

Ausband, D.E., L.N. Rich, E.M. Glenn, **M.S. Mitchell**, P. Zager, C.M. Mack. In Press. Monitoring gray wolf populations using multiple survey methods. Journal of Wildlife Management.

Rich, L.N., R.E. Russell, E.M. Glenn, **M.S. Mitchell**, J.A. Gude, K.M. Podruzny, C.A. Sime, K. Laudon, **D.E. Ausband**,
J.D. Nichols. 2013. Estimating occupancy and predicting numbers of gray wolf packs in Montana using hunter surveys. Journal of Wildlife Management 77:1280-1289.

Brennan, A., P.C. Cross, **D.E. Ausband**, A. Barbknecht, S. Creel. 2013. Testing automated howling devices in a wintertime wolf survey. Wildlife Society Bulletin 37:389-393.

Ausband, D.E., M.S. Mitchell, S.B. Bassing, and C. White. 2013. No trespassing: using a biofence to manipulate wolf movements. Wildlife Research. 40:207-216.

Runge, M.C., J.B. Grand, and **M.S.Mitchell**. 2013. Structured decision making. Pages 51-72 in PR. Krausman and J.W. Cain III, editors. Wildlife Management and Conservation: Contemporary Principles and Practices. The John Hopkins University Press.

Zimova, M., L.S. Mills, P.M. Lukacs, and **M.S. Mitchell**. 2014 Snowshoe hares display limited phenotypic Plasticity to mismatch in seasonal camouflage. Proceedings of the Royal Society B 281:20140029

McCall, B.S., **M.S. Mitchell**, M.K. Schwartz, J. Hayden, S. Cushman, and W. Kasworm. 2013. Combined use of mark-recapture and genetic analyses reveals response of a black bear population to changes in food productivity. Journal of Wildlife Management 77:1572-1582

Newby, J. R., L. S. Mills, T. K. Ruth, D. H. Pletscher, **M. S. Mitchell**, H. B. Quigley, K. M. Murphy, and R. DeSimone. 2013. Human-caused mortality influences spatial population dynamics: pumas in landscapes with varying mortality risks. Biological Conservation 159:230-239

Fierro-Calderón, K. and R. Johnston-González. In press. Species *Chlorochrysa nitidissima*. In: Naranjo, L.G. et al. (Eds.) Libro Rojo de las Aves de Colombia. Segunda Edición. Pontificia Universidad Javeriana. Bogotá, Colombia.

Fierro-Calderón, K. and S. Córdoba-Córdoba. In press. Species *Glaucidium nubicola*. In: Naranjo, L.G. et al. (Eds.) Libro Rojo de las Aves de Colombia. Segunda Edición. Pontificia Universidad Javeriana. Bogotá, Colombia.

Stetz, J.B., K.C. Kendall, and A.C. Macleod. 2013. Black bear density in Glacier National Park. Wildlife Society Bulletin. *In Press*.

Martin, T.E., **Ton, R.**, and Niklison, A. 2013. Intrinsic vs. extrinsic influences on life history expression: metabolism and parentally induced temperature influences on embryo development rate. *Ecology Letters* 16: 738-745.