Raptors and the Energy Sector

Understudied Open Land Raptors

Innovations in Raptor Education

Environmental Contaminants

RAPTOR RESEARCH FOUNDATION 2017

Salt Lake City, UT

RAPTOR RESEARCH FOUNDATION

HAWK WATCH INTERNATIONAL

CONFERENCE AT-A-GLANCE

Tuesday, November 7		
8:00 am - 5:00 pm	Raptor Research Foundation Board Meeting	North Star
Wednesday, November 8		
8:00 am - 12:00 pm	ECRR Workshop: Harnessing Raptors with Transmitters	Deer Valley
8:00 am - 12:00 pm	ECRR Workshop: The Graduate Student's Toolbox: Tips and Tricks	Solitude
8:00 am - 12:00 pm	ECRR Workshop: Raptor Field & In-Hand ID, Ageing & Sexing, Recent Taxonomic...	Sundance
8:30 am - 12:00 pm	ECRR Workshop: Raptor Road Trapping	Canyons Lobby
1:00 - 5:00 pm	ECRR Workshop: Techniques for Handling, Auxiliary Marking, and Measuring...	Solitude
1:00 - 5:00 pm	ECRR Workshop: Handling and Taking Biomedical Samples in Raptors	Sundance
1:00 - 5:00 pm	ECRR Workshop: Learning About Raptors via Telemetry – How to Get The Data...	Deer Valley
1:00 - 4:00 pm	Utah Eagle Working Group Meeting	Snowbird
6:00 - 9:00 pm	Icebreaker Reception	Canyons Lobby
Thursday, November 9		
8:00 - 9:30 am	Plenary Speaker, Jim Bednarz, "Whatever You Do, Don't Study Raptors!"	Canyons
10:00 am - 4:40 pm	Symposium: Raptors and the Energy Sector	Canyons
10:00 - 11:40 am	Symposium: Environmental Contaminants and Raptors	Bryce
10:00 - 11:40 am	General Session: Foraging and Feeding	Arches
12:00 - 1:20 pm	Raptor Population Index Committee Meeting	North Star
1:20 - 4:40 pm	General Session: Migration	Bryce
1:20 - 4:40 pm	Symposium: Conservation and Ecology of Understudied Open Land Raptors	Arches
5:00 - 6:00 pm	ECRR Social	Deer Valley
5:00 - 6:00 pm	HawkWatch International Migration Crew Alumni Social	Bryce
6:00 - 9:00 pm	Poster Session & Reception	Arches
Friday, November 10		
8:00 - 9:30 am	Plenary Speaker, Andre Botha	Canyons
10:00 am - 4:40 pm	Symposium: Conservation and Ecology of Understudied Open Land Raptors	Arches
10:00 am - 2:40 pm	General Session: Anthropological Effects with Raptors	Bryce
10:00 - 11:40 am	Speed Talks	Canyons
12:00 - 1:20 pm	Arctic Falcon Specialist Group Meeting	North Star
1:20 - 4:00 pm	General Session: Ecotoxicology and Health of Raptors	Canyons
3:20 - 4:40 pm	General Session: Public Engagement and Collaborations	Bryce
5:30 - 8:30 pm	Taste of Salt Lake Fiesta Dinner	See page 8
8:00 - 9:00 pm	Film Screening: Resilience-Fish Eagle of Naivasha	Canyons
Saturday, November 11		
8:00 am - 3:20 pm	Symposium: Innovations in Raptor Eduction	Canyons
8:00 - 11:40 am	General Session: Habitat Use	Bryce
8:00 - 11:40 am	General Session: Breeding Behavior of Raptors	Arches
1:00 - 2:40 pm	General Session: Population Monitoring	Bryce
1:00 - 2:40 pm	General Session: Raptor Demographics	Arches
3:30 - 4:30 pm	RRF Members Business Meting	Arches
6:00 - 9:00 pm	Banquet and Photo Contest	Canyons

Sheraton
HOTELS & RESORTS

CANYONS LOBBY	REGISTRATION / INFORMATION
BRYCE	SCIENTIFIC TALKS
CANYONS	PLENARY TALKS / SCIENTIFIC TALKS / SATURDAY BANQUET
ARCHES	SCIENTIFIC TALKS / POSTER SESSION & RECEPTION
DEER VALLEY	VENDORS / COFFEE & SNACK BREAKS
SUNDANCE	POSTERS

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CONFERENCE CO-HOSTS

HawkWatch International

www.hawkwatch.org

The mission of HawkWatch International is to conserve our environment through education, long-term monitoring, and scientific research on raptors as indicators to overall ecosystem health. HWI was founded more than 30 years ago to conduct annual migration counts in the West, and today operates the largest, coordinated migration network in the country.

Raptor Research Foundation

www.raptorresearchfoundation.org

Founded in 1996, Raptor Research Foundation (RRF) is a non-profit scientific society formed to accumulate and disseminate scientific information about raptors in order to inform the scientific and lay public about the role of raptors in nature and to promote their conservation.

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GENERAL INFORMATION

Please wear your name tag at all times, as it serves as your admission ticket to all events covered by your registration fee.

Registration

Registration for the 2017 Raptor Research Foundation Conference includes your welcome packet, conference program, and admission to all Symposia, Plenaries and General Sessions. It also covers the following:

- Coffee/snack breaks
- Icebreaker Social and Poster Session Reception
- Commemorative 9 ounce steel tumbler and your welcome bag
- Conference related hotel charges (meeting rooms, a/v equipment, sound, etc.)

In addition, please note that the cost of your registration helps to subsidize lodging and travel expenses for Plenary Speakers, and also facilitates the lower cost of student registration.

Registration/Information/Lost and Found Table

Tables for registration, information, lost and found, and merchandise sales are located in the Canyons Lobby and will be open Wednesday-Saturday from 8 am- 5 pm and Sunday 7-11 am.

Code of Conduct

The RRF Conference Code of Conduct is located at the end of the program book. Our goal is to make everyone feel comfortable during the conference and provide a friendly environment for exchanging conversation and ideas. Refer to the code of conduct for information on reporting incidents.

Event App

Download the Eventbase app on your smart phone and search for "RRF Conference" to access a full schedule of speaker abstracts and sessions. Star your favorites to create a personal agenda, and take notes directly in the speaker abstract to email to yourself or someone else.

Keep It Green

Coffee for the conference has been donated by Caffe Ibis Coffee Roasting Company, certified QAI organic, Free Trade, and shade grown and bird friendly. Beer for our Friday night event has been donated by Unita Brewing Company, brewed with wind and solar renewable power. Conference books were printed on FSC certified paper (Forest Stewardship Council). Registration bags and commemorative steel mugs were purchased from Eco Imprints, an earth-friendly promotional goods supplier.

Help us keep this conference as green as possible by reducing, reusing, and recycling. Use your reusable steel mug in your registration bag for coffee and water. A water refill station is located by the restrooms in the Canyons Lobby. Walk and take public transit when you explore downtown Salt Lake City. You can access city light rail and bus schedules at www.rideuta.com or download the iRideUTA app on your phone.

VENDORS

Thanks to all of our vendors for their participation! Vendor booths are located in the Deer Valley room from Thursday through Saturday. Make sure to stop by and say hi as you visit the coffee and snack table.

Avian Power Line Interaction Committee

www.aplic.org

Avian Power Line Interaction Committee leads the electric utility industry in protecting avian resources while enhancing reliable energy delivery.

Cellular Tracking Technologies, Inc:

www.celltracktech.com

The founders of Cellular Tracking Technologies have over 40 years of telemetry research experience between them. In 2007, when not satisfied with the current products on the market, they created CTT in order to bring the newest innovations and highest levels of service to the wildlife research market.

GeoTrak Inc.

www.geotrakinc.com

GeoTrak has been designing and manufacturing custom electronic tracking devices for wildlife researchers throughout the world since 1999.

Hawk Migration Association of North America

www.hmana.org

Hawk Migration Association of North America (HMANA) works to advance the scientific knowledge and promote conservation of raptor populations through study, enjoyment, and appreciation of raptor migration.

Kaddas Enterprises

www.kaddas.com

Kaddas Enterprises is the manufacturer of BirdguarD ™, used by Power Utilities to mitigate Animal Caused Power Outages. Kaddas is ISO 9001:2015 Certified and is WBENC Certified 100% Woman Owned. We specialize in Plastic Thermoforming, Pressure Forming, and Hand Fabrication of Polymer solutions. Kaddas uses state of the art Master Cam 3D modeling, 5 Axis CNC Machining and performs all design, development and tooling in our Utah facility. 100% Made in the USA, by choice.

Lotek Wireless Corporation

www.lotek.com

Lotek is a world leader in the design and manufacture of fish and wildlife monitoring systems, with innovative and internationally recognized radio, acoustic, archival and satellite monitoring solutions that allow researchers to track animals, birds, and fish of almost any size, in almost any environment.

LS Traps

www.trapsbyliz.com

LS Traps is a family owned and operated business. At LS Traps, we are people who love birds, that's why we focus on providing quality non-lethal avian traps with the highest levels of care and concern for the species being trapped. We specialize in starling and raptor traps. We also build quality bird traps for various species, for a variety of applications. From airports, to dairies, to research projects, and anything else in between.

Natalia Wilkins-Tyler

www.wilkinsillustration.com

Natalia is a science illustrator and graphic designer. She is a graduate of the Science Illustrator Program at California State University, and of the School of Botanical Art and Illustration at Denver Botanical Gardens.

Nick Dunlop Photography

www.nickdunlop.com

Nick is a wildlife photographer and naturalist whose goal is to capture images of wildlife, primarily birds of prey, in natural settings.

Wildlife Computers

www.wildlifecomputers.com

Wildlife Computers is the leading provider of advanced wildlife telemetry solutions. Propelled by our mission to promote sustainable use of our global environment, we create innovative tags that empower data-driven decisions while providing unique consultations, an unsurpassed quality commitment, and impeccable customer service to get you the data you need.

ACKNOWLEDGMENTS

Many people have been working behind the scenes over the past year to create this year's conference. We want to thank everyone who contributed their time and talents, including the below committees and moderators. Thanks to Bryce Robinson for logo design, and to Joseph Dane for program book design. Special thanks to Libby Mojica for setting up the new RRF Conference registration system and ensuring a smooth transition.

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Contributing Photographers

Alexander Paiement
Annette Hansen
Ben West
Caitlin Davis
Evan Buechley
Iain MacLeod
Jeremy Halka
Jerry Liguori
Joseph Dane
Kate Davis
Kurt Licence
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Mike Smith
Mitchell Pruitt
Neil Paprocki
Phil Robertson
Rob Miller
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Front Cover Photos (top to bottom):
Jerry Liguori
Jerry Liguori
HawkWatch International
Neil Paprocki

Moderators

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Brian Millsap
Brian Washburn
Bryce Robinson
Cameron Nordell
Carol McIntyre
Carol McIntyre
Chris Vennum
Chuck Preston
Erin Brown
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Welcome to Salt Lake County!

We are excited to host the 2017 Raptor Research Foundation Conference and the many raptor biologists, educators, and students who will share the latest science and data on raptor conservation.

Utah is home to diverse habitats and landscapes, from areas that provide homes to Mexican Spotted Owls and condors in the south to Boreal Owls in the north. Not only do many species nest here, we're on the migratory flyway for numerous raptors including Bald Eagles, Rough-legged Hawks, and Short-eared Owls. Our majestic Wasatch Mountains provide a critical travel corridor between the Great Basin and Mojave deserts and the Colorado Plateau. More than 34 million acres of public land in Utah, including national parks and monuments, provide food and shelter for these important and sometimes threatened species.

If you are looking for ideas for how to enjoy your free time outside of the conference, let me suggest Tracy Aviary in Liberty Park, the Natural History Museum of Utah on the Bonneville Shoreline trail near Red Butte Garden, and City Creek Center downtown for a variety of places to eat and shop.

Thank you for your work to preserve and protect the birds that have such a crucial role in our Rocky Mountain ecosystem. Best wishes for a successful conference and an enjoyable stay in the Salt Lake valley.

Sincerely,

Ben McAdams
Salt Lake County Mayor

Welcome message from the President!

On behalf of the Raptor Research Foundation, I welcome you to the 2017 RRF annual conference. It has been nearly 20 years since the last time we met in Utah. And I am sure I represent the feeling of all our members by saying: we are glad to be back! The first time I have been in Utah was in 2005 during a family trip when I visited some of the most beautiful National Parks and wilderness areas I have ever seen. My wife, son and myself fell in love with the state, and secretly I was expecting RRF would meet here again one day so you can also feel enraptured and elated with it as we did. So here we are, having the opportunity to gather in Salt Lake City, the perfect gate to start enjoying Utah's nature in any way you like it, in this time of the year also means lot of raptors to be seen. Many species can be found around the state. Look for them! Watch them! But do your best to allocate time for visiting all the other attractions you will find in Salt Lake City and surrounding areas, and meet the people who make Utah a great state.

Every year, every conference it is a great opportunity for all of us to acquire new knowledge about raptors recently gained by the best researchers from all around the world. This year's program will take us into more than twelve different symposiums with more than 170 presentations and several workshops that should satisfy each one of our personal interests. We will also have two plenary presentations: Dr. James Bednarz, RRF Vice-President, will be guiding us through some of the most interesting aspects of raptor behavior and raptor ecology, most of it learned from his own studies. Also, Dr. Andre Botha is coming from Africa to share with us his work with vultures and the challenges for developing a comprehensive Strategic Conservation Action Plan for these amazing

creatures. An icebreaker, poster reception, other evening events, and our traditional banquet will provide opportunities to continue learning, while at the same time getting to enjoy the company of other raptor enthusiasts and comrades.

As for every conference, we have an amazing host this year. HawkWatch International joined us one more time to prepare this event providing their experience and organizational skills. Immeasurable hours of dedication, planning, implementation, and assessment were needed to prepare and organize a conference like this one. We are deeply grateful for our friends of HawkWatch for hosting this year's meeting. As you probably know, HawkWatch is a North American leader for conserving birds of prey and the environment using science and education. They also spearhead cutting-edge research on raptor migration. Please learn more about HawkWatch by visiting their website. A big thank you goes to local Conference Committee Co-chairs Dave Oleyar and Joseph Dane, whom with the assistance of multiple committee members and volunteers are the ones who lead these efforts. We all should applaud and recognize them for this year's meeting and for taking all of us back to Utah! As we all know, organizing a conference is not an easy task. RRF will be forever grateful with all of you.

A sincere and heartedly thank you to all that, one way or another, are key in several aspects of each annual conference planning and/or for the good functioning of RRF. A special thanks to RRF Conference Committee (Chair Jerry Niemi and member and upcoming Chair Dan Varland), the Scientific program Committee (Chair Elizabeth Wommack), the Early Career Raptor Researcher Committee (Chair Joseph Eisaguirre), the Awards Committee (Chair Gary Santolo), and our Web Manager and upcoming RRF President and Web manager Elizabeth (Libby) Mojica. You and members of your respective committees committed a lot of hours to finally arrive to this day. To all our vendors and sponsors, we know who you are and we thank your generous support to RRF, its mission and goals, this and previous years.

From now on, please, enjoy the conference, Salt-Lake city and Utah. They are waiting for you!

Miguel D. Saggese,
Raptor Research Foundation, President

On behalf of the HawkWatch International staff and board, welcome!

It is our great pleasure to host this year's Raptor Research Foundation conference in Salt Lake City, and to greet all of our many friends and colleagues in the place we call home. It was 35 years ago since Salt Lake City first hosted the conference, and boy oh boy have things changed. That same year the Commodore 64 8-bit home computer was launched, the first ever CD player was sold in Japan, the first permanent artificial heart implant was installed, and ET hit the big screens. Also, HawkWatch International was not yet born. Well, that's not true. Back at that time we were working under the auspices of Western Foundation for Raptor Conservation based out of Albuquerque, New Mexico. It wasn't until 1986 that we formally incorporated as HawkWatch International (HWI).

Over the past 3 decades HWI has also changed and evolved with the times. We still operate the country's single largest coordinated raptor migration monitoring network that spans the western states from the Pacific Northwest to the Gulf coast. Our strategic partnerships and geographic reach have also included international raptor projects in Canada and Africa. Our education and outreach programs reach over 40,000 students and adults every year. And our field research efforts cover a multitude of raptor species and habitats. Like all of you we are passionate about raptor science and work very hard to fill knowledge gaps and strengthen raptor conservation efforts. We are excited about the diversity and excellence of this year's RRF symposia and presentations and we look forward to learning more of the great work of so many dedicated raptor professionals and connecting with friends and colleagues.

Hope you enjoy the conference and your stay in Salt lake City.

Paul Parker
HawkWatch International, Executive Director

CONFERENCE EVENTS

Icebreaker Social
Wednesday, November 8 from 6-9 pm
Canyons Lobby

After visiting the registration table and getting settled into your room, come join us to say hi to old friends and meet new ones. Food and cash bar.

ECRR Social
Thursday, November 9 from 5-6 pm
Deer Valley

Are you an early career raptor researcher? Come join the ECRR social prior to the Poster Session and Reception to connect with peers and meet other friends in the field.

HawkWatch Migration Crew Alumni Social
Thursday, November 9 from 5-6 pm
Bryce

Calling all former HawkWatch International migration crew members. If you have ever worked at one of our migration sites, we want to catch up. Come say hi to the HWI staff and meet some fellow crew members.

Poster Session & Reception
Thursday, November 9 from 6-9 pm
Arches

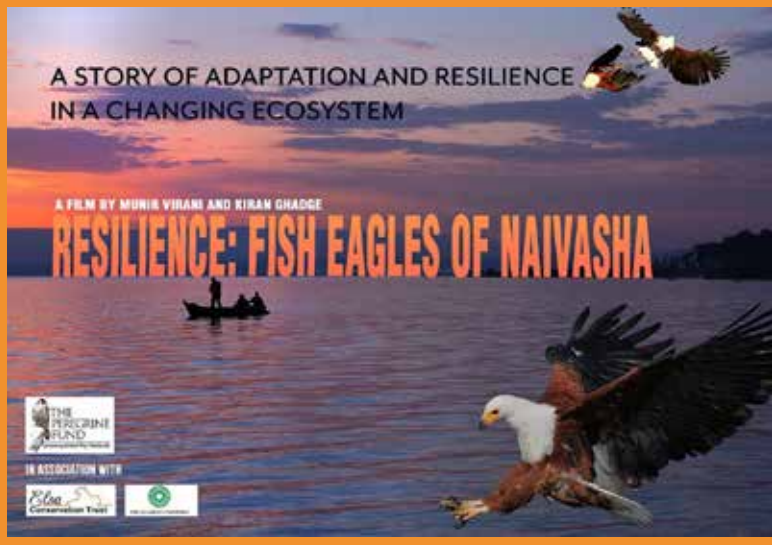
Enjoy food and cash bar while viewing posters and talking to authors about their research.

Taste of Salt Lake Fiesta Dinner
Friday, November 10 form 5:30-8:30 pm

Let's get our fiesta on! Meet in the front lobby at 5:30 pm for shuttle service to the Utah State Capitol. Enjoy the evening city views before walking down to the Memorial House located in Memory Grove Park for an evening of food, beer, and music. Dinner catered by Red Iguana, voted Salt Lake City's best Mexican food and featured on Diners, Drive-Ins and Dives. You have the option to catch the shuttle back to the Sheraton at 8:30 pm, or take the 2 mile pub crawl back with the HWI crew. Preregistration required.

Resilience: Fish Eagle of Naivasha
Friday, November 10 from 8-9 pm
Canyons

Join us for a free screening of Resilience: Fish Eagle of Naivasha, a film by Munir Virani and Kiran Ghadge. Lake Naivasha holds the largest population of African Fish Eagles in the world and has undergone severe environmental and human-caused changes over the last 100 years. Threats include water abstraction, a growing human population, alien species, degradation, overfishing and contamination. Despite this, the lake has an unshakable resilience that continues to support a thriving eagle population. Dr Munir Virani, a Kenyan born scientist has been studying the eagles at Naivasha for over 20 years and takes us through a fascinating journey through the lens of the eagles to show how they have survived through periods of strife.



Banquet and Photo Contest
Saturday, November 11 from 6-9 pm
Canyons

Join us for our farewell banquet and awards dinner. We will also announce the winners of our Photo Contest. Preregistration required. Cash bar provided.

FIELD TRIPS

Visit the Information table before field trip dates for availability and registration.

Snowville/Bear River

7:30 am-4 pm | $35 Wednesday, $40 Sunday
Meet in Canyons Lobby at 7 am for departure

A patchwork of agricultural fields located at the northern extent of the Great Salt Lake basin near the Utah-Idaho border, Snowville hosts amazing densities of wintering raptors including Ferruginous Hawks, Rough-legged Hawks, Prairie Falcons, Golden Eagles, Northern Harriers, and many others. From Snowville, we will explore the premier Great Salt Lake bird refuge. The Bear River Migratory Bird Refuge is a 74,000-acre complex of open water, wetlands, and grasslands supporting a diversity of raptors, shorebirds, and waterfowl to the tune of over 250 species! Boxed lunch provided.

Photo by Annette Hansen

Antelope Island State Park

1-6 pm (this would include sunset) | $25 Wednesday
Meet in Canyons Lobby at 12:30 pm for departure

The largest island in the Great Salt Lake, Antelope Island is host to between 4 and 6 million birds of over 250 species annually. The 28,000-acre island is just over an hour from downtown Salt Lake City. In November you may see Northern Harriers, American Kestrels, Rough-legged Hawks, Bald Eagles, and occasionally Burrowing Owls and Prairie Falcons. A diversity of waterfowl, shorebirds, and gulls may also be observed here as well as large mammal species including: free ranging bison, pronghorn, mule deer, and big-horn sheep.

Photo by Annette Hansen

Farmington Bay Waterfowl Mngt Area

9 am-12 pm/1-4 pm | $15 Wednesday and Sunday
Meet in Canyons Lobby at 8:30 am/12:30 pm

Likely the most famous local birding destination, Farmington Bay Waterfowl Management Area is a short 20-minute drive from downtown Salt Lake City and offers excellent birding opportunities within this extensive wetland complex on the eastern shores of the Great Salt Lake. In November, astonishing densities of Northern Harriers can be found here, along with Bald Eagles, Rough-legged Hawks, American Kestrels, and the occasional Barn and Short-eared Owl. Other highlights include a tremendous quantity and diversity of waterfowl, shorebirds, and gulls! Boxed lunches optional.

Photo by Annette Hansen

Snowbird/Alta

9 am-1:30 pm | $40 Sunday
Meet in Canyons Lobby at 8:30 am for departure

Located up Little Cottonwood in the picturesque Wasatch Mountains, these two world-famous ski resorts top out at over 10,000-ft and offer stunning montane views of the surrounding landscape. Trip includes a gondola ride to the top of the Snowbird resort at 11,000-ft. Take in the views, explore the mountain trails, visit the bird feeders at the base of Alta, or just enjoy the crisp mountain air! This trip is less bird-centric but features possible mountain-west specialty species such as Gray-crowned and Black Rosy Finch, Stellar's Jay, Mountain Chickadee, Cassin's Finch, and Pine Grosbeak.

Photo by Neil Paprocki

CONFERENCE WORKSHOPS

Raptor Road Trapping

Wednesday, November 8 from 8:30 am - 12:00 pm
Jesse Watson and Dave Oleyar, HawkWatch International

This class will cover common materials and techniques used for road trapping raptors. Noose details (i.e., style, monofilament gauge, color) and Bal-chatri design will be discussed along with methods for weighting traps, and the preferred bait when targeting certain species of raptors. Emphasis will be put on: noose preparation, trap placement in different settings (urban, road, etc.), capture cues, and when to call it quits. Class time will be split between the conference center and the field, most of which will be spent outside of Salt Lake City where we will attempt to capture and band wintering raptors. Potential species we may encounter include: Red-tailed Hawk, Ferruginous Hawk, Rough-legged Hawk, American Kestrel, and Prairie Falcon.

Harnessing Raptors with Transmitters

Wednesday, November 8 from 8:00 am - 12:00 pm
Brian Millsap and Jeep Pagel, US Fish and Wildlife Service

This class will cover the process of attaching a transmitter (either VHF or satellite) to raptors, from initial thoughts of the bird's welfare to specifics of making harnesses and attaching them to birds. The majority of the class will be hands-on, involving creation of a backpack-style harness and using that harness to attach a transmitter to carcasses of different sized raptors. As time allows, we may discuss other attachment techniques (e.g., tailmount, patagial) as well as thoughts on data management. Class will be taught at the conference venue.

Fitting a practice harness on a hawk carcass.

Raptor Field & In-Hand ID, Ageing & Sexing, Recent Taxonomic Changes in Raptors, Molt and Its Use in Ageing

Wednesday, November 8 from 8:00 am - 12:00 pm
Bill Clark, Harlingen, TX

This class will begin with an overview of the identification (ID) of diurnal raptors, followed by a session on raptor field ID. The next session is on raptor in-hand ID, ageing, and sexing. The last session will focus on raptor remige molt and its use in ageing with differences between Falconiformes and Accipitriformes molt presented, ending with short discussions of recent changes in raptor taxonomy and raptor hybrids. Class will be taught at the conference venue.

View of Aplomado Falcon wing and tail feathers used for aging. Photo by Bill Clark.

The Graduate Student's Toolbox: Tips and Tricks

Wednesday, November 8 from 8:00 am - 12:00 pm
Chris Vennum and Ben Dudek

Developing tools and learning how to use them efficiently is an important aspect of graduate work. This course will provide an introduction to several of the computer-based tools available and discuss how to apply them to your workflow. This process includes organizing scientific literature (Mendeley, Zotero), analyzing data (R and Rstudio), sharing work with collaborators (Rmarkdown and Latex), and promoting results to the public (Websites and Social Media). As we will actively be working with these software packages, during the course, a personal computer for the workshop is highly recommended.

CONFERENCE WORKSHOPS

Techniques for Handling, Auxiliary Marking, and Measuring Raptors after Capture: A Bird in the Hand is Worth Two in the Bush

Wednesday, November 8 from 1:00 - 5:00 pm
Dan Varland, Coastal Raptors and John Smallwood, Montclair State University

Fitting an aba on a golden eagle.

This course will give students hands-on experience in applying the following types of auxiliary markers to raptors: butt-end and lock-on US Geological Survey leg bands, patagial markers for small and large raptors, and feathers (through feather imping). Students will also have the opportunity to learn and practice proper handling techniques. Class will be taught at the conference venue.

Learning About Raptors via Telemetry – How to Get The Data, and What To Do With It!

Wednesday, November 8 from 1:00 - 5:00 pm
Jessi Brown, University of Nevada, Reno, Ross Crandall, Craighead Beringia South, and Bryan Bedrosian, Teton Raptor Center

So, do you already have birds wearing transmitters and sending you back data, but could use suggestions on what to do next? Or are you still contemplating spending money on fancy transmitters and field work to get them deployed? We'd love to chat with you about our thoughts on telemetry data and its interpretation. We will begin with (A) a module on transmitter selection (why select GSM versus Argos/GPS or other options) with a brief discussion of transmitter mounting options with the resulting ramifications. Then we will discuss (B) day-to-day management of the data as they come in. Then (C) finally we will review things you can do with clean telemetry data, ranging from home range analysis to movement models, with working examples. Please feel free to bring your own laptop with either your own data, or example data that will be available, for following along with the examples. Take-home goodies may include R code to download data, some cleaning/visualizing routines, and examples for home range and movement crunching, as well as a nice clean Excel template for long term storage/sharing. Note that this course intends to complement the course "Harnessing Raptors with Transmitters," which will be offered in the morning.

Handling and Tracking Biomedical Samples in Raptors

Wednesday, November 8 from 1:00 - 5:00 pm
Miguel Saggese, DVM MS PhD, Western University of Health Sciences

Examining a hawk carcass during a necropsy.

Intended for all those who handle birds of prey, both in the field and in captivity, and who need to take biomedical samples in live and dead birds. You will learn how to properly handle and secure the birds – a skill critical to taking quality biomedical samples while avoiding accidents and injuries, which can sometimes be severe if these procedures are not performed correctly. Methods and techniques for collecting a wide range of biomedical samples will be presented and discussed.

Safely Accessing Raptor Nests (Cancelled)

PLENARY SPEAKER – JIM BEDNARZ

Thursday, November 9 at 8 am
Dr. Jim Bednarz, University of North Texas

Whatever You Do, Don't Study Raptors! — Past, Present, and Future Explorations into the Social Ecology of Birds of Prey by a Wayward Ecologist

Raptors can be hard to find and difficult to observe, in part, because they occur mostly in extremely low densities, and in part, because many are found in nearly inaccessible locations (e.g., on the tops of the tallest trees or on massive vertical cliffs). Therefore, I have often given the sage advice, which I received from my mentors, to my students, "Whatever you do, don't study raptors!" Fortunately, or unfortunately, I have not always followed the wisdom of my mentors, and I have become fascinated with the mysteries of raptor ecology certainly putting me in the situation of doing inherently-challenged science. Although I have focused the majority of my science career attempting to answer questions related to raptor conservation, for that is where at least some money can be found to support field research, I am especially fascinated by the social ecology of birds of prey. Thus, whenever I was in the field trapping, sampling, monitoring, and observing, I was also attempting to explore what factors drive and explain the social interactions of raptors. I submit that the understanding of the social ecology of birds of prey is one of the most understudied, but most exciting and intriguing areas of raptor biology. For this presentation, I will first review and discuss the most iconic form of extreme social behavior in raptors, the "cartwheel display" most often reported to be observed in eagles (e.g., Haliaeetus spp.). In this most intense aerial engagement, the participant eagles will grasp each others' talons, violating the principles of aerodynamic flight, stall in mid-air, and engage in a spectacular "cartwheeling" plummet to earth (also called "whirling" or "talon-grapping"). Contrary to many popular and scientific reports that the cartwheel display is a romantic courtship interaction between members of a mated pair, available evidence supports that this behavior represents an aggressive interaction between two rival combatants. I will continue my exploration into raptor social ecology by providing a brief review of cooperative breeding and hunting in Harris's Hawks (Parabuteo unicinctus), discussing sex ratio skews in birds of prey, examining sibling aggression in Red-shouldered Hawks (Buteo lineatus), and delving into the unique polyandrous and social system of the Galápagos Hawk (Buteo galapagoensis). I will conclude the presentation by suggesting several potential avenues of future research into the provocative social ecology of raptors.

Jim Bednarz received his undergraduate degree in Fisheries and Wildlife Biology from New Mexico State University. He completed a M.S. degree in Animal Ecology at Iowa State University and his Ph.D. degree in Biology at the University of New Mexico. Jim has conducted field ecological research on six continents for more than three decades emphasizing avian population ecology and conservation. Most of this work has been focused on birds of prey and Neotropical migratory songbirds. Specifically, Jim has spent more than 10 years investigating the biology of Harris's Hawks, 8 years studying the ecology of Galápagos Hawks, and recently has been involved in ecology and conservation research on American Kestrels, Bald Eagles, Mississippi Kites, Red-shouldered Hawks, Red-tailed Hawks, and Swallow-tailed Kites. Jim has published over 130 scholarly works including peer-reviewed journal articles, monographs, book reviews, book chapters, conference proceedings, one technical book, and was the Editor of the Journal of Raptor Research for 5 years. He was a Professor of Wildlife Ecology at Arkansas State University with an active research lab working with over 40 graduate students for 19 years. Jim moved to North Texas and began teaching Biology, Ecology, and Environmental Sciences courses at University of North Texas (UNT) in 2013. Currently, Jim is a Lecturer and an Advisor with the Department of Biological Sciences at UNT and actively works with 10 – 15 graduate and undergraduate students on field research projects.

PLENARY SPEAKER - ANDRE BOTHA

Friday, November 10 at 8 am
Andre Botha, Overarching Coordinator: CMS Vulture MsAP

The CMS Multi-species Action Plan for Africa-Eurasian Vultures

In October 2015, the meeting of signatories (MoS2) of the CMS Raptors MoU, which was held in Trondheim, Norway, approved the motion to bring together representatives of Range States, partners and interested parties, to develop a coordinated Multi-species Action Plan to conserve African-Eurasian Vultures (Vulture MsAP) for submission to the 12th Meeting of the Conference of the Parties (COP12) to the Convention on Migratory Species (CMS), scheduled to be held in Manilla, Philippines in October 2017. The overall aim is to develop a comprehensive strategic conservation Action Plan covering the geographic ranges of all 15 migratory Old World vultures to promote concerted, collaborative and coordinated international actions to: (1) rapidly halt current population declines in all species covered by the Vulture MsAP; (2) reverse recent population trends to bring the conservation status of each species back to a favourable level; and, (3) provide conservation management guidelines applicable to all Range States covered by the Vulture MsAP. This presentation will review the process in terms of the drafting of the Vulture MsAP to date and will share information on the framework and strategy for adoption and implementation across all 128 range states, as well as the key areas of focus and action that has been suggested by the more than 250 contributors to this process.

André Botha is currently Special Projects Manager at the Endangered Wildlife Trust in South Africa and previously managed the Trust's Birds of Prey Programme between 2004-2016. He has been co-chair of the IUCN SSC Vulture Specialist Group since 2012 and was appointed Overarching Coordinator for the drafting of the Convention on Migratory Species Multi-species Action Plan for African-Eurasian Vultures which was initiated in 2015 and will be adopted by signatories at COP12 in Manilla, Philippines in October 2017. In addition, he was instrumental in the establishment of the International Vulture Awareness Day which is observed on the first Saturday of September annually and which has become a global event since it was first held in 2009. Although the primary focus of his work has been focused on vulture conservation and reducing the impact of wildlife poisoning, he was also involved in a range of research and monitoring projects focused on raptors, owls and Southern Ground Hornbills in southern Africa.

Photo by Evan Buechley

GENERAL SESSION ABSTRACTS

Photo by Alexander Paiement

Photo by Rob Miller

Photo by Mike Smith

** Presenting Author*
*** William C. Andersen Memorial Award Candidate*

Is Fear the Mother of Safety? Understanding the Influence of Intraguild Predation on Nest Site Selection in Mississippi Kites

***FIDEL A. ATUO** (fidelis.atuo@okstate.edu), Oklahoma State University, Stillwater, OK, U.S.A. TIM O'CONNELL, Oklahoma State University, Stillwater, OK, U.S.A.

Selecting nesting cover that minimizes predation risk and improves breeding success is one of the most important decisions in the life history of a bird. This is because natural selection exerts strong selective pressure on species during the breeding period such that eggs, nestlings, and attending adults are more vulnerable to predation. In this study, we assess the importance of local habitat characteristics, food abundance, and predation risk on nest site selection and nest survival in a gregarious raptor species, the Mississippi Kite (Ictinia mississippiensis). At the nest site scale, Mississippi Kites selected areas with closed canopy, taller trees, higher number of trees, and short grass. At a broader scale, Mississippi Kites selected for upland woody vegetation (trees and shrubs) for nesting and this selection was not related to food abundance. However, Mississippi Kite reproductive success was negatively influenced by proximity to predators that tended to be found in riparian woodland, which Mississippi Kites avoided. Notwithstanding, Mississippi Kite nest survival was the highest reported at 80%. Although previous studies often associated Mississippi Kite nest site selection with bottomland and riparian forest, their choice of these sites may largely be dictated by available vegetation structure. Therefore, landscape changes that restricts woody vegetation to riparian habitats may reduce nesting options and compel this species to select available areas irrespective of predation risk. Our study emphasizes the importance of predation risk in understanding species habitat association because its isolation may results in misleading interpretations.

A 37 Year Study of Cape Vulture Reproductive Activities at the Kransberg Colony, South Africa: Long-term Study or a Drop in the Bucket?

***PATRICK C. BENSON** (pbenson.rsa@gmail.com), University of the Witwatersrand, Johannesburg, South Africa and University of Maryland, College Park, Maryland, U.S.A.

Since 1981, more than 27,000 nesting attempts by Cape Vultures (Gyps coprotheres) have been documented at the Kransberg colony in Limpopo Province, South Africa. The presence and timing of reproductive activities have been recorded throughout 37 seasons at over 3400 sites on the 5.1 km long nesting cliff. A decline from almost 1000 active nesting pairs in the early 1980's to less than 600 pairs in 2003 has been followed by an increase that is approaching the original numbers observed. Political dispensations have and continue to determine the ownership of agricultural land in South Africa. Traditional communal versus commercial farming practices affect the numbers and condition of livestock on the land. High density stocking rates result in increased livestock mortality, particularly in communal farming areas where animals are generally accumulated as a sign of wealth rather than bought and sold yearly as occurs on commercial farms. Drought years exacerbate this. Cape Vultures feed primarily on domestic livestock and their numbers are higher in areas where communal grazing practices predominate. The former Transvaal Province (Transvaal Region) is the Cape Vulture stronghold with over 60% of the world population breeding there. Other colonies in the Transvaal Region have shown a similar pattern as observed at Kransberg. Though some breeding colonies are located in game reserves, the birds generally forage outside these refuges in communal areas. A similar pattern of foraging occurs in the Eastern Cape, where Cape Vulture numbers have also increased. Transitions from commercial to communal grazing regimes have occurred throughout the country in the form of legally settled 'land claims', acquired by communal farmers from their commercial counterparts. Changes in land ownership are likely to have major impacts on Cape Vulture numbers in the future.

Dispersal and Survival of Fledgling Golden Eagles in the Southern Great Plains and Trans Pecos Regions of North America

NATASIA MITCHELL, Texas Tech University, Lubbock, TX, U.S.A. ***CLINT BOAL** (clint.boal@ttu.edu), U.S. Geological Survey, Texas Cooperative Fish and Wildlife Research Unit, Lubbock, TX, U.S.A. DALE STAHLECKER, Eagle Environmental Inc., Santa Fe, NM, U.S.A. ROBERT MURPHY, U.S. Fish and Wildlife Service, Albuquerque, NM, U.S.A. BEN SKIPPER, Angelo State University, San Angelo, TX, U.S.A.

Little ecological information is available for Golden Eagles (Aquila chrysaetos) in the southern Great Plains and Trans Pecos regions of North America. In 2015 and 2016, we used GPS transmitters to assess survival rates, dispersal patterns, and habitat associations of 21 fledgling Eagles. Survival across the first 6 mos ranged from 72 – 80%, with first year survival of 60%. Sex had no influence on survival, but there was a temporal affect with 50% of mortalities occurring during the first 2 mos. Home range sizes were highly variable between cohorts, with an average 15,137 km2 during the first 6 mos for the 2015 cohort but only 3,070 km2 for the 2016 cohort. Further, Eagles in the southern Great Plains had a substantially greater risk of encountering wind energy facilities than those in the Trans Pecos. We found 39% and 72% of the marked Eagles in the southern Great Plains had home ranges that overlapped, respectively, 5 km and 50 km buffers around turbine fields; the closest approach detected by GPS locations was 10 m. In contrast, the closest any marked Eagle from the Trans Pecos approached a wind energy center was 86 km. We suspect topography and dominate land cover in the different regions of origin were highly influential on home range and habitat associations. Eagles in the Trans Pecos appear to be more sedentary due to the favorable habitat conditions of remote and contiguous arid grasslands situated between rugged mountain ranges. Eagles in the southern Great Plains are highly mobile due to the dispersed availability of foraging areas

among a landscape dominated by crop and livestock production; however, this mobility may lead to higher encounters with risk factors such as wind energy centers.

Poisoning Intervention and Investigation Training in Southern and East Africa: 2015-2017

***ANDRÉ BOTHA** (andreb@ewt.org.za), Endangered Wildlife Trust, Johannesburg, South Africa and Campbell Murn Hawk Conservancy Trust, Andover, U.K.

Poisoning is widely recognized as the most significant anthropogenic threat to raptors and other wildlife in Africa, with vultures being far the most severely affected. The unrestricted access to highly toxic pesticides and poisons is having devastating effects on natural resources and the people who rely on them. As billions of dollars are being spent on the war against poaching, poachers are adopting increasingly secretive, yet lethal, means of felling target species, including vultures, through the use poisons. Apart from the misuse of these chemicals for poaching, pesticides are widely used to protect livestock and crops, and to harvest bush-meat and fish, which are then sold for consumption with unknown consequences for human health. Wildlife authorities are often overwhelmed with the increasing use of poisons for poaching and the killing of wildlife, and are often poorly prepared, trained, and equipped. A Poisoning Intervention and Investigation training program has been developed in partnership between the Endangered Wildlife Trust (South Africa) and The Hawk Conservancy Trust (UK). Training has been presented to more than 1200 conservation and law enforcement staff in eight countries in southern and East Africa since 2015. The need for equipment is also assessed in areas where training is presented and poisoning reaction kits sourced and issued to responsible organizations. In addition, engagement with traders and users of a range of wildlife products to assess the scale and drivers of use, and to gauge the potential human health impact of the use of wildlife products procured by poisoning have been initiated as a result of the training presented. This presentation will review the work done in this regard over the last 3 yrs and will provide an indication of plans to continue and expand on this work in future within the framework of the CMS Vulture Multi-species Action Plan.

Utilizing Migrating Raptors to Assess Environmental Mercury Trends in North America

***RYAN P. BOURBOUR** (rpbourbour@ucdavis.edu), University of California, Davis, Davis, CA, U.S.A. BREANNA L. MARTINICO, University of California, Davis, Davis, CA, U.S.A. ANGUS C. HULL, Golden Gate Raptor Observatory, Sausalito, CA, U.S.A. MARK P. HERZOG, U.S. Geological Survey, Western Ecological Research Center, Dixon, CA, U.S.A. JOSHUA T. ACKERMAN, U.S. Geological Survey, Dixon, CA, U.S.A. JOSHUA M. HULL, Golden Gate Raptor Observatory, Sausalito, CA, U.S.A. and University of California, Davis, Davis, CA, U.S.A.

Mercury (Hg) from anthropogenic emissions can be detected in even the most remote ecosystems of the world. Once released into the environment, Hg becomes biologically available and enters food webs, leaving top predators, including humans and raptors, vulnerable to toxic levels. Raptors occupy a variety of ecosystems and are increasingly being valued as sentinels for biomonitoring over large regions. However, little is known about how Hg exposure differs between raptor species in western North America, how Hg exposure fluctuates in raptor populations over time, and how Hg levels vary for a single raptor species across the continent. To address these questions, we analyzed breast feathers collected from raptor migration monitoring sites across North America, where collecting feather samples is often standard procedure. Raptor species that specialize on avian prey exhibited higher levels of Hg than raptor species that consume predominantly small mammals, potentially due to consumption of passerines that prey on insects with aquatic larval stages. Over the course of a decade, Hg levels in three species analyzed remained relatively constant. For Merlins (Falco columbarius), Hg levels were higher in eastern North American than in the west. Understanding Hg trends in raptor species temporally and geographically can aid in identifying species most representative of ecosystems and food webs at high risk from environmental contamination. This study highlights the role raptors play as indicators of environmental health and the utility of using raptor migration monitoring operations to assess environmental toxins for managing threats to human and wildlife health.

The American Kestrel Genoscape Project: Using High-Resolution Genomic Markers to Identify Discrete Population Structure in a Continuously Distributed Raptor Species

***MICHAELA S. BRINKMEYER** (michaelabrinkmeyer@u.boisestate.edu), Boise State University, Boise, ID, U.S.A. KRISTEN C. RUEGG, THOMAS B. SMITH, RACHAEL A. BAY, and RYAN HARRIGAN, University of California, Los Angeles, Los Angeles, CA, U.S.A. CHRISTOPHER J.W. MCCLURE, American Kestrel Partnership, The Peregrine Fund, Boise, ID, U.S.A. DAVID OLEYAR, HawkWatch International, Salt Lake City, UT, U.S.A. KARL MILLER, Florida Fish and Wildlife Conservation Commission, Tallahassee, FL, U.S.A. JEAN-FRANCOIS THERRIEN, Acopian Center for Conservation Learning, Hawk Mountain Sanctuary, Orwigsburg, PA, U.S.A. TED SWEM, Anchorage Fish and Wildlife Field Office, U.S. Fish and Wildlife Service, Anchorage, AK, U.S.A. CLINT W. BOAL, Texas Tech University, Lubbock, TX, U.S.A. RUSSELL D. DAWSON, University of Northern British Columbia, Prince George BC, Canada. RICH VAN BUSKIRK, Pacific University, Forest Grove, OR, U.S.A. LANCE MARROW, Shenandoah Valley Raptor Study Area, Timberville, VA, U.S.A. JULIE A. HEATH, Boise State University, Boise, ID, U.S.A.

Effective conservation management requires identifying populations that may be most vulnerable to climate change, and whether these populations may adapt to rapid global warming. Shifts in the timing of annual life-cycle events (i.e., breeding and migration) are some of the most commonly observed and quantified responses to climate change.

Still unknown, though, are the underlying genetic and environmental factors that affect the potential for populations to undergo phenological shifts in response to climate change. The American Kestrel (Falco sparverius) shows differential responses to climate change across its range, with some populations shifting migratory phenology based on climate (while demographic patterns remain static), and others seemingly maintaining migratory patterns at the apparent cost of demographic declines. We used restriction-site associated DNA sequencing (RAD-seq) on 192 individuals from nine breeding populations and revealed 487,168 single-nucleotide polymorphisms across the genome. Preliminary results suggest that despite their continuous distribution, American Kestrels can be genetically grouped into several unique clusters not previously reported. Gradient forests (a type of non-parametric machine learning technique) were then applied to determine how population genomic variation is associated with environmental heterogeneity. We found that temperature seasonality, annual precipitation, and precipitation seasonality were highly associated with unique genomic variation in this species. Finally, we developed genetic assays to determine, in a probabilistic framework, breeding populations of origin for samples collected across the annual life-cycle. Using this framework, our hope is that researchers can better understand threats across the species' range, determine how migratory strategies may accommodate future climate change, and ultimately understand the driving forces connecting migratory phenology to environment in raptor species.

Modeled Directed Movements of Golden Eagles in Western North America

***JESSI L. BROWN** (jlbrown@unr.edu), Univ. of Nevada, Reno, NV, U.S.A. BRYAN BEDROSIAN, Teton Raptor Center, Wilson, WY, U.S.A. DOUGLAS A. BELL, East Bay Regional Parks District, Oakland, CA, U.S.A. MELISSA A. BRAHAM, ADAM DUERR, and TRICIA MILLER, West Virginia Univ., Morgantown, WV, U.S.A. TRAVIS L. BOOMS, Alaska Dept. of Fish and Game, Fairbanks, AK, U.S.A. JEFF COOPER, Virginia Dept. of Game and Inland Fisheries, Richmond, VA. U.S.A. ERICA H. CRAIG, Aquila Environmental, Fairbanks, AK U.S.A. ROSS H. CRANDALL, Craighead Beringia South, Kelly, WY, U.S.A. JOE DIDONATO, Wildlife Consulting and Photography, Alameda, CA, U.S.A. ROBERT DOMENECH and ADAM SHREADING, Raptor View Research Inst., Missoula, MT, U.S.A. JEFFREY R. DUNK, Humboldt State Univ., Arcata, CA, U.S.A. ALAN R. HARMATA, Montana State Univ., Bozeman, MT, U.S.A. MICHAEL J. LANZONE, Cellular Tracking Technologies LLC, Rio Grande, NJ, U.S.A. DAVE LAPLANTE, Natural Resources Geospatial, Yreka, CA, U.S.A. STEPHEN B. LEWIS, U.S. Fish and Wildlife Service, Juneau, AK, U.S.A. TODD LICKFETT and BRIAN W. SMITH, U.S. Fish and Wildlife Service, Denver, CO, U.S.A. CAROL L. MCINTYRE, National Park Service, Fairbanks, AK, U.S.A. ROBERT K. MURPHY, U.S. Fish and Wildlife Service, Albuquerque, NM, U.S.A. BARRY R. NOON, Colorado State Univ., Fort Collins, CO, U.S.A. STEVEN J. SLATER Hawkwatch International, Salt Lake City, UT, U.S.A. JEFF P. SMITH, H. T. Harvey & Associates, Los Gatos, CA, U.S.A. JAMES W. WATSON, Washington Dept. of Fish and Wildlife, Olympia, WA, U.S.A. BRIAN WOODBRIDGE, U.S. Fish and Wildlife Service, Corvallis, OR, U.S.A.

Animals may be particularly vulnerable to threats when moving rapidly through landscapes that are unfamiliar or of suboptimal habitat quality. Our goals included assessing how Golden Eagles (Aquila chrysaetos) used continental western North America while making rapid, directed movements, and effectively modeling those areas disproportionately used by considering topographic, land cover, and meteorological variables. We assessed patterns of directed movements of >270 Golden Eagles of all ages and sexes using satellite telemetry. Telemetry fixes were classified as either rapid, directed movement (transiting), area-restricted and limited-speed movement (sedentary), or intermediate movement, by analysis with behavioral state-space switching models. We then constructed and assessed presence-only resource selection functions from fixes classified as transiting during typical migration seasons as well as summer and winter. Preliminary results suggested that in general, transiting behaviors, which included both long-distance migration and more local commuting movements, were diverse. Although many Eagles concentrated their movements along the eastern slope of the Rocky Mountains from Alaska through Canada and into Wyoming and Colorado when moving through those regions, our analyses highlighted the diversity of movements and identified other important migration and movement corridors. Anthropogenic activities that may harm Golden Eagles in these regions of concentrated Eagle use may impact a disproportionately large fraction of the western continental Eagle population.

Natural Raptor Hybrids

***WILLIAM S. CLARK** (raptours@earthlink.net), Harlingen, TX, U.S.A.

Natural hybrids have been reported for many raptor species pairs, especially in Accipitriformes, but also in Falconiformes and Strigiformes. Hybrids between Buteo species are reported most often, but some hybrids have been reported also in Accipiter, Aquila, Clanga, Circus, Gyps, Milvus, and Pernis. A few records exist for hybrids in Falco, Strix, and Asio. More unusual are three accounts of intergeneric hybrids. I will present many cases of raptor hybrids and conclude with a short discussion of hybrid vigor or heterosis and the importance of hybrids, not only for raptor identification.

Patterns of Space Use by Territorial Golden Eagles in North America

***ROSS CRANDALL** (ross@beringiasouth.org), Craighead Beringia South, Kelly, WY, U.S.A. TODD KATZNER, U.S. Geological Survey, Boise, ID, U.S.A. JAMES WATSON, Washington Department of Fish and Wildlife, Olympia, WA, U.S.A. BRIAN WOODBRIDGE, U.S. Fish and Wildlife Service, Corvallis, OR, U.S.A. JOSEPH BARNES, Nevada Department of Wildlife, Las Vegas, NV, U.S.A. BRYAN BEDROSIAN, Teton Raptor Center, Wilson, WY, U.S.A., DOUGLAS A. BELL, East Bay Regional Park District, Oakland, CA, U.S.A., DAVID BITTNER, Wildlife Research Institute, Ramona, CA, U.S.A., PETER BLOOM, Bloom Research, Inc., Los Angeles, CA, U.S.A., JEFF COOPER, Virginia Department of Game and Inland Fisheries, Fredericksburg, VA, U.S.A., ROBERT DOMENECH, Raptor View Research Institute, Missoula, MT, U.S.A., ERIC HALLINGSTAD, WEST Inc., Cheyenne, WY, U.S.A., MICHAEL LANZONE, Cellular Tracking Technologies, Rio Grande, NJ, U.S.A., ROBERT MARHEINE, Portland General Electric, Portland, OR, U.S.A., TRICIA MILLER, West Virginia University, Morgantown, WV, U.S.A.

Golden Eagle (Aquila chyrsaetos) conservation and management often focuses on protecting breeding areas from disturbance or habitat modification that could lead to "take" under the Bald and Golden Eagle Protection Act. There have been numerous efforts to estimate space use of territorial Golden Eagles but variation of methods prevents broad interpretation of results and the creation of protective buffers. Our goal was to use telemetry data from a large number of breeding-aged Golden Eagles collected across many different studies to quantify patterns of year-round space use at the home range and core area scale. Using 441,932 locations from 94 individuals, we used several different home range models to preliminarily estimate monthly, nesting season and non-nesting season home ranges and core areas for Golden Eagles across North America. Monthly home range estimates ranged from 19.7 km2 to 57.2 km2, while the mean nesting season home range size was approximately 30 km2 and the mean non-nesting season home range size was approximately 35.5 km2. Mean monthly isopleth percentages designating the core areas ranged from 55.9%-62.3%, while the mean isopleth percentage designating the core area during the nesting season was 61.9% (SE=0.6) and the mean non-nesting season isopleth was 58.7% (SE=0.6). Using designated core area isopleths, we estimated monthly core areas from 7.7 km2 to 12.5 km2 and a mean nesting season core area of 6.9 km2 (SE=0.9) and non-nesting season mean core area of 7.8 km2 (SE=1.0). Generalized linear mixed models suggested that space use estimates were influenced by month and nesting success but not by gender. Our results suggest relatively consistent core areas and home ranges for territorial Golden Eagle across North America. These results can be used as a template to designate protective buffers around eagle nests, thus reducing the probability of eagle take.

Do Fire and Recreation Have Interactive Effects on Golden Eagles?

***CAITLIN M. DAVIS** (caitlindavis@u.boisestate.edu), Boise State University, Boise, ID, U.S.A. JULIE A. HEATH, Boise State University, Boise, ID, U.S.A.

Sagebrush steppe ecosystems are vulnerable to several types of threats including invasive species, climate change, recreation disturbance, and changes in fire patterns. Although there are multiple drivers of change in these systems, few studies have examined how these threats interact. The focus of our research is to determine whether fire and recreation may have interactive or additive effects on the nesting ecology of Golden Eagles (Aquila chrysaetos). Golden Eagles rely on healthy shrub habitat to support shrub-reliant prey, like Jackrabbits (Lepus sp.), and respond negatively to recreation disturbance. However, it is unknown how these impacts of fire and recreation may interact. Recreation may decrease in burned areas and increase in unburned areas, resulting in poor nesting success across all territories, or recreation patterns may remain consistent and have additive negative effects on nesting success in burned areas. To address these predictions, we used a before-after-control-impact (BACI) design to study recreation activity and Golden Eagle nesting success at 22 historical eagle territories along the Owyhee Front in Southwestern Idaho. In 2015, 15 of these territories were burned in the Soda Fire and seven were unburned. We collected data on recreation, and eagle territory occupancy, egg-laying and nest survival in burned and unburned territories and compared these data to pre-fire information collected in 2013 and 2014. We found that after fire, occupancy and egg-laying were not affected, however, egg-laying pairs were more likely to fledge young, regardless of recreation volume. Fire did not significantly affect recreation volumes across territories. This suggests that there are other factors affecting eagles after fire. In our changing world, it is critical that we understand not only direct effects of human threats, but their interactive effects on ecosystems so that we can make well-informed decisions about how to manage recovery in post-fire wild lands.

Movements of Red-tailed Hawks (Buteo jamaicenis) Captured During Fall Migration in Western Montana

***ROBERT DOMENECH** (rob@raptorview.org), Raptor View Research Institute, Missoula, MT, U.S.A. ADAM SHREADING, Raptor View Research Institute, Missoula, MT, U.S.A.

We have studied the fall migration of raptors at the MPG Ranch, located in the northern Bitterroot Valley of western Montana since 2011. Our fall migration count annually recorded more Red-tailed Hawks than any of the five other raptor migration count sites in Montana. Banding efforts at our site have yielded modest totals, but impressive species diversity, with a relatively high proportion of Red-tailed Hawks. In 2015,

we began a satellite telemetry study to specifically target fall migrating Red-tailed Hawks. We hope to identify migration routes, wintering and summering ranges and discover if our birds use stopover areas while on migration. We are also interested in learning about the seasonal movements of non-breeding aged Red-tailed Hawks. For this pilot project, we outfitted eight Red-tailed Hawks (4 adults, 4 hatch-year), with 22g solar Argos/GPS transmitters. We will share basic movement demographics and anecdotal observations collected thus far.

Factors that Predict Mexican Chicken Bug Abundance in Golden Eagle Nests and the Effects of Infestation on Nestling Eagles

***BENJAMIN M. DUDEK** (benjamindudek@boisestate.edu), Boise State University, Boise, ID, U.S.A., BRITT A. PENDLETON, Boise State University, Boise, ID, U.S.A. MICHAEL T. HENDERSON, Boise State University, Boise, ID, U.S.A. JENNIFER S. FORBEY, Boise State University, Boise, ID, U.S.A. IAN C. ROBERTSON, Boise State University, Boise, ID, U.S.A. LOGAN P. TREAT, Wheaton College, Wheaton, IL, U.S.A., and JULIE A. HEATH, Boise State University, Boise, ID, U.S.A.

Hematophagous ectoparasites that live in raptor nests can cause anemia, reduced mass, and may have long-term effects on the individual fitness of raptor nestlings. Nestlings require substantial energy for growth and development, leaving little capacity to deal with health challenges caused by nest ectoparasites, and cliff-nesting raptors may be particularly susceptible because young birds cannot escape the source of ectoparasites. Despite the negative effects of ectoparasites on raptor health, little is known about the factors that contribute to ectoparasite infestation or the consequences of ectoparasitism on raptor productivity. We visited Golden Eagle (Aquila chrysaetos) cliff nests throughout the 2016 breeding season and quantified the abundance of Mexican chicken bugs (Haematosiphon inodorus; Hemiptera: Cimicidae). We measured nest site characteristics hypothesized to affect H. inodorus abundance in nests, such as previous nest use within the last 3 yrs, nest aspect, proximity to other cliff-nesting species, proportion of aromatic green nest material, and nest timing. In addition, we measured the physiological effects of H. inodorus infestation through an examination of eagle nestling mass, hematocrit levels, and timing of fledging. Nests that had been used within the last 3 yrs had lower H. inodorus abundance; a result that is opposite the hypothesis that nest reuse increases ectoparasites. Instead, this result indicates eagles may be selecting less parasitized nests in consecutive yrs. South-facing nests had higher H. inodorus abundance than north-facing nests, and eagle pairs that bred later in the season experienced higher H. inodorus abundance. Increasing levels of infestation had a negative effect on nestling mass and hematocrit, and increased the probability that nestlings either fledged early or died in the nest. Understanding the factors that predict ectoparasite abundance and their effects on eagle nestlings may be important for the future conservation of raptor populations severely impacted by ectoparasites.

Influence of Topographic Variation on Flight Altitude of Golden Eagles and Implications for Modeling Mortality Risk from Wind-turbine Collisions

***ADAM E. DUERR** (adamduerr@bloombiological.com), Bloom Research Inc., Los Angeles, CA, U.S.A. DOUGLAS A. BELL, East Bay Regional Park District, Oakland, CA, U.S.A. ROBERT N. FISHER, U.S. Geological Survey, San Diego Field Station, San Diego, CA, U.S.A. JEFF TRACEY, U.S. Geological Survey, San Diego Field Station, San Diego, CA, U.S.A. TODD KATZNER, U.S. Geological Survey, Forest and Rangeland Ecosystem Science Center, Boise, ID, U.S.A.

Managing the risk of Golden Eagle (Aquila chrysaetos) mortality at wind-energy developments requires understanding factors that influence Eagle flight, and where Eagle flight may overlap with wind turbine blades. We used GPS-GSM transmitters to investigate how flight altitude above ground level (AGL) of 91 Golden Eagles changed with topographic variation throughout the multiple regions of California, U.S.A. Preliminary results indicated that flight AGL increased the more a slope faced eastward and decreased as both elevation and topographic roughness increased. Flight AGL was, on average, highest in deserts and lowest in mountains and it generally increased on more north-facing slopes (except in northwestern rainforests). Eagle flight AGL decreased as slopes became steeper and it varied by topographic position with lowest AGL on steep slopes and ridges and highest AGL over valleys and gentle slopes. There were also temporal patterns in eagle behavior, such that flight AGL was lowest early (0600), peaked midday (1200–1400) and decreased as the afternoon progressed. Region-specific patterns suggest factors other than topography (probably weather) influenced Eagle flight altitude. If this is correct, incorporating weather into predictive models of flight risk may improve risk prediction over topography-based models. That said, topographic models are easy to apply to risk management because topography varies with space but not time. Weather, however, varies with both space and time and thus managing risk from wind turbines to Eagles based on weather is more difficult than managing risk based solely on topography.

Using Landscape-scale Estimates of Relative Electrocution Risk to Inform Prioritization of Retrofits: An Example with Golden Eagles

***JAMES F. DWYER** (jdwyer@edmlink.com), EDM International, Inc., Fort Collins, CO U.S.A. RICK E. HARNESS, EDM International, Inc., Fort Collins, CO U.S.A. GARY E. WILLIAMS, U.S. Fish and Wildlife Service, Cheyenne, WY U.S.A. TODD LICKFETT, U.S. Fish and Wildlife Service, Lakewood, CO U.S.A. BRIAN WOODBRIDGE, U.S. Fish and Wildlife Service, Lakewood, CO U.S.A. TRACY JONES, Powder River Energy Corporation, Sundance, WY U.S.A.

Electrocution continues to be a significant source of mortality for Golden Eagles (Aquila chrysaetos) despite decades of retrofitting efforts. This is perhaps not surprising due to the enormous number of power poles in the United States (> 115 million and increasing) and the high cost of retrofitting (often > $1,000/pole). Given this situation, it is critically important to retrofit the riskiest poles first. Landscape-scale models of Golden Eagle habitat and electrocution hazard can be used to develop retrofitting prioritization schemes that focus on high risk areas first and result in fewer electrocutions over time. Here, we demonstrate such an approach by overlaying landscape-scale models of Golden Eagle breeding habitat (i.e., estimates of exposure) with a landscape-scale model of electrocution hazard to identify priority areas for retrofits. We assume that electrocution risk would be greater where high quality habitat (i.e. higher potential for exposure) overlaps areas of high electrocution hazard. To evaluate this prediction, we will present results of a comparison of electrocution records from the service areas of two utilities in Wyoming and Nevada to our mapped predictions of relative electrocution risk. Preliminary analyses in Wyoming indicated electrocution rates were approximately 2.5 times higher in areas classified as high electrocution risk when compared to the average across the landscape. Here, we will be presenting the results of a refined approach that we predict will perform even better in classifying risk within broad landscapes. Prioritization using this approach should prove helpful for both regional scale retrofit prioritization as well more locally for utilities that lack formal retrofitting plans.

Mechanistic Movement Model Reveals Multi-Scale Behavioral Patterns in a Soaring Bird During Migration

***JOSEPH M. EISAGUIRRE** (jmeisaguirre@alaska.edu), University of Alaska Fairbanks, Fairbanks, AK, U.S.A. MARIE AUGER-MÉTHÉ, Ocean Tracking Network, Dalhousie University, Halifax, NS, Canada. CHRIS P. BARGER, Alaska Department of Fish & Game, Fairbanks, AK, U.S.A. STEPHEN B. LEWIS, U.S. Fish & Wildlife Service, Juneau, AK, U.S.A. CAROL L. MCINTYRE, National Park Service, Fairbanks, AK, U.S.A. TRAVIS L. BOOMS, Alaska Department of Fish & Game, Fairbanks, AK, U.S.A. GREG A. BREED, Institute of Arctic Biology, University of Alaska Fairbanks, Fairbanks, AK, U.S.A.

Migration is a costly phenological period for many taxa. Birds often stopover to minimize the cost of migration, but soaring birds also minimize cost by utilizing meteorological phenomena as direct flight subsidies. Golden Eagles (Aquila chrysaetos) are large soaring birds. Migratory individuals from Alaska often travel thousands of km annually during migration. Uplift influences flight parameters and behavior of Golden Eagles on short temporal scales; however, we have little insight into how these microscale patterns translate to form an Eagle's behavioral budget across an entire migration. We developed a correlated random walk movement model (CRW) with time-varying parameters to infer behavior and the effects of environmental covariates on behavior of migrating Golden Eagles that summer in Alaska. Eagles were equipped with solar powered GPS transmitters during spring migration in Alaska, 2014–2016. We annotated fall and spring migration tracks of Eagles with thermal and orographic uplift and used Bayesian Hamiltonian Monte Carlo to fit the model to each track. Model results showed a clear daily rhythm in behavior across tracks, which is consistent with diurnality and was tied to the development of thermal uplift each day. However, this effect decayed notably with increasing latitude, and there was variability among individuals. We also noted effects of season on how Eagles use flight subsidies. Additionally, large-scale behavioral patterns emerged, which reflected unpredictable behavioral budgets that might be attributable to Golden Eagles' highly opportunistic foraging behavior. That is, rather than stop in predictable time intervals or habitats to deposit fuel during migration, eagles took advantage of prey across habitats and time.

Reintroducing Endangered Raptors: a Case Study of Supplementary Feeding and Removal of Nestlings from Wild Populations

***MIGUEL FERRER** (mferrer@ebd.csic.es), Estacion Biológica de Doñana (CSIC), Sevilla, Spain. VIRGINIA MORANDINI, Estacion Biológica de Doñana (CSIC), Sevilla, Spain. GERARDO BÁGUENA, Fundación para la Conservación del Quebrantahuesos, Ian Newton Centre for Ecology & Hydrology, Wallingford, U.K.

Supplementary feeding is a common practice to raise reproductive output in raptors and other species, either for experimental or for conservation purposes. Despite the widespread use of this technique over the last 50 yrs, its application in conservation has only recently been critically discussed, revealing important differences in evaluation of the technique. Here we critically analyze the effect of supplementary feeding in territorial raptors, taking advantage of two long-term data sets for the Spanish Imperial Eagle (Aquila adalberti) and Bearded Vulture (Gypaetus barbatus). Using a GLMM, no differences in the intensity of response between species was found ($P = 0.890$). However, in both species a significant effect of supplementary feeding on relative productivity was found ($P = 0.013$). This productivity did not seem to be affected by territories alone ($P = 0.192$), but by the interaction between territory and supplementary feeding ($P = 0.030$). This implied a different response among territories to supplementary feeding. Poor quality territories with low productivity levels responded

more strongly to supplementary feeding than did territories with higher levels of natural productivity ($r = -0.435$, $P = 0.002$, $n = 45$,). A reintroduction based on supplementary feeding and extractions would costs eight times less than the same program based on captive breeding, and would take 10 yrs less.

Priorities for Gyrfalcon Research: Food, Weather, and Phenology in a Changing Climate

***ALASTAIR FRANKE** (alastair.franke@ualberta.ca), Arctic Raptors Project, Rankin Inlet, NU, Canada. DAVID L. ANDERSON, The Peregrine Fund, Boise, ID, U.S.A. CHRISTOPHER J.W. MCCLURE, The Peregrine Fund, Boise, ID, U.S.A.

The Peregrine Fund has published a new book entitled "Applied Raptor Ecology: Essentials from Gyrfalcon Research" that builds on the legacy of the 2011 international conference (Gyrfalcons and Ptarmigan in a Changing World) hosted by The Peregrine Fund, Boise State University, and the United States Geological Survey. The conference focused on the ecology and conservation of Gyrfalcons (Falco rusticolus) and ptarmigan (Lagopus spp.). A main objective of the book is to provide introductory material on specific aspects of animal ecology that can be applied to raptors in general, and Gyrfalcons in particular. To provide easy access to raptor biologists worldwide, the book will be accompanied by a website where users can download individual chapters, R scripts, and access data. In this talk we argue for a coordinated, broad scale, multi-study area approach using standardized monitoring. We believe that simultaneous assessment of the relative effects of weather and food is a necessity, and that studying one without the other will not provide the level of understanding that is required to achieve the stated goal of the 2011 Gyrfalcon and ptarmigan conference. We suggest that sourcing and archiving relevant population, weather, and landscape data in conjunction with the newly established Polar Raptor Data Bank are activities that can be achieved immediately. Finally, we argue that the Arctic Falcon Specialist Group formalize activities such as liaising with Circumpolar Biodiversity Monitoring Program, organizing workshops, and resourcing field programs. Implementing a broad scale research effort will require considerable human and financial resources, as well as commitment to long-term studies and international collaboration. However, executing a common philosophy and promoting study designs that are constrained by a plausible framework will facilitate pooling of data and, ultimately, future meta-analyses.

Educational Curriculum Utilizing Migratory Movement Data of the Broad-winged Hawk (Buteo platypterus) and Google Earth Pro

***KIRSTEN A. FULLER** (Kirstenafuller@gmail.com), Hawk Mountain Sanctuary, Kempton, PA, U.S.A.

Broad-winged Hawks are an ideal test species for the study of movement ecology in a classroom setting. These birds make a 10,000 km round-trip migration each yr from eastern forests in North America, to the tropical biomes of Central and South America. Throughout this migration these birds will encounter a variety of ecosystems, each with their own set of obstacles. The Broad-winged Hawk Project at Hawk Mountain Sanctuary used satellite telemetry to track the movement of 13 Broad-winged Hawks; this satellite telemetry data gives scientists and students alike the capability to track individual birds and study the ecological niches they inhabit. The Broad-winged Hawk curriculum uses free software, Google Earth Pro, to inform high school students of the natural history, ecology of the nesting/wintering grounds, and migratory activity of the Broad-winged Hawk. Activities and extension projects included in this curriculum are intended to engage students, promote critical thinking, and inspire active learning. Utilizing real data collected by Hawk Mountain Sanctuary researchers, teachers will address topics outlined in Pennsylvania State Science Standards and national Next Generation Science Standards. This curriculum is an interdisciplinary study, which connects overarching concepts of ecology with geography, mathematics, reading and writing in science, and has cross cutting ties to social studies. Utilizing current scientific data in curricula makes standard topics in science classrooms relevant to students, and is intended to inspire the next generation of scientists.

Stopover Habitat of Migrating Broad-winged Hawks

REBECCA A. MCCABE, Hawk Mountain Sanctuary Association, Orwigsburg, PA, U.S.A. ***LAURIE J. GOODRICH** (goodrich@hawkmountain.org), Hawk Mountain Sanctuary Association, Orwigsburg, PA, U.S.A. DAVID BARBER, Hawk Mountain Sanctuary Association, Orwigsburg, PA, U.S.A. KEITH L. BILDSTEIN, Hawk Mountain Sanctuary Association, Orwigsburg, PA, U.S.A. TERRY L. MASTER, East Stroudsburg University, East Stroudsburg, PA, U.S.A.

From 2014 through 2016 we tagged nine adult and four juvenile Broad-winged Hawks (Buteo platypterus) with 9.5 g Argos satellite units in three regions of Pennsylvania and tracked them for up to two yrs. Migration stopover sites, where birds spent more than 24 hr during autumn or spring migration, were mapped for the U.S. ($n = 106$), Mexico ($n = 44$) and Central America ($n = 104$). We quantified land cover within 1 km of stopover locations to assess habitat use by Broad-winged Hawks during stopover periods. Forest cover of U.S. stopover sites varied widely with a mean of $73 \pm 24\%$. Developed land represented a mean of $10 \pm 10\%$, wetlands or water $3 \pm 8\%$,

and grassland or crops 17 ± 16%. Stopover habitat in the U.S. did not differ between adults and juveniles except that adults (n = 74) had higher proportions of nearby wetlands or water than juveniles (n = 23) during autumn migration. Adults used a greater proportion of forest during autumn stopover, 72% (n = 74), than spring 26%, although the sample for spring was small (n = 9 stopovers). Stopover sites in Central or South America averaged 86% forest cover and 13% open or agriculture land cover. Juvenile stopovers during autumn migration in Mexico were represented by 34% forest, 26% shrub scrub, and 40% agriculture or grassland cover. Few stopovers in Mexico were recorded for adults. Broad-winged Hawks use large forests for nesting and appear to also seek out heavily forested areas during migration stopover as well. Conservation of forests in Central and South America as well as Mexico may be important steps to conserving this long-distance migrant.

What Curriculum Can Do for Our Rarely-Loved Raptors

***ZOEY T. GREENBERG** (talonhms@gmail.com), Hawk Mountain Sanctuary, Kempton, PA, U.S.A.

Black Vultures (Coragyps atratus) are a common sight throughout the Eastern United States, and their range is expanding quickly. This pattern is likely to continue due to their adaptability and proclivity to seek out areas of human habitation. Black Vultures possess characteristics that make them difficult to love, and frequently susceptible to human interaction, often resulting in an umbrella of negative perception towards common vultures in the United States. With heightened occurrences of human-vulture conflict, research and education are critical in order to mediate further issues and avoid systematic persecution, which has plagued many raptors in the past and contributed to ecosystem imbalance time and time again. Curriculum development is a promising tool with which to facilitate a culture of appreciation and understanding for various raptor species, while exposing students to the concept of conservation biology at an early age. This presentation will 1) highlight a curriculum that utilizes Black Vulture movement data collected by Hawk Mountain Sanctuary in conjunction with R-generated visualizations to provide a free, interactive Google-Earth experience for middle school students, and 2) provide an applicable, education-based framework for studying movement ecology that can assist those involved in raptor conservation everywhere. In addition, this presentation will discuss ways to provide students with skills in critical thinking, data analysis, and applied conservation biology that can help positively shape our emerging ranks of innovative and passionate raptor advocates.

Accuracy of Call-Back Surveys and Automated Sound Recorders to Determine Territory Occupancy Rates of Forest Owls and Efficiency of Recording Analysis Methods

***KATHERINE GURA** (katherine@tetonraptorcenter.org), Teton Raptor Center, Wilson, WY, U.S.A. BRYAN BEDROSIAN, Teton Raptor Center, Wilson, WY U.S.A. CARRIE ANN ADAMS, Teton Raptor Center, Wilson, WY, U.S.A. SUSAN PATLA, Wyoming Game and Fish Department, Jackson, WY, U.S.A. NICK CIARAVELLA, Teton Raptor Center, Wilson, WY, U.S.A. TIM GRIFFITH, Teton Raptor Center, Wilson, WY STEVE POOLE, Teton Raptor Center, Wilson, WY, U.S.A.

The typical protocol for monitoring forest owls involves a nighttime play-back survey methodology, which entails broadcasting a conspecific call during the courtship period to elicit a response from territorial breeding owls. However, the effectiveness of play-back surveys is not well documented and our previous survey data, specifically on Great Gray Owls (Strix nebulosa), suggest that they may not be adequate to assess territory occupancy. In 2016, we simultaneously conducted play-back surveys and continuously recorded all sounds within 18 known Great Gray Owl territories in western Wyoming to compare the two protocols as means to determine occupancy. We also investigated several recording data analysis systems. After conducting two play-back surveys per wk during two different wks at each territory, we estimated that 40% of territories were unoccupied. In contrast, automated recording units detected 100% occupancy rates during those same wks in which we conducted surveys. We found that manual analysis of recordings is the most precise, albeit labor-intensive, way to determine whether and when owls are calling. However, classifiers created in Kaleidoscope Pro 4.0.a using a hidden Markov model to identify potential Great Gray Owl territorial vocalizations may be the more effective method for determining Great Gray Owl occupancy. In the 11 sites tested, manual analysis detected Great Gray Owls at all sites, and generally found more calls overall. The Kaleidoscope classifier detected Great Gray Owls at all 11 of the sites as well, while significantly reducing analysis time. Data indicate that nighttime play-back surveys, in comparison to using automated recording units, is not an effective method for determining occupancy of nesting Great Gray Owls.

Golden Eagles in Yellowstone National Park, Exploring Their Role in the Greater Yellowstone Ecosystem

***DAVID B. HAINES** (dbhaines@gmail.com) National Park Service, Yellowstone National Park, WY, U.S.A DOUGLAS W. SMITH National Park Service, Yellowstone National Park, WY, U.S.A

Golden Eagles (Aquila chrysaetos) are large, wide-ranging avian predators found throughout the northern hemisphere. With varying measures of population stability documented across the western United States, how human population effects Golden Eagle demography is a management need. The Greater Yellowstone Ecosystem (GYE) is relatively pristine habitat and presents a unique opportunity to study this predator under conditions of minimal human disturbance. Thus, in 2011, we initiated survey and monitoring efforts for this species throughout Yellowstone National Park (YNP). We identified at least 28 eagle territories park wide; in northern Yellowstone we found 21 territories for an average density of 47.3km2/territory. All

eagle territories were occupied in all study yrs (2011-2016), but nest success averaged only 30%, and average productivity was only 0.37 young/territory. Accurate historic records of eagle abundance in YNP are largely unavailable, but limited, unpublished data from the late 1970s to mid-1980s suggests that Golden Eagles may be more abundant in YNP today. We aim to identify the effects of prey and weather on Golden Eagle reproduction, which may help reveal how past conditions contributed to the current population status and in turn help predict future change. We suspect productivity may be low due to limitations in prey availability. Nest prey remains from YNP suggest a diverse diet, with marmot and grouse most commonly observed. Further, the availability of carrion, early in the nesting season from winter kill has significantly decreased since Gray wolf (Canis lupus) reintroduction in 1995, and may be negatively impacting egg production. Although the density of eagles found in the northern range is comparable with two extant studies in the GYE, eagles in YNP are much less productive. Identifying how differences in habitat, prey, weather, and protection drive local demography will contribute to the development of effective management practices in this high profile ecosystem.

Seasonal Inter Island Movements of Striated Caracaras (Phalcoboenus australis) in the Falkland Islands

***KATIE J. HARRINGTON** (katiejharrington@gmail.com), Acopian Center for Conservation Science, Hawk Mountain Sanctuary, Kempton, PA, U.S.A. WOUTER VANSTEELANT, University of Amsterdam, Amsterdam, The Netherlands. SUZAN POLE-EVANS, Hawk Mountain Sanctuary, Kempton, PA, U.S.A. DAVID R. BARBER, Hawk Mountain Sanctuary, Kempton, PA, U.S.A. KEITH L. BILDSTEIN, Hawk Mountain Sanctuary, Kempton, PA, U.S.A.

Movement strategies comprise a critical component of survival in raptors by permitting access to spatially and temporally available resources. As the southernmost distributed bird of prey, Striated Caracaras are said to be non-migratory in their highly restricted range in coastal southern South America and the Falkland Islands 500 km northeast of Cape Horn. Once common throughout the Falklands archipelago, the distribution of this IUCN Near-Threatened endemic species' has been shunted to outer islands where breeding habitat remains untouched by sheep farming. While historically places of conflict for caracaras, human settlements provide oases during times of nutritional stress in winter. In 2013, we outfitted eight previously banded Caracaras (one adult, four subadults, and three juveniles) with 30 g solar-powered GPS/PTTs, to better understand their seasonal distribution and association with farm settlements. Tracking periods ranged from 1.8 mos to 3.7 yrs and averaged 16.6 mos (n = 6). Of the three individuals that transmitted for a minimum of 1 yr (one adult and two subadults), results show daily distances traveled were greater during spring and early summer. The adult island hopped northwest from the Saunders farm settlement to the Jason Island Group in mid spring recorded both the greatest distance between consecutive hourly transmissions, 45.4 km, and the greatest daily displacement, 48.3 km. Our analysis suggests caracaras engaged in exploratory inter island spring movements before remaining in highly localized summer ranges, presumably for breeding, and that farm settlements may support both breeding and non-breeding individuals during times of nutritional stress in winter. Understanding the caracaras' seasonal movements is critical to sustained management and conservation of this historically persecuted species.

Martial Eagle Demography, Diet, and Habitat Use in the Greater Maasai Mara Ecosystem of Southwest Kenya

***RICHARD S. HATFIELD** (stratton.hatfield@uky.edu), University of Kentucky, Lexington, KY, U.S.A. RALPH BUIJ, Wageningen University, Wageningen, Netherlands. MUNIR Z. VIRANI, The Peregrine Fund, Boise, ID, U.S.A. JOHN J. COX, University of Kentucky, Lexington, KY, U.S.A.

The Martial Eagle (Polemaetus bellicosus) is the largest eagle species in Africa and is listed as vulnerable by the IUCN. In July 2016, we began field studies on the species in the Maasai Mara ecosystem in southwest Kenya to investigate its demography, diet, and habitat use. We found 19 pairs with 18 active nest sites in a 3200 km2 area indicating a minimum density of one pair to every 168 km2, which is in the upper range of breeding density recorded for Martial Eagles. Of the 18 nests we found, 94% were in riverine woodland. Between March and May 2017, we confirmed 72 kills made by 17 adult non-breeding Martial Eagles fitted with solar powered GPS-GSM backpack transmitters and identified them to species level. This is one of the only datasets containing a significant sample size of prey items for non-breeding adult Martial Eagles. The three most common prey items were hare species (Leporidae; 21%), Impala fawns (Aepyceros melampus; 14%) and Thomson Gazelle fawns (Eudorcas thomsonii; 11%). Domestic stock accounted for 7% of confirmed kills (two chickens, two shoats and a house cat). Additionally, a camera trap placed at a nest for 58 d recorded 109 prey deliveries with gamebirds comprising 78% of prey items. These preliminary results suggest that riverine woodlands in the Maasai Mara need to be prioritized in conservation planning, grasslands should be managed to promote gamebirds, hares, and small ungulates, and livestock and poultry husbandry practices need to be improved to prevent human-eagle conflict.

The Black Kites Suffer Secondary Poisoning Crisis Due to Intentional Poisonings of Farm Land Birds in Taiwan

***SHIAO-YU HONG** (laughrain@gmail.com), National Pingtung University of Science & Technology, Pingtung, Taiwan. HUI-SHAN LIN, National Pingtung University of Science & Technology, Pingtung, Taiwan. BRUNO A. WALTHER, Taipei Medical University, Taipei, Taiwan. JI-EN SHIE, National Pingtung University of Science & Technology, Pingtung, Taiwan. YUAN-HSUN SUN, National Pingtung University of Science & Technology, Pingtung, Taiwan.

The Black Kite (Milvus migrans) has a limited distribution within Taiwan,

which is due to a dramatic population decrease during the late 20th century. Prompted by some poisoning events of Black Kites and other farm land birds in 2012, we hypothesized that poisoning may be an underreported yet important threat for this species. Therefore, we set up a citizen-science type Facebook group in October 2014 in order to receive more information about possible farm land poisoning events. Through September 2016, we had received reports of 213 suspected poisoning events with a total of 4,753 dead birds. The crops most often associated with poisoning events were seeded rice, rice harvest, and red beans. We tested 29 dead birds (each from a different event) for pesticide residues and found that 28 contained Carbofuran and one contained Terbufos (both highly toxic pesticides), respectively. Furthermore, seven Black Kites were found dead from 2010 to 2016. Four dead kites contained Carbofuran, and the other three contained residues of second-generation anticoagulant rodenticides. After interviewing farmers and reviewing older agricultural literature, we established that most of these events were intentional poisonings of farmers to control so-called pest birds and rats. The dramatic decrease of the Black Kite in the 1980s also coincided with the rapid increase of seeded rice and widespread use of Carbofuran and rodenticides. We thus conclude that the Black Kites were likely victims of inadvertent secondary poisoning events. We initiated public awareness campaigns, and the Taiwan government has consequently made some policy adjustments.

Mitigating Adverse Effects of Illegal Poisoning on the Eastern Imperial Eagle Population in Hungary

***MARTON HORVATH** (horvath.marton@mme.hu), BirdLife Hungary, Budapest, Hungary. GABOR DEAK, BirdLife Hungary, Budapest, Hungary. IMRE FATER, BirdLife Hungary, Budapest, Hungary. TIBOR JUHASZ, Hortobágy National Park Directorate, Debrecen, Hungary.

The most western and isolated population of globally vulnerable Eastern Imperial Eagles (Aquila heliaca) occurs in the Pannonian region of Central Europe. Most of the population breeds in Hungary, where slow growth in the early 2000s stabilized at around 150 pairs in 2012. Over the past decade, 78 poisoned Eastern Imperial Eagles were found in Hungary, leading us to hypothesize that this extremely high non-natural mortality may limit the population. To address illegal poisoning, we developed a complex conservation project with the financial support of the European Union's LIFE program. The project involved: 1) genetic tracking of 145 breeding adult Eastern Imperial Eagles; 2) satellite tracking of 40 immature eagles; 3) intensive communication, cooperation, and education among conservation biologists, hunting associations, farmers, veterinarians, police, and prosecutors; and 4) a special poison and carcass-searching dog unit employed to document and remove poisoned baits and eagles from the landscape. Genetic tracking indicated the estimated mortality of breeding individuals decreased from 15–25% in 2012 at the beginning of the project, to 6–9% in 2016. Satellite tracking indicated poisoning of immature eagles decreased from 20–30% to 0–10% over the course of the project. The number of poisoned Imperial Eagles dropped from 16 poisoned eagles in 2012 to a single bird by 2016. The combination of public communication and the dog unit have led to reduced incidents of poisoning, and to seven prosecutions of perpetrators of illegal poisoning. In parallel with the decreasing rate of poisoning and increased education, the breeding population has increased by 30% and exceeded 200 pairs by 2016. The correlation of decreased poisoning and increased population size suggests that our hypothesis was correct, poisoning likely was limiting the population, and suggests that our conservation project directly benefited the Eastern Imperial Eagle population in Hungary.

Genomic Resources Reveal New Insights into the Ecology of Bald Eagles (Haliaeetus leucocephalus)

***MEGAN E. JUDKINS** (megan.trope@okstate.edu), Integrative Biology, Oklahoma State University, Stillwater, OK, U.S.A. RONALD A. VAN DEN BUSCHE, Integrative Biology, Oklahoma State University, Stillwater, OK, U.S.A. BRIAN COUGER, High Performance Computing Center, Oklahoma State University, Stillwater, OK, U.S.A. WESLEY C. WARREN, McDonnell Genome Institute, Washington University, St. Louis, MO, U.S.A.

Bald Eagles suffered from anthropogenic stressors that resulted in a severe population bottleneck. While the bottleneck occurred over a short period of time and almost extirpated the species, little work has been conducted to look into its effect on the species. As bottlenecks are known to decrease the genetic variation leading to a correlative decrease in fitness for the species, it is important to investigate the effects of the decline on the population for management purposes. Furthermore, to aid in in the recovery of the species after the bottleneck, reintroductions of Bald Eagles from areas less impacted to areas of low population density helped aid in reestablishing populations across the contiguous United States. The translocations were conducted based on population density, without regards to existing population genetic structure. While bald eagles are currently experiencing exponential growth, the species now provides us with a unique system in which to investigate the effects of a rapid population crash and subsequent recovery. To understand the effects of the population bottleneck and reintroductions, a genomics approach was taken utilizing a custom Axiom myDesign SNP array utilizing ~50k single nucleotide polymorphisms. This array was used to evaluate the current population genetic structure across the range of the Bald Eagle and to evaluate the population genetics of a 30 yr dataset of bald eagles in New Jersey that incurred relocated Bald Eagles. Results indicate that in the current distribution of bald eagles, significant population structure and variation is evident, despite the population decline and mixing of individuals. This new information will be of importance for the development of Bald Eagle management plans.

Insights from Banding: Survival and Causes of Mortality of American Kestrels

***JULIE A. HEATH** (julieheath@boisestate.edu), Boise State University,

Boise, ID, U.S.A. BENJAMIN P. PAULI, Saint Mary's University of Minnesota, Winona, MN, U.S.A. HANNA M. MCCASLIN, Boise State University, Boise, ID, U.S.A. LEAH L. DUNN, Boise State University, Boise, ID, U.S.A. CHRISTOPHER J.W. MCCLURE, The Peregrine Fund, Boise, ID U.S.A.

Understanding spatial and temporal patterns in reproduction and survival are key to identifying causes of population declines. In parts of their range, populations of American Kestrels (Falco sparverius) are declining. Causes of declines, and of regional variation in population trends, remain unclear. Nest box data show that indices of reproductive performance are relatively similar across sites and regions. Consequently, we analyzed banding and recovery data to investigate regional variation in survival or mortality causes as potential drivers of regional differences in population trends. We queried the U.S. Geological Survey's Bird Banding Lab for banding and encounter records of American Kestrels from 1960-2016 and estimated survival of male and female kestrels using dead-recovery models. We examined "how obtained" data associated with these records to explore spatiotemporal variation in mortality causes. We found little evidence for spatiotemporal variation in survival estimates. The most commonly reported sources of mortality, include: unknown, disease, drowned, shot, snare-trap, vehicle collisions, building collisions, and predation. We did not find spatial variation in reported mortality causes. The probability of disease being reported as cause of death declined over time, while the probability of death due to collisions (vehicles or buildings) increased over time. Whether these temporal trends in mortality causes in dead encounter data reflect true changes in mortality causes or changes in reporting practices is not clear. We conclude that despite the large amount of banding and recovery data available for Kestrels, our analysis did not provide explanations for regional variation in population trajectories nor did it provide actionable insights into causes of population regulation across the annual cycle. We suggest that additional techniques, used in combination with banding, are needed to provide insight on demographic rates across the annual cycle are important for determining drivers of Kestrel populations.

Origins of Lead in Populations of Wild Raptors

***TODD E. KATZNER** (tkatzner@usgs.gov), U.S. Geological Survey, Boise, ID, U.S.A. MATTHEW J. STUBER, U.S. Fish and Wildlife Service, Portland, OR, U.S.A. VINCENT A. SLABE, West Virginia University, Morgantown, WV, U.S.A. JAMES T. ANDERSON, West Virginia University, Morgantown, WV, U.S.A. JEFFREY L. COOPER, Virginia Department of Game and Inland Fisheries, Richmond, VA, U.S.A. LINDSEY L. RHEA, University of Iowa, Iowa City, IA, U.S.A. BRIAN A. MILLSAP, U.S. Fish and Wildlife Service, Arlington, VA, U.S.A.

Although poisoning from anthropogenically-derived lead threatens wildlife of many species, routes of lead exposure are unclear and rarely empirically tested. We used blood lead concentration and isotope ratio (207Pb/206Pb) data from populations of four species of raptors from across North America to test hypotheses associated with lead exposure via inhalation vs ingestion. Preliminary results suggest that within-nest variation in blood lead concentration was non-zero at nests of Ferruginous Hawks (Buteo regalis) and Osprey (Pandion haliaeetus) ($p = 0.00003$ and $p < 0.00001$), indicating exposure via episodic ingestion. However, within-nest variation in blood lead concentration was not significantly different from zero at nests of Bald (Haliaeetus leucocephalus) and Golden Eagles (Aquila chrysaetos) ($p = 0.01427$ and $p = 0.02249$), consistent with exposure via continuous inhalation. Isotope ratio data corroborated the lead concentration data and within-nest average and variance of blood lead concentrations were positively correlated ($r = 0.70$ to 0.94), also indicating episodic ingestion. This study provides some of the first empirical population-level data to evaluate mechanisms of lead exposure and demonstrates the importance of lead ingestion to avian scavengers.

Raptor Population Trends in the Pacific Coast Bioregion of North America

***JOHN J. KEANE** (jkeane@fs.fed.us), Pacific Southwest Research Station, U.S.D.A. Forest Service, Davis, CA, U.S.A. ANGUS C. HULL, Golden Gate Raptor Observatory, Golden Gate National Parks Conservancy, Sausalito, CA, U.S.A. JOSHUA M. HULL, Department of Animal Science, University of California, Davis, CA, U.S.A. SYLVIA R. MORI, Pacific Southwest Research Station, U.S.D.A. Forest, Service, Albany, CA, U.S.A. ALLEN M. FISH, Golden Gate Raptor Observatory, Golden Gate National Parks Conservancy, Sausalito, CA, U.S.A.

Monitoring long-term raptor population trends at bioregional spatial scales presents logistical and funding challenges. We estimated trends for 19 species of diurnal raptors using standardized migration counts conducted at the Marin Headlands, California, from 1990-2011. Banding and telemetry studies indicated the majority of raptors are from populations in the Pacific Coast Bioregion, with some from the Intermountain Bioregion. Migration counts indicated significant or non-significant increases for 16 species, and non-significant declines for three species -- Sharp-shinned Hawk (Accipiter striatus), Northern Goshawk (A. gentilis), American Kestrel (Falco sparverius). No species showed a significant decline. We found broad congruence in the trend estimates from migration counts with trend estimates from Breeding Bird Survey (BBS) and Christmas Bird Count (CBC) data for the Pacific Coast Bioregion. Significant declines were estimated in the CBC counts for Sharp-shinned Hawk and Rough-legged Hawk (Buteo lagopus); and no species in the BBS counts. Significant or non-significant population increases across the three methods were estimated for 12 species. American Kestrels showed non-significant declines across all methods, while Sharp-shinned Hawk and Northern Goshawks showed declines in CBCs and increases in BBSs. White-tailed Kites (Elanus leucurus) and Northern Harriers (Circus cyaneus) showed non-significant declines in BBSs, although both exhibited increases for migration counts and CBCs. Overall, our results suggest most raptor species were stable or increasing during 1992-2011. We hypothesize two general factors associated with these trends: (1) continued post-DDT era recovery for

many species; and (2) expansion of many species into human-modified landscapes. These results will assist to identify management needs and prioritize research questions for species with the strongest evidence for declining populations, such as American Kestrels and Sharp-shinned Hawks. Migration counts, coupled with studies to identify target populations, and BBSs and CBCs provide useful broad-scale indices for estimating trends and status of Pacific Coast raptor populations.

Diet, Behavior, and Productivity of Ferruginous Hawks Nesting in Rural and Exurban New Mexico, USA

***WILLIAM H. KEELEY** (keeleyw@bouldercolorado.gov), Boise State University, Boise, ID, U.S.A. and Hawks Aloft, Albuquerque, NM, U.S.A. MARC J. BECHARD, Boise State University, Boise, ID, U.S.A. GAIL L. GARBER, Hawks Aloft, Albuquerque, NM, U.S.A.

Habitat loss from human development affects native wildlife populations, especially in the western United States where the human population is growing two to three times faster than any other part of the country. We studied diet, behavior, and productivity of Ferruginous Hawks (Buteo regalis), a species considered sensitive to human presence, nesting in rural and exurban grasslands in New Mexico, USA, to better understand the conservation needs of this species on the periphery of its breeding range. Hawks breeding in the exurban grassland (i.e., exurban hawks) consumed more Gunnison's prairie dogs (Cynomys gunnisoni), whereas hawks in the rural area (i.e., rural hawks) consumed more lagomorphs. From 1998–2005, and during the 2 yrs of our prey use study, exurban hawks delivered more biomass and prey items and experienced greater nesting success and productivity than rural hawks. The presence of prairie dogs, a colonial mammal whose occurrence theoretically reduces predatory search time, assisted in the maintenance of relatively high productivity levels for exurban hawks. As predicted by the food-niche hypothesis, males and females used prey differently, with females delivering larger prey items in each delivery. Flushing distance was considerably higher than that documented in other studies and was negatively related to degree of urbanization. We found that a distance of 650 m prevented 95% of nest-attending Ferruginous Hawks from flushing in response to human intruders. Extant prairie dog colonies and habitat supporting other medium-sized mammals (e.g., Geomyidae) should be conserved to enable maintenance of Ferruginous Hawk populations in the western United States, particularly in anthropogenically altered areas.

Can the Myth of Fasting Migration in Swainson's Hawks (Buteo swainsoni) Finally Be Put to Rest?

***JACK KIRKLEY** (jack.kirkley@umwestern.edu), The University of Montana – Western, Dillon, MT, U.S.A.

The possibility of long-distance fasting migration in trans-equatorial, thermal soaring hawks, such as Broad-winged Hawks (Buteo platypterus) and Swainson's Hawks was first postulated by Smith in articles published the early 1980's, and was later formalized into energetic models advocating the likelihood of fat-fueled, long-distance, fasting migration in these hawks. These fasting migration precepts were also advocated by Houston in presentations about Saskatchewan Swainson's Hawks. Kirkley raised objections to the fasting migration hypothesis, based on physiological and ecological considerations. In 2006, Kirkley proposed that arboreal foraging behavior may frequently be the way that hawks refuel in or near the roosting sites, based on the behaviors he documented during his three Octobers observing migrant Swainson's hawks in Chiapas, Mexico. Bechard analyzed yearly body weight fluctuations of Swainson's Hawks in Argentina and North America, concluding that the body weight patterns don't reflect the magnitude of body fat deposition and depletion predicted by the model of Smith. Kochert analyzed PTT-based migration tracks, noting that mid-migration stopovers were common, thus suggesting that hawks use these as refueling stops, instead of showing the steady progress predicted for a fat-fueled, fasting type of migration. New technological tools can now provide GPS-accurate locational tracks recorded at critical, early morning time intervals when most of these feeding events should be occurring. The use of detailed locational data, in combination with 3D flight simulation imagery, should reveal details of the terrain selected by migrant hawks, thus yielding the key elements needed to demonstrate both the frequency and the likely methods of foraging that migrant Swainson's Hawks employ enroute to their destinations. The superior terrain visualization capabilities provided by this new, 3D space navigation technology will be demonstrated.

Assessment of Glucocorticoids in the Critically Endangered California Condor (Gymnogyps californianus) Using Plasma, Urate, and Feathers

***ZEKA E. KUSPA** (zkuspa@ucsc.edu), University of California, Santa Cruz, CA, U.S.A. DONALD R. SMITH, University of California, Santa Cruz, CA, U.S.A. CHRISTOPHER W. TUBBS, San Diego Zoo Global, Institute for Conservation Research, Escondido, CA, U.S.A. JENNIE JONES SCHERBINSKI, National Park Service, Pinnacles National Park, Paicines, CA, U.S.A. ALACIA WELCH, National Park Service, Pinnacles National Park, Paicines, CA, U.S.A. JOSEPH BURNETT, Ventana Wildlife Society, Salinas, CA, U.S.A. MICHAEL CLARK, Los Angeles Zoo and Botanical Gardens, Los Angeles, CA, U.S.A. MYRA E. FINKELSTEIN, University of California, Santa Cruz, CA, U.S.A.

California Condors are a critically endangered, chronically lead poisoned, and intensively managed vulture species lacking information on glucocorticoid hormone (GC) response to stress. We validated a commercially available corticosterone I125 double antibody radioimmunoassay kit to for measurement of GC and metabolite (GC(m)) in California Condor plasma, urates, and feathers. Measurements of total GC in plasma collected from 39 wild and captive condors within 15 min of a handling stressor were highly variable (range = 1–189 ng/mL, median = 73 ng/mL, n = 51) but within the range of GC measurements reported for other avian species. Flight feather GC(m) concentrations from five condors

were also within ranges reported for other avian species (range = 5.7–69 ng/g, median = 9.3 ng/g), but additional work is needed to interpret changes in condor feather GC(m) concentrations. We quantified individual responses to capture and handling in a field setting by measuring GC(m) in sequentially collected urate samples. We measured 1.1–380-fold increases in urate GC(m) concentrations in response to capture and handling, providing a biological validation for our measurement method. First collected urate samples GC (ng/g) were significantly correlated with plasma GC (Spearman's p = 0.47, P = 0.01, n = 30), indicating that urate GC(m) is a suitable proxy for circulating GCs. Plasma GC was also correlated with age (Spearman's p = 0.34, P = 0.029) and blood lead concentrations (Spearman's p = -0.40, P = 0.01, n = 45) in wild condors, but additional factors such as variation in captivity before sampling and lead exposure histories require development of a more complex model for determining variables affecting the stress response. Alterations to the GC response can have consequences for survival and reproduction in wild birds. Our preliminary results suggests sub-lethal impacts of lead poisoning on the reintroduced California Condor population.

Quantifying Bald and Golden Eagle Behavior Using High Frequency GPS Sampling and Accelerometry Data

***MICHAEL LANZONE** (michael.lanzone@celltracktech.com), ANDREW MCGANN, TRICIA MILLER, ROBERT FOGG, and SHELDON BLACKSHIRE, Cellular Tracking Technologies, Rio Grande, NJ, U.S.A.

Critical to understanding energy budgets is understanding how an animal spends its time. To improve our understanding of energy budgets, we continuously tracked six Bald Eagles (Halieeatus leucocephalus) and six Golden Eagles (Aquila chrysaetos) in eastern North America using GSM-GPS BT3- CTT telemetry units (Cellular Tracking Technologies, LLC.). We recorded GPS data at 5 sec intervals and recorded triaxial accelerometer data at 40Hz (forty points per sec) when the eagle was in flight. We collected 700k – 1.2 million accelerometer data points per bird per d for a total of ~46 million locations over 17 ds. We used the GPS data to determine flight speed, altitude, and location. We used the high-resolution accelerometer data to determine wing-beat frequency, total number of flapping events, and the proportion of time eagles spent flapping during flight, and energy expenditure of flapping. Both species had similar wing-beat frequencies (Bald Eagle = 2.53±0.03 Hz SE; Golden Eagle = 2.41±0.18 Hz). However, Bald Eagles spent much more time flapping during flight than did Golden Eagles (24.7±4.5% vs. 3.1±0.5%). This translated to Bald Eagles flapping on average 47.4±6.0 times/km compared to Golden Eagles flapping 6.4±1.1 times/km. Energy expenditure for flapping flight as estimated by the Overall Dynamic Body Acceleration (ODBA) was higher for Bald Eagles than for Golden Eagles (1.07±0.02 vs. 0.74±0.04). All of this suggests that Golden Eagles are much more efficient fliers than Bald Eagles. Higher energy use by Bald Eagles may explain why Bald Eagles exhibit higher dietary plasticity than do Golden Eagles. These data provide, for the first time, an estimate of the amount of energy use for flapping flight for these species use during flight and suggest how life history strategies may influence flight behavior.

Golden Eagle Migratory Behaviors in Response to Arctic Warming

***SCOTT LAPOINT** (sdlapoint@gmail.com), Lamont-Doherty Earth Observatory, Palisades, NY, U.S.A. and Max-Planck Institute for Ornithology, Radolfzell, Germany. GIL BOHRER, Ohio State University, Columbus, OH, U.S.A. SARAH CAIN DAVIDSON, Max-Planck Institute for Ornithology, Radolfzell, Germany and Ohio State University, Columbus, OH, U.S.A. ELIZIER GURARIE, University of Maryland, College Park, MD, U.S.A. University of Washington, Seattle, WA, U.S.A. PETER MAHONEY, University of Washington, Seattle, WA, U.S.A. NATALIE BOELMAN, Columbia University, New York, NY, U.S.A.

Understanding how animals adapt to climate change is a conservation priority, particularly in arctic landscapes where these changes are accelerated. Doing so however, remains challenging because animal behavior datasets have typically been collected at site- or population-specific scales, often for short periods (e.g. 2-3 yrs), and likely had objectives not pertaining to climate change research. We have overcome this challenge by compiling a long-term (25 yrs), large-scale (northwestern North America) dataset of > 0.5 million locations collected via 86 adult-aged Golden Eagles (Aquila chrysaetos) fitted with satellite and GPS data loggers. We used mechanistic range shift analyses to identify the locations and dates when each bird performed a behavioral switch from a stationary phase (e.g. over-wintering or breeding) to migration and vice-versa. Preliminary generalized additive mixed-models suggest these Eagles have performed significant shifts in their departure dates, yet their arrival dates have remained relatively consistent. We have now annotated these spatio-temporal data with a suite of environmental data (i.e. % snow cover, time-to snow cover, time-to greening, air temperature, and wind direction and magnitude) that we expect to affect migratory decisions. We will next use a survival analysis (e.g. Cox proportional-hazard regression model) to quantify the influence of the environmental variables on these dates. Preliminary trends suggest Golden Eagles migrating across northwestern North America are adapting to changes in the timing and duration of artic winters by arriving at their northern breeding grounds earlier, presumably to extend their breeding and chick rearing phases. Golden Eagles exhibit some resiliency to changes in the arctic climate, but further work is warranted to identify the drivers of these patterns and those across other taxa and populations.

Technology Saves Time and Money: Assessment of Electrocution Risk of Endangered Raptors by Means of High-Resolution GPS/GSM Telemetry in Spain

***PASCUAL LOPEZ-LOPEZ** (Pascual.Lopez@uv.es), University of Valencia, Cavanilles Institute of Biodiversity and Evolutionary Biology, Valencia, Spain. ARTURO MARTÃ-NEZ, University of Valencia, Cavanilles Institute of Biodiversity and Evolutionary Biology, Valencia, Spain.

Electrocution on power lines is one the most important non-natural causes of raptor mortality worldwide. To date, most conservation actions aimed at decreasing avian mortality in power lines have focused on the correction of dangerous pylons based on their configuration or by establishing a fixed radius around nesting sites, which is usually set arbitrarily. This assumption is frequently not based on scientific evidence and could be biologically meaningless if other pylons within the home range are not corrected too. We report the results of a pilot project aimed at identifying potentially dangerous power lines within Bonelli's Eagle (Aquila fasciata) home ranges considering landscape composition and space use. Bonelli's Eagle is one of the most endangered raptors in Europe. Until June 2017, 27 territorial Bonelli's Eagles were fitted with high-resolution GPS/GSM transmitters in eastern Spain. Of these, nine were found dead, mainly by electrocution and collision with power lines (44.4% of them). Using a database including more than 2.3 million GPS locations of two selected breeding pairs, we assessed spatial and temporal patterns of habitat use, quantified home range size, and evaluated the relationship between space use and distribution of the wiring network within home range areas. Overall, 305 pylons were identified within 75% kernel contour, which were classified as high (34.4%), medium (20.3%) and low (45.2%) electrocution risk for eagles. After habitat use analysis, 86 pylons were identified as priority for correction and the power company accepted to correct them. This resulted in a saving of 71.8% of money considering the budget for correction of all poles, and a saving of 18.1% considering only the most dangerous ones after habitat use analysis. Our project shows that targeting mitigation actions on the correction of the most dangerous pylons using spatially explicit information is useful for raptor conservation.

Tolerance to Changing Weather by Migrant Turkey Vultures (Cathartes aura)

***JULIE M MALLON** (jmmallon@umd.edu), University of Maryland, MD, U.S.A. KEITH L BILDSTEIN, Hawk Mountain Sanctuary, Acopian Center for Conservation Learning, PA, U.S.A. WILLIAM F FAGAN, University of Maryland, MD, U.S.A.

Although differing climates of allopatric Turkey Vulture races make it difficult to compare stopover behavior directly, it is possible to compare stopover behavior in terms of risk tolerance. To understand if stopover use varied temporally and spatially due to changes in risk tolerance, I compared the stopover likelihoods of four migratory Turkey Vulture subspecies (C. a. meridionalis, C. a. septentrionalis, C. a. aura, and C. a. ruficollis) under uniform weather conditions. Stopovers were used less frequently in the spring compared to the fall for all subspecies, suggesting Turkey Vultures are more time restricted during spring migration than fall migration. During spring migrations, meridionalis and septentrionalis were most tolerant to risk (i.e. used stopovers less), whereas aura and ruficollis were least tolerant to risk (i.e. used stopovers more). At the end of spring migrations, ruficollis and septentrionalis were most risk tolerant, suggesting timing on breeding grounds influences their migratory behavior. During the middle of migrations, ruficollis and aura (fall) and septentrionalis (spring) were the least tolerant to risk, suggesting these migrants are restricted during mid-migration. Stopover use at the species level was predicted by average hourly migration speed ($r^2=0.4246$, $\beta=-0.0004081$, $SE=0.0001446$, $P=0.00477$) and explains much of the difference in stopover use among populations. Short distance, partial migrants (septentrionalis) used stopovers most frequently, due to low energetic costs of migration. In contrast, long distance, obligate migrants (meridionalis) used stopovers the least and were the least risk tolerant at the end of their spring migration, but most risk tolerant at the end of their fall migration, suggesting their energetic demands differ between outbound and inbound migrations. These changes in risk tolerance during migrations suggests that stopovers used by Turkey Vultures in response to weather may be used at rates that optimize energetic expenditure.

Using High-Resolution GPS Data to Examine Burrowing Owl Nocturnal Foraging Patterns

***ALAN MARSH** (alanjmarsh@gmail.com), Lotek Wireless Newmarket, ON, Canada. ERIN BAYNE, University of Alberta, AB, Canada. TROY WELLICOME, Environment and Climate Change Canada, AB, Canada.

Studies of habitat selection by foraging animals assume patterns of animal presence correlate with successful foraging, without explicit evidence this is valid. We used GPS data loggers and digital video recorders to determine precise locations where nocturnally foraging Burrowing Owls (Athene cunicularia) captured vertebrate prey. We compared land-cover type selection patterns using a presence-only Resource Selection Function (RSF) to create a model that incorporated prey capture locations (CRSF). We also compared net prey returns in each cover type to better measure reward relative to foraging effort. Finally, we measured vegetative conditions at foraging and random locations. The RSF method did not reflect prey capture patterns, and cover-type rankings from this model are inaccurate. Burrowing Owls successfully forage across all cover types, albeit where vegetation is relatively sparse, with highest net energy returns in native grass. Conservation efforts for Burrowing Owls should focus on ensuring heterogeneity of plant heights and densities across the landscape.

Movement Ecology of Satellite Tagged Broad-winged Hawks (Buteo platypterus)

***REBECCA A. MCCABE** (rebeccamccabe2@gmail.com), Acopian Center for Conservation Learning, Hawk Mountain Sanctuary, Kempton, PA, U.S.A. LAURIE J. GOODRICH, Acopian Center for Conservation Learning, Hawk Mountain Sanctuary, Kempton, PA, U.S.A. DAVID R. BARBER, Acopian Center for Conservation Learning, Hawk Mountain Sanctuary, Kempton, PA, U.S.A. KEITH L. BILDSTEIN, Acopian Center for Conservation Learning, Hawk Mountain Sanctuary, Kempton, PA, U.S.A. JESSE WATSON, HawkWatch International, Salt Lake City, UT, U.S.A. ERIN BAYNE, University of Alberta, AB. Canada. AUTUMN-LYNN HARRISON, Smithsonian Conservation Biology Institute, Washington DC, U.S.A. PETER MARRA, Smithsonian Conservation Biology Institute, Washington DC, U.S.A.

During the 2014 – 2016 breeding seasons, we attached 9.5 g solar-powered satellite transmitters to 13 Broad-winged Hawks (four juveniles and nine adults) from Pennsylvania and three adults from Alberta to track movements from breeding to overwintering sites. Evidence of pre-outbound (post-breeding) migration movements was documented in four individuals. Adults initiated migration between 22 August and 11 September. Three juveniles began outbound migration between 18 August and 22 August, while the fourth juvenile was tagged on migration on 18 September with no initial start date recorded. Adults had 1- 10 ($\dot{x}$= 4.71) stopovers in autumn lasting for 1-24 ds ($\dot{x}$ = 4.88 days, n = 7) and juveniles had 2- 5 stopovers ($\dot{x}$ = 3) lasting between 2- 51 ds ($\dot{x}$ = 13.55 days). Adults from Pennsylvania wintered in Brazil, Peru and Colombia (n = 7) whereas Alberta Broad-winged Hawks wintered in Suriname, Venezuela, and Bolivia (n = 3). The distance traveled on autumn migration was greater for Alberta birds ($\dot{x}$ = 10021 km, n = 3) compared to Pennsylvania ($\dot{x}$ = 8684 km, n = 6). Of the 16 tagged Broad-winged Hawks, seven adults returned in the spring, taking similar routes used during autumn migration. Return migration varied among individuals and occurred between 6 December and 26 February. Distances travelled were broken down into 10˚ latitudinal blocks to compare rate of travel by latitude, age and breeding area. This study will further define Broad-winged Hawk intercontinental migration and provide insight to the timing, locations and habitat use during migration.

Environmental Correlates of Long-distance Dispersal in American Kestrels

***HANNA M. MCCASLIN** (mccaslinhm@gmail.com), Boise State University, Boise, ID, U.S.A. JULIE A. HEATH, Boise State University, Boise, ID, U.S.A.

Dispersal is a critical process for animals given its influence on population structure and dynamics. Additionally, long-distance dispersal movements can be critical for gene flow and maintaining genetic diversity through immigration. In this time of global change, understanding the relationship between environmental variation and animal populations is a research priority, with implications for management and conservation. However, few studies have assessed the role of environmental factors in directing dispersal decisions or the frequency of long-distance dispersal movements. Understanding the environmental conditions associated with long-distance dispersal is important for forecasting how population distributions may change in response to land use and climate change. We used band encounter data from the Bird Banding Laboratory (BBL) to study patterns of environmental change and long-distance natal and breeding dispersal in American Kestrels (Falco sparverius) throughout North America from 1960-2015. We defined long-distance dispersal as any movement between distinct 10 minute blocks. Using climate and land cover data and Bayesian hierarchical models, we identified how variation in temperature, precipitation, and human alteration of the landscape over time influenced dispersal distance and direction. We also studied regional variation in dispersal and the interacting effects of environmental factors and individual characteristics like sex and breeding latitude. We found that Kestrels from higher latitudes dispersed farther than those at lower latitudes, which is consistent with the hypothesis that migratory strategies affect dispersal movements. Our study highlights the need to study the effects of global change on processes at the individual level so that we understand the mechanisms underlying observed population declines and shifts in distributions.

One Size Does Not Fit All: What Movements of Pre-breeding Individuals Tells Us About Conserving Golden Eagles in Alaska

***CAROL L. MCINTYRE** (Carol_McIntyre@nps.gov), National Park Service, Fairbanks, AK, U.S.A. STEPHEN B. LEWIS, U.S. Fish and Wildlife Service, Juneau, AK, U.S.A.

Effective conservation of Golden Eagles (Aquila chrysaetos) requires identifying the factors that regulate their abundance, including demographic and environmental processes acting through their annual cycles. This includes identifying areas and resources that both breeders and pre-breeders (i.e. individuals who have not entered a breeding population) use throughout their annual cycle. Golden Eagles do not generally enter a breeding population until they reach 4 yrs of age. Entry requires either replacing a bird or establishing a new territory. Thus, many Golden Eagles probably spend a substantial portion of their lives as pre-breeders. Given that pre-breeders are future breeders, it is surprising that little is known about their ecology. To address this information gap, we are studying pre-breeding migratory Golden Eagles throughout their annual cycle. Here, we describe movements of pre-breeding Golden Eagles during the breeding season (March – September) in Alaska. Our sample includes eagles telemetered with satellite radios as hatch year or after-hatch-year (but not breeders) in interior Alaska between 1997 and 2016. Breeding migratory Golden Eagles remain on or near

their nesting territories throughout the breeding season in Alaska. In striking contrast, most pre-breeding eagles exhibited nomadic behavior patterns, moving thousands of kilometers across the breeding season and using a variety of habitats ranging from coastal wetlands to interior alpine areas. The extensive movements and use of multiple habitats suggest that pre-breeding Golden Eagles are using resources at a State-wide scale during the breeding season in Alaska. Further, use of the same areas by individual eagles telemetered decades apart suggests that some areas, including wetlands on Alaska's North Slope, are providing essential resources for pre-breeding Golden Eagles. We will continue to study pre-breeding eagles to expand our understanding of their role on the population dynamics and stability of Alaska's Golden Eagles.

Reproductive Output, Parental and Juvenile Condition, and Habitat Quality for Flammulated Owls in a Changing Environment

***MARKUS MIKA** (mmika@uwlax.edu), University of Wisconsin La Crosse, La Crosse, WI, U.S.A. M. DAVID OLEYAR, HawkWatch International, Salt Lake City, UT, U.S.A. CLAYTON M. WHITE, Department of Integrative Biology, Brigham Young University, Provo UT, U.S.A.

While raising young, parental birds face significant energetic trade-offs. Increased parental provisioning may drain reserves in adult birds while their juveniles experience improvements in individual growth or numbers of successful fledglings. Breeding locations in areas of high quality food resources can offset the need for more food deliveries by parents while still enhancing reproductive output or accelerating juvenile growth rates. Sub-optimal foraging habitat may decrease clutch sizes unless parental efforts are increased. In a long-term study effort, we measured food resource abundance, parental and juvenile condition, and reproductive output in Flammulated Owls (Psiloscops flammeolus) using nest boxes over ten breeding seasons across four habitat patches in northern Utah. Due to their semi-colonial breeding distribution in relatively small nesting territories, these nocturnal raptors are excellent study organisms to investigate foraging and breeding relationships. Nest sites near higher quality habitat patches positively impacted reproductive output and juvenile growth rates. We did not observe a relationship between the condition in females and fledgling numbers during nesting periods. However, during two particularly severe drought yrs (2015 & 2016), females lost weight significantly faster and nestling mortality increased as well compared to other survey years. The results underline the potential issues facing relatively common avian species in predicted climate change scenarios.

Presence of Bald Eagle (Haliaeetus leucocephalus) in Upland Landscapes of the Upper Midwest During Winter: Implications for Wind Energy

SARA SCHMUECKER, U.S. Fish & Wildlife Service, Rock Island Ecological Services Field Office, Moline, IL, U.S.A. DREW BECKER, U.S. Fish & Wildlife Service, Atlanta, GA, U.S.A. MICHAEL LANZONE, Cellular Tracking Technologies, LLC, Rio Grande, NJ, U.S.A. TODD KATZNER, U.S. Geological Survey, Forest & Rangeland Ecosystem Science Center, Boise, ID, U.S.A. BOB FOGG, Cellular Tracking Technologies, LLC, Rio Grande, NJ, U.S.A. ***TRICIA MILLER** (tricia.a.miller@gmail.com), Peregrine Fund, ID, U.S.A. and Conservation Science Global, Inc. West Cape May, NJ, U.S.A.

Wind energy production is expected to increase dramatically over the next 35 yrs especially in the Upper Midwest. Concurrent with increasing Bald Eagle (Haliaeetus leucocephalus) populations in the region, the Upper Midwest has experienced the greatest number of Bald Eagle mortalities at wind facilities. Because Bald Eagles are strongly associated with waterbodies, research to-date on this species has primarily focused on riparian corridors. Consequently, upland agricultural landscapes, where wind energy development is occurring, were thought to be benign environments in term of risk to eagles. However, a substantial Bald Eagle presence has been documented outside of riparian areas. Significant eagle mortality and use of upland areas have resulted in the need for more information regarding biology and movements in non-riparian landscapes. To guide management and reduce interactions with potentially hazardous structures, we captured and telemetered 22 adult and sub-adult eagles in Iowa and Illinois during the winters of 2013-2016. The local movements of these birds were recorded from their wintering grounds until spring migration. We collected 328,945 GPS data points and tracked eagles an average of 59.1 $\pm$ 39.0 (SD) ds per bird. To understand environmental correlates of eagle habitat use, we used logistic mixed effects models to compare conditions in upland areas to conditions in riparian areas. We evaluated five models with variables describing extreme cold, storm systems, and spring migration conditions. Our results indicated that Bald Eagles were more likely to be present on upland landscapes during extreme cold events. This suggests that when ice cover restricts foraging on open water, eagles move into areas with other food sources and may encounter wind turbines. The relationship between weather and Bald Eagle foraging behavior may be useful to understand how Bald Eagles use Midwestern landscapes and help guide management decisions for the conservation of this iconic species.

Density-dependent Parameters of Reintroduced Populations: Age of First Breeding and the Overestimation of Extinction Risks

***VIRGINIA MORANDINI** (morandini@ebd.csic.es), Doñana Biological Station (CSIC), Sevilla, Spain. SABRINA DIETZ, Doñana Biological Station (CSIC), Sevilla, Spain. Ian Newton Centre for Ecology & Hydrology, Wallingford, UK. MIGUEL FERRER, Doñana Biological Station (CSIC), Sevilla, Spain.

The present biodiversity crisis has led to an increasing number of reintroduction programs, and it seems that this conservation tool is going to be more used in the future, especially in the face of climate change. Many fundamental questions in population ecology center on the mechanism whereby populations escape extinction.
Population Viability Analyses (PVA) is the most common procedure to analyze extinction risk. In the use of PVA to model the trajectories of reintroduced populations, demographic values are sometimes taken from other existing wild populations or even from individuals in captivity. No allowance is made in viability models for density-dependent effects on demographic parameters such as reproductive and mortality rates. However, density-dependent variation in age of first breeding has a buffer effect on population fluctuations and, in consequence, on population persistence.
We simulated population viability of Spanish Imperial Eagles (Aquila adalberti) and Ospreys (Pandion halietus) using both data of established populations and data from reintroduced populations in southern Spain. Our results show that, populations of long-lived birds resulting from reintroductions or colonizations of new areas increase at maximum rate only when the age of first breeding is reduced. To ignore this variation in PVA means that we are seriously limiting the potential of the model population to respond to fluctuations in density, decreasing its resilience and viability.

Evaluating Long-term Turnover of Northern Goshawks (Accipiter gentilis) within the Minidoka Ranger District of the Sawtooth National Forest

***CARLY F. MUENCH** (carly.muench@umontana.edu), University of Montana, Missoula, MT, U.S.A. ROBERT A. MILLER, Intermountain Bird Observatory, Boise, ID, U.S.A. ERICK GREENE, University of Montana, Missoula, MT, U.S.A. MICHAEL K. SCHWARTZ, Rocky Mountain Research Station, National Genomics Center for Wildlife and Fish Conservation, Missoula, MT, U.S.A.

The U.S. Forest Service recently highlighted the Northern Goshawk as a management indicator species for the Minidoka Ranger District (MRD) of the Sawtooth National Forest in Idaho. To properly inform management decisions in this region, it is important to obtain data on goshawk population health and ecology. Annual turnover of breeding individuals is considered a crucial metric of population viability; providing evidence for death, abandonment, or other population disturbances. Previous data on goshawks within the MRD suggests an abnormally high rate of turnover, especially in females, compared to other places they have been studied. Since 2012, the Intermountain Bird Observatory has color-banded and collected blood and feather samples from goshawks. Their annual turnover estimates are based on mark-resight of birds, while most genetic samples have not been included in turnover analysis. To produce a more accurate picture of goshawk turnover in the MRD, I will conduct genetic parentage analyses using 2012–2017 blood and feather samples collected from goshawks. This approach will compare microsatellites and shared alleles from samples collected of parent and offspring hawks to uncover genetic relationships. In addition, I will assist with mark-resight surveys and trapping efforts during summer 2017 to further turnover data. This study will help further knowledge of population dynamics, threats, life history, and movements of goshawks within the MRD, as well as increase the resolution of turnover data.

American Kestrel (Falco sparverius) Survival and Productivity in the Llano Estacado of Texas

***SHEA MULLICAN** (shea.d.smith@ttu.edu), Texas Tech University, Lubbock, TX, U.S.A. CLINT W. BOAL, U. S. Geological Survey, Texas Cooperative Research Unit, Lubbock, TX, U.S.A.

American Kestrel populations are experiencing long-term declines across North America, except for two regions in Texas: the shortgrass prairie and the Tamaulipan Brushlands. We initiated a Kestrel nest box program across three study sites in Lubbock County TX in January - March 2013, and have monitored occupancy and reproduction from 2013 - 2017. Among 30 – 32 nest boxes, we observed box occupancy rate increase from 12% in 2013 to 28% in 2014, which leveled off at 57 – 63% in subsequent yrs. We monitored 59 first nest attempts and 8 second nest attempts for which we have known fates. Nest success was 89.8% for first attempts and 100% for second attempts; all second nest attempts followed successful fledging of first attempts. The daily survival rate for all first nesting attempts was 0.99 (± 0.03). Across all 5 yrs, average clutch size was 4.8 eggs (± 0.9) per nest, 4.1 nestlings (± 1.3) per hatched nest, and 3.2 (± 1.4) fledglings per successful nest; 51.7% of nestlings were male and 48.3% were female. Hatching success across all 5 yrs was 78.9% which produced a total of 198 fledglings. Double-brooding frequency in 2014 was 11% that increased to 26% in 2016, and one nesting female produced two successful broods in three consecutive years (with 2017 pending). Double-brooding is uncommon to rare in raptor species. In Florida, 10.6% of kestrel pairs initiated a second clutch, following a successful first attempt, but only 54% of the second attempts experienced nest success. Kestrels that have double-brooded in our study area have experienced 100% nest success which may be due to the nesting experience of the pair, favorable climate, and/or an extended breeding season.

Ferruginous Hawk (Buteo regalis) Habitat Quality Defined as Habitat Selection and Reproductive Success Along a Gradient of Human Land-use

***JANET W. NG** (janet.ng@ualberta.ca), Department of Biological Sciences, University of Alberta, Edmonton, AB, Canada. ERIN M. BAYNE, Department of Biological Sciences, University of Alberta, Edmonton, AB, Canada. TROY I. WELLICOME, Department of Biological Sciences, University of Alberta, Edmonton, AB, Canada and Canadian Wildlife Service, Environment and Climate Change Canada , Edmonton, AB, Canada.

Human land use has resulted in habitat loss, degradation, and fragmentation of grassland ecosystems worldwide. However, some species historically associated with grassland are observed using landscapes with high proportions of cropland and some species, including Ferruginous Hawk (Buteo regalis), are found along the entire gradient of low to high proportions of cropland. Our objective was to evaluate the influence of human land use on habitat use and reproduction. First, we modeled home range habitat selection and relative nest abundance to determine the influence of land-cover composition on habitat use. Next, we evaluated nest survival, clutch size, fledging rate, and post-fledging survival across the gradient of grassland composition. Lastly, we compared habitat and reproduction models to determine if landscape composition similarly influences habitat use and reproduction, if habitat use can predict reproduction, or if population sinks occur. Our abundance model was developed using systematic surveys (n = 223) conducted using a stratified random sampling design. The landscape was stratified by the amount of proportion of cropland, density of transmission lines, road density, and oil & gas well density in each block. We also monitored nests from 2010 to 2015 (n = 758 nests and 1533 nesting attempts), using the same stratified design, and gathered reproduction metrics such as nest survival, clutch size, fledging rate, source of mortality, and post-fledging survival. Models were developed using variables categorized into six classes: intrinsic variables, geography, land-cover, industrial development, soil characteristics, and weather. Predictors of Ferruginous Hawk habitat selection and reproductive performance differ depending on the spatial scale, metric of consideration, and include both environmental and human variables. Habitat loss, in the form of cropland conversion, is implicated as a potential factor for Ferruginous Hawk decline, therefore understanding the influence of grassland loss and human development is important for species conservation and recovery.

Approaches to Determining the Potential Risk Posed to Raptors at Wind Energy Project Sites

***JOSEPH B. PLATT** (PlattEnvironmental@gmail.com), Dixie State University, St. George, UT, U.S.A.

Wind energy came onto the scene as a solution to our energy needs. It was soon evident that there were serious environmental consequences. How can raptor biologists and environmental consultants assist in bringing about the good of wind without the liabilities to wildlife? Wind energy projects interact with their environmental setting in many ways. The U.S. Fish and Wildlife Service administers national jurisdiction through the compliance with Endangered Species Act, the Migratory Bird Treaty Act, and the Bald and Golden Eagle Act. The presentation will discuss a biologist's responsibility in working with the developer to avoid, minimize and mitigate potential impacts to raptors and other protected species. Specific strategies for identifying and dealing with the potential of risk, and the role of mitigation and options for its use will be presented.

Meteorological and Environmental Variables Affect Flight Behavior and Decision-making of an Obligate-soaring Bird, the California Condor

***SHARON A. POESSEL** (spoessel@usgs.gov), U.S. Geological Survey, Forest and Rangeland Ecosystem Science Center, Boise, ID, U.S.A. JOSEPH BRANDT, U.S. Fish and Wildlife Service, Hopper Mountain National Wildlife Refuge Complex, Ventura, CA, U.S.A. TRICIA A. MILLER, Division of Forestry and Natural Resources, West Virginia University, Morgantown, WV, U.S.A. TODD E. KATZNER U.S. Geological Survey, Forest and Rangeland Ecosystem Science Center, Boise, ID, U.S.A.

Movements of animals are limited by evolutionary constraints and ecological processes, and are strongly influenced by the medium through which they travel. For flying animals, variation in atmospheric conditions are critically influential to movement. Obligate-soaring birds depend on external sources of updraft more so than do other flying species, and, without that updraft, they are unable to sustain flight for extended periods. Consequently, these species are good models for understanding how the environment can influence decisions about movement. We used meteorological and topographic variables to understand the environmental influences on the decision to engage in flight by obligate-soaring and critically-endangered California Condors (Gymnogyps californianus). Our preliminary results indicated that condors were more likely to fly and they flew at higher altitudes and over smoother terrain under conditions that promoted either thermal or orographic updrafts, e.g. when turbulence and solar radiation were higher and when winds from the east and north were stronger. However, increased atmospheric stability, which is inconsistent with thermal development but may be associated with orographic updrafts, was correlated with a somewhat higher probability of being in flight

at lower flight altitudes and over rougher terrain. The tight and previously-undescribed linkages between condor flight and conditions that support development of thermal and orographic updrafts provide important insight into the behavior of obligate-soaring birds and into the environmental parameters that may define the currently expanding distribution of condors within and outside of California.

Local to Landscape: Establishing a Network of Collaborative Golden Eagle Monitoring and Research Sites

***CASEY B. POZZANGHERA** (caseypozzanghera@boisestate.edu), Boise State University, Boise, ID, U.S.A. JULIE A. HEATH, Boise State University, Boise, ID, U.S.A. BRIAN WOODBRIDGE, United States Fish and Wildlife Service, Corvallis, OR, U.S.A.

Golden Eagle (Aquila chrysaetos) breeding populations have been monitored and studied at local scales in many regions of western North America for decades, creating a wealth of information on this apex species. Standardization among sites will increase the ability to collate data across these independent study sites and facilitate comparative analyses at a landscape-level. This project aims to address this need by fostering collaboration among eagle researchers and biologists and building upon work done in established long-term monitoring programs for breeding Golden Eagles. We interviewed the principal investigators at six such long-term Golden Eagle monitoring sites to compare and contrast monitoring approaches and identify potential ways to create consistent metrics among sites. These study sites varied by agency affiliations, composition of their program staff, size of the study area and numbers of territories monitored. We found that territory occupancy and productivity were commonly reported population parameters and that there was consistency in the way that these parameters were reported. However, we found survey design and protocols differed among studies, suggesting that direct comparisons among study sites may be inappropriate, hindering our ability to assess eagle populations at larger scales. Improving collaboration among this "network" of long-term monitoring sites, and working to expand it, can be achieved through increased communication among members of this self-organized group, coupled with a network workshop and meta-analysis on key population parameters. This type of collaboration can aid in basic and applied research questions, improving our understanding of common demographic measures such as territory occupancy and productivity, while also opening the door for more detailed studies on the effects of climate, habitat alteration, anthropogenic disturbance, and parasites and disease, at more biologically meaningful scales.

Community Engagement in Raptor Monitoring and Habitat Enhancement Projects in central Alberta - Partnering Business and Conservation

***CHUCK E. PRIESTLEY** (chuck@STRIXeco.ca), STRIX Ecological Consulting, Tofield, AB, Canada. LISA TAKATS PRIESTLEY, STRIX Ecological Consulting, Tofield, AB, Canada

Lafarge Canada Inc. is a member of the Wildlife Habitat Council (WHC), a nonprofit, non-lobbying group of corporations, conservation organizations, and individuals dedicated to restoring and enhancing wildlife habitat. WHC helps large landowners, particularly corporations, manage their unused lands in an ecologically sensitive manner for the benefit of wildlife. Habitat projects vary in scope, but are corporate-driven cooperative efforts between management, employees, community members, local conservation groups and local, state/provincial and federal agencies. During 2010 - 2017 we participated in a variety of community engagement initiatives including delivering presentations at schools and community events and hosting on-site events to showcase raptor monitoring and habitat enhancement projects at and around Lafarge's active gravel mine sites. Since 2011, we have partnered with the Parkland School Division and worked alongside their curriculum facilitator and teachers to ensure that outreach content met learning objectives. The goal of the partnership was finding new and meaningful ways to engage and involve local students with Lafarge's Biodiversity Program and use local examples to help students learn biodiversity and ecosystem concepts. Content delivered during school visits described local research, monitoring and conservation projects. Common messages we aimed to convey included, "science-based projects are happening locally and you can get involved", "Alberta is fortunate to support a variety of interesting wildlife and ecosystems", and "conservation and management projects can ensure that people and wildlife can thrive alongside each other." During community engagement activities we had the opportunity to interact directly with more than 15,000 people who live in the communities around two of Lafarge's active mine sites. During those interactions we shared what we learned during nocturnal owl surveys, nest box monitoring for owls and American Kestrels (Falco sparverius), and stick nest surveys and described how community members could get involved with raptor monitoring and conservation efforts.

Use of GPS Dataloggers to Examine Behavior and Resource Selection of Barn Owls in Relation to Roads

***TEMPE REGAN** (temperegan@boisestate.edu), Boise State University, Boise, ID, U.S.A. BEN PAULI, Saint Mary's University of Minnesota, MN, U.S.A. JIM BELTHOFF, Boise State University, Boise, ID, U.S.A.

Anthropogenic development, including roads, has the potential to affect Barn Owl (Tyto alba) populations. Along Interstate-84 in southern Idaho, Barn Owls suffer the world's highest reported rates of roadway mortality. However, little is known about the behavior of Barn Owls in relation to this interstate. Thus, we initiated studies to examine movements and habitat selection of Barn Owls. We instrumented four male Barn Owls during 2015 and obtained location data that spanned two weeks of activity during the nesting season from each. We examined the efficacy of GPS data loggers for tracking Barn Owls and assessed methods for recapturing owls to facilitate retrieval of data from the loggers. We recaptured all instrumented males and found that manual- or laser-break triggered trap doors mounted on the nest box were especially effective for recapturing Barn Owls. Using the location data, we mapped home ranges, evaluated habitat selection, and quantified movements. Owl behavioral results are discussed in relation to population biology and roadway mortality.

Dietary Plasticity in a Specialist Predator, the Gyrfalcon (Falco rusticolus): Implications for Species Survival Under Climate Change

***BRYCE W. ROBINSON** (bryce@ornithologi.com). The Peregrine Fund, Boise, ID, U.S.A. TRAVIS L. BOOMS, Alaska Department of Fish and Game, Fairbanks, AK, U.S.A. DAVID L. ANDERSON, The Peregrine Fund, Boise, ID, U.S.A.

Climate and landscape change are expected to effect species distributions and interactions, with potentially harmful consequences for specialist predators such as the Gyrfalcon. To better understand Gyrfalcon dietary habits during the breeding season and better forecast possible responses to climate-driven changes, we described Gyrfalcon diet during the brood rearing period over two breeding seasons. We characterized diet from 2,008 images of prey deliveries obtained by motion-activated cameras in 20 nests on the Seward Peninsula, Alaska. We tested two hypotheses: the ecosystem phenology hypothesis in which changes in prey use reflect ecosystem phenology (i.e., changes in prey availability over time), and the nestling age hypothesis in which changes in prey use reflect the developmental and energetic needs of growing nestlings. Two important dietary shifts occurred: the proportion of Ptarmigan (Lagopus lagopus and L. muta) in the diet declined significantly throughout the brood rearing period in both years, and differed significantly between years. In both cases, Ptarmigan were replaced by Arctic Ground Squirrel (Urocitellus parryii) in the diet. The change from Ptarmigan to Ground Squirrel was best explained by the ecosystem phenology hypothesis, which indicates that dietary habits may follow changes in prey availability and may represent an ability to shift diet with changing prey landscapes. This result is important for predicting effects of climate change on Gyrfalcon populations because it may hint at resiliency to future, predicted shifts in prey distributions, abundance, or availability resulting from climate-induced changes in the Arctic. Further, because Ptarmigan and Ground Squirrels have different habitat associations, models predicting climate change impacts to Gyrfalcons must include habitat of both species to provide a more complete assessment of the future of this keystone predatory bird.

Pesticide Toxicosis in Wild Red-Shouldered Hawks (Buteo lineatus)

***DAVID SCOTT** (dscott@carolinaraptorcenter.org), Carolina Raptor Center, Charlotte, North Carolina, U.S.A.

Neurologic disease is commonly seen in birds of prey presented to wildlife rehabilitation facilities. An accurate diagnosis and proper treatment are often difficult and is complicated by the large number of possible agents. Exposure to environmental pesticides is well known as a potential cause of neurologic disease, but a definitive diagnosis is rarely made as the required testing is expensive and is usually a post-mortem event. This study looked at birds that presented signs of central nervous system disease (i.e. tremors, seizures and/or extreme lethargy) over an 18 mo period. For reasons yet to be determined, red-shouldered hawks represent over 90% of the cases included in this study. Sixteen cases were included and the most common identifiable causes of neurologic disease were determined to be pesticide toxicosis (n = 6, 37%), trauma (n = 5,31%) and West Nile Virus (WNV) (n = 1, 6%). All (100%) of the pesticide cases were fatal within 24 hrs of admission and the chemical determinations were made post-mortem using GC/MS on samples of liver or brain. The most commonly identified pesticides were the organochlorines dieldrin and chlordane and they were often found to be at concentrations many multiples above published lethal levels. Toxicosis from pesticides should always be included in the list of differentials for any raptor exhibiting signs of central neurologic disease and, in this study, pesticide toxicosis was more common than trauma as a cause of admission.

Daily Vocal Activity of Barred Owls, Great Horned Owls, and Boreal Owls and Interspecific Overlap in Vocalization Behavior

***JULIA SHONFIELD** (shonfiel@ualberta.ca), Department of Biological Sciences, University of Alberta, Edmonton AB, Canada. ERIN M. BAYNE, Department of Biological Sciences, University of Alberta, Edmonton AB, Canada.

Many species of owls use territorial vocalizations to defend breeding territories. Larger owl species can be predators or dominant competitors of smaller owls, so vocal activity may be reduced or altered due to predation risk and interference competition in areas where species overlap. We used autonomous recording units (ARUs) to conduct passive acoustic surveys for owls in northeastern Alberta to study their vocalization behavior. We programmed the ARUs to turn on and record for 10 mins every hr, on a 24hr basis, for 2 wks at each location surveyed. We developed automated recognizers to detect the territorial calls of Barred Owls (Strix varia), Great Horned Owls (Bubo virginianus), and Boreal Owls (Aegolius funereus) and used them to scan all recordings collected. We found that peak vocal activity for Barred Owls occurred at 0400, peak vocal activity for Great Horned Owls occurred at 0500, and peak vocal activity for Boreal Owls occurred between midnight and 0200. Barred Owls called occasionally in the middle of the day, but this was rare for Great Horned Owls. Boreal Owl vocal activity was strictly nocturnal, and they only called between 1900 and 0700. Barred Owls and Great Horned Owls had a greater amount of overlap in their daily vocal activity patterns than Boreal Owls did with either of the two larger owl species. Barred Owls were more vocally active in the middle of the day and less active during their peak vocal time in areas where Great Horned Owls were present compared to areas where they were absent. This suggests that Barred Owls may be altering their vocal behavior in areas with Great Horned Owls. This research contributes to our general understanding of vocal behavior of owls and our findings have practical implications for when passive surveys are conducted for monitoring efforts.

The Difficulty of Becoming a Breeding Osprey (Pandion haliaetus): Insight From a Telemetry Study Based in Western Montana

***ADAM SHREADING**, Raptor View Research Institute, Missoula, MT, U.S.A. ROBERT DOMENECH (rob@raptorview.org), Raptor View Research Institute, Missoula, MT, U.S.A.

In 2006, we began testing the blood of nestling Ospreys for mercury and other heavy metals to establish contaminant status, pinpoint pollution hotspots, and assess the success of restoration efforts associated with past mining activities along the Clark Fork River in western Montana. We began using colored leg bands with unique alphanumeric combinations in 2010 to investigate where these Ospreys travel each winter, and where juveniles disperse. We bolstered these efforts in 2012, when we began instrumenting with GPS transmitters Osprey families from three nests near Florence, Montana. To date, we have tracked 10 adult breeding Ospreys and 17 of their young from these nests. As predicted from re-sightings of our color-banded Ospreys, GPS tracked individuals wintered in Mexico, northern Central America, and along the Gulf Coast. Though approximately half of our GPS instrumented nestlings survive their initial meandering fall migration and first winter, we have yet to document one successfully producing a clutch of their own young. Similarly, we have yet to document a successful nesting effort by any of the 203 color-banded nestlings from our larger regional study. These results may suggest the process of becoming a breeding Osprey is longer and more arduous than we expected when we began our study.

Quantifying Eagle Vehicle Strike Risk in the Western U.S.

***STEVEN J. SLATER** (sslater@hawkwatch.org), HawkWatch International, Salt Lake City, UT, U.S.A. DUSTIN M. MALONEY, HawkWatch International, Salt Lake City, UT, U.S.A.

Roads represent a danger for both Bald Eagles (Haliaeetus leucocephalus) and Golden Eagles (Aquila chrysaetos) in the western U.S., primarily in relation to foraging on road-killed wildlife. Vehicle strike risk for eagles is generally greater during fall and winter months, when eagles move off breeding areas, live prey is less available and big game species move to lower elevations. We conducted the first yr of a planned 4 yr study of eagle activity and mortality along roadways in central Utah and southeastern Oregon from 15 September 2016–13 February 2017. We performed repeated driving surveys to record carcasses and live eagles, walking and dog surveys of right-of-ways to detect additional carcasses, and placed camera traps on carcasses to quantify eagle use patterns. One Bald Eagle and two Golden Eagle mortalities were found during approximately 7,500 and 3,000 driving survey miles in Oregon and Utah, respectively, but walking and dog surveys of <5% of the combined study areas produced an additional 4 recent eagle carcasses. We found over 2.6 times as many mammal carcasses per road mile in Utah, likely responsible for the higher abundance of both live and dead eagles there. While mammal carcass abundance was relatively stable over time in Utah, jackrabbit carcasses increased dramatically in Oregon beginning in mid-December, accompanied by a significant increase in eagle sightings on carcasses. Considering both study areas, driving surveys recorded a relatively even mix of eagle species (54.0% Golden Eagle; 43.9% Bald Eagle) and documented 65 eagle-carcass associations (1.6 eagles/carcass) and 830 available carcasses. Camera traps placed opportunistically on roadside carcasses captured eagles at 29.1% of sites and gathered over 6,400 eagle pictures. We will also present preliminary results on eagle behavior at carcasses and information on variability in detectability and persistence of carcasses by survey type.

The Effect of Local Weather Patterns on American Kestrel Reproduction

***JOHN A. SMALLWOOD** (smallwoodj@montclair.edu), Department of Biology, Montclair State University, Montclair, NJ, U.S.A. MARISA DEL CORSO, Department of Biology, Montclair State University, Montclair, NJ, U.S.A.

American Kestrel (Falco sparverius) populations have been declining over much of North America during recent decades. The causes for this decline remain elusive. Many studies on a variety of bird species have demonstrated a relationship between climate change and life history patterns, including geographic distributions and the timing of migratory movements. The potential impact of climate change on American Kestrel ecology has so far received little attention. Since 1995 we have maintained approximately 100 nest boxes for kestrels in rural northwestern New Jersey. The objectives of this study were to determine if the climate of this region has changed significantly during the past 22 yr, and if kestrel breeding performance was related to variations in weather variables. We obtained temperature, rainfall, and snowfall data from five weather stations located within or adjacent to our study area. Weather variables were not correlated with yr over the study period, except that the mean temperature for May tended to increase. Weather did not appear to influence how many kestrels reached the breeding grounds. However, temperature and snowfall exhibited the most variability and had the strongest relationships with clutch and brood size, number of fledglings per breeding attempt, and nesting success. Climate change, at least initially, may have a positive effect on kestrel reproduction in this region, suggesting that the cause or causes of population decline might be more closely tied to mortality factors.

The Yellowstone Raptor Initiative: Monitoring Migration and Diversity of Raptors Not Historically Assessed

***DOUGLAS W. SMITH** (doug_smith@nps.gov), US National Park Service, Yellowstone National Park, WY, U.S.A. DAVID B. HAINES, US National Park Service, Yellowstone National Park, WY, U.S.A. KATY DUFFY, US National Park Service, Yellowstone National Park, WY, U.S.A.

Yellowstone National Park's (YNP) bird program historically monitored three raptors: Bald Eagles (Haliaeetus leucocephalus), Peregrine Falcons (Falco peregrinus), and Osprey (Pandion haliaetus). Over 20 species went un-monitored, or were unknown. In 2011, YNP secured a five yr grant to inventory and monitor raptor (excluding Accipiters), as well as investigate a fall migration route through the park. We identified Golden Eagles (Aquila chrysaetos), Red-tailed Hawks (Buteo jamaicensis), Swainson's Hawks (Buteo swainsoni), Prairie Falcons (Falco mexicanus) and five breeding owls as species of emphasis. We documented 25 raptor species, with 17 breeding. Red-tailed Hawks occurred at high density, with 60 territories and monitored 17–44 territories/yr. Occupancy was 100%, nest success averaged 62% (range = 32–89%), productivity 1.10 young/occupied territory (range = 0.46–1.74), and brood size 1.72 young/successful nest (range = 1.44–1.96). We discovered 18 Swainson's Hawk territories and three nests. In total, we monitored 12 nesting attempts; 11 attempts were successful, fledging 14 young. Based on comparisons with surveys from the 1970s, Swainson's Hawk distribution appears stable. Prairie Falcon density was low and we found reliable productivity data difficult to obtain. We recorded seven species of owls: Great Horned (Bubo virigianus), Northern Pygmy Owl (Glaucidium gnoma), Great Gray Owl (Strix nebulosa), Long-eared Owl (Asio otus), Short-eared Owl (Asio flammeus), and Northern Saw-whet Owl (Aegolius acadicus); all except Long-eared Owl and Short-eared Owls were detected on nighttime surveys. We confirmed raptor migration through Hayden Valley and observed 6,441 birds over 107 total ds from 2011–2015. We documented 17 species at an average passage rate from 4.8 (2012) to 9.5 (2011) birds/hr. Half (53%) were Buteos, with Red-tailed Hawks comprising 23–32%. Other common raptors included eagles (16%), Accipiters (12%), and falcons (10%). Public outreach additionally developed a visitor reporting program that tallied 1,650 raptors of 25 species.

Using Falconers for Raptor Ringing Along the Eastern Black Sea Migration Bottleneck in Turkey

***LUKE-DOGAN SMITH** (falcon7man@hotmail.com), LS Traps, Port Orchard, WA, U.S.A.

In Northeast Turkey nearly a million birds of prey migrate between the Black Sea and the Lesser Caucasus Mtns. Over 1,500 yrs ago falconry began in this region by the native Lazuri people. With abundant migrating Quail (Coturnix coturnix) they use Sparrow Hawks (Accipiter nisus) for falconry even today. Hundreds of hawks are trapped every autumn and only a small number of these are kept. The vast majority of the birds captured are undesirable and released. The author took advantage of this for a ringing project completed in two phases. Phase I: education of falconers across the country about reporting rings and Phase II: Ringing with falconers at key sites. Talks were given and posters hung at all major falconry meetings places (n = 12) along the eastern and western Black Sea. With the help of 37 falconers, ringing was conducted in the eastern Black Sea in Spring and Autumn 2009 and Spring 2010. Numbers of trappers each day varied from three to ten at different trap sites during different weather patterns. A total of 578 Sparrow Hawks, 17 Hobbies (Falco subbuteo), 12 Levant Sparrow Hawks (Accipiter brevipes), 11 European Kestrels (Falco tinnunculus), 7 Steppe Buzzards (Buteo buteo vulpinus), 1 European Honey Buzzard (Pernis apivorus) and 5 Booted Eagles (Aquila pennata) were ringed during this project. From our ringed birds and educational effort, a total of 22 Sparrow Hawks, 1 Levant Sparrow Hawk and 1 Black Kite (Milvus migrans) were recovered as a result of this project. Of these, 15 were recaptures nationally along the migration route from 5 mins to 1 yr later after initial capture. Seven returns were captures by local falconers in Turkey of birds from other countries. From this project new

data was learned about the Sparrow Hawk migration across Europe, Asia and Africa.

Development and Morphological Aging Metrics of Osprey Nestlings in West Central Idaho

***TYRELL STYHL** (styh9361@vandals.uidaho.edu), University of Idaho, ID, U.S.A. ELIZABETH MEISMAN, Humboldt State University, CA, U.S.A. KERRI VIERLING, University of Idaho, ID, U.S.A. MARC BECHARD, Boise State University, ID, U.S.A. DUSTY PERKINS, College of Western Idaho, ID, U.S.A.

Nestling development and morphological metrics provide critical information central to understanding and evaluating raptor breeding ecology. Ospreys (Pandion haliaetus) are specialized piscivorous top predators of aquatic ecosystems. Considerably distinct from other diurnal raptors, ospreys belong to the monotypic family Pandionidae. Ospreys are adapted to human landscapes and, like other raptors, can be useful for monitoring environmental contaminants and ecosystem health. Despite their unique classification and importance as a sentinel species, researchers have yet to create an Osprey nestling aging guide or morphometric aging model. We studied six Osprey nests in Long Valley, Idaho to monitor nesting phenology and collect morphological and photographic data on nestling ospreys. We used these data to meet three objectives: 1) to describe nesting phenology in Long Valley, Idaho; 2) to develop a photographic and descriptive Osprey nestling aging guide; and 3) to collect morphometric measurements of nestling Ospreys to assess the reliability of correlation between age and developmental morphological parameters. We installed camera traps on each nest before the breeding season and programmed them to take one photograph every five min during daylight hours. Nests were visited six times during the breeding season to collect morphological measurements and photograph each nestling (n = 14). This analysis shows a strong correlation in nestling forearm length and age (r^2 = 0.97). Our study has shown that the use of a suite of morphometrics to age nestling Ospreys is possible and estimates of age can be produced. The combination of age prediction equations, nestling photographs and behavior descriptions provide a robust means for estimating Osprey nestling age throughout the breeding season. Since this study was restricted to Long Valley, Idaho, we acknowledge that our results could be geographically biased and encourage additional nestling development studies be conducted on Ospreys across their range.

Diel Behavior Patterns of Golden Eagles

***MAITREYI SUR** (maitreyisur@boisestate.edu), Department of Biological Sciences, Boise State University, Boise, ID, U.S.A. ADAM DUERR, Bloom Biological Inc., Los Angeles, CA, U.S.A. DOUGLAS A. BELL, East Bay Regional Park District, Oakland, CA, U.S.A. ROBERT FISHER, U. S. Geological Survey, San Diego Field Station, San Diego, CA, U.S.A. JEFF TRACEY, U. S. Geological Survey, San Diego Field Station, San Diego, CA, U.S.A. PETER H. BLOOM, Bloom Biological Inc., Los Angeles, CA, U.S.A. TODD KATZNER, U.S. Geological Survey, Forest and Rangeland Ecosystem Science Center, Boise, ID, U.S.A

In spite of the environmental benefits of wind energy, wind farms have been contentious in their effects on wildlife, particularly for birds that share the same airspace. Golden Eagles (Aquila chrysaetos) are one of the most high profile species killed at wind facilities. One of the outstanding questions regarding eagle risk is if there are times of day that birds are more likely to interact with wind turbines. Therefore to understand this problem we used GPS telemetry data from 92 Golden Eagles to study diel cycles and the factors affecting their decision to fly and their movement speeds. Preliminary analysis showed that Golden Eagles are more likely to be moving during the hours between 1100 and 1400 H. We also found that the decision to fly was significantly affected by updraft condition. When in flight, hourly speeds responded strongly to updraft conditions, topographical roughness, slope, aspect, elevation, precipitation and downward solar radiation. Hourly speeds were also influenced by sex of the birds and seasons of the yr, strongly suggesting variation in diel cycles associated with the breeding status of the individual. As the scale and pace of development of wind energy increases, operators can incorporate knowledge about the diel movement of Golden Eagles to reduce eagle fatalities due to collision to the wind turbines.

The Effect of Prey Abundance and Nestling Demand on the Foraging Patterns of Arctic-Breeding Peregrine Falcons (Falco peregrinus tundrius)

***MATHIEU TÉTREAULT** (mathieu.tetreault@uqar.ca), Université du Québec à Rimouski, Rimouski, QC, Canada, Centre d'Études Nordiques, Québec, QC, Canada, and Arctic Raptor Project, Rankin Inlet, NU, Canada. KEVIN HAWKSHAW, University of Alberta, Edmonton, AB, Canada, and Arctic Raptor Project, Rankin Inlet, NU, Canada. ALASTAIR FRANKE, Arctic Raptor Project, Rankin Inlet, NU, Canada. JOËL BÊTY, Université du Québec à Rimouski, Rimouski, QC, Canada, and Centre d'Études Nordiques, Québec, QC, Canada.

Predators breeding in arctic ecosystems are facing important spatio-temporal variations in prey density within their habitat. To prevent nestling mortality associated with food supply, breeding raptors must match prey deliveries with increasing demand from growing nestlings. Breeding raptors are central place foragers, and as a consequence, home range configuration should be, in part, determined by prey density within the surrounding landscape. We investigated the effect of prey density and nestling demand on home range size (95% biased random bridge) and mean daily travel distance of arctic-nesting Peregrine Falcons tracked with GPS accurate Platform Terminal Transmitters (n = 16) during the brood-rearing period. We used distance sampling to estimate density of insectivorous birds (primary prey species), and density surface modelling to map their distribution within falcon home ranges. We used daily brood mass as a proxy for nestling demand. Our results indicate that home range size and mean

daily travel distance were directly related to nestling demand. Although prey density at the home range scale was similar among individuals, those nesting immediately within the vicinity of prey-dense locations had smaller home ranges and shorter mean daily travel distances. These findings suggest that Arctic breeding Peregrine Falcons adjust their foraging patterns (home range size and mean daily distance travelled) in order to accommodate increasing nestling demand and differences in prey density within their territory.

Breeding ecology of the Hooded Vulture (Necrosyrtes monachus) in the Kruger-to-Canyons Biosphere Region, South Africa

***LINDY J. THOMPSON** (lindojano@yahoo.com), University of KwaZulu-Natal, Scottsville, South Africa. COLLEEN T. DOWNS, University of KwaZulu-Natal, Scottsville, South Africa. ANDRE J. BOTHA, Endangered Wildlife Trust, Modderfontein, Johannesburg, South Africa. KEITH L. BILDSTEIN, Hawk Mountain Sanctuary, Acopian Center for Conservation Learning, Orwigsburg, PA, U.S.A, CAMPBELL MURN, Hawk Conservancy Trust, Andover, Hampshire, U.K.

The Hooded Vulture has declined by >80% in the last 40 yrs, and the species was recently reclassified as Critically Endangered. Although it is widespread throughout Africa, it was, until recently, relatively little studied. We investigated the breeding biology of Hooded Vultures in and around the Kruger-to-Canyons Biosphere Region, South Africa. We report on Hooded Vulture breeding behavior and breeding success, and highlight visits to the nests by other species during the breeding and non-breeding seasons. Confirmed nest predators included Chacma Baboons (Papio ursinus) and Martial Eagles (Polemautus bellicosus). These results will be included in a species management plan for dissemination to land managers and other stakeholders in the Kruger-to-Canyons Biosphere region.

Winter Diet of Short-eared Owls (Asio flammeus) in the Grand Prairie Region of Illinois, U.S.A.

***TIH-FEN TING** (tting1@uis.edu), University of Illinois at Springfield, Springfield, IL, U.S.A. BRIAN E. WASHBURN, National Wildlife Research Center, USDA APHIS Wildlife Services, Sandusky, OH, U.S.A.

The Short-eared Owl is a state-endangered species with an overlapping breeding and wintering range in Illinois. We investigated the diet of wintering Short-eared Owls in the Grand Prairie Region of Illinois within a landscape dominated by agriculture, an area where little is known about this species. For two winters, during January–March of 2016 and 2017, we collected owl pellets in conjunction with field surveys of wintering Short-eared Owls. We collected and analyzed a total of 379 intact pellets (246 in 2016 and 133 in 2017). Pellets obtained from both winters yielded the same average number of small mammal skulls (1.35 per pellet). Based on the skulls found in the owl pellets, we were able to readily identify six different species of small mammal, including Meadow Vole (Microtus pennsylvanicus), Prairie Vole (Microtus ochrogaster), Deer Mouse (Peromyscus maniculatus), White-footed Mouse (Peromyscus leucopus), northern short-tailed shrew (Blarina brevicauda), and North American Least Shrew (Cryptotis parva). The Meadow Vole was the most common prey species, accounting for more than half of total prey items identified in each winter (60.8% in 2016 and 57.2% in 2017). Prairie Voles were next with 19.6% in 2016, whereas Northern Short-tailed Shrews (Blarina brevicauda) increased by 12% in 2017. Our surveys of wintering owls covered a total of 12.49 km2 in 2016 and 20.34 km2 in 2017. There were 53% fewer wintering Short-eared Owls observed during 2017 compared to 2016. This finding parallels our observation of fewer pellets over the same period. Relative abundance of wintering raptors usually synchronizes with fluctuations in prey densities, likely due to the high mobility of raptors outside of the breeding season.

Winter Home Range and Habitat Use of a Short-eared Owl (Asio flammeus) in the Grand Prairie Region of Illinois, U.S.A.

***TIH-FEN TING** (TTing1@uis.edu), University of Illinois-Springfield, Springfield, MO, U.S.A. BRIAN E. WASHBURN, USDA Wildlife Services, Sandusky, OH, U.S.A.

Little is known about local winter movement and habitat use of Short-eared Owls. On 24 December 2016, we captured, radio-tagged, and released a Short-eared Owl in the Grand Prairie Region of Illinois within a landscape dominated by agriculture. We conducted daily radio-tracking of the tagged owl from 15:00 – 07:00 hr until 22 March 2017, when we believe the owl migrated north. During this time period, we obtained a total of 938 locations for this owl, via a combination of homing and triangulation. We used the kernel density estimation (KDE) method for home range analysis and delineated the habitat types within the study area using ArcGIS. The overall winter home range of this owl was 7.5 km2. However, its monthly home ranges showed contraction and expansion following the fall and rise of monthly temperatures, with the smallest monthly home range (2.6 km2) observed in January and the largest (10.9 km2) in March. Throughout the entire tracking period, 81% of the owl's locations were equally divided between agricultural fields and cool-season grass (i.e., smooth brome) areas. In January when it was the coldest, 54% of its locations were in the cool-season grass areas while 20% were in the agricultural fields. As it became warmer, percentages of the locations in agricultural fields increased to 51% in February and 68% in March, whereas the corresponding percentages in the cool-season grass area decreased to 35% and 20%, respectively. We suspect the warmer temperatures allowed the owl to forage more in the agriculture fields that had little to no cover. Our findings suggest that ambient temperatures might affect local winter movements of Short-eared Owls.

Gyrfalcons in Montana: Chasing the Silver Specter

JEFFREY MCPARTLIN, McPartlin Realty, Great Falls, MT, U.S.A. ***JAY TISCHENDORF** (WildlifeVetUSA@gmail.com), American Ecological Research Institute (--AERIE), Conroe, TX, U.S.A.

Gyrfalcons (Falco rusticolus) can occasionally be found wintering in the continental USA. Information on the species' winter ecology remains sparse. The senior author has spent approximately four decades studying this species as a winter migrant in Montana. He has accrued data on a substantial sample size of individuals. In hopes of adding to the knowledge base surrounding this large circumpolar falcon, this paper will discuss plumage, sex, and age characteristics, as well as aspects of Gyrfalcon wintertime ecology, including putative fidelity in winter range use and other considerations.

Belize Offshore: Investigating the Southernmost Breeding Ospreys in the Western Hemisphere

PAUL SPITZER, Trappe, MD, U.S.A. ***JAY TISCHENDORF** (Jay_Tischendorf@merck.com), American Ecological Research Institute (--AERIE), Conroe, TX, U.S.A. BEN WURST, Conserve Wildlife Foundation of NJ, Woodbine, NJ, U.S.A.

Our team is continuing long-term monitoring of the non-migratory Ridgway's Osprey (Pandion haliaetus ridgwayi) in the Caribbean. In February 2017 we boat-surveyed portions of the offshore Belize coastal zone, finding roughly 25 active nests:10 in the Turneffe Atoll and 15 from Dangriga south to Placencia. There are also several active nests at Glovers Reef. We estimate Belize's maximum active nest count is 40 to 50, all in zones of coralline and mangrove keys many miles east of the mainland. This area spans approximately 241 km, from 18 degrees to 16 degrees N Latitude. Thus this uniquely white-headed subspecies of the Osprey nests at very low density. No active Osprey nests are known south of Belize along the east coast of Central and South America. Kleptoparasitism by Magnificent Frigatebirds (Fregata magnificens) is hypothesized to be among the factors that limit this population. Significantly, the migratory subspecies P. h. carolinensis is rarely encountered during our surveys; we think they avoid this region for that reason. Ridgwayi reproduction is a small fraction of that typical in migratory temperate-zone carolinensis Ospreys. It probably ranges from 0.3–0.5 young fledged/active nest, based on a limited sample from 2014-2017 surveys. For this southernmost tropical population to be marginally stable, annual adult survivorship must be substantially higher than that of the migratory subspecies, roughly 90%, and mean age at first breeding must be lower, 3 yrs of age or occasionally even less. This inexperience of young breeders could contribute to the high nest failure rate we have noted. Most nests are in mangroves, and their site instability also reduces reproductive success. Experimental provision of stable high nest platforms at strategic offshore keys is a management, educational, and research option that has proved highly successful over many decades in North America. We are exploring this possibility in Belize.

Breeding Ecology and Habitat Suitability of Ferruginous Hawks (Buteo regalis) in Southern Idaho

***KASSANDRA TOWNSEND** (kassandratownsend@mycwi.cc), College of Western Idaho, Nampa, ID, U.S.A. TALIA JOLLEY, College of Western Idaho, Nampa, ID, U.S.A. ZACH SANCHEZ, College of Western Idaho, Nampa, ID, U.S.A. STEVE ALSUP, Birds of Prey NCA Partnership, Boise, ID, U.S.A. BRYAN KROUSE, College of Western Idaho, Nampa, ID, U.S.A. JOSEPH WELDON, Boise District Bureau of Land Management, Boise, ID, U.S.A. MATTHEW STUBER, U.S. Fish and Wildlife Service, Migratory Birds and Habitat Program, Pacific Region, Portland, OR, U.S.A. DUSTY PERKINS, College of Western Idaho, Nampa, ID, U.S.A.

Ferruginous Hawks are the largest North American buteo and are avian apex predators known to inhabit grassland and shrub steppe ecosystems in the western United States. Their apparent sensitivity to a variety of ecological parameters associated with climate change and increasing anthropogenic landscape change makes them an appropriate indicator species of ecosystem health. In the Great Basin, widespread habitat alteration associated with invasive annual grasses, increased fire frequency, and increasing anthropogenic encroachment within breeding habitats have been suggested as drivers of breeding population declines. Currently the Ferruginous Hawk is listed as a "Species of Greatest Conservation Need" by the Idaho Fish and Game, and as a "Type II Sensitive Species" by the Bureau of Land Management, with the loss of suitable habitat listed as a primary threat. Despite this status, there is little published information available on the distribution, demography and reproductive performance of Ferruginous Hawks in southern Idaho. To better understand the characteristics of southern Idaho's breeding population we are establishing a long-term collaborative monitoring program to provide baseline data on the ecology and population demography of Ferruginous Hawks in and around the Morley Nelson Snake River Birds of Prey National Conservation Area. We monitored 76 breeding territories and documented territory occupancy and productivity between March and July 2017. We used a multivariate generalized linear model with model selection procedures to evaluate the relative importance of ecological attributes and human disturbance agents on Ferruginous Hawk breeding success. Here, we present the results of our monitoring and preliminary models, and discuss their implications for Ferruginous Hawk breeding ecology and management.

Assessing Owl Collisions with U.S. Civil and U.S. Air Force Aircraft

***BRIAN E. WASHBURN** (brian.e.washburn@aphis.usda.gov), USDA/APHIS/Wildlife Services, Sandusky, OH, U.S.A. KIMBERLY E. LINNELL, Montana Fish, Parks, and Wildlife, Great Falls, MT, U.S.A.

Wildlife-aircraft collisions (wildlife strikes) with civil and military aircraft pose notable risks and economic losses. Previous research on wildlife strikes has emphasized a variety of birds and mammals, but no comprehensive evaluation of owl-aircraft incidents has been conducted. We queried the Federal Aviation Administration's National Wildlife Strike Database and the U.S. Air Force's Birdstrike Database from 1990 to 30 June 2014 to characterize owl-aircraft collisions within the USA and foreign countries. We found 2,531 owl-aircraft collisions involving more than 20 individual species of owl. Barn Owls (Tyto alba) were the most frequently struck species, accounting for 42% of all reported owl-aircraft collision events. Almost 75% of owl-aircraft collisions occurred during night-time hours. Owl-aircraft collisions typically occur within the airfield environment itself; 86% of owl strikes occurred when the aircraft was at or below 30 m above ground level. Some mitigation tools and techniques are currently available to reduce the frequency and severity of owl-aircraft collisions. An important area of future research will involve the development and evaluation of effective, publicly acceptable methods of reducing owl-human conflicts.

Do Swainson's Hawks Use the Stopover or Staging Strategy to Complete Long-Distance Migration?

***KATHERYN A. WATSON** (katheryn.watson@ttu.edu), Texas Tech University, Lubbock, TX, U.S.A. CLINT W. BOAL, United States Geological Survey, Texas Cooperative Fish and Wildlife Research Unit, Texas Tech University, Lubbock, TX, U.S.A. JAMES D. RAY, Consolidated Nuclear Security, LLC, USDOE/NNSA Pantex Plant, Amarillo, TX,, U.S.A.

Swainson's Hawks (Buteo swainsoni) migrate from the western United States to Argentina annually, and researchers debate over the migration strategy the hawks use. Hawks may stage (move to areas in large groups to forage prior to a migration lasting days to weeks), or may make stopovers (stop for periods of 2-10 ds multiple times to forage en route). It was once suggested that Swainson's Hawks continuously migrate on fat reserves, but that model did not hold up against body mass measurements from Central America. Later satellite transmitter evidence from birds across the range suggested that stopovers en route to rest and forage were the most likely strategy. We trapped and attached GPS transmitters to 24 adult Swainson's Hawks from the Southern High Plains of Texas, a region from which the species had not previously been studied, in 2012 and 2013 to examine migration strategies. Surprisingly, our results suggest that Swainson's Hawks from our study area did not perform stopovers along the migration route, but instead followed the staging strategy, with prolonged stops in Texas prior to a long and fairly-contiguous journey southward. The difference between our study and previous research suggests that Swainson's Hawks at lower latitudes may use a different strategy for migration. Explanations for this are not clear yet and analysis is ongoing. Perhaps the longer growing season and prey availability leads to larger body fat reserves at southern latitudes, allowing for continuous migration after staging periods. Birds in this study occasionally and sporadically stopped for 1-2 ds en route; we are investigating possible associations between these brief stops and inclement weather. Differences may also be due to technology and how data was gathered among studies. Regardless, our findings suggest that this species may show plasticity depending on starting latitude.

CONSERVATION AND ECOLOGY OF UNDERSTUDIED OPEN LAND RAPTORS SYMPOSIUM ABSTRACTS

Photo by Mitchell Pruitt

Photo by Kate Davis

Photo by Mike Smith

** Presenting Author*
*** William C. Andersen Memorial Award Candidate*

Prairie Falcons: the Knowns and Unknowns: A California Perspective

***DOUGLAS A. BELL** (dbell@ebparks.org), East Bay Regional Park District, Oakland, CA, U.S.A. JACQUELINE M. DOYLE, Towson University, Baltimore, MD, U.S.A. JOE DIDONATO, Wildlife Consulting and Photography, Alameda, CA U.S.A. LARRY LAPRE, Bureau of Land Management, Moreno Valley, CA, U.S.A. SHELLY C. BURANEK, California State University, Sacramento, CA, U.S.A. MARA SOLOMON, California State University East Bay, Hayward, CA, U.S.A. GAVIN EMMONS, Pinnacles National Park, Paicines, CA, U.S.A. WILLIAM I. BOARMAN, Conservation Science and Research and Consulting, Spring Valley, CA, U.S.A. AMY L. FESNOCK, Bureau of Land Management, Sacramento, CA, U.S.A. PETER H. BLOOM, Bloom Research Inc., Los Angeles, CA, U.S.A. PHILLIP SAN MIGUEL, Purdue University, Lafayette, IN, U.S.A. RICK WESTERMAN, Purdue University, Lafayette, IN, U.S.A. J. ANDREW DEWOODY, Purdue University, West Lafayette, IN, U.S.A.

The Prairie Falcon (Falco mexicanus) is locally distributed as a breeding bird throughout several regions in California including the Inner Coast Ranges, the Great Basin, and the southern deserts. A flurry of studies in the 1970s and 1980s addressed aspects of the species biology in the latter areas, yet very little is known about the species use of the Inner Coast Ranges and whether populations of nesting falcons across divergent habitats are interconnected. Such information is vital for assessing the long-term sustainability of Prairie Falcon populations in the face of rampant development, conversion of grazing lands to other uses, and the build-out of solar and wind projects throughout the state. We report here on Prairie Falcon home range and habitat use in the Inner Coast Ranges as determined by radio-telemetry, and preliminary results from a long-term banding and population genetics study. Home ranges were large and overlapping. We compared proportional use of eight categories of habitat in a breeding population: agriculture, chaparral, conifer, floodplain, grassland, oak, scrub and urban. By sex, females used grasslands more and agriculture less, while males used grasslands less and agriculture more than expected. We sequenced the genome of the Prairie Falcon, generated a draft assembly containing >16,000 presumptive genes, identified nearly 600,000 single nucleotide polymorphisms (SNPs), and developed a SNP assay featuring >140 gene-associated markers along with a molecular-sexing marker. Nearly 100 individuals from three regions in California were genotyped: the San Francisco East Bay Area, Pinnacles National Park and the Mojave Desert. Preliminary results suggest that these populations are panmictic, which implies impacts at the local or regional level have the potential to ripple through the species' gene pool. Overall, our data provide key insights into Prairie Falcon biology that may be important for the conservation and management of the species.

Ageing and Sexing Rough-legged Hawks in Hand

***WILLIAM S. CLARK** (raptours@earthlink.net), Harlingen, TX, U.S.A.

Rough-legged Hawks (Buteo lagopus) have four recognizable different light-morph plumages by age: Juvenile, Basic II, Basic III, and Definitive Basic (adult), but field guides show only two plumages: Juveniles and Adult. Only light-morph Basic III hawks and adults have different plumages by sex. Dark-morph hawks also show four age-related plumages, same as light-morph, but only some adult males are sexed by plumage. Light-morph Basic II hawk plumages of both sexes are like those of adult females and are distinguished by retention of pale uppersides of primaries and by remige molt. Dark-morph Basic II hawks are aged by pale uppersides of primaries and remige molt. Light-morph Basic III plumages are distinguishable by sex and are aged by retention of pale uppersides of some primaries not shown by adults. Dark-morph Basic III hawks are aged by pale uppersides of some primaries. Most individuals can be sexed by wing chord, but with a small overlap. I will show the plumage characters that serve to correctly age light-morph Basic III and adult Rough-legged Hawks and wing chord measurements that serve to correctly sex most hawks. However, a few adults show plumage characteristics of the other sex.

Prey Abundance and Distribution in a Dual Raptor System in the Central Canadian Arctic

***KEVIN HAWKSHAW,** Arctic Raptors Project, Rankin Inlet, NU, Canada, and University of Alberta, Edmonton, AB, Canada. ALASTAIR FRANKE (alastair.franke@ualberta.ca), Arctic Raptors Project, Rankin Inlet, NU, Canada. LEE FOOTE, University of Alberta, Edmonton, AB, Canada.

As central place foragers, breeding raptors are subject to spatial and temporal variation in food resources. Such variation can influence parental conditioning, reproductive capacity, phenology, and nestling growth and survival. We investigated prey abundance and distribution from 2015–17 in the area surrounding Rankin Inlet, NU, a community on the western shore of Hudson Bay home to a well-studied, dense population of Arctic Peregrine Falcons (Falco peregrinus) and a variable population of Rough-legged Hawks (Buteo lagopus). Using distance sampling, we estimated the abundance of avian and mammalian prey groups from late May to late August using freshwater, vegetation and terrain ruggedness indices, elevation and distance from the coast, as well as seasonal weather and microtine rodent abundance, as predictors. Final conclusions are pending analysis of data collected in 2017, but the two yrs of existing data show significant variation in the prey community. 2015 was relatively cool and wet with low microtine rodent abundance and lower numbers of Arctic ground squirrels (Spermophilus parryii) and geese, while 2016 showed the opposite trends. Other prey groups (i.e., songbirds, shorebirds, ducks, gulls) did not vary significantly between yrs. The raptor community was radically different between yrs, with 2016 seeing more than double

the number of breeding raptor pairs in the study area compared to 2015, with the bulk of the increase coming from Rough-legged Hawks. Although the relationship between microtine rodent and Rough-legged Hawk population dynamics is supported by previous research, preliminary diet analysis has indicated that mammalian prey are also important to the Peregrine Falcon population in this study area.

Rough-legged Hawks (Buteo lagopus), Ferruginous Hawks (Buteo regalis)—Wintering Raptors of the Great Basin: Oases in the High Desert, Census and Banding Study 1985-2017

***AL HINDE** (alkehinde@yahoo.com), Cambridge, MA, U.S.A.

In 1985, I began a banding study of Rough-legged Hawks in the Great Basin to augment HawkWatch International's (HWI) migration study in the Goshute Mountains, NV. By 1989, eight major concentration areas for wintering raptors had been identified, and the study evolved to include a census. With each 20- to 30-square-mile area consistently containing 100–300+ individuals of nineteen raptor species, and regional counts totaling 1000+ raptors, sometimes including 200+ Rough-legged Hawks. These areas primarily consist of alfalfa farming—the common denominator, producing great numbers of rodents for wintering raptors. Lovelock, western NV, contained a previously undocumented communal roost (December 1992) of 200+ buteos, including 150 Rough-legged Hawks, and 50 Ferruginous Hawks. Standardized counts in these eight areas began in January 2004. Diamond Valley-Eureka, central NV (700 m higher than other areas), consistently contained the highest numbers of Rough-legged Hawks (up to 145). Ferruginous Hawks are usually most abundant in Pahvant Valley, central UT. Most sites continue to sustain large numbers of wintering raptors, with Lovelock routinely containing a mixed-species roost of dozens of buteos. So far drought conditions in the Southwest appear to create favorable conditions for rodent infestation, coinciding with record peaks of wintering raptor populations. This long-term study suggests that these artificially created oases in the high desert are among the most significant winter landscapes for raptors in western North America, and the counts provide a means of monitoring population changes in relation to habitat, land-use, and climatic changes. The banding of 436 raptors (12 species)—including 130 Rough-legged Hawks—yielded morphometric, photographic, and genetic data. Dramatic drops in the water table, crop changes, and mining threaten or have already affected some areas. Gratifyingly, since 2011 HWI has assumed the counts in Utah, and Nevada Department of Wildlife biologists now conduct counts in Nevada.

Summer Ranges, Site Fidelity, Dispersal and Migration of Adult and Juvenile Rough-legged Hawks (Buteo lagopus) from the Seward Peninsula, Alaska

***JEFF W. KIDD** (jeff@kiddbioinc.com), Kidd Biological, Inc Anacortes, WA, U.S.A. TRAVIS L BOOMS, Alaska Department of Fish and Game, Fairbanks, AK, U.S.A. CHRIS P. BARGER, Alaska Department of Fish and Game, Fairbanks, AK, U.S.A. JOSEPH M. EISAGUIRRE, University of Alaska Fairbanks, Fairbanks, AK, U.S.A. NEIL PAPROCKI, HawkWatch International, Inc., Salt Lake City, UT, U.S.A.

During July 2016 and 2017, we deployed GSM-GPS transmitters on breeding adult and nestling Rough-legged Hawks (Buteo lagopus) on the Seward Peninsula, Alaska. Breeding sites were selected along three major road systems within 100km of Nome, Alaska. Trapping was conducted at occupied nest sites with chicks no less than four weeks of age that were located within 1km of a road. Adults were captured near nest ledges using bal-chatri's baited with two white mice (Mus musculus) or a dho-gaza with a mounted Great-horned Owl (Bubo virginianus). In 2016, six nestlings close to fledging age were also fitted with transmitters at sites where at least one adult had been tagged. During the 2016 pilot study, we focused on establishing successful trapping methods and began preliminary analysis of summer ranges, dispersal and migration of adults and fledglings. During 2017, we initiated data collection on mate and breeding dispersal, philopatry, and continued investigating summer ranges, post breeding movements of adults, post fledgling dispersal, and other aspects of migration ecology.

Range and Route Fidelity of Rough-legged Hawks (Buteo lagopus) in North America

***JEFF W. KIDD** (jeff@kiddbioinc.com), Kidd Biological Inc, Anacortes, WA, U.S.A. JEFF P. SMITH, H.T. Harvey & Associates, Los Gatos, CA, U.S.A. TRAVIS L. BOOMS, Alaska Department of Fish and Game, Fairbanks, AK, U.S.A. ALASTAIR FRANKE, Arctic Raptors Inc, Sherwood Park, AB, Canada. SCOTT E. THOMAS, Kidd Biological Inc, Mission Viejo, CA, U.S.A.

From January 2014 through August 2017, we expect to have deployed approximately 85 GPS transmitter (PTT, GSM, GSM-UHF) on Rough-legged Hawks (Buteo lagopus) during winter in the western United States and during summer on subarctic breeding grounds at two sites in Alaska and Nunavut, Canada. For this presentation, we evaluated winter and summer range fidelity and migration route fidelity by season for 28 adult hawks that we have tracked for more than one annual cycle. Tracking results demonstrate that some hawks show strong inter-annual fidelity to their winter and summer ranges and seasonal migration routes, whereas other hawks show more variable patterns. Many of the latter individuals revisited previously used or winter ranges briefly, but ultimately settled in new areas during a given season. In general, it appears that prospecting different subareas in search for optimal prey conditions may be a common feature of both winter and summer range selection among Rough-legged Hawks. We review and compare insights gained from previous mark-recapture studies and our more recent GPS tracking studies. We are also investigating age, weather, timing, rodent cycle, snow cover, and other factors that may be influencing this variable behavior.

Project WAFLS: Evaluating Short-eared Owl (Asio flammeus) Distribution, Habitat Use, Population Trend, and Future Viability within the Great Basin and Intermountain West of North America

***ROBERT A. MILLER** (RobertMiller7@boisestate.edu), Boise State University, Boise, ID, U.S.A. NEIL PAPROCKI, HawkWatch International, Salt Lake City, UT, U.S.A. BRYAN BEDROSIAN, Teton Raptor Center, Jackson, WY, U.S.A. CRIS TOMLINSON, Nevada Department of Wildlife, Las Vegas, NV, U.S.A. JAY D. CARLISLE, Boise State University, Boise, ID, U.S.A.

The Short-eared Owl is an open-country, ground-nesting species found in marshes, grasslands, shrublands, and tundra across North America and around the world. Evidence suggests that Short-eared Owl populations are experiencing long-term, range-wide, substantial declines in North America, but sufficient monitoring data is lacking to quantify any possible trend. Complicating trend analysis efforts for this species is the expected annual variation in breeding densities, believed to be associated with prey availability. We present evidence from 3 yrs of surveys within the Intermountain West confirming annual variation in both density and distribution of Short-eared Owls. Furthermore, we have identified the landscapes features where owls are least susceptible to this variation. Lastly, we present climate-informed projections for the future viability of the species within the Great Basin and Intermountain West. The results of our work will directly inform the prioritization of actions to help conserve this often neglected species.

North America's Only Caracara: Wide-Ranging But Little Known

***JOAN L. MORRISON** (joan.morrison@trincoll.edu), Corrales, NM, U.S.A.

In North America, populations of the Crested Caracara (Caracara cheriway) occur in Florida, Texas, and Arizona and in areas of northern Mexico. Although relatively common where it occurs, the species has received little attention compared to many North American raptors. Research conducted by myself and my colleagues in Florida represents the only in-depth study of this species anywhere throughout its range. In Texas, where the population is increasing, and in Mexico, what we know about this raptor comes from only a few short-term studies. The Arizona population has never been formally studied. Landscapes vary among regions where this raptor occurs in North America, thus its ecology probably varies as well. The geographic isolation of Florida's population likely has had a strong influence on its ecology, so this non-migratory population may not be representative of the species, generally. Early evidence suggests the Arizona population may be partially migratory. Also worthy of investigation are the species' strange vagrancy patterns. An increasing number of sightings have been reported in the past 10 yrs, in far northern states and even in Canada. Why has this colorful, roaming, and non-reclusive raptor received so little attention, especially since it occurs in relatively open habitats and often in large groups, thus is not all that difficult to observe? Perhaps because it is most often perceived as a scavenger and it regularly associates with vultures. Or, given the caracara's association with agricultural lands, issues of access to nests and roosts on private land may deter interest in developing further studies. To better understand our only caracara, however, these perceived barriers must be overcome.

Canadian Ferruginous Hawk (Buteo regalis) Population Status

***JANET W. NG** (janet.ng@ualberta.ca), Department of Biological Sciences, University of Alberta, Edmonton, AB Canada. BRANDY DOWNEY, Alberta Environment and Parks, Lethbridge, AB, Canada. ERIN M. BAYNE, Department of Biological Sciences, University of Alberta, Edmonton, AB Canada. TROY I. WELLICOME, Department of Biological Sciences, University of Alberta, Edmonton, AB, Canada and Canadian Wildlife Service, Environment and Climate Change Canada , Edmonton, AB, Canada.

Ferruginous Hawks are a federally threatened species as listed in the Species At Risk Act and a provincially endangered species in the Alberta Wildlife Act. These legal designations became necessary because since the 1980's, Canadian populations of Ferruginous Hawks declined by ~50% and they also experienced a ~50% range contraction. Possible factors behind their decline include habitat loss and degradation, poisoning and persecution, climate change and extreme weather, human disturbance or direct mortality from energy development, and reduction in prey availability. Large-scale population inventories have been conducted in Alberta since 1982 and provide population estimates used to track population trends through time. Recent habitat modeling has also allowed researchers to estimate populations across the Canadian range by mapping available suitable habitat. These population estimates are important for developing benchmarks for conservation and recovery planning, including setting population goals and identifying required protected habitat. Long term population and reproduction trends in Alberta, as well as Canadian wide, will be presented.

Ferruginous Hawk Use of Fence Posts Decreased in Response to Post-top Deterrents

***CAMERON J. NORDELL** (nordell@ualberta.ca) Department of Biological Sciences, University of Alberta, Edmonton, AB, Canada. TROY I. WELLICOME, Environment Canada, Edmonton, AB, Canada. JESSE L. WATSON, HawkWatch International, Salt Lake City, UT, U.S.A. ERIN M. BAYNE, Department of Biological Sciences, University of Alberta, Edmonton, AB, Canada.

Raptors in the Canadian grasslands typically perch on man-made structures (e.g. fence posts, distribution poles), often selecting high

and conspicuous perches to scan for prey. Grassland dwelling raptors represent potential predators of Greater Sage-Grouse (Centrocercus urophasianus urophasianus). As Greater Sage-grouse populations have declined substantially in Canada, there is interest in preventing raptor predation on the small remaining populations. Our objective was to determine the effectiveness of previously untested perch deterrents to decrease or prevent the use of fence posts by Ferruginous Hawks (Buteo regalis), a large grassland Buteo. Thirty-six solar GSM/GPS 20-70 transmitters were attached to Ferruginous Hawks from 2013 through 2015, in southwestern Alberta, Canada. Transmitters acquired fixes dynamically at a rate of up to 1/min. We installed metal perch deterrents on segments of wooden fence posts in Ferruginous Hawk home ranges in 2016. Our study used a Before-After / Control-Impact (BACI) design, such that fence segments with perch deterrents were paired with nearby control segments without deterrents. Hawks perched along focal fence segments represented 3463 (12.3%) of all telemetry fixes. Ferruginous Hawk perch use decreased by 85% and increased by 55% after deterrent installation on treatment and control segments, respectively. On-foot fence surveys showed an 88% decrease in raptor prey remains and excretion at treatment fence segments compared to controls. Our study suggested that perch deterrents can viably decrease or prevent raptor use of fence posts as perches, which may be implemented with the goal of conserving their prey species. Additionally, post-top deterrents appeared to be a reasonable multi-species deterrent that could be used to dissuade raptors from engaging in potentially harmful perching behavior; for example, perching on electrical infrastructure or near high traffic roadways.

Summer Ranges, Dispersal, and Migration of Adult and Juvenile Rough-legged Hawks from the Western Hudson Bay, Nunavut, Canada

***ALEX PAIEMENT**, Arctic Raptor Project, Rankin Inlet, NU, Canada, University du Quebec, Rimouski, Rimouski, Quebec, Canada. JEFF KIDD, Kidd Biological Inc, CA, U.S.A. MARK PROSTOR, Arctic Raptor Project, Rankin Inlet, NU, Canada. MATHIEU TETREAULT, Arctic Raptor Project, Rankin Inlet, NU, Canada and University du Quebec, Rimouski, Rimouski, QC, Canada. ALASTAIR FRANKE (alastair.franke@ualberta.ca), Arctic Raptor Project, Rankin Inlet, NU, Canada.

North American populations of Rough-legged Hawks (Buteo lagopus) are generally considered to be secure, and the species is underrepresented in the literature. Rough-legged hawks are known to be small mammal specialists, and the species' breeding activity is generally associated with local abundance of ground squirrels, voles or lemmings, but will prey on birds when small mammals are scarce, particularly juvenile passerines and shorebirds. Previous research in our study group indicates breeding pairs prefer rugged terrain with steeper slopes in areas associated with primary production, and were most likely to nest in large productive valleys surrounded by high-elevation plateaus. In 2016 and 2017, we captured breeding adults at occupied nest sites when chicks were no less than 4 weeks of age. We used backpack-style GPS-GSM loggers to collect movement information, including basic information such as mean departure date (September 14), mean duration of outward migration (58 ds), mean migration distance (2325 km) and mean migration rate (32 km/d). We used Biased Random Bridge analysis to construct home ranges and outward migration routes. Most individuals wintered in Idaho, Utah, Wyoming, Nebraska and Kansas; one individual wintered as far south as Arizona. Future work will use density surface modeling to estimate density of primary prey species within home ranges.

Wintering and Migration Trends of North American Rough-legged Hawks (Buteo lagopus)

***NEIL PAPROCKI** (npaprocki@hawkwatch.org), HawkWatch International, Salt Lake City, UT, U.S.A. TARA CREWE, Bird Studies Canada, Port Rowan, ON, Canada. DAVE OLEYAR, HawkWatch International, Salt Lake City, UT, U.S.A. LAURIE J. GOODRICH, Hawk Mountain Sanctuary, Orwigsburg, PA, U.S.A. DAVID BRANDES, Lafayette College, Easton, PA, U.S.A. STEPHEN W. HOFFMAN, Hawk Migration Association of North America, Bozeman, MT, U.S.A.

Recent published literature assessed raptor population trends using data from multiple parts of the annual cycle. Adapting this same framework, we assessed Rough-legged Hawk population trends in different parts of the annual cycle (migration and winter) to better understand regional population trends and their relationship to changes in migration. We conducted 10-yr, 20-yr, and 30-yr trend analyses using pan-North American standardized migration counts and Christmas Bird Counts. We also compared seasonal trends by latitude within different migratory flyways. Rough-legged Hawks are known to be broad-front migrants, making interpretation of low migration counts difficult, and relatively few migration sites count significant numbers of the species. Conversely, significant concentrations of Rough-legged Hawks can be found on the wintering grounds, making interpretation of Christmas Bird Count trends more promising; however, issues of sampling bias also exist in this dataset. Determination of population status of the North American Rough-legged Hawk is further complicated by the remoteness of their breeding range (i.e., arctic Alaska and Canada); however, long-term breeding census data is available for particular areas in Alaska and Canada. We discuss the importance of our migration and winter trend results, as well as the need for further research to assess the population status of this relatively common, but understudied North American raptor.

Long-term movements of Northern Harrier (Circus cyaneus) following translocation

***WENDY J. PEARSON-PRESTERA** (wendy.j.prestera@usmc.mil), U.S. Marine Corps Base Camp Pendleton, CA, U.S.A. JEFF KIDD, Kidd Biological Inc., Anacortes, WA, U.S.A.

Between 2013 – 2016, we captured and translocated 11 Northern Harriers as part of a program to assess the effectiveness of translocation as a method to reduce predation pressure on threatened and endangered beach-nesting birds at Marine Corps Base Camp Pendleton. Minimum translocation distances of 20 – 80 km are recommended in our Migratory Bird Treaty Act Depredation Permit; however, because anecdotal evidence suggested that some translocated birds returned to their capture points shortly after release, we began to translocate individuals known to be predating federally-listed species to habitat at least four times the recommended distance (390 – 680 km). Each bird was fitted with an ARGOS satellite transmitter to record their movements. Results varied as one breeding adult returned within 10 ds, while others bred in subsequent years in the San Joaquin Valley and near Santa Maria, and another spent time in both southern British Columbia and eastern Washington. Some Harriers returned to Camp Pendleton and bred in their previous home range whereas some selected more inland areas where they were not impacting sensitive beach-nesting bird species. This project is the first to our knowledge to track long-term movement patterns of Northern Harriers following translocation and, although translocation may have altered their behavior, we have found varied behaviors from high site fidelity to nomadism.

Wintering Ecology and Movements of Rough-legged Hawks (Buteo lagopus) in Western North America

***GENEVIEVE C. ROZHON** (gcr32@humboldt.edu), Humboldt State University, Arcata, CA, U.S.A. JEFF W. KIDD, Kidd Biological Inc., Murrieta, CA, U.S.A. JEFFERY BLACK, Humboldt State University, Arcata, CA, U.S.A.

As a grassland and seasonal wetland obligate species, Rough-legged Hawks are more susceptible to habitat loss than habitat generalists. Research also suggests that Rough-legged Hawks are more sensitive to human development than other grassland raptors. Until now, no studies have comprehensively examined wintering habitat requirements for Rough-legged Hawks in western North America. We initially examined winter ranges, habitat selection, and site fidelity at the 95% range level for nine Rough-legged Hawks captured in California and Nevada during 2014. We recently expanded on this preliminary analysis by further exploring Rough-legged Hawk habitat selection for seventeen individuals in 2014 and 2015 at nigh-time roost sites, within the 50% core range, 95% winter range, and at the geographic range level. All study individuals (seven males and ten females) were equipped with 22g GPS/PTTs or 24g CTTs. Winter ranges were located in California, Oregon, Nevada, Idaho, and Montana. Results indicate that global models are not appropriate to draw conclusions regarding habitat selection preferences for this species across such a wide geographic area. Therefore, we examined habitat selection preferences between sex and among individual birds, and found significant differences between groups and individuals. For example, males preferentially selected for herbaceous wetlands while females avoided this land cover type. In addition, all individuals avoided developed areas and preferred grassland, scrub, and pastureland. We hypothesize that hawks may be selecting certain land cover types during the winter as proxies for prey density. Since Rough-legged Hawks are experiencing population pressures year-round in North America, with the effects of climate change altering habitat on their breeding grounds and urbanization contributing to habitat loss on their wintering grounds, it is crucial to fully understand Rough-legged Hawk wintering behavior in order to ensure that appropriate habitat is conserved or developed for the species.

Challenges in Long-term Monitoring of Nesting Prairie Falcons

***KAREN STEENHOF** (karensteenhof@gmail.com), Owyhee Desert Studies, Murphy, ID, U.S.A. MICHAEL N. KOCHERT, U.S. Geological Survey, Forest and Rangeland Ecosystem Science Center, Boise, ID, U.S.A. JOSEPH M. WELDON, Morley Nelson Snake River Birds of Prey NCA, Boise District, BLM, Boise, ID, U.S.A.

Cavity-nesting Prairie Falcons (Falco mexicanus) present unique challenges for monitoring because of their inconspicuous nest locations and tendency to nest on isolated buttes and in linear canyons. A workshop held in 2008 recommended that Prairie Falcon abundance and reproduction in the Morley Nelson Snake River Birds of Prey National Conservation Area (NCA) be assessed in 3 of every 5 yrs, with a full canyon survey followed by a stratified random sample of sections of canyon in the other 2 yrs. However, due to high costs and budget cuts, Prairie Falcons have not been monitored in the NCA since 2003. To be consistent, future monitoring should replicate past procedures. In past years, we determined the number of nesting Prairie Falcons in the NCA by searching cliffs from observation points on the canyon floor in each of 260 1km segments, and we evaluated reproductive rates by assessing nesting success of 50 pairs in randomly selected nesting territories. We recommend searching each segment for 2 hrs in each of two stages of the nesting season (17 March to 11 April and 19 May to 13 June). A full canyon survey and assessment of reproduction would require eight seasonal technicians, a field leader, and four 4x4 trucks for an estimated cost of $128,000. The reproduction assessment and a sample of abundance in 10 randomly selected 5 km stretches of canyon (116 of 260 segments) would require four seasonal technicians, a field leader, two 4x4 trucks for an estimated cost of $78,000. The BLM Boise District plans to request funding to monitor Prairie Falcons, starting with the 2019 nesting season. Funds for a 5 yr monitoring period will be requested through BLM's Budget Proposal Submission System, and funds to supplement monitoring efforts will

be pursued through the BLM's National Conservation Lands Scientific Studies Support Program.

Lead Exposure of Ferruginous Hawks Nesting in Southwestern Idaho

***MATTHEW J. STUBER** (matthew_stuber@fws.gov), U.S. Fish and Wildlife Service, Migratory Birds and Habitat Program, Pacific Region, Portland, OR, U.S.A. TODD KATZNER, U.S. Geological Survey, Forest and Rangeland Ecosystem Science Center, Boise, ID, U.S.A. KEVIN WARNER, Idaho Army National Guard, Boise, ID, U.S.A. JOSEPH WELDON, Bureau of Land Management, Boise District, Boise, ID, U.S.A.

Shooting of small mammals, especially ground squirrels (Sciuridae), is a relatively common form of recreation in the western USA. Studies have shown that fragments of lead may be present in game animals, including ground squirrels that are shot with lead bullets. When these carcasses are not recovered, this source of lead is available for uptake by avian scavengers. Although Ferruginous Hawks (Buteo regalis) are not widely considered to be scavengers, they have been known to exhibit scavenging behavior. Thus, lead may be available for uptake by Ferruginous Hawks through opportunistic scavenging of and provisioning of young with shot ground squirrels. We investigated lead exposure by quantifying blood lead concentrations of nestling Ferruginous Hawks in 2015 (n = 32 nestlings at 11 nests) and 2016 (n = 49 nestlings at 14 nests) within the Morley Nelson Snake River Birds of Prey National Conservation Area in southwestern Idaho. Preliminary analysis shows that blood lead concentrations of these 81 birds ranged from <0.50 µg/dL to 4.50 µg/dL. This analysis suggests that, in this area, Ferruginous Hawks are often exposed to anthropogenically produced lead during the breeding season either through diet or inhalation; however, although no level of lead is considered safe, concentrations are generally below those likely to have measurable effects on most raptor species.

The Rough-legged Hawk (Buteo lagopus) in North America: A Brief Summary of Ecology and Potential Future Management Concerns

***TED R. SWEM** (ted_swem@fws.gov), U.S. Fish and Wildlife Service, Fairbanks, AK, U.S.A.

The Rough-legged Hawk remains an "under-studied" raptor, despite being Holarctic in breeding distribution, numerous, diurnal, and highly visible. In this paper, I will briefly review some of the species' ecology, highlighting gaps in our knowledge and areas where variation in observations or interpretation may be important. For example, counts of breeding pairs, migrants, and the number seen during winter can show substantial inter-annual variation, causing speculation that Rough-Legged Hawks use nomadic searching migrations to locate and exploit areas with rodent population peaks. Yet, information on the fidelity of individuals to breeding and wintering areas is scant, and it is unknown how fidelity varies between males and females, and among yrs, regions, and individuals. Information on other demographic parameters and factors that limit populations is also lacking. I will also briefly discuss possible future conservation and management challenges, which may include climate change in Arctic and Subarctic breeding areas, and habitat loss, effects of agricultural practices, and energy development and transmission in wintering areas. Hopefully, thoughtful consideration of impending conservation issues will ensure future research and monitoring efforts are strategically targeted, maximizing the value of information derived.

Reproductive and Movement Ecology of Rough-legged Hawks Breeding in the high Arctic

***J. F. THERRIEN** (therrien@hawkmountain.org), Hawk Mountain Sanctuary, Orwigsburg, PA, U.S.A. ANDRÉANNE BEARDSELL, Université Laval, Québec, QC, Canada. GILLES GAUTHIER, Université Laval, Québec, QC, Canada. NICOLAS LECOMTE, Université de Moncton, Moncton, NB, Canada. JOËL BÊTY, Université du Québec à Rimouski, Rimouski, QC, Canada.

The Rough-legged Hawk (Buteo lagopus) is an important top predator of the Arctic terrestrial ecosystem, but its reproductive and movement ecology are poorly known. We examined the effect of variation in Lemming (Dicrostonyx sp.) density, its primary prey, on breeding density and reproductive output as well as individual fidelity to nest sites over consecutive years on our long-term study site of Bylot Island, Nunavut, Canada. We also examined nest-site physical characteristics, patterns of nest reuse and the vulnerability of nesting structures to collapse due to geomorphological mass movements triggered by climatic events. The density of active nests and reproductive output both increased with increasing lemming densities. Hawk nests inaccessible to Foxes (Vulpes sp.) and sheltered by an overhang were associated with high reproductive success. Reproductive success was also negatively related to rainfall. Nest survival analysis suggested a relatively short persistence of Rough-legged Hawk nesting structures on Bylot Island compared to other Arctic cliff-nesting species. The anticipated increase in precipitation and temperature due to climate change is likely to augment the exposure of hawk nests to mass movements, which could ultimately reduce the availability of suitable sites for the reproduction of this Arctic-nesting raptor. On-going tracking of individual hawks suggests that while some individuals do come back to use the same nesting structures and/or territory to breed in consecutive years, not all individuals use this strategy.

Ghost Birds of the Golden Triangle: Ferruginous Hawks in North Central Montana

***JAY TISCHENDORF** (WildlifeVetUSA@gmail.com), American Ecological Research Institute (--AERIE), Conroe, TX, U.S.A. JEFFREY MCPARTLIN, McPartlin Realty, Great falls, MT, U.S.A.

Ferruginous Hawks (Buteo regalis) nest only within the prairies of North America. The bird is one of the continent's most uncommon raptors, with total numbers uncertain but concerningly low. With their spectacular size and their large and conspicuous nests the Ferruginous Hawk is well-suited for "citizen science" monitoring and study. These same qualities of course also make the species vulnerable to disturbance and persecution. Along with several associates, I have monitored nesting Ferruginous Hawks, as well as other raptorial species, in north central Montana since 2000. Our study area roughly encompasses a region known locally as the "Golden Triangle", for its long tradition of dry-land wheat farming. Indeed, agriculture is a key driver of the area's culture and economics. Continued raptor research and monitoring in this area are a necessity due to a spectrum of ongoing concerns. These include the relative uncertainty that still exists in regard to Ferruginous Hawk ecology, questions as to the species' overall status – there is evidence of range shrinkage and diminishing density – and impacts of habitat disruption due to oil and gas extraction, wind farms, and real estate development. At present, it seems Montana and the Canadian province of Alberta, and possibly Wyoming, may be key strongholds for this aptly named regal species. This paper will highlight some general perspectives on the species in Montana and describe future plans to aid in the birds' continued existence there.

Juvenile Swainson's Hawk Demography: Environmental Impacts and Trends Across Three Decades

***CHRISTOPHER R. VENNUM** (crvennum@gmail.com), Colorado State University, Fort Collins, CO, U.S.A. CHRISTOPHER W. BRIGGS, Hamilton College, Clinton, NY, U.S.A. PHILLIP A. STREET, University of Nevada – Reno, Reno, NV, U.S.A. MICHAEL W. COLLOPY, University of Nevada – Reno, Reno, NV, U.S.A. BRIAN WOODBRIDGE, U.S. Fish and Wildlife Service, Corvallis, OR, U.S.A.

Studies of younger age classes are underrepresented compared to those on breeding birds, particularly for species with delayed maturation. For species such as Swainson's Hawks (Buteo swainsoni) this problem is further compounded by the inability to observe individuals before they begin breeding. Here we apply multi-state models in Program Mark to model pre-breeder dynamics. Specifically, we estimate annual cohort breeding recruitment probabilities (range 0.01–0.20) and first-year survival probabilities (range 0.07–0.31) from 1985–2014, a time period with significant population changes for Swainson's Hawks. For example, breeding surveys across the state of California estimated a 91% decline in the number of breeding pairs in 1979, prompting a state listing-status of "threatened" in 1983. While multiple factors probably contributed to population declines, pesticide induced mass mortality events in the mid-1990s were documented across northern Argentina. Models that accounted for the permanent ban of pesticides responsible for mortality events in Argentina received the most support, suggesting that the disuse of this pesticide in 2000 was particularly important for this species. In addition, annual cohort recruitment rates notably increased after 2000. This result emphasizes the necessity and value of long-term monitoring and conservation work.

Human-Made Structures, Vegetation, and Weather Influence Ferruginous Hawk Breeding Performance

***ZACH WALLACE** (zwallac2@uwyo.edu), Wyoming Natural Diversity Database, Laramie, WY, U.S.A. PATRICIA L. KENNEDY, Oregon State University, Union, OR, U.S.A. JOHN R. SQUIRES, USDA Forest Service, Rocky Mountain Research Station, Missoula, MT, U.S.A. LUCRETIA E. OLSON, USDA Forest Service, Rocky Mountain Research Station, Missoula, MT, U.S.A. ROBERT J. OAKLEAF, Wyoming Game and Fish Department, Lander, WY, U.S.A.

Studies of anthropogenic impacts on wildlife may produce inconclusive or biased results if they fail to account for natural sources of variation in breeding performance and do not use probabilistic sampling at a scale functional for management. We used stratified random sampling and generalized linear mixed models to test hypotheses on relationships of daily nest survival rate (DSR) and fledgling production with anthropogenic and environmental factors that influence reproduction in the Ferruginous Hawk (Buteo regalis). We conducted the study across Ferruginous Hawk range in Wyoming, USA, 2010–2013. We performed extensive field surveys of prey, vegetation, and nest substrates, and used spatially explicit data to quantify weather, and the most widespread forms of anthropogenic infrastructure (i.e., roads, oil and gas well pads) in Ferruginous Hawk territories. We found strong evidence that DSR and productivity were greater for nests on anthropogenic structures (i.e., artificial nest platforms, gas condensation tanks, abandoned windmill platforms, power poles) compared to natural substrates (i.e., trees, cliffs, rock outcrops). Additionally, Ferruginous Hawks produced more fledglings at territories with greater shrub cover and fewer severe storms during the June brood-rearing period. Amount of oil and gas development and prey was not associated with either measure of breeding performance. Our results suggest that artificial nest platforms are an effective tool to improve breeding success of Ferruginous Hawks and nesting on anthropogenic structures does not constitute an ecological trap for this species. Although Ferruginous Hawks nested in some areas with very little vegetative cover, territories with greater amounts of shrub cover produced more fledglings. The negative impact of severe spring storms on fledgling production illustrates the importance of including future weather scenarios in management planning for this species because storms are predicted to increase in frequency and intensity as

a result of climate change.

Do Patterns of Range Use and Migration Support a Nomadic Lifestyle in the Ferruginous Hawk?

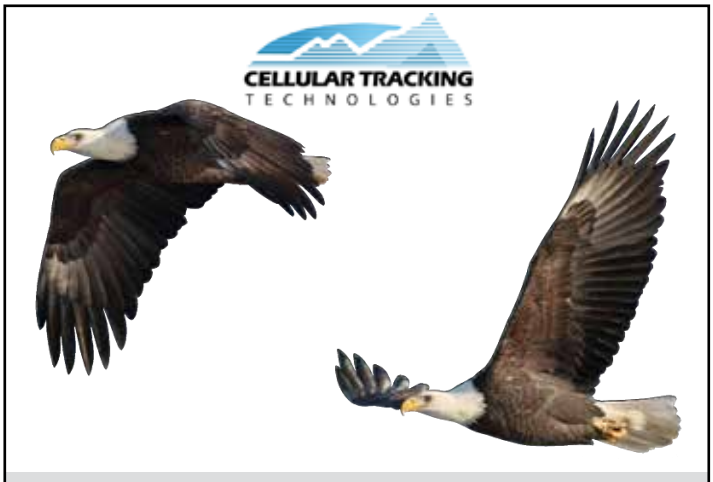
***JAMES W. WATSON** (James.Watson@dfw.wa.gov), Washington Department of Fish and Wildlife, Olympia, WA, U.S.A. TIMOTHY BYER, U.S. Forest Service, Thunder Basin National Grassland, Douglas, WY, U.S.A. DANIEL N. SVINGEN, U.S. Forest Service, Dakota Prairie Grasslands, Bismarck, ND, U.S.A. ROBERT MCCREADY, The Nature Conservancy, Bainbridge Island, WA, U.S.A.

Nomadism, the tendency to wander and breed in different regions in response to changing conditions has been described as a characteristic of the lifestyle of the Ferruginous Hawk (Buteo regalis). The degree that hawks use the same seasonal ranges and migration paths over multiple years has important implications for conservation and population assessment of this species. From 1999 to 2014 we satellite-monitored 69 adult hawks and 56 fledgling hawks from range-wide populations. We assessed the tendency of hawks that survived 1 $\geq$ 7 yrs to reoccupy seasonal ranges and whether they repeated use of migration routes. Adult hawks (n = 39) strongly favored use of traditional seasonal ranges and migration routes. They returned to the same breeding territory 100% of the time, occupied the exact summer range used previously 74% of the time, and occupied the exact winter range 95% of the time. In summer migration, hawks used the exact route (i.e., <30 km separation) in 55% of flights, increasing to 62% in fall migration, and 72% in spring migration. Eighty-percent of repeat migration paths were separated by <125 km. Juvenile hawks (n = 14) gradually developed affinity to seasonal ranges and settled an average of 350 km (SD = 346) from their natal ranges during the first breeding season following fledging, and the farthest hawks became localized from natal ranges during any subsequent nest season was 252 km. Two females that eventually nested were 25 km and 101 km from natal territories. Our initial assessment among range-wide breeding habitats of various qualities did not document nomadism in Ferruginous Hawks. We are conducting additional analyses to refine measures of nomadism.

Characteristics of Elevated Perches that Drive Space Use and Foraging Efficiency of Nesting Ferruginous Hawks (Buteo regalis)

***JESSE L. WATSON** (jwatson@hawkwatch.org), University of Alberta, Edmonton, AB, Canada, and HawkWatch International, Salt Lake City, UT, U.S.A. ERIN M. BAYNE, University of Alberta, Edmonton, AB, Canada. TROY I. WELLICOME, University of Alberta, Edmonton, AB, Canada, and Environment Canada, Edmonton, AB, Canada.

The Ferruginous Hawk is listed as threatened in Canada and endangered in Alberta. Population declines have been associated with habitat loss from conversion of native grassland to agriculture and energy development. The infrastructure associated with this development has resulted in increased types and densities of elevated perches. Ferruginous Hawks often employ a sit and wait hunting strategy, and spend a large proportion of their time (> 50%) using elevated perches. Thus, increased elevated perches could impact hawk ecology by changing their use of space, reflected in changing home range size and shape, and prey delivery rates which could have implications for breeding success. We used high resolution satellite telemetry to track the perching behavior and home range use of 34 adult male Ferruginous Hawks in southern Alberta and Saskatchewan. We present initial analysis of comparisons in perch use between individuals on home ranges with variable perch densities and types of perches. Specifically, we considered the density of perches across three categories of height: fence posts (low), distribution poles (medium), and transmission towers (high). We tested for relationships of prey delivery rates (n = 45 nests), determined from remote digital cameras, to perch characteristics and perch density. Preliminary results suggest that although fence posts are the most abundant perch type, taller perches are used more intensively when available. We will discuss how these results can aid in understanding the impact of future development on breeding Ferruginous Hawks.



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RAPTORS AND THE ENERGY SECTOR SYMPOSIUM ABSTRACTS

Photo by Steve Slater

Photo by Kate Davis

Photo by Neil Paprocki

** Presenting Author*
*** William C. Andersen Memorial Award Candidate*

A Test of an Automated Camera-Based System for Detecting and Identifying Eagles at a Wind Energy Facility

***TABER D. ALLISON** (tallison@awwi.org), American Wind Wildlife Institute Washington, DC, U.S.A. CHRIS MCCLURE, The Peregrine Fund, Boise, ID, U.S.A.

We conducted a test of IdentiFlight, an automated camera-based system designed to detect and classify eagles and other target species at a wind energy facility near Casper, Wyoming. We tested detection ability within a time frame that supports the use of informed curtailment to minimize eagle collision risk. We had four objectives for this study: 1) Establish detection reliability—the frequency with which the unit or system fails to detect an eagle-sized object; 2) Determine accuracy with which an object is classified as eagle/non-eagle—estimate rates of sensitivity and specificity; 3) Calculate the mean (±SD) elapsed time from detection to classification of the object; and 4) Estimate classification distance – the average distance from the nearest IdentiFlight tower at which identification occurs. Field work was conducted from August 8, 2016 to September 2, 2016 and included using human observers stationed near IdentiFlight units as a baseline for evaluating IdentiFlight detection capabilities. IdentiFlight detected 96% of the large birds detected by human observers. IdentiFlight had a high rate of sensitivity, a component of the measure of false negatives; there was a 93.8% chance that IdentiFlight was correct, leading to a false negative rate of 6.2%. IdentiFlight had a lower rate of specificity, 68.8%, or a false positive rate of 31.2%. Most of these false positives were turkey vultures. The time from detection to classification by IdentiFlight was approximately 0.40 seconds, and eagles were classified at approximately 800 m from the IdentiFlight towers. We further discuss comparisons to human observer data and caveats to our analyses.

Overview of Raptor Interactions with Utility-Scale Solar Projects in Southern California

***THOMAS V DIETSCH** (thomas_dietsch@fws.gov), US Fish and Wildlife Service, Carlsbad, CA, U.S.A.

Within the last decade, there has been a considerable push to increase renewable energy production in the Mojave Desert in southern California. As projects have become operational the US Fish and Wildlife Service (Service) has documented avian interactions with these facilities. In general, the Service collaborates with federal, state, and private partners to identify causes of wildlife mortality and to implement appropriate measures to help avoid, minimize and mitigate impacts during construction and operation of both traditional and renewable energy facilities. The Service has worked with solar project operators to standardize mortality reporting and to implement effective systematic monitoring across solar technology types. Since 2009, thousands of acres have been converted from agriculture and natural habitat for utility-scale solar energy developments. An updated summary of avian mortalities at California solar facilities will be presented with a focus on raptors. Hypotheses for the causes of reported raptor mortalities will be considered along with potential direct and indirect risks to raptor populations. Finally, I will discuss next steps that the Service is taking to reduce and mitigate impacts to migratory bird populations. The Service remains committed to meeting renewable energy goals while working to better understand, avoid, minimize, and mitigate avian mortalities at existing and planned utility-scale solar projects.

Documenting and Reducing Avian Electrocutions in Hungary: A Conservation Contribution from Citizen Scientists

***JAMES F. DWYER** (jdwyer@edmlink.com), EDM International, Inc., Fort Collins, CO, U.S.A. IVÁN DEMETER, MME BirdLife Hungary, Budapest, Hungary. MÁRTON HORVÁTH, MME BirdLife Hungary, Budapest, Hungary. KÁROLY NAGY, MME BirdLife Hungary, Budapest, Hungary. ZOLTÁN GÖRÖGH, MME BirdLife Hungary, Budapest, Hungary. PÉTER TÓTH, Agria Ökoszisztéma Kft, Rózsa Károly u. Hungary. JÁNOS BAGYURA, MME BirdLife Hungary, Budapest, Hungary. SZABOLCS SOLT, MME BirdLife Hungary, Budapest, Hungary. ANDRÁS KOVÁCS, Eger, Hungary. RICK E. HARNESS, EDM International, Inc., Fort Collins, CO, U.S.A.

Electrocutions of birds on power structures is a global conservation concern that has not been thoroughly reported in all areas where it occurs. Here we provide information from citizen scientists describing 3,400 avian carcasses of at least 79 species found at the bases of 57,486 electrical pylons in Hungary. Of these carcasses, 3% were found at the bases of pylons retrofitted to reduce electrocution risk. On average, one carcass was found per 15 non-retrofitted pylons surveyed, compared to one carcass per 89 retrofitted pylons; an 83% difference in frequency. Electrocutions included four species of conservation concern in Hungary, Red-footed Falcons (Falco vespertinus), European Rollers (Coracias garrulous), Saker Falcons (F. cherrug), and Eastern Imperial Eagles (Aquila heliaca). Only 3 of 104 (3%) electrocutions involving these species occurred on retrofitted pylons. Across birds of various sizes (small ≤ 25 cm long, medium 26–49 cm long, and large ≥ 50 cm long) differences in electrocution frequencies on non-retrofitted and retrofitted pylons were smallest for small birds, apparently because small birds could walk across the unprotected gaps in coverage directly below energized conductors. In this study, citizen scientists documented the breadth of the electrocution problem in Hungary, but were not trained to record detailed pylon-specific configuration details. Rather, each pylon surveyed was categorized into one of eight general configurations. Pylons with terminal connections were the most dangerous, accounting for 8% of pylons and 24% of electrocutions. Future mitigation may benefit from professional scientists conducting detailed analyses of how electrocutions occurred on retrofitted pylons.

Avian/Power Line Issues: Background and How Electrocutions Occur

***HALEY EDWARDS** (haley.edwards@pse.com), Puget Sound Energy, Bellevue, WA, U.S.A.

Electrocutions are one of the more frequent and readily identifiable causes of raptor mortality. This presentation will focus on a variety of factors that influence raptor electrocution, along with a general background of the raptor electrocution issue. Topics covered will include the history of raptor electrocutions and the role of the Avian Power Line Interaction Committee (APLIC) in addressing this, a brief overview of the electrical utility industry perspective and regulatory requirements, and the engineering, biological, and environmental factors that influence raptor interaction with power lines.

Mitigating Eagle Nests on Transmission Lines: Challenges and Recommendations

***CRISTINA A. FRANK** (cristina.frank@pepcoholdings.com), Pepco Holdings, Newark, DE, U.S.A. DUNCAN ECCLESTON, EDM International, Inc., Fort Collins, CO, U.S.A. ELIZABETH K. MOJICA, EDM International, Inc., Fort Collins, CO, U.S.A. RICHARD E. HARNESS, EDM International, Inc., Fort Collins, CO, U.S.A.

Bald Eagle (Haliaeetus leucocephalus) nests on transmission structures threaten system reliability and may affect the safety of operators, the public, and Eagles. Nest material or feces can cause an outage affecting thousands of customers and critical facilities, and a nest fire can place responders and Eagles at risk. The inherent difficulty of eagle nest management is compounded by bird and nest protections, under the Bald and Golden Eagle Protection Act (BGEPA). Actions affecting Eagles or their nests require a permit from the U.S. Fish and Wildlife Service (USFWS), and Pepco Holdings (PHI) regularly addresses nesting issues because of: a) the robust recovery of the Chesapeake Bay Bald Eagle population; and b) a new regulatory definition that expands the scope of structures protected as "Eagle nests." Nest management can be complex and incur significant costs. In 2016, PHI applied for a BGEPA permit to remove a problematic nest from a 500 kV tower. Project costs were $220,000 in the first year, including required mitigation: a nesting platform, discourager spikes, and monitoring/hazing. At another site in 2016, PHI invested over $400,000 to prevent a determined pair from nesting so that a critical construction project could proceed. To address operational concerns, PHI and EDM International, Inc. (EDM) are developing in-situ containment, a strategy for stabilizing nests in place at a fraction of the cost of removal, and without need for federal permits. To facilitate a flexible and timely response to problematic Eagle nests that cannot be contained, PHI and EDM recommend that USFWS permit USDA Wildlife Services (WS) to supervise the emergency removal of incomplete or inactive Eagle nests from power lines. Eagle conservation, utilities, and federal agencies should all benefit from the development of in-situ containment as a nest management strategy and a WS permit (or permits) for nest removal.

Update from the U.S. Fish and Wildlife Service on the Eagle Rule and Take Permits

***KEVIN J. KRITZ** (kevin_kritz@fws.gov), U.S. Fish and Wildlife Service, Denver, CO, U.S.A. BRIAN A. MILLSAP, U.S. Fish and Wildlife Service, Albuquerque, NM, U.S.A. ELIZA H. SAVAGE, U.S. Fish and Wildlife Service, Falls Church, VA, U.S.A.

In 2009 the U.S. Fish and Wildlife Service (USFWS) promulgated regulations establishing two new permits allowing for limited authorized take of Bald Eagles (Haliaeetus leucocephalus) and Golden Eagles (Aquila chrysaetos) under the Bald and Golden Eagle Protection Act (Eagle Act). In such cases the take must be associated with otherwise lawful activities. Also the take must be both compatible with the preservation of Eagles and associated with an action that cannot practicably be avoided. The 2009 regulations also established permit provisions for intentional take of Eagle nests under particular, limited circumstances. Under the Eagle Act take means to: "pursue, shoot, shoot at, poison, wound, kill, capture, trap, collect, destroy, molest, or disturb." The USFWS found that it was difficult to implement the 2009 regulations for complex projects within a reasonable timeframe and without consuming a disproportionate share of the USFWS increasingly limited resources. USFWS also needed to update the regulations to account for new information on the status of Bald and Golden Eagles, and to incorporate that information into an updated permitting and management framework. In December, 2016 USFWS finalized revisions to the 2009 eagle permit regulations for both incidental take and take of nests. The 2016 revisions are intended to create a permitting framework that can be implemented more efficiently and thus encourage greater public compliance while ensuring protection of Bald and Golden Eagles. Revisions to the take permit regulations include changes to permit issuance criteria and durations, definitions, compensatory mitigation standards, criteria for nest removal permits, permit application requirements, and fees. During our presentation we will elaborate on the 2016 revisions including practical ramifications for permit applicants. We also will present the updated USFWS management objectives for Eagle populations and permitting framework as finalized in the December, 2016 Programmatic Environmental Impact Statement for the Eagle Rule Revision.

Solar Energy and Nesting Swainson's Hawks in California's Antelope Valley: How Long of a Future Together?

***MICHAEL KUEHN** (michaelkuehn@bloomresearch.org), Bloom Research Inc, Los Angeles, CA, U.S.A. PETER BLOOM, Bloom Research Inc, Los Angeles, CA, U.S.A.

The Antelope Valley in northern Los Angeles County has become a global hub for solar energy development. It is also home to a small population of the California Threatened Swainson's Hawk (Buteo swainsoni). Research is needed to understand how land-use changes in this region impact Swainson's Hawks, and how efforts to minimize those impacts can best be directed. In 1979, a statewide survey in California found only three breeding pairs of Swainson's Hawks from Kern County south; one in eastern San Bernardino County and two in the Antelope Valley. Since then, the species has remained extirpated from previously occupied areas in Southern California, except for about 10 pairs that have bred annually in the Antelope Valley, and a few other pairs nearby in Kern County. Since 2000, energy development has increased dramatically in the Antelope Valley, stemming from the construction of new transmission lines, and the concomitant development of numerous wind and solar energy facilities. Solar Facilities have replaced foraging and potential nesting habitat of Swainson's Hawks, including irrigated agricultural fields, native and non-native grasslands, desert scrub, and Joshua Tree (Yucca brevifolia) woodland. We focus on describing where solar development has occurred, and where it is planned to occur, relative to current and historic Swainson's Hawk nest sites, and the extent and types of habitat that have been lost to date to solar development. We also discuss the need for research to better understand what factors contribute to the persistence of this population, and how solar energy development might impact those processes.

Multi-species Management Conflicts: "Prey vs Predator"

NATALIE J.S. TURLEY (nturley@idahopower.com), Idaho Power Company, Boise, ID U.S.A. ***DIANA LEIKER**, Tri-State Generation $ Transmission Association, Westminster, CO, U.S.A.

Land management plans often recommend the use of perch discouragers on power line structures to reduce raptor and raven perching opportunities in habitat with sensitive species, such as Desert Tortoise (Gopherus sp.) and Greater Sage-Grouse (Centrocercus urophasianus). However, perch discouragers can increase electrocution risk for large birds of prey. Greater risk is thought to be due to altered flight behavior as the bird tries to land on the pole despite the discourager. Another unintended consequence of adding perch discouragers is that they may aid corvids in their nest-building activities, as the birds use the discouragers to anchor nest material. Perch discouragers were originally intended to move birds from an unsafe perching location to a safer alternative, either on the same structure or nearby. Several studies have assessed the effectiveness of discouragers in minimizing perching. These studies have found that discouragers reduced perch duration and frequency, however some species used alternate natural perch sites or other locations on the structures such as cross braces and the shield wire to perch on when discouragers were present or perched on or between the discouragers. The potential negative impact of perch discouragers on birds of prey and the provision of potential nesting sites for Common Ravens (Covus corax) should be considered against any potential benefits discouragers may provide to prey species.

Retrofitting Effectiveness and Lessons Learned: A Summary of 17 Years of Power Line Surveys in the West

***SHERRY LIGUORI** (sherry.liguori@pacificorp.com), PacifiCorp, Salt Lake City, UT, U.S.A.

Since 2001, PacifiCorp, an electric utility in the Intermountain West and Pacific Northwest, has conducted avian electrocution and collision risk assessment surveys, proactive retrofitting, and follow-up surveys of its power lines. Surveys have been conducted at over 100,000 poles, and have provided data on electrocution and collision risk factors and retrofitting effectiveness. Field testing of specific products and techniques have resulted in an "adaptive management" approach to retrofitting methods and products within the company. Species-specific differences have been documented in electrocution and collision risks, with differing factors for various raptor species. Retrofitting effectiveness varied with technique and product type, with current adaptive practices having greater effectiveness in mortality reduction and durability than historic products and techniques. Current retrofitting methods have documented significant reductions in avian mortality.

Review and Synthesis of Research Investigating and Mitigating Golden Eagle Electrocutions

***ELIZABETH K. MOJICA** (lmojica@edmlink.com), EDM International, Inc., Fort Collins, CO, U.S.A. JAMES F. DWYER, EDM International, Inc., Fort Collins, CO, U.S.A. RICHARD E. HARNESS, EDM International, Inc., Fort Collins, CO, U.S.A. GARY E. WILLIAMS, U.S. Fish & Wildlife Service, Division of Migratory Birds, Mountain-Prairie Region, Denver, CO, U.S.A. BRIAN WOODBRIDGE, U.S. Fish & Wildlife Service, Division of Migratory Birds, Mountain-Prairie Region, Denver, CO, U.S.A.

Golden Eagle (Aquila chrysaetos) electrocution on power poles is a global conservation problem with an estimated 504 eagles electrocuted annually in North America alone. Despite widespread use of mitigation techniques to retrofit existing poles and to build new poles to avian-friendly standards, electrocution remains a leading anthropogenic cause of death for the Golden Eagle. To assist electric utilities and wildlife managers in understanding eagle electrocution, we provide a review and synthesis of risk factors and mitigation techniques from published literature spanning 1940-2016. Eagles have eight electrocution risk factors: pole design, eagle age, morphology, habitat and topography, prey availability, season, weather, and behavior. Pole configuration was the most frequently identified electrocution risk factor and electrocution incidents were most often associated with distribution level (<69 kV) equipment poles. Age was the second most frequently identified risk factor, with juvenile eagles electrocuted at approximately twice the rate of either sub adults or adults. Risk was also associated with larger body size (females), high quality habitat, high prey density,

winter dispersal, inclement weather, and intraspecific interactions. Risk modeling based on these factors can assist electric utilities in identification of high risk poles at the regional scale. High risk poles need prioritization for retrofitting by electric utilities. Compensatory mitigation funding becoming available through wind energy facility permitting may be useful in offsetting costs to utilities. Electrocution mitigation approach would likely result in substantial reductions of golden eagle annual mortalities, fundamentally increasing the effectiveness of conservation efforts by inserting them in a regional systematic strategy of retrofitting prioritization.

Evaluating Survey Designs to Predict Wind-Wildlife Interactions Using Simulations: An Example Focused on Golden Eagles

***MAITREYI SUR** (maitreyisur@boisestate.edu), Department of Biological Sciences, Boise State University, Boise, ID, U.S.A. JAMES R. BELTHOFF, Department of Biological Sciences, Boise State University, Boise, ID, U.S.A. EMILY R. BJERRE, U.S. Fish & Wildlife Service, Division of Migratory Bird Management, Haleiwa, HI, U.S.A. BRIAN A. MILLSAP, US Fish and Wildlife Service, Division of Migratory Bird Management, Albuquerque, NM, U.S.A. TODD KATZNER, US Geological Survey, Forest and Rangeland Ecosystem Science Center, Boise, ID, U.S.A.

Wind energy development is rapidly expanding in North America, often accompanied by requirements to survey potential facility locations for wildlife. Within the USA, use by Golden Eagles (Aquila chrysaetos) of areas proposed for wind development frequently is estimated using modified point counts. However, often it is not clear what drives variation in the relationship between on-site point count data (i.e., the sample) and actual use of the project footprint. We used existing GPS-GSM telemetry data, collected at 15 min intervals from 13 Golden Eagles in 2012 and 2013, to explore the relationship between individual eagle use of sample plots within a project footprint and eagle use of the entire project footprint. To do this, we overlaid the telemetry data on hypothetical project footprints and simulated a variety of point count sampling strategies for those footprints. We compared the time an eagle was found in the sample plots with the time it was found in the project footprint using a metric we called "error due to sampling". Preliminary results showed that error due to sampling for individual eagles appeared to be influenced by interactions between the size of the project footprint (20, 40, 90 or 180 km2) and the sampling type (random, systematic or stratified) and was greatest on 90 km2 plots. However, use of random sampling resulted in lowest error due to sampling on intermediate sized plots. In addition sampling intensity and sampling frequency both influenced the effectiveness of point count sampling. Although our work focuses on individual eagles (not the eagle populations typically surveyed in the field), our analysis shows the utility of simulations to identify specific influences on error and potential improvements to sampling that consider the context-specific manner that point counts are laid out on the landscape.

Techniques to Prevent Raptor Electrocutions

***NATALIE TURLEY**, Idaho Power Company, Boise, ID, U.S.A. SHERRY LIGUORI (sherry.liguori@pacificorp.com), PacifiCorp, Salt Lake City, UT, U.S.A.

Raptor electrocutions can occur on power line structures, however, techniques for preventing electrocutions have been developed and refined since the 1970s. "Avian safe" designs can include framing structures to achieve adequate separation or covering exposed conductors and/or equipment. Both avian-safe modifications of existing/historic structures and avian-safe new construction can be employed in areas with known populations of raptors or other birds of concern. Given the diversity of line designs and voltages used by power companies, across-the-board standards are not possible, however, general principles can be applied to various pole types, habitats, and bird use areas to achieve avian protection. This presentation will provide the basics of avian protection techniques, using the industry best practices developed by the Avian Power Line Interaction Committee (APLIC), which can be applied to a variety of pole configurations and locations. In addition, current knowledge regarding retrofitting and product effectiveness will be discussed.

Avian Power Line
Interaction Committee

APLIC leads the electric utility industry in protecting avian resources while enhancing reliable energy delivery.

ENVIRONMENTAL CONTAMINANTS AND RAPTORS SYMPOSIUM ABSTRACTS

Photo by Phil Robertson

Photo by Kate Davis

Photo by Joan Morrison

** Presenting Author*
*** William C. Andersen Memorial Award Candidate*

An Overview of Mercury Toxicosis in Raptors

***MICHAEL P. JONES** (mpjones@utk.edu), University of Tennessee, Knoxville, TN, U.S.A.

Mercury (Hg) occurs naturally in the environment, but it is easily introduced into ecosystems, especially aquatic systems as a contaminant due to various human activities. Because of the ease with which it can enter the environment, Hg can be potentially toxic to raptors as well as people. Mercury occurs in several forms, an elemental (metallic) form, an organic form (Methylmercury [MeHg]), and as inorganic Hg salts/compounds when combined with other elements such as chlorine, sulfur, or oxygen. The latter, while considered not toxic, may be converted to MeHg through methylation by aquatic bacteria. Approximately 80% of Hg that enters the environment is through geological disasters (e.g., volcanic eruptions), wildfires, fossil fuel combustion, solid waste management, and mining, and everyone is considered exposed to very low levels of Hg. Methylmercury is the most toxic form and is of special concern as it tends to bioaccumulate and biomagnify in both freshwater and marine fish as well as marine mammals. Inorganic Hg tends not to bioaccumulate in the environment. Raptors encounter Hg via movement through, and foraging within, a contaminated ecosystem. Scattered morbidity and mortality is more common with Hg toxicity, as large-scale die-offs are reportedly rare. Definitive diagnosis of Hg toxicity may be difficult at best as raptors and other avian species accumulate and tolerate varying levels of Hg. However, monitoring Hg levels in whole blood, necropsy samples of the liver and kidney, integument (growing feathers), and eggshells may provide insight into the cause of illness, death, environmental exposure and contamination. Clinical signs include emaciation, incoordination, tremors, weakness, ruffled feathers, drooping eyelids, and acute death. Generally, treatment of suspected Hg toxicity is unrewarding, although various agents may be effective at chelating Hg in some cases.

Pentobarbital Poisonings in Raptors: Overview and Case Reports

***LISA A. MURPHY** (murphylp@vet.upenn.edu), University of Pennsylvania School of Veterinary Medicine, Kennett Square, PA, U.S.A.

Pentobarbital and other drugs commonly used in animal euthanasia may result in secondary toxicoses in raptors predating carcasses. This overview presents the method of intoxication, clinical signs in affected raptors, and successful treatment protocols, using actual cases of raptors presented for rehabilitation.

Anticoagulant Rodenticides in Birds of Prey

***MAUREEN MURRAY** (maureen.murray@tufts.edu), Tufts Wildlife Clinic, Cummings School of Veterinary Medicine at Tufts University, North Grafton, MA, U.S.A.

Exposures to and mortalities from anticoagulant rodenticides (ARs) in free-living birds of prey are a well recognized problem in multiple countries. The US Environmental Protection Agency (EPA) issued restrictions on sales and packaging of ARs, which went partially into effect in 2011. These restrictions prohibit the sale of the more potent and longer acting second-generation ARs (SGARs) through general consumer retail outlets, while allowing use by pest management professionals (PMPs) and agricultural users. Two studies in Massachusetts, USA, evaluate exposure to and toxicosis from ARs among four species of birds of prey: Red-tailed Hawks (Buteo jamaicensis), Barred Owls (Strix varia), Great Horned Owls (Bubo virginianus), and Eastern Screech-Owls (Megascops asio) for the time periods 2006 – 2010 and 2012 – 2016. These studies combined reveal continued widespread exposure to SGARs among these species, with 86 % and 96 % of tested birds positive for SGAR residues in liver tissue in the earlier and later time periods, respectively. In the later time period an increase in exposures to multiple SGARs was observed. These findings have implications for mitigation measures. In addition, these studies combined detail common ante-mortem and post-mortem signs in birds of prey with AR toxicosis resulting from exposure through natural prey items. Signs include profound anemia, subcutaneous and/or intramuscular hemorrhage, excessive bleeding from a minor wound, and pallor of internal organs. These findings aid the recognition of signs of AR toxicosis in these species.

Exploring the Risk of Neonicotinoids in Wild Birds

***JULIA B. PONDER** (ponde003@umn.edu), University of Minnesota, St. Paul, MN, U.S.A. MARK JANKOWSKI, U.S. Environmental Protection Agency, Seattle, WA, U.S.A. CHARLOTTE ROY, Minnesota Department of Natural Resources, Grand Rapids, MN, U.S.A. DA CHEN, Southern Illinois University, Carbondale, IL, U.S.A.

Neonicotinoid pesticides, the most widely used pesticides worldwide, are applied as seed treatments on most corn, soybean, sunflower and wheat seeds. While their unintended impact on insect pollinators has caused the greatest amount of concern, evidence of their lethal and sub-lethal effects on vertebrates is accumulating. Recent studies have shown potential risk to wild birds from neonicotinoid exposure. The most likely route of exposure to large doses of neonicotinoids for birds is ingestion of treated seeds, although numerous other mechanisms exist (e.g., crops, soil, water). In our studies, multiple species of wild birds have been documented to eat treated seeds from seed spills in agricultural areas, and residues have been found in hunter-harvested carcasses. Although studies in raptors are lacking, one recently published study documented neonicotinoid exposure in an owl nestling. Ingestion of a small number of treated seeds has been shown to be lethal to small birds. While larger birds of prey are less likely to ingest a lethal dose, they may still be at risk for sub-lethal health impacts and may be exposed to multiple types of neonicotinoids. Additionally, a reduction in prey base is possible in areas that are contaminated. Sub-lethal effects found in the lab include behavioral abnormalities, declines

in reproductive success, and immune suppression. The European Union issued a temporary ban on three neonicotinoids on certain flowering crops in 2013 and recently proposed a complete ban on their use in fields. In the United States, neonicotinoids are currently under review by the Environmental Protection Agency. Additional regulations have been implemented at the state level.

The Art of Sample Collection and Processing for Toxicology Analysis in Raptors

***NINA SCHOCH** (nschoch@adkloon.org), Adirondack Center for Loon Conservation, Saranac Lake, NY, U.S.A.

Free-ranging raptors have potential to be exposed to a variety of environmental toxins, which can cause morbidity and mortality at the individual bird and the population level. This presentation will provide an overview of how to collect appropriate tissue samples from a raptor to determine exposure to a toxicant, as well as the techniques required for processing samples for laboratory submission to analyze them for a given toxicant. A summary of how to establish a quality field laboratory for sample preparation and the importance of record-keeping to document sample collection, processing, and laboratory submission will also be discussed.

Photo by Alexander Paiemnet

INNOVATIONS IN RAPTOR EDUCATION SYMPOSIUM ABSTRACTS

Photo by Joan Morrison

Photo by Ben West

Photo of Team Naturaleza

** Presenting Author*
*** William C. Andersen Memorial Award Candidate*

Distance Education and Virtual Programming at Hawk Mountain Sanctuary

ERIN BROWN, Hawk Mountain Sanctuary, Kempton, PA, U.S.A. ***ADAM CARTER** (carter@hawkmountain.org), Hawk Mountain Sanctuary, Kempton, PA, U.S.A.

Since its founding in 1934, Hawk Mountain Sanctuary's (HMS) educational outreach has primarily been local and 'place-based'. The education department's newest initiative allows schools constrained financially or by physical distance to gain exposure to its mission of conserving raptors globally. Distance Education programs are conducted using 'Raptor Trunks', shipped to a classroom prior to a virtual presentation with an educator facilitated through Skype. Three different trunks have been tailored to accommodate elementary, middle, and high school learning levels. In addition to a variety of visuals and raptor parts, trunks also contain lesson plans for teachers in alignment with the PA Department of Education's Environment and Ecology Standards and the Next Generation Science Standards. The trunks also include Black Vulture and Broad-wing Hawk curricula that incorporates HMS satellite tracking data. Through generous private donation, HMS is able to offer these programs for free and is working to extend its distance education programs internationally.

Monitoring Raptor Populations in Central New Mexico: A Citizen Science Study

***GAIL L. GARBER** (gail@hawksaloft.org), Hawks Aloft, Inc., Albuquerque, NM, U.S.A. TREVOR W. FETZ, Hawks Aloft, Inc., Albuquerque, NM, U.S.A. EVERETT OGILVIE, Hawks Aloft, Inc., Albuquerque, NM, U.S.A. GERALD K. HOBART, Hawks Aloft, Inc., Albuquerque, NM, U.S.A.

Beginning in 1995, Hawks Aloft, Inc. established point count surveys on eight 20-mile driving routes throughout the central Rio Grande and Estancia Valleys, New Mexico. Surveys quantified populations of resident raptors during summer and winter seasons in the Rio Grande Flyway. Each route, typically 20 miles in length with a timed stop approximately every mile, was surveyed monthly during December–February and June–August. A total of 32 raptor species were documented. Trained citizen scientists conducted surveys within the middle Rio Grande Valley from Isleta Pueblo south to Engle, New Mexico and also the Macintosh area of the Estancia Valley. Surveys documented summer and winter population trends for seven regularly occurring breeding raptors and eight wintering raptors. We compare cumulative annual raptor population trends by species and route, across all survey years. We also compare seasonal population trends (summer and winter) by species and survey route. Cumulatively, across all routes, we documented significant variations in annual densities in 1995–2016 for Red-tailed Hawks (Buteo jamaicensis) during both summer and winter, and for American Kestrels (Falco sparverius) during winter. Population trends along specific survey routes were significantly different between yrs for six of ten regularly occurring raptor species during winter, summer, or both seasons.

The Pennsylvania Farmland Raptor Project: Conserving Farmland Raptors using Citizen Science and Landowner Outreach

***LAURIE J. GOODRICH** (goodrich@hawkmountain.org), Acopian Center for Conservation Learning Hawk Mountain Sanctuary Association, Orwigsburg, PA, U.S.A. KATIE ANDREWS, Acopian Center for Conservation Learning Hawk Mountain Sanctuary Association, Orwigsburg, PA, U.S.A.

Grassland-nesting raptors have declined across northeastern North America in recent decades with several listed as endangered or threatened in some states. Breeding Bird Atlas and hawk migration counts show declines in nesting American Kestrels (Falco sparverius), Northern Harriers (Circus cyaneus), Short-eared Owls (Asio flammeus) and Barn Owls (Tyto alba) across Pennsylvania. Despite concern for populations, three of the four species lack reliable survey data to assess their breeding status. Moreover, because most of the grassland habitat is privately owned, both surveys and conservation management require engagement with the private land owner. To address these needs, Hawk Mountain conducted a citizen science and landowner outreach project from 2012 through 2017 to promote grassland raptor conservation and inform species assessment. Outreach focused on farmers, birdwatchers, and other naturalists. Farmers were asked to place nest boxes, conserve grassland for ground nesters, and report sightings. Birders were recruited to visit historical nest sites. Reports were solicited during both nesting and wintering periods, and sightings mapped to share with state agencies. The effort resulted in 100 to 300 sightings collected each yr, supplemented by EBird reports from birdwatchers. In the first 2 yrs, 291 landowners were engaged, erecting nest boxes or reporting sightings. Annual results document a continued decline in nesting Short-eared Owls contrasting with a more consistent wintering population, highlighting the importance of Pennsylvania to wintering owls. Barn Owl and Northern Harrier showed a reduced but persistent core range, while American Kestrels were widespread but reported more in winter than summer. The project demonstrates how public and citizen science engagement can augment and inform conservation status assessment and conservation management.

Inspiring Conservation through Interpretive Outdoor Experiences, Research, Mentorship, Art, and Literature

***SHAWN E. HAWKS** (shawn-hawks@uiowa.edu), University of Iowa, Iowa City, IA, U.S.A. LAURA SEMKEN, Kirkwood Community College, Cedar Rapids, Iowa, U.S.A. DAVID CONRADS, University of Iowa, Iowa City, IA, U.S.A.

Inspiring people of all ages is a key motivation of an educator.

Personal experiences, knowledge, an inspiring location, interpersonal relationship skills, props, and creativity are the necessary tools. The Iowa Raptor Project is a jointly sponsored program of the University of Iowa and Kirkwood Community College. Our focus is to connect students and the community to the conservation of raptors through research and education opportunities. At the University of Iowa, creativity is not only at the core of research and discovery, but also central to our human existence. Promoting lifelong learning is a primary mission of Kirkwood Community College. We strive to inspire a conservation ethic by using traditional raptor talks, hosting a yr-round once-a-mo Family Day with interactive activities designed to foster eco-literacy, and by fostering strong collaborative efforts between professors and students from different colleges, as well as the local community. Research projects focus broadly on monitoring the life-cycle of raptors by surveying for wintering raptors and monitoring breeding raptors to discern habitat needs, monitoring the health of migrating bird populations through count and banding efforts, monitoring the health of captive birds through behavior enrichment studies, and using the social sciences to evaluate the success of our educational outreach. Relationships between students, citizen scientists, docent volunteers, and the public are important to us as we strive to cultivate a conservation ethic that may inspire people on their journeys throughout life. Although the purpose of this symposium is to explore raptor science for educators and best practices for delivering science to the general public, we also argue for the continued holistic approach to ultimately get people to reflect.

Providing Good Welfare for the Education Raptors in Our Care

***ERIN E. KATZNER** (erinkatzner@peregrinefund.org), The Peregrine Fund, Boise, ID, U.S.A.

Using live birds of prey as conservation ambassadors can be an incredibly valuable tool to create an emotional connection between audiences and animals, habitats, and conservation. When utilizing and caring for live raptors, it is our responsibility to provide them with the best welfare possible to ensure a high quality of life for each bird, and to provide an appropriate representation of the bird to our audiences. This presentation will explore what good welfare looks like for birds of prey under human care, and will include discussion of industry standards for animal care. Topics covered will include choosing the right bird for the job, appropriate husbandry techniques, increasing handler sensitivity to bird body language, training plans and positive reinforcement, and training the trainer. It will also discuss ways that those of us caring for birds can begin to take incremental steps toward improving the welfare of the raptors in our collections and it will provide resources for additional learning for raptor biologists and educators who care for captive birds.

Project OspreyTrack: Using Satellite Tracking of Ospreys as a Teaching Tool to Foster Understanding and Appreciation of Migratory Birds, Ecology, and Avian Life Cycles

***IAIN C. MACLEOD** (iain.macleod@nhnature.org), Squam Lakes Natural Science Center, Holderness, NH, U.S.A. RICHARD O. BIERREGAARD, JR., Academy of Natural Sciences, Drexel University, PA, U.S.A.

In 2011, the Squam Lakes Natural Science Center launched an education and research project in New Hampshire (NH) using the satellite tracking of Ospreys (Pandion haliaetus) as a teaching tool. In partnership with Richard Bierregaard, we have tagged 15 Ospreys in NH. The satellite tracking devices and the graphically appealing presentation of the data makes for exciting – and near-real-time – education opportunities both in formal classroom settings and informal web presentations and blogs. In 2013 MacLeod and Bierregaard attended an international seminar in Israel that highlighted the global nature of Ospreys and satellite tracking. A partnership formed between New Hampshire, several European countries, and The Gambia in Africa allowing for the creation of World Osprey Week. Thousands of students in classrooms across the globe follow migrating Ospreys on a website created by The Rutland Water Osprey Project in the UK. Curriculum materials have been developed that allow students to learn about the life cycles of Ospreys. A network of schools and nature centers along the US Eastern seaboard have used the materials and followed the birds online. A new distance learning program on the Osprey project is being developed by the Squam Lakes Natural Science Center for presentation in middle schools in northern NH.

A Wintering Golden Eagle Survey Citizen Science Project

***SCOTT A. MEHUS** (scott@nationaleaglecenter.org), National Eagle Center, Wabasha, MN, U.S.A.

The survey originated in 2004 after the author noticed more wintering Golden Eagles (Aquila chrysaetos) than had been previously reported. To prove that there were in fact this many wintering Golden Eagles, he enlisted his birding friends to help prove his theory. The survey's first yr had 24 observers counting 21 Golden Eagles in southeast Minnesota and western Wisconsin. The 2016 survey had over 180 trained observers counting 147 Golden Eagles in Minnesota, Wisconsin and Iowa. Interest in the survey grows and new survey routes continue to be established. Because of the numbers that the survey was finding, The Golden Eagle Project began as a partnership with the National Eagle Center, Minnesota Audubon, Minnesota and Wisconsin Department of Natural Resources and the USFWS Winona District. The goals of the project were to: determine breeding origins and migration patterns for this population, educate the public and encourage conservation of critical habitats in the regions these birds inhabit. This project has released six Golden Eagles with satellite transmitters,

proving that birds that winter in Minnesota and Wisconsin are then breeding in Northern Canada, including Nunavut, Northwest Territories and along the Labrador Sea. The National Eagle Center (NEC), the main educator of this project, currently houses 5 Bald Eagles, and 1 Golden Eagle that are un-releasable because of injury and serve as Educational Ambassadors. The NEC averages over 80,000 visitors a year from around the world and country that are eager to learn about eagles and then have the opportunity to learn about this citizen science based project and hopefully encourages them to be involved in this project or other projects of their interest. Charismatic eagles, engaging educators, public outreach programs, and social media all help spread the projects message.

Project WAFLS: Engaging Citizen Scientists Across Western North America in a Statistically Rigorous Survey of an Under-Studied Raptor

***ROBERT A. MILLER** (RobertMiller7@boisestate.edu), Boise State University, Boise, ID, U.S.A. NEIL PAPROCKI, HawkWatch International, Salt Lake City, UT, U.S.A. BRYAN BEDROSIAN, Teton Raptor Center, Jackson, WY, U.S.A. CRIS TOMLINSON, Nevada Department of Wildlife, Las Vegas, NV, U.S.A. JAY D. CARLISLE, Boise State University, Boise, ID, U.S.A.

The Short-eared Owl (Asio flammeus) is an open-country, ground-nesting species found in marshes, grasslands, shrublands, and tundra across North America and around the world. Evidence suggests that Short-eared Owl populations are experiencing long-term, range-wide, substantial declines in North America, but sufficient monitoring data is lacking to quantify any possible trend. Complicating trend analysis efforts for this species are its rarity on the landscape, the broad geographic range it occupies, the narrow time window of efficient detection, and the expected annual variation in breeding densities. These factors speak to the need for a large distributed survey team to adequately assess this species. We have engaged more than 400 citizen scientist and professional volunteers across four states in western North America to assess the distribution, habitat use, population trend, and future viability of the Short-eared Owl within the region. In addition to exceeding our core population assessment objectives the project has led to unexpected citizen led projects and collaborations, speaking to the strength of our citizen engagement approach. We present a summary of our approach, address the strengths and challenges, emphasize why we believe we have been successful, and highlight some of the unexpected project extensions.

Incorporating HawkWatch International Data in the High School Classroom Through the Informal Science Education Enhancement (iSEE) Collective

NIKKI WAYMENT (nwayment@hawkwatch.org), HawkWatch International, Salt Lake City, UT, U.S.A. ***JANET NELSON**, HawkWatch International, Salt Lake City, UT, U.S.A. ANNETTE HANSEN, HawkWatch International, Salt Lake City, UT, U.S.A.

Creating excitement about data in the classroom is often an abstract and challenging endeavor, while at the same time it is a critical aspect of understanding the workings of science. HawkWatch International (HWI), as part of a statewide collective of STEM organizations, is working to change that in Utah. Through funding from the Utah State Legislature, HWI educators are making use of HWI's 30 plus yrs of raptor data and scientific research to discuss topics including migration, evolution, adaptations, the food chain, predator-prey relationships, data interpretation, understanding different kinds of data, natural selection, and evolution in high school classes across the state of Utah. The 90-min presentation includes an interactive data activity, using actual, relevant HWI data, which allows students to use math and critical thinking to make predictions about natural history, populations, and to develop solutions to threats that birds of prey face. Examples include comparing both numerical and categorical data to evaluate correlation, relativity, and comparison of variables to make inferences. The data sets change on an annual basis around cross-departmental conversations related to what types of data are available, and are easily adapted to a high school classroom setting. Previous iterations of the program have used migration data of Sharp-shinned Hawks (Accipiter striatus) and survivorship rate and mortality data of nestling Golden Eagles (Aquila chrysaetos) fitted with satellite telemetry units. A live education bird is used in each presentation as a catalyst for the connection between humans and raptors.

Alberta's Nocturnal Owl Monitoring Program: The Importance of Citizen Science for Engaging the Public

***LISA TAKATS PRIESTLEY** (lisa@STRIXeco.ca), STRIX Ecological Consulting, Tofield, AB, Canada.

Long-term monitoring is important for longer lived species, like owls, as they may not breed every year and show population fluctuations due to food availability. Long-term surveys however can be costly, and citizen science programs have become an important means for collecting long-term data on a variety of wildlife taxa. The Alberta Nocturnal Owl Survey was initiated in 1998 with a few keen volunteers interested in collecting some distribution information on nocturnal owls in central Alberta. The survey gained momentum in 2002 when Bird Studies Canada initiated a Canada-wide nocturnal owl survey. The Alberta survey is now coordinated by STRIX Ecological Consulting and Beaverhill Bird Observatory. In 2017, the program celebrated its 16th yr of monitoring. Surveys are conducted between March 20th and May 5th along accessible roads on randomly set routes with 10 stations. Volunteers stop at each station and listen for owls, then play calls to increase the owl responses. We had 192 volunteers survey 99 owl survey routes across Alberta in 2016, and they detected 578 owls (seven species). Some important considerations to make when setting up a long-term citizen science program will be discussed, as well as some of the lessons learned from running a program for 16 yrs. Using a captive non-releasable owl to connect volunteers to what they will

experience has been invaluable.

Engaging the Public Through Citizen Science: The American Kestrel Partnership

***SARAH E. SCHULWITZ** (Schulwitz.Sarah@peregrinefund.org), The Peregrine Fund, Boise, ID, U.S.A. CHRISTOPHER J. W. MCCLURE, The Peregrine Fund, Boise, ID, U.S.A.

The American Kestrel (Falco sparverius) is one of the most widespread raptors in the Americas. However, data from the U.S. Geological Survey's Breeding Bird Survey, National Audubon Society's Christmas Bird Count, nest box monitoring programs, and migration counts indicate population declines for American Kestrels in much of North America. Causes of population declines are unknown and limited to speculation because data regarding potential threats are sparse and inconsistent. Understanding the decline of the American Kestrel requires a range-wide perspective that is why The Peregrine Fund launched the American Kestrel Partnership in 2012 whose mission is to uncover the primary threats to American Kestrels and to conserve this falcon across its range. We focus simultaneously on research and education. Integral to both is our continent-wide next box monitoring program. Professional and citizen scientists contribute nest observation data and genetic samples from across the range. The nest box program serves as a relevant tool to engage non-scientists across the Americas with issues in raptor conservation. Toward achieving our outreach goals, we also host a live-streamed Kestrel Cam each spring with features that encourage active engagement. We bring professional and committed citizen scientist partners under the same roof in periodic meetings. We are translating all educational materials into Spanish and creating curricula for use in classrooms across Latin America to ensure accessibility by Spanish speaking audiences. Although much of our research focuses on kestrel biology, we also want to know how participation with the American Kestrel Partnership influences the understanding, behaviors, and attitudes of our partners and supporters. We are working with sociologists to help us better understand the motivations and experiences of our partners.

Using Behavioral Ecology in Training and Managing Raptors in Education Programs

***THOMAS SPROAT** (sproat@nku.edu), BIOSE, Ryland Heights, KY, U.S.A.

For decades, science education organizations have used raptors to promote awareness of raptor biology and conservation. Many of these organizations train their educational raptors to demonstrate adaptations, behaviors, and ecology concepts for public education programs. Education programs that connect people with wildlife can increase the public's interest in wildlife and help facilitate habitat and species conservation. This presentation describes how raptor behavioral ecology can be used in the training and care of educational raptors. An understanding of raptor circannual behavior has helped our organization improve and shorten the training period for several educational raptors. Experienced educational raptors were also used to model behaviors we wanted new raptors to emulate. By applying behavioral ecology in our raptor training and education programs our volunteers have developed new questions for raptor behavioral ecology research. So, raptor education programs not only present information already known about raptors but may also provide new insights to behavioral ecology.

From Continental to Global: The African Raptor Data Bank and its potential as a citizen science tool for global raptor conservation

***MUNIR Z. VIRANI** (virani.munir@pererginefund.org), The Peregrine Fund, Boise, ID, U.S.A. ROB A. DAVIES, Habitat Info Ltd, Solva, Pembrokeshire, U.K. ANDREW RAYNER, Habitat Info Ltd, Solva, Pembrokeshire, U.K. TIM C. WROBLEWSKI, Habitat Info Ltd, Solva, Pembrokeshire, U.K. RAHMAN LUTFOR, Habitat Info Ltd, Solva, Pembrokeshire, U.K. DARCY OGADA, The Peregrine Fund, Boise, ID,. U.S.A ANDRE BOTHA, The Endangered Wildlife Trust, Modderfontein, South Africa. RALPH BUIJ, Wageningen University Research, Wageningen, Netherlands. JOOST BROUWER, West African Bird DataBase, Bennekom, Netherlands. CLIVE R. BARLOW, Birds of the Gambia, Banjul, Gambia. HICHEM AZAFZAF, Les Amis des Oiseaux (AAO / BirdLife Tunisie) Immeuble ERIS, Ariana, Tunisia. CORINNE J. KENDALL, North Carolina Zoo, Asheboro, NC, U.S.A. RICHARD T. WATSON, The Peregrine Fund, Boise, ID U.S.A. CHRIS J.W. MCCLURE, The Peregrine Fund, Boise, ID, U.S.A. DAVID L. ANDERSON, The Peregrine Fund, Boise, ID, U.S.A. KURT ECKERSTROM, Kurt Eckerstrom Consulting Ltd. Washington DC. U.S.A. NICK P. WILLIAMS, Coordinating Unit of CMS Raptors MoU, Abu Dhabi, United Arab Emirates.

The African Raptor Databank has grown rapidly since inception at PAOC13 in Arusha, October 2012. This is thanks to the support of hundreds of raptor observers across the continent, coordination by key individuals, and critical financial support from a range of sponsors and individual donors. We have now completed a five-yr data collection period. A total of > 168k records have been assimilated. The ARDB is managed by Habitat Info and makes use of the latest spatial data technologies to acquire, manage, analyze and disseminate distribution data. The project was conceived to address the issue of habitat loss for many species, but with the imminent threats facing vultures from poisoning, the purpose and objectives of the ARDB have been brought forward and adapted to enable the ARDB to serve a future role as a monitoring tool. The ARDB model has proven its value to raptor conservation on the continent of Africa: improvement of vulture range maps helped with the IUCN up listing of African vultures and the recent vulture mapping project has informed the international vulture MSAP. We have now adapted the technologies to roll out this model worldwide with a global databank and mobile apps. With the development of environmental datasets for modeling the new data from all regions of the globe this will enable us to greatly refine our assessments of area of occupancy, i.e. accurate measurement of a species' past, current

and future habitat space, subject to anthropogenic and climate change influences. Unlike other bird recording systems, the global raptor app and database is a specialized niche product with very accurate placement of records and dedicated design for information relevant to raptor species and subspecies, and their conservation and biology. However these datasets can be combined in collaborative studies. Different language modules will be added over time.

Using Satellite Transmitters as an Outreach Tool to Prevent Illegal Shooting

***HEIDI E. WARE** (heidiware@boisestate.edu), Boise State University, Boise, ID, U.S.A. HEATHER M. HAYES, Boise State University, Boise, ID, U.S.A. JAY D. CARLISLE Boise State University, Boise, ID, U.S.A.

The Long-billed Curlew (Numenius americanus) is listed as a Species of Greatest Conservation Need in the state of Idaho. Their populations are declining range-wide, but in particular a population in southwestern Idaho has seen a decline of over 90% since 1979. Factors contributing to their population decline include incompatible land uses such as illegal off-trail OHV use, trash dumping, and shooting. To mitigate these anthropogenic problems, the Intermountain Bird Observatory began a "Curlews in the Classroom" outreach problem in local schools. We will share how naming curlews and following their satellite tracks online has become a key outreach tool for addressing illegal shooting. We will share how our "Curlews in the Classroom" model can be adapted for raptor satellite tracking data to tackle similar issues.

Recruitment, Development, and Engagement of Volunteers for Citizen Science and Educational Programs

***MEGHAN WARREN**, Teton Raptor Center, Wilson, WY, U.S.A. CARRIE ANN ADAMS (CarrieAnn@tetonraptorcenter.org), Teton Raptor Center, Wilson, WY, U.S.A. BRYAN BEDROSIAN, Teton Raptor Center, Wilson, WY, U.S.A.

There is an increasing reliance on citizens and volunteers for data collection, education, and organizational support in conservation efforts. As organizations consider using volunteers for aspects to advance their mission or projects, several key aspects and challenges should be addressed to ensure the best chance of success for both the organization and volunteers. Teton Raptor Center has relied on volunteers for all three pillars of our mission: research, education, and rehabilitation to varying degrees from supplementing to essential for programs. We will present on the challenges of volunteer recruitment, development, and continued engagement. Based on volunteer surveys, we found that most people learn about our volunteer opportunities through editorial coverage, features in our partner organizations' newsletters, and social media. We developed a standardized training protocol for each project involving citizen scientists and sometimes require that they demonstrate proficiency before advancing to more difficult tasks. We keep volunteers engaged by balancing tedious tasks with exciting opportunities in the field or rehabilitation clinic. Acknowledgement, awards for the most dedicated volunteers, and creation of specific positions for some volunteers to give them a sense of ownership over a particular project can be useful tools for volunteer retention. Maintaining consistent email contact, inviting volunteers to special events, and celebration of birthdays and other life events fosters a sense of community that is integral to the volunteer experience.

Migratory Story – Building a Raptor Educational Program in the Golden Gate National Recreation Area Where Kids Can Also be the Authorities

***STEP B. WILSON** (swilson@parksconservancy.org), Golden Gate Raptor Observatory, Golden Gate National Parks Conservancy, Sausalito, CA, U.S.A.. KELSI JU, Crissy Field Center, Golden Gate National Recreation Area, National Park Service, San Francisco, CA, U.S.A. FRANCIS TAROC, Crissy Field Center, Golden Gate National Parks Conservancy, San Francisco, CA, U.S.A.. AUDREY YEE, Golden Gate National Parks Conservancy, San Francisco, CA, U.S.A.. LYNN FONFA, Golden Gate National Recreation Area, National Park Service, San Francisco, CA, U.S.A. CHARITY MAYBURY, Crissy Field Center, Golden Gate National Parks Conservancy, San Francisco, CA, U.S.A. ALLEN M. FISH, Golden Gate Raptor Observatory, Golden Gate National Parks Conservancy, Sausalito, CA, U.S.A.

In 2015 and 2016, the Golden Gate Raptor Observatory developed Migratory Story – an inner-city educational program – in cooperation with our partner organization, the Crissy Field Center. Focusing on Title One schools in the San Francisco Unified School District, we asked fourth-grade students to explore the essential question, "Why do living things move?" Students were engaged in a three part-program to consider how migration is a regular event in the lives of both birds and humans. Education specialists and raptor experts joined together as teaching teams: first, to meet the kids in their classroom; second, to host the kids on Hawk Hill during the migration; and third, to make a follow-up visit to the classroom, to work with the kids on telling migration stories of their own inspiration and experience. Some of these stories will be shared in the RRF education symposium. Nearly 500 fourth-graders from 19 classrooms participated in Migratory Story in 2015 and 2016. They came from five different schools, four of which were English Language Learners while the fifth was a classroom of Special Learning Needs. Students spoke five languages in total: Tagalog, Cantonese, Mandarin, Spanish, and English. Each non–English language class was matched by an outdoor educator of that language skill. The Migratory Story learning activities were developed to meet California Department of Education Next Generation Science Standards. Both The CFC and the GGRO are programs of the Golden Gate National Parks Conservancy and the National Park Service. Migratory Story was made possible by a grant in memory of Superior Court Judge Jennie Rhine.

SPEED TALKS SESSION ABSTRACTS

Photo by Neil Paprocki

Photo by Megan Morgan

Photo by Joseph Dane

** Presenting Author*
*** William C. Andersen Memorial Award Candidate*

The Importance of Demography in Post-release Monitoring: Translocated Ridgway's Hawks (Buteo ridgwayi) Survive at Similar Rates as those Remaining in Source Populations, but have Higher Rates of Recruitment

***DAVID L. ANDERSON** (danderson@peregrinefund.org) The Peregrine Fund, Boise, ID, U.S.A. BRIAN W. ROLEK University of Maine, Orono, ME, U.S.A. THOMAS HAYES The Peregrine Fund, Boise, ID, U.S.A. CHRISTINE D. HAYES Boise State University, Boise, ID, U.S.A., The Peregrine Fund, Boise, ID, U.S.A. RUSSELL THORSTROM The Peregrine Fund, Boise, ID, U.S.A. CHRISTOPHER J.W. MCCLURE The Peregrine Fund, Boise, ID, U.S.A.

Demographic data regarding survival and recruitment are important for estimating viability and efficacy of proposed management actions for populations of translocated animals. This information requires intensive monitoring post-release, which might not always be economically or logistically feasible. Since 2009, The Peregrine Fund has been translocating juveniles of the critically endangered Ridgway's Hawk from Los Haitises National Park to Punta Cana, Dominican Republic. Here, we use a multistate capture-recapture model to estimate survival and recruitment of these translocated hawks. We further examine whether survival or recruitment differ between sexes or study sites. Survival was relatively high for breeders, non-breeders, and juveniles and did not differ between study sites or sexes. In Punta Cana, juveniles recruited into the breeding population at more than double the rate of juveniles in Los Haitises National Park—likely because more unoccupied territories were available in Punta Cana. Our results therefore do not reveal any issues regarding the survival or recruitment of Ridgway's Hawks in the translocated population. Future work should evaluate reproductive performance of Ridgway's Hawks in Punta Cana and determine the effects of translocations on the population in Los Haitises National Park. Although the types of data collected during post-release monitoring are often determined by funding, feasibility, and research objectives, our results demonstrate the importance of monitoring the demography of translocated animals, post-release.

Habitat Associations of Golden Eagle Prey in a Long-term Study Area of Utah

JESSICA L. BROWN University of Nevada, Reno, Reno, NV, U.S.A. ***GEOFFREY BEDROSIAN** (geoffrey_bedrosian@fws.gov) Division of Migratory Birds, U.S. Fish and Wildlife Service, Denver, CO, U.S.A. KENT R. KELLER West Valley, UT, U.S.A.

We investigated Golden Eagle (Aquila chrysaetos) food habits in north-central Utah, U.S.A., from 1970–2014 through the identification of prey remains at 254 nest locations. We identified 147 prey species representing 26,769 individuals at a minimum, with the majority of species occurring at low frequencies. Golden Eagle diets were dominated by Black-tailed Jackrabbits (Lepus californicus), with Cottontails (Sylvilagus sp.), Rock Squirrels (Otospermophilus variegatus), and Yellow-bellied Marmot (Marmota flaviventris) also found frequently. We hypothesized that variation in observed prey species could be predicted using localized (6.4 km radius) environmental factors. Partial canonical correspondence analysis (controlling for sampling effort due to number of nest site visits) suggested that prey assemblages were associated with environmental variables, including: 1) forest cover and elevation versus shrub, grass, sagebrush, and pinyon cover; and 2) alfalfa, wetland, and crop cover versus grass. Non-metric multidimensional scaling identified three prey assemblages typical of sagebrush steppe, wetlands, and mountain ecosystems. Latent variable modeling using Bayesian ordination and regression analysis with fixed site effects also suggested three clusters of prey groups. Thus, observed prey remains were better predicted by measured environmental factors than biogeographic boundaries. Zero-inflated Poisson regression models identified a reduced set of environmental variables that predicted the probability an individual prey species would be brought to the nest and found as prey remains, and how many individuals were likely to be observed in the nest given that a species was a possible prey item. Our analyses indicate that Golden Eagle diet varied within ecoregion boundaries and that prey use was influenced by localized environmental factors that are strong predictors of observed prey remains.

Feeding en Route: Is Raptor Migration Fueled by Migrating Songbirds?

***RYAN P. BOURBOUR** (rpbourbour@ucdavis.edu) University of California, Davis, Davis, CA, U.S.A. JOSH M. HULL University of California, Davis, Davis, CA, U.S.A.

Documenting prey selection of migrating raptors has been challenging in the past, and as a result, most of our knowledge is derived from opportunistic observations. However, with the advent of modern genetic techniques, molecular evidence may be used to systematically study complex trophic interactions within migratory flyways. We seek to understand the diet composition of bird-eating raptors during fall migration, and to what extent prey-tracking of songbirds may be occurring along the Pacific Flyway. Merlins (Falco columbarius) and Sharp-shinned Hawks (Accipiter striatus) are closely associated during fall migration, and both rely on avian prey to meet high energy requirements for their journey. To investigate predator-prey interactions and resource partitioning, we developed a novel technique using DNA metabarcoding to document recent feedings of raptors trapped at a migration banding station along the Pacific Flyway operated by the Golden Gate Raptor Observatory. We aim to identify trace prey DNA to species from samples collected from the exterior of beaks and talons. Preliminary results indicate that universal COI primers are sufficient in detecting passerine DNA obtained from the beaks and talons of Merlins and Sharp-shinned Hawks even with no visible evidence. Additionally, pilot data from a captive raptor population with known diets indicates that only prey species eaten by the raptor are detected

using this method. This novel dietary study technique has the potential to reveal ecological interactions within migratory flyways when direct observations are difficult, and creates a new avenue to safely study the diet of raptor species around the world.

Nocturnal Hunting by Eleonora's Falcons (Falco eleonorae) on their Breeding and Non-breeding Grounds

***RALPH BUIJ** (ralph.buij@gmail.com) Wageningen University, Wageningen, Netherlands.

We report on nocturnal hunting by Eleonora's Falcons in their breeding range in the Mediterranean region and in their non-breeding range in Madagascar. Hunting activity of Eleonora's Falcons near floodlights during the breeding season in western Morocco peaked 30–60 min after sunset, but continued into the early morning. Hunting activity and prey capture rates near floodlights were highest during nights with little moonlight or overcast conditions. Fifty-one percent of 73 group capture attempts were successful. Of the migratory prey species identified at the Morocco study site (26 species), 73% belonged to species mainly migrating at night, whereas 57% of all migratory bird prey species of Eleonora's Falcon reported to date (122 species) migrate predominantly at night. Sylvia and Acrocephalus were the most commonly recorded genera among prey caught after dark. Our direct observations and analysis of satellite transmitter data indicated that Eleonora's Falcons also hunted away from artificial light in Morocco, Italy, and frequently so in Madagascar. Flight activity was detected in 18% of 342 night-time locations of seven satellite-tagged Eleonora's Falcons in Madagascar, at an average moon illumination of 60%. We conclude that nocturnal hunting by Eleonora's Falcons is more common than previously assumed and occurs preferably, but not exclusively, at above-average moon illumination on wintering grounds or near artificial lights during the breeding period.

Assessing the Umbrella Effect of Greater Sage-Grouse Management on Golden Eagles

***JASON D. CARLISLE** (jcarlisle@west-inc.com) Western EcoSystems Technology, Inc., Laramie, WY, U.S.A. GEOFFREY BEDROSIAN U.S. Fish and Wildlife Service, Denver, CO, U.S.A. TRENT L. MCDONALD Western EcoSystems Technology, Inc., Laramie, WY, U.S.A.

Landscape-scale conservation strategies are underway to protect Greater Sage-Grouse (Centrocercus urophasianus) across vast areas of the western U.S.A. Golden Eagles (Aquila chrysaetos) co-occur with Greater Sage-Grouse in much of their range, and the two species face many of the same threats (e.g., habitat loss due to anthropogenic disturbance, invasive annual grasses, and altered fire regimes). Therefore, management actions taken on behalf of Greater Sage-Grouse may provide a conservation umbrella to Golden Eagles by preserving key habitat resources that may otherwise be lost without proactive management. Our objective was to determine the amount and suitability of Golden Eagle habitat within federally designated Priority Areas for Conservation (PAC) managed for Greater Sage-Grouse. We analyzed data from spatially explicit habitat suitability models for Golden Eagles during the breeding and winter seasons within seven ecoregions spanning the western U.S.A. We found that Greater Sage-Grouse PACs contained nearly one-fifth of Golden Eagle breeding (mean = 21.3%) and winter (mean = 19.6%) habitat, but that the amount of overlap varied widely among ecoregions (breeding range = 3.3 – 44.7%, winter range = 1.6 – 45.3%). To further understand the effectiveness of PACs at capturing high-suitability Golden Eagle habitat, we created 250 simulated PACs within each ecoregion that were the same size as the established PACs, but sited with no respect to Greater Sage-Grouse. We found that the established PACs outperformed the simulation-based expectation for only four of the possible 14 ecoregion-season combinations tested. Our findings suggest that Golden Eagle conservation may be substantially augmented by efforts to protect Greater Sage-Grouse in some, but not all, western ecoregions. Additionally, the large size of the PACs, and not concordance in each species' preferred habitat, may be the key mechanism to the success of the conservation umbrella provided by Greater Sage-Grouse.

To Hit or Not to Hit: Nest-defense Behavior of Suburban Red-shouldered Hawks

***CHERYL R. DYKSTRA** (cheryldykstra@gmail.com) Raptor Environmental, West Chester, OH, U.S.A. MELINDA M. SIMON RAPTOR Inc., Cincinnati, OH, U.S.A. ANN R. WEGMAN Museum of Natural History and Science, Cincinnati, OH, U.S.A. JEFFREY L. HAYS RAPTOR Inc., Cincinnati, OH, U.S.A.

Many species of raptors aggressively defend their nests against potential predators, including researchers climbing to the nests and unsuspecting residents on the ground. Urban/suburban raptors experience and tolerate more disturbance from humans near nests than do raptors in more natural, remote environments. Yet urban raptors may also respond more aggressively than their rural counterparts, and little is known about the causes and contributing factors of such behavior. We report preliminary results of our investigations on Red-shouldered Hawks (Buteo lineatus) in southwestern Ohio. Red-shouldered Hawks defended their nests by hitting the climbing researcher on 11% of climbs to suburban nests (n = 166 climbs, 2011 – 2015), but on only about 2% of climbs to rural nests. In the suburban study area around Cincinnati, Ohio, we measured attributes of the nest site at nests where hawks hit or dived at a climber or landowner and compared them to nests where landowners reported no known aggression. Only nest height differed between these sites: nests of aggressive hawks were significantly lower (mean = 12.6 m) than those of non-aggressive birds (mean = 17.0 m). Finally, we experimentally approached the nests of suburban and rural birds and recorded hawk responses during the incubation and early-nestling stages. Most hawks in both places did not leave their nests during this disturbance and often looked intently toward

the researcher. However, rural birds were much more likely to flush and fly away from the researcher than suburban birds (26% vs. 0% during incubation, and 36% vs. 3% during the early-nestling stage, respectively). A small minority of birds defended their nests by calling or flying around the immediate area (4.3% of rural vs. 7.1% of suburban during incubation; 4.5% of rural vs. 12.5% of suburban during early-nestling stage), but none struck the researcher.

Pattern of Juvenile Dispersal in an Uninhabited Continent: Spanish Imperial Eagles

***ENRIQUE GONZÁLEZ** (egonzalez@ebd.csic.es), Estación Biológica de Doñana (CSIC), Seville, Spain. VIRGINIA MORANDINI, Estación Biológica de Doñana (CSIC), Seville, Spain. MIGUEL FERRER, Estación Biológica de Doñana (CSIC), Seville, Spain.

The Spanish Imperial Eagle (Aquila adalberti) disappeared as a breeding species in Africa in the 1960s and subsequent sightings have been anecdotal. Since 2002, a reintroduction project has been carried out in Cadiz, near the Strait of Gibraltar, and there has been a significant increase in the presence of these eagles in Africa. Using GPS-GSM transmitters, we studied the movements of juveniles that crossed this strait to test whether their dispersive behavior varies in an area devoid of breeding territories; a situation possibly representing the beginning of a recolonization of previously extirpated continent. We compared the distances between roosting sites in both Andalusia and North Africa, and found they were significantly longer in the latter, indicating that the presence of adults may be the main driver in juvenile dispersal. We also detected a lower number of temporary stopovers for each individual in Africa than in Andalusia, and a shorter distance between these areas. The duration of time spent at temporary stopovers was also greater in Africa. We found a clear tendency to return to sites in these tracked eagles, which reinforces our hypothesis that the existence of conspecific adults is a critical factor to juvenile dispersal. This information is essential to understanding the connectivity between populations and becomes crucial when planning future reintroductions. We have also brought to light that the recent colonization of Spanish Imperial Eagles in Cadiz functions as a step between the rest of the Iberian population and extirpated areas of North Africa, facilitating the resettlement in part of this species' prior range. Finally, our monitoring has identified dispersal patterns of this species, and located areas of mortality from electrocution on power lines, which may represent population sinks that might require intervention.

Native Parasitic Nest Flies Impact Fitness of an Island-endemic Host: a Potential Conservation Concern and Short-term Solution

***CHRISTINE D. HAYES** (cmdhayes@gmail.com) Boise State University, Boise ID, U.S.A., The Peregrine Fund, Boise, ID, U.S.A. THOMAS I. HAYES The Peregrine Fund, Boise, ID, U.S.A. CHRISTOPHER J.W. MCCLURE The Peregrine Fund, Boise, ID, U.S.A. MARTÍN QUIROGA Universidad Nacional del Litoral – Consejo Nacional de Investigaciones Científicas y Técnicas (UNL-CONICET), Esperanza, Santa Fe, Argentina. RUSSELL K. THORSTROM The Peregrine Fund, Boise, ID, U.S.A. DAVID L. ANDERSON The Peregrine Fund, Boise, ID, U.S.A.

Parasitic nest flies (Philornis spp.) are a driving force threatening the extinction of bird species endemic to Neotropical islands such as the Galápagos, where introduced P. downsi negatively impacts reproductive success of naive avian hosts. Elsewhere in the Neotropics, we suspect Philornis is related to the documented decline of at least some Caribbean birds. We manipulated parasitism by the native Hispaniolan nest fly P. pici on a critically endangered endemic host, Ridgway's Hawk (Buteo ridgwayi), to study the impact of parasitism on hawk breeding success, and with the goal of providing a management option for highly endangered species until long-term solutions can be found. Topical application of fipronil (0.25% solution) at 14 mg/kg was enough to reduce parasitism intensity by 89% and increase fledging rate by 179% in treated young. Our results indicate parasitism by nest flies has a significant impact on survival and fledging rates of nestling hawks and is a likely factor in the decline of the species. To our knowledge, this work represents the first quantitative evidence of nest fly impact on survival or productivity in a non-passerine host.

Trophic Niche Partitioning Between Male and Female Golden Eagles (Aquila chrysaetos) in Western Alaska

***JESSICA L. HERZOG** (jlherzog@alaska.edu) University of Alaska Fairbanks, Fairbanks, AK, U.S.A. JOSEPH M. EISAGUIRRE University of Alaska Fairbanks, AK, U.S.A. and Colorado College, Colorado Springs, CO, U.S.A. Alaska Department of Fish and Game, Threatened, Endangered, and Diversity Program, Fairbanks, AK, U.S.A. BRIAN LINKHART Colorado College, Colorado Springs, CO, U.S.A. TRAVIS L. BOOMS Alaska Department of Fish and Game, Threatened, Endangered, and Diversity Program, Fairbanks, AK, U.S.A.

Climate-related changes in the Arctic are influencing populations of prey utilized by top predators, potentially leading to alterations in predator-prey dynamics and intraspecific competition. We investigated how male and female Golden Eagles in Western Alaska, may use niche partitioning to avoid competing and compared diet between two breeding seasons to detect potential interannual variability in diet. We collected whole and partial regurgitated pellets and uneaten prey remains from nests and presumed perches at 35 and 30 occupied eagle sites on the Seward Peninsula, Alaska in July 2014 and 2015, respectively. Using comparison with museum specimens and microscopic techniques, we identified and sorted prey remains and pellet contents including bones, fur, and feathers, to categories of either avian order or mammalian family. We conducted a post hoc comparison of the two primary prey found in male and female diet with a Fisher's Exact Test to better understand niche partitioning. We found that Golden Eagles mainly consume Arctic Ground Squirrel (Urocitellus parryii) and Ptarmigan (Lagopus sp.), with males consuming about

13% more Ptarmigan (mean mass = 545.8 g) and about 12% less Squirrel (mean mass = 713 g) in comparison to females. Our post hoc comparison shows a significant difference in mean prey weight consumed by males and females (P <0 .001), possibly due to reversed sexual size dimorphism. Our research provides baseline data on how Golden Eagles use resources and interact with each other, which can improve our understanding of the Arctic's fragile ecosystems.

Restoring the Ridgway's Hawk: Is Current Management Effective?

***CHRISTOPHER J.W. MCCLURE** (cmcclure@peregrinefund.org) The Peregrine Fund, Boise, ID, U.S.A. BENJAMIN P. PAULI Saint Mary's University of Minnesota, Winona, MN, U.S.A. BRIAN W. ROLEK University of Maine, Orono, ME, U.S.A. THOMAS HAYES, The Peregrine Fund, Boise, ID, U.S.A. CHRISTINE HAYES The Peregrine Fund, Boise, ID, U.S.A. RUSSELL THORSTROM The Peregrine Fund, Boise, ID, U.S.A. DAVID L. ANDERSON The Peregrine Fund, Boise, ID, U.S.A.

The Ridgway's Hawk (Buteo ridgwayi) is a critically endangered raptor endemic to the island of Hispaniola. The Peregrine Fund has been managing this hawk primarily using two methods: 1) using pesticide to control parasitic botflies (Philornis pici); and 2) translocating nestlings from Los Haitises National Park to Punta Cana, Dominican Republic. We have demonstrated that controlling botflies drastically improves productivity, but it is unclear whether this increase is enough to stabilize the population. Further, translocated birds in Punta Cana survive at similar rates as those raised in the national park, yet it is unknown how that translates to viability of this restored population. Increasing productivity of hawks in the national park and translocating nestlings to Punta Cana are also potentially counter-balancing, with unknown consequences to population levels in the national park. We therefore built an individual-based population model to assess the effects of botfly management and translocations on population levels of Ridgway's Hawks in Los Haitises National Park and to gauge the viability of the translocated population in Punta Cana. Our results show that botfly management improves the population growth rate enough to overcome the effects of translocation to Punta Cana, and that the population in Punta Cana should continue to grow, as long as botflies are managed.

Natal Dispersal Distances of Golden Eagles in the Southwestern United States Based on Satellite Telemetry

***ROBERT K. MURPHY** (robert_murphy@fws.gov) U.S. Fish and Wildlife Service, Albuquerque, NM, U.S.A. BRIAN A. MILLSAP U.S. Fish and Wildlife Service, Albuquerque, NM, U.S.A. DALE W. STAHLECKER Eagle Environmental, Inc., Santa Fe, NM, U.S.A. KENNETH V. JACOBSON Arizona Game and Fish Department, Phoenix, AZ, U.S.A. ARAN JOHNSON Southern Ute Indian Tribe, Division of Wildlife Resource Management, Ignacio, CO, USA. CHAD S. SMITH Navajo Nation, Natural Heritage Program, Window Rock, AZ, U.S.A. KYLE J. TATOR Jicarilla Apache Nation, Game and Fish Department, Dulce, NM, U.S.A.

Knowledge of natal dispersal is vital to understanding avian population dynamics. Data on natal dispersal distances (NDDs) of Golden Eagles (Aquila chrysaetos) in North America are needed for defining local area populations to inform decisions authorizing take (i.e., injury, death, or disturbance) of individuals. However, only one NDD dataset, based on band encounter data mostly from central and northern portions of the western United States, is published; datasets based more accurately on tracking of individuals from natal sites via satellite telemetry would be a particularly valuable addition. Twelve Golden Eagles (four males, eight females) that we tagged with satellite transmitters as ~8 wk-old nestlings in the southwestern United States during 2010-2013 dispersed an average of 49.8 km (SD = 32.6, median = 53.4) between their natal sites and sites they occupied when reaching adult age (4.75 yr ± 1 mo) or where they first bred as subadults (3.75 yr ± 1 mo). The median value corroborates that published earlier from band encounters. To the dataset we added NDDs from seven male and four female eagles tracked through subadult age but that did not breed, reasoning that some subadults on the study area bred, and addition of this sample could provide tentative insight into sex-biased NDD. In the combined dataset (11 males, 12 females), male NDDs were shorter than those of females (mean = 40.6 km and 62.6 km, SD = 25.0 and 24.7, median = 34.5 and 65.6, respectively; one-tailed $t = 1.96$, $P = 0.03$, $df = 20$), corroborating findings from Europe of female-biased NDDs for the species and suggesting that decisions on take of Golden Eagles from local areas at least in the southwestern United States should be based on the more limiting distance (males).

Examination of the Geographic Distribution of Polymorphic Plumage of Diurnal Raptors in North America

***ELIZABETH A. WOMMACK** (ewommack@uwyo.edu) University of Wyoming Museum of Vertebrates, University of Wyoming, Laramie, WY, U.S.A.

Polymorphism is the presentation of multiple forms of a trait within a population. Plumage color polymorphism is found in over half of all orders of birds; and raptors, owls, and falcons show some of the highest percentage of polymorphic species within bird families. All three families of birds of prey (Accipitridae, Strigidae, and Falconidae) are not closely related phylogenetically, and many species that exhibit polymorphic plumage occupy a wide range of habitat and behavioral niches. No clear reason has yet been found to explain why raptors have evolved and maintained such a high percentage of color variation across so many different species. However, one impediment to studying polymorphic color in some birds of prey is the large geographic ranges that they occupy. This makes it difficult to identify the extent and distribution of morph characteristics, and how this may relate to population structure, or habitat and behavioral differences within a

species. In this study I examined the distribution of plumage morphs for five species of diurnal raptor in North America. I georeferenced museum specimens to determine the exact locality of different color morphs of Red-tailed Hawks (Buteo jamaicensis; n = 441), Swainson's Hawks (B. swainsoni; n = 237), Broad-winged Hawks (B. platypterus; n = 296), Ferruginous Hawks (B. regalis; n = 108), and Rough-legged Hawks (B. lagopus; n = 225) for both breeding and wintering months across the continent. Both Red-tailed Hawks and Swainson's Hawks showed a geographic division in the occurrence of different morphs. However, the geographic distribution patterns for the other three species were less distinct or not present. The creation of these maps will provide the base data to test hypotheses on what evolutionary factors may be driving these five closely related species to evolve and maintain polymorphic plumage.

Photo by Caitlin Davis

POSTER SESSION ABSTRACTS

Photo by Jeremy Halka

Photo by Melissa Hunt

Photo by Miguel Saggese

** Presenting Author*
*** William C. Andersen Memorial Award Candidate*

The Polar Raptor Databank: A Tool for Collaborative Data Sharing and Analysis across the Arctic

***DAVID L ANDERSON** (danderson@peregrinefund.org) The Peregrine Fund, Boise, Idaho, U.S.A. ROB DAVIES, Habitat Info, Rookwood Studios, Llanunwas, Solva, Haverfordwest, Pembrokeshire, UK. ANDREW RAYNER, Habitat Info, Rookwood Studios, Llanunwas, Solva, Haverfordwest, Pembrokeshire, UK.

Most raptor research projects occur at local scales because of the dual reality of restricted funding and the complicated logistics of fieldwork that are manageable by individuals or organizations. In contrast, the ranges of most Arctic raptors are circumpolar. Similarly, global climate change affects raptor populations at geographic scales exceeding those at which most studies are conducted. To better understand the population biology of Arctic raptors beyond the scale of individual study areas, and to study climate change effects across the scale of the whole Arctic, requires collaborative data sharing and analysis. The Peregrine Fund, USA, and Habitat Info, Wales, partnered to create the Polar Raptor Databank (PRDB) as a means to share data from individual research programs on Arctic raptors, and to allow researchers to conduct collaborative research that addresses questions at scales difficult or impossible to achieve by individuals working alone. The PRDB Version 1.0 features an interactive map with multiple base layers where researchers can register their interests, digitize their study areas and enter metadata that describe their research. Researchers can also query the databank by species, project, date range and type of observation; use administration tools to manage projects and individual study sites within projects; use a proforma spreadsheet to standardize and facilitate nest observation data entry; and use tools for data querying and export. Upcoming revisions to the PRDB are designed to facilitate the handling of other types of data and sharing of information.

The Latest in Diurnal Raptor Migration Count Trends Suggest Some New Concerns in Migratory Raptor Populations

DAVID OLEYAR, HawkWatch International, Salt Lake City, UT, U.S.A. LAURIE J. GOODRICH, Hawk Mountain Sanctuary, Acopian Center for Conservation Learning, Orwigsburg, PA, U.S.A. TARA L. CREWE, Bird Studies Canada, Port Rowan, ON, Canada. ***DAVID BRANDES** (brandesd@lafayette.edu) Lafayette College, Easton, PA, U.S.A. STEPHEN W. HOFFMAN, Helena, MT, U.S.A. JULIE BROWN, Hawk Migration Association of North America, Detroit, MI, U.S.A. JASON SODERGREN, Hawk Migration Association of North America, Detroit, MI, U.S.A.

Through the Raptor Population Index (RPI) project, a partnership consisting of the Hawk Migration Association of North America, Hawk Mountain Sanctuary, HawkWatch International, and Bird Studies Canada, recreational hawk watching has become a major citizen-science effort contributing to raptor conservation. In 2008, RPI produced the volume, State of North America's Birds of Prey, which summarized trends in count data from 21 migration watch sites using data collected through 2004. More than 10 years of additional data have accrued since that time, and many additional sites have been added to the monitoring network. This poster highlights the results of the 2016 update and synthesizes the individual site trend results into regional patterns for each species. Species with decreasing migration counts in the most recent decade include: Osprey (Pandion haliaetus), Sharp-shinned Hawk (Accipiter striatus), Cooper's Hawk (A. cooperii), and Northern Harrier (Circus hudsonius) in the east; Northern Goshawk (A. gentilis) in the east, central, and west; Red-tailed Hawk (Buteo jamaicensis) in the east and gulf; Rough-legged Hawk (B. lagopus) and American Kestrel (Falco sparverius) in the east and central; and Prairie Falcon (F. mexicanus) in the west. Species with increasing migration counts include Bald Eagle in the east, Swainson's Hawk (B. swainsoni) in the west, and Merlin (F. columbarius) and Peregrine Falcon (F. peregrinus) across all regions. It is recognized that for partial or short-distance migrants these results may reflect shifts in migratory behavior and ranges rather than population changes (e.g., Red-tailed Hawk). Nonetheless, the results suggest that some formerly stable populations are now in decline (e.g., Osprey and possibly Northern Harrier in the east) and may warrant additional conservation efforts by the raptor research community.

Occupancy and Success of Barred Owls Along a Forest-to-Urban Land Cover Gradient in Clemson, South Carolina

***MARION CLEMENT** (mcleme2@clemson.edu) Forestry and Environmental Conservation Department, Clemson University, SC, U.S.A. KYLE R. BARRETT Forestry and Environmental Conservation Department, Clemson University, SC, U.S.A. PAUL B. LEONARD U.S. Fish and Wildlife Service, AK, U.S.A. CLAIRE STUYCK Alaska Songbird Institute, Fairbanks, AK, U.S.A. ROB BALDWIN Forestry and Environmental Conservation Department, Clemson University, SC, U.S.A.

Urban areas are increasing in size and population density throughout the United States. Many wildlife species respond negatively to habitat fragmentation, noise, and other pressures accompanying urbanization. Nevertheless, some species quickly adjust to anthropogenic changes in the environment. While the Barred Owl (Strix varia) has been used as a management indicator species for mature forest health, some studies have found they can inhabit urban settings providing some key habitat features remain. We plan to sample Barred Owls along a forest-to-urban land cover gradient to assess the impacts of urbanization in the Piedmont ecoregion of South Carolina. This region is currently experiencing high population growth rates and rapid development; however, some areas on and near Clemson University retain mature trees. The presence of established and newer developed areas offers an opportunity to assess Barred Owl sensitivity to a range of urban landscape types. To date we have visited 55 sites three times each during the 2017 breeding season. We plan to apply an occupancy

analysis framework to these data to understand the influences of land cover, canopy, and water features on the presence of Owls. In our preliminary analysis, sites were categorized as within or near campus (urban) or forested (n = 19 and 36, respectively). Fewer breeding pairs were found on campus sites (n = 1) than in the forested sites (n = 8). Detection was relatively consistent across survey months (20% occupancy rate in February, 18% in March, 16% in June/July). In addition to continuing site surveys in 2018, we hope to investigate finer scale movement patterns along the forest-to-urban gradient. Describing habitat necessary for the survival and breeding of Barred Owl populations is increasingly important in light of expanding urbanization. This work is part of an ongoing graduate research study in Clemson University's Department Forestry and Environmental Conservation.

The Arctic Falcon Specialist Group, the Circumpolar Biodiversity Monitoring Program and Trends in Arctic Falcon Populations

***ALASTAIR FRANKE** (alastair.franke@ualberta.ca) Arctic Raptors Project, Rankin Inlet, Canada KNUD FALK South Greenland Peregrine Project, Ljusstöparbacken Stockholm, Sweden. SØREN MØLLER Roskilde University Library, Universitetsvej Roskilde, Denmark. OLAFUR K. NIELSEN Icelandic Institute of Natural History, Borgum vid Nordurslod, Akureyri, Iceland. CAROL MCINTYRE National Park Service, Fairbanks, AK, U.S.A. DAVID MOSSOP, Yukon College, Whitehorse, YT, Canada. TUOMO OLILLA, Metsähallitus, Natural Heritage Services, Finland. PETER BENTE (Retired), Alaska Department of Fish and Game, AK, U.S.A. KURT BURNHAM, High Arctic Institute, Orion, IL, U.S.A. TOM CHRISTENSEN, Aarhus University, Ny Munkegade, Denmark. PERTTI KOSKIMIES, Kirkkonummi, Finland. SERGEY GANUSEVICH, ANO Wild Animal Rescue Centre, Moscow, Russia. SERGEY KHARITONOV, Bird Ringing Centre of Russia, Moscow, Russia. KENNETH JOHANSEN, Kautokeinovn, Alta, Norway. DAVID L. ANDERSON, The Peregrine Fund, Boise, ID, U.S.A. ULLA FALKDALEN, Projekt Jaktfalk/Birdlife Sweden & Jämtlands läns Ornitologiska Förening, Frösö-Berge, Frösön, Sweden. ARVE ØSTLYNGEN, Alta, Norway. KIM POOLE, Aurora Wildlife Research, Nelson, BC, Canada. MARK PROSTOR, Arctic Raptors Project, Rankin Inlet, Canada. ALEKSANDR SOKOLOV, Russian Academy of Sciences, Labytnangi Yamal-Nenets Autonomous District, Russia. VASILY SOKOLOV, Russian Academy of Sciences, Labytnangi Yamal-Nenets Autonomous District, Russia. TED SWEM, US Fish and Wildlife Service Fairbanks, AK, U.S.A.

The Peregrine Falcon (Falcon peregrinus tundrius) and Gyrfalcon (Falco rusticolus) are top avian predators of the Arctic terrestrial environment, and have been identified as Focal Ecosystem Components within the Circumpolar Biodiversity Monitoring Program led by the Arctic Council. Although both species have been the subjects of long-term monitoring, much of the available information on population trends and reproduction is limited to works published by individual researchers. The objective of this poster is to introduce the Arctic Falcon Specialist Group that has initiated data sharing and joint analyses from study areas and monitoring projects throughout the Arctic in order to conduct a comprehensive and comparative synthesis of the long-term trends. Results of our combined efforts will appear in the Arctic Council's "State of the Arctic Terrestrial Biodiversity Report" due in 2018. In addition to supporting the Circumpolar Biodiversity Monitoring Program, the goals of Arctic Falcon Specialist Group are to organize workshops and collaborative field programs that allow for implementation of broad scale research efforts. This work represents a first effort to harmonize data sets that were collected using different protocols that make comparisons among studies challenging. The Arctic Falcon Specialist Group will work towards the use of consistent data collection protocols and terminology to facilitate comparisons of data over time and space, reduce confusion and allow for clear communication of results. Here we summarize preliminary information from Peregrine Falcon monitoring in Nunavut, Canada, South Greenland, and northern Finland; and for Gyrfalcon monitoring in Alaska, USA, northern Greenland, and Iceland. The preliminary compilation shows the now well-established recovery of Peregrine Falcon populations that were depleted, but with variable, and in some cases declining, reproductive performance over time. Results for Gyrfalcons exhibit a cyclic response to Ptarmigan (Lagopus sp.), which are critical to successful reproduction in most areas.

Trends in Bald Eagle Nesting Habitat: Insights Gained from the Wind Energy Industry

***JULIA C. GARVIN** (julia.garvin@tetratech.com) Tetra Tech, Inc. Portland, OR, U.S.A. JENNY TAYLOR, Tetra Tech, Inc. Portland, OR, U.S.A. KRISTINA DICK, Tetra Tech, Inc. Portland, OR, U.S.A. RICH YOUNG, Tetra Tech, Inc. Portland, OR, U.S.A.

The recovery of the Bald Eagle (Haliaeetus leucocephalus) population over the past 40 yrs has led to an increase in nest locations throughout the United States. Historically, suitable nesting habitat typically included forested areas in close proximity to large bodies of water and away from human activity. The recovery of the Bald Eagle has resulted in increased nesting densities within the most suitable habitats. We hypothesize that as the most suitable nesting habitats become saturated; Bald Eagles will increasingly breed in areas that were previously considered marginal habitat. To test our hypothesis, we examined Tetra Tech's dataset of Bald Eagle nest locations gathered during aerial and ground-based nest surveys at nearly 30 wind-energy projects (proposed and operational). In order to address the non-random nature of our dataset, we also examined recent data from several statewide Bald Eagle nest datasets. Using geographic information system (GIS) tools, we examined habitat factors that included prey resources and anthropogenic disturbance in relation to nest location. Two broad-scale patterns emerged from our analyses. First, a large number of new nests, not previously recorded in agency databases, were located. This result is consistent with published studies on increasing Bald Eagle populations. Second, as hypothesized, nesting Bald Eagles are increasingly using habitats traditionally described as marginal. For example, one-third of the nests detected in conjunction with surveys at wind-energy projects and nearly

half of the nests in the statewide datasets were located more than 3 km from large water bodies. In comparison to statewide datasets, the nests recorded in conjunction with wind project surveys had a higher percentage of developed habitat. We present the implications of this study as it relates to Bald Eagle research, conservation, and regulatory protection, including recommendations for planning future eagle nest surveys and factors to consider when assessing nest disturbance risk.

Effects of Diet Composition and Nest-site Characteristics on Nestling Physiological Condition and Parental Investment in Gyrfalcons (Falco rusticolus) on the Seward Peninsula, Alaska

**MICHAEL T. HENDERSON (michaelhenderson2@u.boisestate.edu) Boise State University, Boise, ID, U.S.A. MARK J. BECHARD, Boise State University, Boise, ID, U.S.A. TRAVIS L. BOOMS, Alaska Fish and Game, Fairbanks, AK, U.S.A. JENNIFER S. FORBEY, Boise State University, Boise, ID, U.S.A. DAVID L. ANDERSON, The Peregrine Fund, Boise, ID, U.S.A.

One consequence of climate change is novel challenges to wildlife, particularly dietary and range-restricted specialists like the Gyrfalcon. Two influential factors in determining population density in raptors are the availability of preferred prey and quality nest-sites. As a result of dramatic landscape reconfiguration and shifts in spring temperatures, the future of these population constraints are uncertain, potentially leaving Gyrfalcons susceptible to lower reproductive success. Lower quality habitats accrue costs to reproductive efforts by decreasing nestling physiological condition or encouraging an increase in parental investment, both likely precipitating carry-over effects for adults and nestlings. Previous research by our lab has revealed dietary shifts from ptarmigan (Lagopus sp.) to Arctic ground squirrel (Urocitellus parryii), both within and between years, but the physiological and behavioral ramifications remain unclear. Additionally, nest site characteristics will undoubtedly influence the microclimate experienced by nestlings, changing their thermoregulatory needs. We hypothesize that nest microclimate and diet composition will affect nestling physiological condition and parental investment of nesting Gyrfalcons on the Seward Peninsula, Alaska. We installed cameras to capture prey deliveries and determine parental investment for the duration of the nestling period. We installed data loggers to record nest temperature during the incubation period and collected blood and feather samples when nestlings were roughly 25 and 35 d old. Physiological condition was assessed by examining feather corticosterone and by performing hematological tests. In 2016 and 2017 we installed four and 13 cameras, respectively and collected samples from 13 and 45 nestlings. Results from the 2017 season will help determine the relationship between microclimate, offspring physiological condition, parental investment, and nest-site characteristic. As the Arctic continues to see dramatic shifts to its climate, it is important to understand how these changes influence a top avian predator, whose trends are indicative of the health of a vulnerable ecosystem.

Assessment of the Exposure to Anticoagulant Rodenticides in Three Raptor Species of Taiwan

*SHIAO-YU HONG (laughrain@gmail.com) National Pingtung University of Science & Technology, Pingtung, Taiwan. HUI-SHAN LIN, National Pingtung University of Science & Technology, Pingtung, Taiwan. YUAN-HSUN SUN, National Pingtung University of Science & Technology, Pingtung, Taiwan. CHENG-TE YAO, Endemic Species Research Institute, Nantou, Taiwan. TE-EN LIN, Endemic Species Research Institute, Nantou, Taiwan. TSYR-HORNG SHYU, Agricultural Chemicals and Toxic Substances Research Institute, Taichung, Taiwan. WEN-LOUNG LIN, Taichung Wildlife Rescue Group, Taichung, Taiwan

Anticoagulant rodenticides (AR) are used worldwide for vertebrate pest control but also cause serious secondary poisoning to predators. Large-scale monitoring has been conducted in Europe and North America, however, very few cases were reported in Asia. We tested for first- and second-generation AR residues in livers of the three common raptor species in Taiwan: Black-shouldered Kite (BK, Elanus caeruleus, n = 43), Crested Goshawk (CG, Accipiter trivirgatus, n = 44), and Collared Scops-owl (CS, Otus lettia, n = 41). Samples mainly came from rescue centers in the period 2013-2016. The AR exposure rates were 88.4% (BK), 59.1% (CG), and 56.1% (CS). Average residue values were 0.152 (SD = 0.212), 0.051 (SD = 0.043), and 0.057 (SD = 0.075) mg/kg, respectively. There were 35% of BKs that exceeded the speculated threshold of toxicity (0.1 mg/kg). In samples in which AR was detected (n = 87), 55.2% had more than one type of AR with a maximum of six types (in a CG sample). The most frequently detected ARs were Brodifacoum (79.3%), Flocoumafen (51.7%), and Bromadiolone (27.6%). BK had the highest exposure rate due to its specialized habit of eating rats. The Taiwan government has been promoting an anti-rodent campaign and hundreds of tons of second-generation ARs have been provided to farmers and inhabitants for free since the 1980s. This is the first record to show that secondary poisoning of raptors by ARs is a serious and common phenomenon in Taiwan. The rodent control policy has made some adjustments accordingly.

Flammulated Owl Occurrence in Western Wyoming

*NATHAN HOUGH (nathan@tetonraptorcenter.org) Teton Raptor Center, Wilson, WY U.S.A. SAMANTHA DIAZ, Teton Raptor Center, Wilson, WY U.S.A. BRYAN BEDROSIAN, Teton Raptor Center, Wilson, WY U.S.A. KATHERINE GURA, Teton Raptor Center, Wilson, WY U.S.A.

The Flammulated Owl (Psiloscops flammeolus) is a small, nocturnal, migratory owl whose populations in Wyoming are unknown. No nesting records exist for this state sensitive species in western Wyoming, but recent studies have located calling owls nearby in eastern Idaho. In 2016 and 2017, we conducted nocturnal call-back surveys for Flammulated Owls in Teton County, Wyoming. In 2016, we surveyed 160

locations and detected 14 different Flammulated Owls. We used remote sensing data from 2016 detection locations to create a preliminary habitat model to inform 2017 survey locations. We continued surveys in 2017, with an additional 11 detections to date. We classified habitat within 100m and found high use of coniferous forest, followed by mixed conifer and aspen stands. Our results indicate that this species is likely a regular breeder in western Wyoming and regular surveys need to be conducted to assess its range in Wyoming.

Developing a Telomere Length Measurement Assay for Raptor Biology

***STEPHANIE F. HUDON** (stephaniehudon@boisestate.edu), Boise State University, Boise, ID, U.S.A.

Telomeres are short, repetitive DNA sequences (TTAGGG)n on the ends of chromosomes which have been shown to shorten with age and decreased fitness. Several studies have shown a distinct link between the level of stress in a population and the relative rate of telomere shortening. This shortening can be measured through the use of quantitative polymerase chain reaction (qPCR) to determine the effect on avian fitness of a particular stressor. Telomere assays have been performed in songbirds to study the effects of natural and anthropogenic stressors but have not been studied in raptors due to the need to develop reliable reference gene primers to normalize the assay. In species without a published genome this can be particularly challenging. Raptors in the Northwest are subjected to many stressors that can directly affect their fitness. These can include everything from the need to fly further to locate adequate resources and nesting grounds when habitat destruction occurs, the cost of overwintering, and even blood parasite loads. qPCR telomere length measurements give us the ability to measure the effect of these and other environmental factors in a straight forward and rapid manner. The subject of my research is to develop a universal telomere assay for raptors that can provide direct evidence of the effect of environmental and social stressors on raptors.

Comparative Analysis of the Habitat Characteristics, Nest Density and Survivability of Richardson's Merlin (Falco columbarius richardsonii) in the City of Winnipeg, Manitoba

***JUSTINE N. JOSEPHSON-LAIDLAW** (umjosepj@myumanitoba.ca) University of Manitoba, Winnipeg, MB, Canada. RICHARD K. BAYDACK, University of Manitoba, Winnipeg, MB, Canada. DAVID WALKER, University of Manitoba, Winnipeg, MB, Canada. KEVIN FRASER, University of Manitoba, Winnipeg, MB, Canada. RICHARD WESTWOOD, University of Winnipeg, Winnipeg, MB, Canada.

Urban landscapes are thought to provide an environment conducive to enhanced productivity and distribution of Merlins, as observed across North America. In the city of Winnipeg, however, research on the Merlin is unavailable, even though local rehabilitation centres and other efforts have recorded a significant Merlin presence. My study involves ring-banding wild Merlins and those released from local rehabilitation centres, recording nest density for neighbourhoods containing similar habitat characteristics (i.e. mature spruce trees, older homes and vegetation diversity suitable for prey) and radio tracking home range and movement of individuals across the landscape. This research will estimate nesting densities in selected areas of Winnipeg, document specific habitat usage, generate insights and information to assist wildlife rehabilitation operations to improve their practices, and compare spatial ecology in wild and rehabilitated Merlins.

Managing Cliff-nesting Falcon and Eagle Habitat in an Exurban Landscape with High Human Visitation in Boulder, Colorado, USA.

***WILLIAM H. KEELEY** (keeleyw@bouldercolorado.gov) City of Boulder Open Space and Mountain Parks, Boulder, CO, U.S.A.

Growing evidence exists that recreational activity can negatively affect sensitive species – a salient concern for land managers in areas with increasing human populations, but that operate under a dual mandate to provide recreational opportunities and conserve natural resources. The City of Boulder Open Space and Mountain Parks (OSMP) receives 5.6 million visits a yr – almost twice Rocky Mountain National Park – but is chartered to protect 19,000 ha of forest and grassland habitat along the northern Front Range of Colorado, an area with one of the fastest growing human populations in the USA. OSMP manages a series of sandstone slabs about 11 km long, the Flatirons, which offer world-class recreational climbing, but also support a dense population of nesting falcons and eagles (1 nesting pair / 1 km). Using site-specific temporal and spatial restrictions on 13-16 rock formations, and support from local climbing communities and the citizens of Boulder, OSMP has been successful in managing raptor habitat using an adaptive management framework. OSMP seasonal raptor closures average 28 ha in size (range: 0.8 ha – 100 ha); closures enacted to protect Golden Eagles are 60% larger than falcon closures. OSMP annually closes approximately 10% of cliff-habitat from 2/1-7/31 to protect nesting raptors, unless monitoring indicates that closures can be lifted sooner. Since seasonal closures and concurrent nest monitoring were first initiated in 1986, Golden Eagles (Aquila chrysaetos), Prairie Falcons (Falco mexicanus), and Peregrine Falcons (Falco peregrinus) have experienced high nesting success and productivity levels as compared to other raptor populations in the western USA, although our recent data suggests Prairie Falcons may be losing nest sites to Peregrine Falcons. Seasonally closing rock formations and protecting high-quality foraging habitat (i.e., undeveloped grasslands and prairie dog colonies) allow OSMP to support a dense population of cliff-nesting raptors in a relatively exurban landscape.

Could Agitation of the Nest Cup Floor and a Leafy Sprig Lining Help Deter Bird Blow Fly Parasites?

***JOHN S. KIRKLEY** (jack.kirkley@umwestern.edu) The University of Montana, Western Dillon, MT, U.S.A.

Those who study nesting raptors are often familiar with the fact that parasitic fly maggots frequently develop within the ear canals of raptor nestlings. Probably less well known is the fact that many species within these groups of avian-specific, parasitic flies, called bird blow flies (Protocalliphora and Trypocalliphora) also commonly inhabit the soft lining material of bird nests, hiding there as larval maggots and periodically crawling up to the nestlings to obtain blood meals by attaching to the skin of their avian hosts. The incidence of these parasites in the nests of raptors is less well studied, since raptor nests are frequently inaccessible. Video-recorded observations of nest bowl agitation and/or excavation behaviors of a female Northern Goshawk (Accipiter gentilis) in 2015 exhibit a very conspicuous, but apparently unexplained behavior, characterized by the adult using her beak to vigorously pull and jerk the material of the nest cup floor. The observation of a nearly identical sequence of parental nest agitation movements was witnessed by the author in 2016 as he viewed via a live web-cam the activities of the pair of Bald Eagles (Haliaeetus leucocephalus) nesting at the National Arboretum. These observations prompt the question of whether this behavior might be fairly widespread among raptors. Also, one might speculate that the widely observed, but inadequately explained, phenomenon involving parental raptors delivering leafy twigs to their nests throughout much of the nestling period may also potentially have some deterrent function which helps to counter the impacts of these parasitic bird blow fly maggots.

Falconry Techniques in Raptor Rehabilitation

***KRISTIN K. MADDEN** (kristin_madden@fws.gov) U.S. Fish and Wildlife Service, Albuquerque, NM, U.S.A. MATTHEW MITCHELL, San Antonio, NM, U.S.A.

Thousands of raptors are raised, rehabilitated, and released annually throughout the world. In addition, rehabilitation of injured and orphaned eagles has been suggested as a potential option for compensatory mitigation related to eagle take permits. Due to the inadequacy of cage flight alone in pre-conditioning raptors for release, falconry techniques in raptor rehabilitation have become more prevalent, particularly in the last decade. We have found the use of certain falconry techniques to decrease apparent stress in raptors undergoing rehabilitation and have reduced the amount of time required to properly prepare them for release. For example, a study on restraint using falconry hoods in place of towels during treatment and gavage feeding showed a dramatic reduction in stress-related behaviors, such as panting, vocalization, and attempts to escape or attack. The use of millennia-old methods of tethering has eliminated feather and cere damage that is common when maintaining restricted activity birds in pet carriers. Imping broken feathers has eliminated the need for some birds to wait for a molt before release. Conditioning through "Jump-Ups" and creance flight has improved flight and hunting performance, and reduced the time needed to prepare for release, particularly for birds with multiple injuries. The next frontier of rehabilitation might well be the use of drones to carry lures safely on long lines for raptors to chase. Falconers are already using this method for conditioning and training of falconry birds.

Factors Influencing Nest Site Defense Toward Humans by Cooper's Hawks (Accipiter cooperii) in the Albuquerque Area

***KRISTIN K. MADDEN** (kristin_madden@fws.gov) U.S. Fish and Wildlife Service, Albuquerque, NM, U.S.A. BRIAN A. MILLSAP U.S. Fish and Wildlife Service, Albuquerque, NM, U.S.A.

Formerly believed to be secretive and sensitive to human disturbance, Cooper's Hawks are now common urban hawks in many areas. While Cooper's Hawks are more likely to exhibit aggressive behaviors toward conspecific intruders of the same age and sex, agonistic behaviors directed toward humans are reported more and more frequently as these hawks settle increasingly in urban areas. In order to identify potential factors influencing nest site defense toward humans, we collected data from 49 nests during the 2010 breeding season: 24 in Albuquerque urban areas and 25 in the riparian woodland corridor (bosque) that runs through the center of the city. Chi-square tests results support the hypothesis that hawks nesting in urban areas and surrounded by regular human activity are less responsive in defense of nest sites than those nesting in forested areas with minimal human activity. Also individuals in juvenile plumage were more responsive than older Cooper's Hawks. In addition, chi-square tests results indicate a significant relationship between nest site defense and nesting stage. There were increases in nest site defense after hatching and during the fledging stage.

Post-DDT Historical Demography and Population Structure of the Merlin (Falco columbarius) in North America

***BREANNA L. MARTINICO** (Bmartinico@ucdavis.edu) University of California Davis, Davis, CA, U.S.A. GEORGE K. SAGE U.S. Geological Survey, Alaska Science Center, Anchorage, AK, U.S.A. MEG C. GRAVLEY U.S. Geological Survey, Alaska Science Center, Anchorage, AK, U.S.A. SANDRA L. TALBOT U.S. Geological Survey, Alaska Science Center, Anchorage, AK, U.S.A. ANGUS C. HULL Golden Gate Raptor Observatory, Sausalito, CA, U.S.A. BRUCE A. HAAK Eagle, ID, U.S.A. JOSHUA M. HULL Golden Gate Raptor Observatory, Sausalito, CA, U.S.A. and University of California Davis, Davis, CA, U.S.A.

In the mid-1900s, Merlin populations experienced range-wide declines due to eggshell thinning caused by persistent organic pollutants (DDT and DDE). After DDT was banned, North American Merlins steadily recovered over the past 50 yrs, as documented through migration counts, Breeding Bird Surveys, and Christmas Bird Counts. Comprehensively inferring population trends of Merlins across North America has proven to be difficult, as breeding may occur in remote areas and non-breeding populations are dispersed over vast geographic regions. In addition to traditional methods, genetic tools can provide insights into past effects of DDT in Merlins across their North American range. We investigated historical demography and contemporary population structure of Merlins across North America with 24 polymorphic microsatellite loci and a 569 bp sequence of the COI gene of the mitochondrial DNA. We collected contour feathers from 272 Merlins caught at 13 raptor migration monitoring stations across North America. We found no evidence of population structure across all locations sampled. We did, however, detect a signature of population expansion within the last 50 yrs. Our findings are consistent with a bottleneck and recovery associated with DDT use and restriction, suggesting DDT impacted the genetic structure of Merlins in North America. The recovery of Merlin populations in North America mirrors that of other species affected by DDT, however Merlin recovery appears to have trailed behind those species that received focused conservation efforts. Future targeted genomic studies will help to identify additional fine-scale patterns of differentiation and selection.

Microbiome Analysis of Parasitic Louse Flies on Migrating Raptors and the Potential for Pathogen Dispersal

***REBECCA A MCCABE** (rebeccamccabe2@gmail.com) Hawk Mountain Sanctuary, Kempton, PA, U.S.A. KAYLI L. THOMAS Millersville University, Millersville, PA, U.S.A. JOHN R. WALLACE Millersville University, Millersville, PA, U.S.A. JOSEPH P. RECEVEUR Michigan State University, East Lansing, MI, U.S.A. M. ERIC BENBOW Michigan State University, East Lansing, MI, U.S.A. JENNIFER L. PECHAL Michigan State University, East Lansing, MI, U.S.A.

Louse flies (Diptera: Hippoboscidae) are obligate ectoparasites that often cause behavioral, pathogenic and evolutionary effects to their hosts. Interactions between ectoparasites and avian hosts, especially migrating taxa, may influence avian pathogen spread in tropical and temperate ecosystems and affect long-term survival, fitness and reproductive success. Our objectives were to: 1) characterize the abundance of Icosta americana louse flies on migrating raptors over time, and 2) examine the microbial communities found within blood feeding louse flies to provide baseline information on the possible movement and dispersal of avian pathogens via migrating ectoparasites. Surveys for louse flies occurred during fall migration in 2015 and 2016 at a banding station in Northampton County, Pennsylvania where louse flies were collected from eight species of migrating raptors, Bald Eagle (Haliaeetus leucocephalus), Broad-winged Hawk (Buteo platypterus), Cooper's Hawk (Accipiter cooperii), Northern Goshawk (A. gentilis), Northern Harrier (Circus cyaneus), Red-shouldered Hawk (B. lineatus), Red-tailed Hawk (B. jamaicensis), and Sharp-shinned Hawk (A. striatus). Metagenomic analyses of bacterial communities from the louse fly samples was used in addition to QIIME software for determining the abundance of occurring taxa. We found that I. americana microbiomes were characterized by over 90% Enterobacteriaceae. After the removal of Enterobacteriaceae, Firmicutes and Proteobacteria comprised over 80% of the bacterial phyla within I. americana for all raptor species. Firmicutes, Proteobacteria, and Cyanobacteria detected within louse fly microbiomes include genera that act as causative agents of common avian pathogens. The association between louse flies and their microbiomes may elucidate useful information for the conservation of migrating raptors and the direct effects from ectoparasite loads to their avian hosts.

Temporal and Spatial Patterns in Home Range Use by Flammulated Owls (Psiloscops flammeolus) in Pike National Forest

****KATHERINE A. MCGINN** (katherine.mcginn@coloradocollege.edu) Colorado College, Colorado Springs, CO, U.S.A. BRIAN D. LINKHART Colorado College, Colorado Springs, CO, U.S.A.

Home range studies provide a unique approach to understanding the complicated ways individuals interact with their environment. The spatial ecology of most mobile fauna indicate the distribution and abundance of interspecific and intraspecific competitors, shed light on predator-prey dynamics, facilitate understanding of community structure, and illustrate energetic trade-offs associated with foraging. Modern home range studies integrate multivariate approaches grounded in random walk probabilities and the optimal foraging theory to analyze home range use and habitat selection. Avian research has adopted radio telemetry to unpack habitat use by birds to show the diverse ways in which avifauna most efficiently use their environments. Dr. Brian Linkhart's extensive research in Pike National Forest demonstrated that Flammulated Owls preferentially establish home ranges in Ponderosa Pine/Douglas Fir overstory. His work using radio telemetry illustrated Flammulated Owl habitat selection for foraging, territorial singing, and roosting, among other behaviors. My project seeks to expand on this understanding by implementing pinpoint GPS technology to identify changes in temporal and spatial habitat usage by male Flammulated Owls as the breeding season progresses. During the 2017 summer breeding season, we attached trackers to six breeding, territorial male Flammulated Owls in Pike National forest. We recorded GPS coordinate fixes to reflect their movements during the early night and midnight hrs of foraging. Spatial data was recorded over a period of 6 ds during the incubation period and 6 ds during the nestling period. Our results have the potential to: 1) show how foraging behaviors change during the span of one night; 2) show subtle changes in male behavior as their broods mature and energy requirements on the males increase; and 3) expose which particular aspects of their territories males preferentially

target to meet their increasing energetic demands.

Skeletal Lead as a Biomarker of Lead Exposure and Poisoning in California Condors (Gymnogyps californianus)

***GISELE MIGLIORANZA RIZZI** (gmiglior@ucsc.edu) UC Santa Cruz, Santa Cruz, CA, U.S.A. MYRA FINKELSTEIN UC Santa Cruz, Santa Cruz, CA, U.S.A. DONALD R. SMITH UC Santa Cruz, Santa Cruz, CA, U.S.A.

Lead poisoning from feeding on carcasses shot with lead ammunition is the primary cause of mortality in California Condors, but lead-mortalities are likely underestimated because the cause of death (CoD) for many condors is undiagnosed. Here, we investigated whether Condor bone lead levels could serve as an accurate lead exposure biomarker that reflects lead exposure history and poisoning status at time of death. Little is known about lead accumulation in bones of large birds such as Condors, or whether lead levels in different bones reflect exposure history and mortality risk. Lead levels were measured in bones (femur, humerus and tibiotarsus) and bone regions (diaphysis, proximal and distal epiphyses) from 11 California Condors to determine which bones were most diagnostic of lead poisoning. Results indicate that lead-exposed Condors had bone lead levels >50-fold higher (range ~10–200 µg/g) than unexposed birds (~0.5–1 µg/g); and that bone lead levels varied by 3–13 fold between different bones within exposed Condors, but only by ~2 fold between bones in unexposed birds, reflecting interactions between bone mineral turnover rates and lead exposure history. Moreover, lead concentrations in largely trabecular proximal and distal epiphysis of tibiotarsus are higher than in comparable regions of other bones in lead poisoned birds, suggesting that those bone regions are most reflective of recent exposure (wks to mos); lead levels in those bone regions were also are higher ($p < 0.01$) in birds that died of lead poisoning compared to others, while the largely cortical diaphyses of these long bones reflected longer-term cumulative exposure (months-years). Next, we will measure bone lead in Condors with unknown CoD to better determine the impact of lead poisoning on Condor mortality. This approach could be applied to other scavenging birds, including Eagles and Vultures, to help understand the impact of lead exposure on mortality.

Demography and Metapopulation Dynamics of an Urban Cooper's Hawk Subpopulation

***BRIAN A. MILLSAP** (bmillsap@nmsu.edu) New Mexico State University, Las Cruces, NM, U.S.A., and U.S. Fish and Wildlife Service, Albuquerque, NM, U.S.A.

Two general models have been proposed to describe relationships among subpopulations in a metapopulation: (1) source-sink, where immigrants from sources sustain sinks; and (2) balanced dispersal, where dispersal is proportionally equal among subpopulations. Subpopulations in urban and adjacent exurban areas offer an ideal opportunity to test these hypotheses. I conducted such a test using demographic data for female Cooper's Hawks (Accipiter cooperii) from an urban subpopulation in Albuquerque, New Mexico, U.S.A. I used a Bayesian integrated population model to combine annual counts of breeding females and demographic data for the urban subpopulation to estimate immigration. The urban subpopulation grew at an average rate of 8% per year from 2011 – 2015. All surviving juvenile female Cooper's Hawks bred each year; 69% settled on nesting territories in the urban subpopulation, and 31% emigrated to a nearby exurban subpopulation. The annual immigration rate averaged only 1.4%, thus emigration exceed immigration by nearly 30% and balanced-dispersal was not a plausible model. Although these results suggest the urban subpopulation served as a source, the primary recipient subpopulation was not a demographic sink. Instead, differences in migratory behavior appeared to provide urban females with a competitive advantage over exurban females in securing exurban nesting sites. Higher winter prey abundance in the urban subpopulation supported year-long residency among urban female Cooper's Hawks, whereas exurban females were long-distance winter migrants. Urban females that emigrated settled on exurban nesting territories before migrants returned. Thus, emigrant urban females obtained exurban nesting territories without direct competition from philopatric returning migrants. These findings provide further evidence that patch dynamics in a metapopulation can be complex, and may be governed by factors other than just demographic rates and connectivity.

Investigation of the Geographic Origin of Burrowing Owl Fleas with Implications for the Ecology of Plague

****KARA A. MORAN** Boise State University, Boise, ID, U.S.A. DAVID H. JOHNSON Global Owl Project, Alexandria, VA, U.S.A. SAMANTHA EVANS Boise State University, Boise, ID, U.S.A. MATTHEW J. KOHN Boise State University, Boise, ID, U.S.A. JIM BELTHOFF (jbeltho@boisestate.edu) Boise State University, Boise, ID, U.S.A.

Western Burrowing Owls (Athene cunicularia hypugaea) are ground-dwelling owls of western North American grasslands and steppes. These Owls rely on rodent prey and occupy burrows once, or concurrently inhabited by, fossorial mammals and thus frequently harbor fleas. Fleas are noteworthy because they have the potential to vector plague through transmission of Yersinia pestis, the etiological agent of plague. In an unusual association, one predominant species of flea infesting Burrowing Owls is Pulex irritans (Siphonaptera: Family Pulicidae), the so-called human flea. The potential role of P. irritans found on Burrowing Owls in plague dynamics is the subject of investigation. Here, we were interested in the extent to which migratory Burrowing Owls may transport fleas from wintering grounds, where plague can be prevalent, to the breeding grounds. Thus, we used a stable isotopes approach to examine geographic origin of fleas collected from both adult and nestling Burrowing Owls in two populations of Owls in Idaho and Oregon. We examined ratios of stable isotopes of hydrogen, which varies geographically, in breeding season

collections of fleas from Owls, Owl feathers and Owl talons to compare isotopic signatures and decipher geographic origins. We tested the hypothesis that springtime fleas on adult Owls breeding in Idaho and Oregon, but not those from local nestlings, have wintering-ground origins by comparing stable isotope ratios in flea keratin to ratios in feathers and talons of adults and nestlings in each population. Our study helps further the understanding of Burrowing Owl host-parasite relationships and the ecology of plague in western landscapes.

Prospective Wind Energy Projects Posing Very Low Risk to Golden Eagles in the U.S. Southern Great Plains: A Conceptual Approach for Rapid Risk Categorization and Take Permitting

***ROBERT K. MURPHY** (robert_murphy@fws.gov) U.S Fish and Wildlife Service, Albuquerque, NM, U.S.A.

I propose development of a risk-scoring tool to distinguish prospective wind energy projects posing relatively low risk to Golden Eagles (Aquila chrysaetos) from those posing greater levels of risk. Applications of the tool probably would be limited to landscapes where (1) land cover and land use patterns are relatively simple and the Eagle's habitat associations are straightforward, and (2) Golden Eagles are, for the most part, widely scattered. The southern Great Plains, a region experiencing the most rapid, extensive growth in wind energy development in the United States, seems unique in these respects. The risk-scoring tool would be part of the Stage 1 assessment per the U.S. Fish and Wildlife Service's Eagle Conservation Plan Guidance and could limit the need for extensive pre-construction surveys for predicting Eagle fatality rates. I propose that the "scoring" be based on seven attributes important to Golden Eagle occurrence or risk at wind energy projects; six are landscape attributes (percentage cropland, occurrence of Eagle nests, proximity to water bird concentrations, ha of playa wetlands, ha of prairie dog colony, and km of escarpment/ridges for uplift) and the other is total rotor-swept area of proposed turbines. Attributes could be weighted based on known or likely importance. The intent would be for scoring to be done via desktop with modest field verification. Under the Service's current permitting framework, authorized take of Golden Eagles would still be offset by compensatory mitigation completed near the time of permit issuance. In the Southern Great Plains, a tool like this could conceivably help steer wind energy development away from landscapes where risks posted by projects to Golden Eagles are greatest, towards those where risks are least, though its implementation would require considerable policy development and review by the Service.

Buffering Wind Turbines from Mesa Rims to Reduce Risk of Golden Eagle Blade-Strike Mortality

***ROBERT K. MURPHY** (robert_murphy@fws.gov) U.S Fish and Wildlife Service, Albuquerque, NM U.S.A. BRIAN WOODBRIDGE U.S. Fish and Wildlife Service, Yreka, CA, U.S.A. DAVID W. LAPLANTE Natural Resource Geospatial, Yreka, CA, U.S.A. CLINT W. BOAL U.S. Geological Survey Texas Cooperative Wildlife Research Unit, Lubbock, TX, U.S.A. DALE W. STAHLECKER Eagle Environmental, Inc., Santa Fe, NM, U.S.A.

In the Southern High Plains Region of the southwestern United States, Golden Eagles (Aquila chrysaetos) often nest or roost on upper escarpments of mesas and forage at or transit through mesa tops. Rims of these mesas can be optimal places for siting wind energy turbines, such that Golden Eagles may be vulnerable to blade-strike mortality; such instances have been documented in the region. The U.S. Fish and Wildlife Service needs science-based guidance to assist the wind energy industry with turbine siting decisions that minimize risk to Golden Eagles. We used satellite telemetry data from Golden Eagles associated with mesas to quantify the relationship between intensity of use of areas across mesa tops in relation to edges of the mesa rims. Data were derived from six Golden Eagles that dispersed from nests along mesas and one juvenile that dispersed from outside of the study area to a broad area with mesas; we added data from four adults nesting along mesa escarpments outside our study area, as no adults on our study area had been tagged with satellite transmitters. We binned GPS locations of each Eagle in 100m increments across mesa tops, starting with mesa rim edges (± 50m), then quantified locations of each Eagle within 50%, 75%, and 90% kernel density estimates (KDEs) of use intensity across mesa tops. Regardless of KDE scale, most (~55-90%) locations of individual Eagles were within 100m of mesa rims. This distance could be used by the U.S. Fish and Wildlife Service as a recommended, absolute minimum buffer for siting turbines along rims of mesas in the Southern High Plains Region, but further evaluation of KDEs may indicate larger buffers as appropriate depending on how risk averse decision-makers wish to be.

Development of a Species Distribution Model of Golden Eagles in the Kitakami Mountains, Northern Japan

****HARUKI NATSUKAWA** (natsukawa-haruki-gy@ynu.jp) Yokohama National University, Yokohama, Japan. TAKU MAEDA IWATE Prefectural Research Institute for Environmental Sciences and Public Health, Morioka, Japan. HIROYUKI MATSUDA Yokohama National University, Yokohama, Japan.

The Japanese subspecies of Golden Eagle (Aquila chrysaetos japonica), consisting of about 500 individuals in Japan, is designated as endangered species in the Japanese Red List. A conservation policy for the Eagles can be developed by constructing distribution models that elucidate their habitat selection. We studied the nest site distribution of Golden Eagles in the Kitakami Mountains, northern Honshu, one of the densest breeding areas of the Eagles in Japan. The study area was divided into square cells of 1 × 1 km2 and 4 × 4 km2. For each cell, land cover features such as areas of deciduous forest, evergreen forest, logging site or grassland, farmland, urban and water, and topographic features such as mean elevation, mean slope, standard deviation of the slope, area with an inclination of 45° or greater, area with an inclination of 60° or greater, and the difference

between the highest and the lowest altitudes were calculated. These features were compared between the cells with or without Eagle's nests by using a conditional auto-regressive model that considers spatial auto-correlation. The best model was selected by minimum deviance information criterion value. The best models were –0.454 + 1.079 × mean slope + 0.925 × slope standard deviation + 1.815 × difference in altitudes for 1 × 1 km2 scale and –0.282+2.638 × mean slope – 1.007 × slope standard deviation + 0.933 × logging site or grassland + 2.772 × area with an inclination of 60° or more for 4 × 4 km2 scale. The model indicates that the Golden Eagles selected precipitous landscape with high logging sites or grasslands in their nest's neighborhood, and avoided farmland. In conclusion, we need to preserve steep mountainous terrain, facilitate forestry and livestock farming to maintain grasslands for the conservation of Golden Eagles.

Using Mobile Database Technology to Enhance Conservation of Nesting Raptors While Facilitating Military Mission

***SAMANTHA E. PHILLIPS** (sam.phillips@sesincusa.com) Select Engineering Services, Dugway, UT, U.S.A. CORY C. WEBER Argonne National Laboratory, Lemont, IL, U.S.A. JOSHUA K. THROOP Maden Technology, Dugway, UT, U.S.A. ROBERT N. KNIGHT Dugway Proving Ground Natural Resources Office, Dugway, UT, U.S.A. TODD A. KIMMELL Argonne National Laboratory, Lemont, IL, U.S.A.

Dugway Proving Ground (DPG) is an active military testing and training facility located in the West Desert of central Utah. This 3,243 km2 U.S. Army installation provides critical support for chemical and biological defense testing, as well as training facilities to support our nation's warfighter. DPG is also home to several species of nesting raptors, including Golden Eagles (Aquila chrysaetos), three species of Buteo, two species of Accipiter, three species of Falcon (Falco spp.), and at least five species of Owl. These protected raptors often attempt to nest in close proximity to active military testing or training operations, causing conflicts for mission and sometimes leading to mission delay or alteration. In the face of frequent mission disruption, the Natural Resources Office (NRO) at DPG identified the need for a more efficient field data collection and dispersal method. Select Engineering Services and Argonne National Laboratory together developed a mobile database hosted on the ArcGIS Collector application. This new database encompasses 8 yrs of raptor nesting data collected within DPG, complete with nest locations, photos, and histories accessible to a researcher in the field. It also allows for real-time input of new nesting data into the master database. The mobile database assists the DPG NRO in locating and identifying new and previously active raptor nests, mapping nests in relation to military mission activities, controlling undesirable nesting activity using past data to inform proactive nesting deterrents, and protecting currently active nests in active military use areas. The database saves observers' time, increases accuracy of data collection, helps prioritize monitoring efforts using past data, and immediately packages data into useable maps and reports. Overall, this mobile nest database increases the ability of the DPG NRO to facilitate military missions while also preserving and conserving nesting raptors.

Winter Occurrence and Roosting Behavior of Northern Saw-whet Owls (Aegolius acadicus) in Northwestern Arkansas

****MITCHELL L. PRUITT** (mlpruitt@uark.edu) University of Arkansas, Fayetteville, AR, U.S.A. KIMBERLY G. SMITH University of Arkansas, Fayetteville, AR, U.S.A.

Though widely captured in fall in eastern North America, little is known about the southern winter distribution of Northern Saw-whet Owls, hereafter Saw-whet. A fall migration study was conducted from 2014–2016 in northwest Arkansas, during which time 60 Saw-whets were captured, documenting their seasonal existence in the region. However, the extent of that existence is still largely unknown. Captures began in late October, but few were captured by mid-December. Studies and records are nonexistent further south, making Saw-whet distribution in the mid-south a mystery. Based on Arkansas' 13 historical records, we hypothesized that some individuals spend winter in the area. To begin filling this knowledge gap, we attached radio transmitters to 11 Saw-whets in November of 2016 to determine how long they remained in the region. Six individuals stayed for up to 4 mos near our field site, situated on the 5842 ha Madison County Wildlife Management Area. This length of time suggests that some birds are wintering in northwest Arkansas, a region previously not known to be part of the species' winter range. Additionally, we surveyed vegetation surrounding known roosting trees (n = 6), all of which were tall short-leaf pines (Pinus echinata). Average canopy height including roost tree was 20.3 m. All roost trees were in areas that were much more open and sparsely vegetated than expected based on known wintering habitat for the species elsewhere in North America. Average canopy cover was found to be 32.1%, with a range of 9.4–69.7%. The discovery of Saw-whets spending winter in northwestern Arkansas suggests the importance of this region, and others like it throughout the south, in connecting the more well-studied breeding ecology and behavior of Saw-whet Owls to their lesser known non-breeding ecology and behavior.

Use of a Small Unmanned Aircraft Systems (sUAS) to Document Breeding Season Accumulation of Anthropogenic Materials in Osprey Nests

***MICHAEL C. TINCHER** Rocky Mountain Raptor Program, Fort Collins, CO, U.S.A. JAMES F. DWYER (jdwyer@edmlink.com) EDM International Inc., Fort Collins, CO, U.S.A.

Osprey (Pandion haliaetus) regularly incorporate anthropogenic materials into their nests. This often includes plastic twine discarded as litter by people. Twine creates two distinct problems. First, twine creates entanglement hazards, particularly for nestlings who pick up loops of twine on their toes and feet while moving around within the nest. Nestlings can become so entangled in short loops of twine

that blood flow is restricted, causing the foot to become necrotic and binding the nestling in place. In other cases, nestlings attempting to fledge are tethered to the nest by longer loops of twine, allowing birds to jump from the nest, but not fly, and resulting in fledglings dangling upside down below the nest. The second problem created when Osprey incorporate twine in their nests occurs when nests are placed on energized power poles, and twine creates potential paths for electric current, leading to Osprey electrocutions and fires. Because of this risk, electric utilities sometimes remove twine from nests between breeding seasons. In this study, we used a small unmanned aircraft system (sUAS) to document the presence or absence of twine in 13 Osprey nests around Fort Collins, Colorado before and after the 2017 nesting season. On 18 February 2017 we collected high resolution straight-down imagery from 1–2 m above each nest. Twine was present in eight nests. The remaining five nests had been recently cleaned by a local electric utility. After the breeding season concludes, we will repeat our sUAS flight. We expect nearly all nests to include twine, and because two of these nests included twine-related nestling mortalities in 2016, we expect to document additional mortalities. The results of our second sUAS survey will be reported in our poster, as will recommendations for cleaning twine from nests.

Sexual Segregation by Habitat in American Kestrels (Falco sparverius) Wintering in North Texas

**DANIELLE N. VAGUINE (daniellevaguine@my.unt.edu) University of North Texas, Denton, TX, U.S.A. KAYLA R. BROWN University of North Texas, Denton, TX, U.S.A. JAMES C. BEDNARZ University of North Texas, Denton, TX, U.S.A.

American Kestrels in North America have been found to exhibit sexual segregation by habitat on their wintering grounds in Florida, California, Georgia, and elsewhere. Based on these previous results, we predicted that wintering female American Kestrels in north Texas would occupy significantly more open habitats, and that males would be found at sites with more woodland habitat. We also expected the sex ratio of wintering Kestrels in our study area to approximate 1:1. We captured 19 Kestrels in Denton County, Texas in the vicinity of Lewisville or north of Denton. In addition, we included in our analysis the locations of two repeatedly observed birds that proved wary of traps. We then characterized and measured the area of cover types (i.e., disturbed grassland, restored prairie, open pasture, woodland, or other) within a 1 ha circular plot (radius = 56.4 m) using Google Earth images for those 21 locations where Kestrels (12 males and 9 females) were trapped or repeatedly found. The mean percentage of open grassland or prairie in plots occupied by females (84.4%) was significantly greater ($P = 0.036$) compared to the amount of open habitat measured in male plots (66.7%). Further, male plots contained more woodland cover (33.3%) than female plots (15.6%), but this trend was not significant ($P = 0.093$). Our limited sample supported that American Kestrels in north Texas exhibited sexual segregation of habitat similar to that reported elsewhere. Additional data are needed to fully test this hypothesis.

From Continental to Global: The African Raptor Data Bank and its Potential as a Citizen Science Tool for Global Raptor Conservation

*MUNIR Z. VIRANI (virani.munir@peregrinefund.org) The Peregrine Fund, Boise, ID, U.S.A. ROB A. DAVIES Habitat Info Ltd, Rookwood Studios, Solva, Pembrokeshire, U.K. ANDREW RAYNER Habitat Info Ltd, Rookwood Studios, Solva, Pembrokeshire, U.K. TIM C. WROBLEWSKI Habitat Info Ltd, Rookwood Studios, Solva, Pembrokeshire, U.K. RAHMAN LUTFOR Habitat Info Ltd, Rookwood Studios, Solva, Pembrokeshire, U.K. DARCY OGADA The Peregrine Fund, Boise, ID, U.S.A. ANDRE BOTHA The Endangered Wildlife Trust, Modderfontein, South Africa. RALPH BUIJ Wageningen University Research, Wageningen, Netherlands. JOOST BROUWER West African Bird DataBase, Bennekom, The Netherlands. CLIVE R. BARLOW Birds of the Gambia, Banjul, Gambia. HICHEM AZAFZAF Les Amis des Oiseaux (AAO / BirdLife Tunisie) Immeuble ERIS, Ariana, Tunisia. CORINNE J. KENDALL North Carolina Zoo, Asheboro, NC, U.S.A. RICHARD T. WATSON The Peregrine Fund, Boise, ID, U.S.A. CHRIS J. W. MCCLURE The Peregrine Fund, Boise, ID, U.S.A. DAVID L. ANDERSON The Peregrine Fund, Boise, ID, U.S.A. KURT ECKERSTROM Kurt Eckerstrom Consulting Ltd., Washington DC, U.S.A. NICK P. WILLIAMS Coordinating Unit of CMS Raptors MoU, Abu Dhabi, United Arab Emirates.

The African Raptor Databank (ARDB) has grown rapidly since inception at the Pan African Ornithological Congress in October 2012 thanks to the support of hundreds of raptor observers across Africa, coordination by key individuals, and critical financial support from a range of sponsors and donors. We have now completed a 5 yr data collection period. A total of >168k records have been assimilated. The ARDB is managed by Habitat Info and makes use of the latest spatial data technologies to acquire, manage, analyze and disseminate distribution data. The project was conceived to address the issue of habitat loss for many species but with the imminent threats facing Vultures from poisoning, the purpose and objectives of the ARDB have been brought forward and adapted to enable the ARDB to serve a future role as a monitoring tool. The ARDB model has proven its value to raptor conservation on the continent of Africa: improvement of vulture range maps helped with the IUCN up listing of African Vultures and the recent Vulture mapping project has informed the international Vulture multi-species action plan. We have now adapted the technologies to roll out this model worldwide with a global databank and mobile apps. With the development of environmental datasets for modeling new data from all regions of the globe, this will enable us to greatly refine our assessments of area of occupancy, i.e. accurate measurement of a species' past, current and future habitat space, subject to anthropogenic and climate change influences. Unlike other bird recording systems, the global raptor app and database is a specialized niche product with very accurate placement of records and dedicated design for information relevant to raptor species and subspecies and their conservation and biology. These datasets can be combined in collaborative studies. Different language modules will be

added over time.

Risk of Encountering Wind Turbines for Migrating Swainson's Hawks Using Flight Altitude Data

***KATHERYN A. WATSON** (katheryn.watson@ttu.edu) Texas Tech University, Lubbock, TX, U.S.A. CLINT W. BOAL United States Geological Survey Texas Cooperative Fish and Wildlife Research Unit, Lubbock, TX, U.S.A. LAURIE M. GROEN Texas Tech University, Lubbock, TX, U.S.A. JAMES D. RAY Consolidated Nuclear Security, LLC, Amarillo, TX, U.S.A.

Swainson's Hawks (Buteo swainsoni) breed in western North America and migrate over 10,000 km to Argentina. Wind energy is expanding globally, and little research has assessed the potential threat wind turbines pose to migrating Swainson's Hawks. To explore this question, we attached 3-dimensional GPS transmitters to 24 adult Swainson's Hawks near Amarillo, TX. We collected location data from May 2011 to April 2017. We used average wind speed data to classify the migration pathway by the potential for wind energy development as being areas of high (winds > 6 m/s), moderate (4.2-6 m/s), or low (< 4.2 m/s) wind potential. We defined a "risk zone" where flying Swainson's Hawks are potentially at risk of encountering turbines to be 0 to 150 m above ground. We used Aster and GMTED2010 digital elevation models to convert our altitude data to above ground height for analysis. Preliminary results suggest that 61% of migration data points were recorded within the risk zone. Twenty percent of location data were in high-wind-potential areas, where 63% of points were within the risk zone. Ninety-four percent of roost points and 48% of points during active hours were within the risk zone of high-wind-potential regions. Our results indicate that if turbines are built within the migration pathway of Swainson's Hawks in the areas we identified as having high wind potential, migrating birds are likely to be flying at altitudes that put them at risk of turbine collision nearly half of the time. The moments when birds experience the greatest risk of encountering a turbine may be when they are entering and leaving roosting and resting areas. We do not know yet if wind energy will be a detriment to Swainson's Hawk populations, but our results suggest that their migratory behaviors may put them at risk where turbines are installed.

Northern Goshawk Monitoring on the Ashley National Forest: A Framework for Species Conservation

***MARILYN WRIGHT** (wright.marilyn13@gmail.com) Utah State University, Logan, UT, U.S.A., DAN ABEYTA U.S. Forest Service, Vernal, UT, U.S.A., FRASER A. GUY U.S. Forest Service, Vernal, UT, U.S.A., JEANANN DALTON Bureau of Land Management, Challis, ID, U.S.A., STEVE ZANONI Utah State University, Logan, UT, U.S.A., BECKY WILLIAMS Utah State University Uintah Basin, Vernal, UT, U.S.A.

Since 1991, the Ashley National Forest (ANF) has carried out an intensive monitoring effort for Northern Goshawks (Accipiter gentilis). Each year, crews completed a series of nest checks, broadcast surveys, and active nest monitoring protocols, which has created a robust data set of both historical nesting territories and current nesting territories. Regular population cycles are clearly evident in the percent of occupied territories and percent fledged. To date, the ANF Northern Goshawk percent-occupancy rate 3 yr moving average has remained stable during the period of this study from 1992 to 2016, despite large fluctuations in fledgling productivity on a 7–8 yr cycle. This nesting data has also helped shape the understanding of Northern Goshawk nesting habitat use within the forest as well as guiding forest managers to mitigate negative impacts towards the species. Over the next few yrs, we will be adding to the understanding of Goshawks on the ANF by incorporating habitat modeling through remote sensing, prey DNA analysis, predator-prey cycling patterns, and survivorship assessment. Northern Goshawks are important apex predators in forest ecosystems, but they face many threats including pine beetle kill, fire suppression and high-intensity burns, overgrazing, and potential adverse impacts from climate change. The completeness of the ANF's long-term study provides a unique opportunity to examine how Goshawks have responded to some of these potential threats throughout the last 26 yrs and may provide the opportunity for us to predict how future threats may impact Goshawk populations, potentially giving us the chance to mitigate these impacts before they occur.

GPS-GSM Telemetry of Red-tailed Hawks (Buteo jamaicensis) on Fall Migration at San Francisco, CA

***LAURA G. YOUNG** (lyoung@parksconservancy.org) Golden Gate Raptor Observatory, Sausalito, CA, U.S.A. CHRISTOPHER W. BRIGGS Golden Gate Raptor Observatory, Sausalito, CA, U.S.A. ALLEN M. FISH Golden Gate Raptor Observatory, Sausalito, CA, U.S.A. ANGUS C. HULL Golden Gate Raptor Observatory, Sausalito, CA, U.S.A.

Recent studies of Red-tailed Hawk movements suggest more complex migration strategies than a simple "south in the fall, north in the spring" pattern, and birds in the Pacific Flyway appear to follow that trend. From 2012 to 2015, the Golden Gate Raptor Observatory deployed GPS/GSM transmitters on Red-tailed Hawks during fall migration at the Marin Headlands. Of fourteen units set out, seven reported for 3-14 ds, one for 55 ds, and six for >200 ds. A final unit failed to report after the bird was released—the bird was brought into a local wildlife clinic 12-mo later still carrying the transmitter but the manufacturer was unable to recover any data. For those birds (n = 6) with sufficient data, a few trends emerged. Four of the six wintered in the greater San Francisco Bay (including areas north to Point Reyes, south to Palo Alto, and east to Livermore), while the other two moved to southern Oregon. The regionally mild climate and abundant sciurid population in the Bay area make it an excellent stopover point for many migrants. Evidence further suggests birds may use a pass in the southern Cascades to move between coastal California and the northern Great Basin.

CONFERENCE SCHEDULE

THURSDAY, NOVEMBER 9

	Canyons	Arches	Bryce
8:00 am	Announcements and Plenary Jim Bednarz		
9:40 am	Break		
	Raptors and the Energy Sector Symposium I (S. Slater)	**Foraging and Feeding (B. Washburn)**	**Environmental Contaminants and Raptors Symposium (M. Jones)**
10:00 am	K. Kritz, Update from USFWS on Eagle Rule and Permits	R. Hatfield, Martial Eagle Ecology in Kenya	N. Schoch, Raptor Toxicology Sample Collection-Processing
10:20 am	M. Sur, Evaluating Survey Designs for Wind-Wildlife Interactions	T. Ting, Winter Diet of Short-eared Owls in Illinois	- - -
10:40 am	T. Allison, Automated Eagle Detection	A. Marsh, Tracking Burrowing Owls with Hi-res GPS	M. Murray, Anticoagulant Rodentcides
11:00 am	T. Dietsch, Raptors and Solar	W. Keeley, Diet and Behavior of Ferruginous Hawks	J. Ponder, Exploring the Risk of Neonicotinoids in Wild Birds
11:20 am	M. Kuehn, Swainson's Hawks and Solar Energy in California	M. Tétreault, Foraging Patterns of Arctic-Breeding Peregrine Falcons	L. Murphy, Pentobarbital Poisoning in Raptors
11:40 am	Panel Discussion	B. Robinson, Dietary Plasticity in a Specialist Predator, the Gyrfalcon	M. Jones, Mercury Toxicosis in Raptors
12:00 pm	Lunch		
	Raptors and the Energy Sector Symposium II (S. Liguori)	**Understudied Open Land Raptors Symposium I (J. Watson)**	**Migration I (C. McIntyre)**
1:20 pm	H. Edwards, Avian Electrocutions: Background	T. Swem, Rough-legged Hawks: Ecology and Conservation	J. Keane, Pacific Raptor Trends
1:40 pm	N. Turley, Preventing Raptor Electrocutions	A. Paiemnet, Rough-legged Hawk Movement Ecology	D. Smith, Yellowstone Raptors
2:00 pm	D. Leiker, Multi-species Management Conflicts	N. Paprocki, Wintering and Migration Rough-legged Hawks	R. Domenech, Red-tailed Hawks, Migration
2:20 pm	E. Mojica, Mitigating Golden Eagle Electrocutions	J. Kidd, Range and Route Fidelity of RLHA in North America	J. Kirkley, Putting to Rest the Myth of Fasting Migration
2:40 pm	S. Liguori, Power Pole Retrofitting Effectiveness	J. Kidd, Movements of Rough-legged Hawks in Alaska	K. Watson, Swainson's Hawk Migration Strategy
3:00 pm	Break		

CONFERENCE SCHEDULE

THURSDAY, NOVEMBER 9

	Canyons	Arches	Bryce
	Raptors and the Energy Sector Symposium III (S. Liguori)	**Understudied Open Land Raptors Symposium II (J. Kid)**	**Migration II (C. McIntyre)**
3:20 pm	J. Dwyer, Avian Electrocutions in Hungary	J. Ng, Canadian Ferruginous Hawk Population Status	L. Goodrich, Stopover Habitat of Migrating Broad-winged Hawks
3:40 pm	C. Frank, Mitigating Eagle Nests on Transmission Lines: Challenges and...	J. W. Watson, Ferruginous Hawk Nomadism	R. McCabe, Movement Ecology of Broad-winged Hawks
4:00 pm	Panel Discussion	J. L. Watson, Perches and Ferruginous Hawks	J. Mallon, Tolerance to Changing Weather by Turkey Vultures
4:20 pm	Panel Discussion	C. Nordell, Deterrents Reduce Ferruginous Hawk Fence Use	J. Eisaguirre, Movement Model Reveals Behavioral Patterns
4:40 pm	- - -	Z. Wallace, Influences on Ferruginous Hawk Breeding Performance	S. LaPoint, Golden Eagle Migration and Climate Change
6:00 pm-9:00 pm		Poster Session & Reception	

Photo by Neil Paprocki

CONFERENCE SCHEDULE

FRIDAY, NOVEMBER 10

	Canyons	Arches	Bryce
8:00 am	Announcements and Plenary Andre Botha		
9:40 am		Break	
	Speed Talks - 10 minutes each (T. Booms)	**Understudied Open Land Raptors Symposium III (J. Watson)**	**Anthropological Effects with Raptors I (J. Ng)**
10:00 am	R. Buij, Nocturnal Hunting... R. Bourbour, Do Migrating Songbirds...	J.F. Therrien, Reproductive Ecology of Rough-legged Hawks	B. Washburn, Owl-aircraft collisions
10:20 am	J. Carlisle, Golden Eagles under... J. Herzog, Niche Partitioning Between...	G. Rozhon, Wintering Ecology and Movements of Rough-legged Hawks	S. Slater, Eagle Vehicle Strike Risk
10:40 am	G. Bedrosian, Habitat of Golden... E. González, Spanish Imperial Eagles...	K. Hawkshaw, Prey Abundance and Distribution	C. Davis, Wildfire, Recreation and Golden Eagles
11:00 am	R. Murphy, Golden Eagle Natal... C. Dykstra, Nest-defense of...	J. Tischendorf, Ferruginous Hawks in North Central Montana	J. Platt, Determining Risk to Raptors at Wind Energy Projects
11:20 am	E. Wommack, Polymorphic Plumage... C. Hayes, Nest Flies Impact Fitness...	M. Stuber, Lead Exposure of Ferruginous Hawks Nesting in Southwestern Idaho	J. Heath, Kestrel Survival
11:40 am	D. Anderson, Ridgway's Hawk Survival C. McClure, Restoring the Ridgway's Hawk	- - -	M. Sur, Diel Behavior Patterns of Golden Eagles
12:00 pm	Lunch		
	Ecotoxicology and Health of Raptors I (M. Stuber)	**Understudied Open Land Raptors Symposium IV (C. Nordell)**	**Anthropological Effects with Raptors II (J. Garvin)**
1:20 pm	S. Hong, Black Kite Poisoning Crisis in Taiwan	A. Hinde, Wintering Raptors of the Great Basin	T. Miller, Bald Eagles in Upland Landscapes
1:40 pm	M. Horvath, Mitigating the Poisoning of Imperial Eagle	W. Clark, Ageing and Sexing Rough-legged Hawks	J. Dwyer, Golden Eagle Electrocution
2:00 pm	A. Botha, Poisoning Intervention in South Africa	K. Steenhof, Monitoring Prairie Falcons	A. Duerr, Golden Eagle flight and topography
2:20 pm	D. Scott, Pesticide Toxicosis in Red-Shouldered Hawks	D. Bell, Prairie Falcons in California	P. López-López, Technology Saves Time and Money: Assessment of Electrocution
2:40 pm	B. Dudek, Mexican Chicken Bugs in Golden Eagle Nests	- - -	- - -
3:00 pm	Break		

CONFERENCE SCHEDULE

FRIDAY, NOVEMBER 10

	Canyons	Arches	Bryce
	Ecotoxicology and Health of Raptors II (A. Duerr)	**Understudied Open Land Raptors Symposium V (N. Paprocki)**	**Public Engagement and Collaborations (C. Preston)**
3:20 pm	Z. Kuspa, Glucocorticoid Measurement in Condors	J. Morrison, North America's Only and Little-known Caracara	C. Pozzanghera, Golden Eagle monitoring network
3:40 pm	R. Bourbour, Migrating Raptors and Mercury Trends	R. Miller, Short-eared Owls in the Intermountain West	L. D. Smith, Raptor Ringing Using Falconers in Turkey
4:00 pm	T. Katzner, Lead in Raptors	W. Pearson-Prestera, Long-term Movements of Northern Harrier	C. Priestley, Community Engagement in Raptor Monitoring
4:20 pm	- - -	C. Vennum, Juvenile Swainson's Hawk Demography	Z. Greenberg, What Curriculum Can Do for Our Rarely-loved Raptors
4:40 pm	- - -	Discussions	K. Fuller, Broad-wing Curriculum Using HMS Migration Data

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CONFERENCE SCHEDULE

SATURDAY, NOVEMBER 11

	Canyons	Arches	Bryce
	Innovations in Raptor Education Symposium I (E. Brown)	**Breeding Behavior of Raptors I (J. Morrison)**	**Habitat Use I (L. Priestley)**
8:00 am	Opening Talk - P. M. Maxifled, Communicating Science to Non-Science...	F. Atuo, Landscape Characteristics and Predator Proximity Alter Nesting...	R. Crandall, Golden Eagle Space Use
8:20 am	I. MacLeod, Using Satellite Tracking of Ospreys as a Teaching Tool	J. Smallwood, Weather and Breeding American Kestrels	J. Ng, Ferruginous Hawk Habitat Quality & Human Landuse
8:40 am	S. Hawks, Inspiring Conservation through Interpretation	P. Benson, 37 years of Cape Vulture Reproductive Activities	K. Townsend, Ferruginous Hawk Habitat Suitability
9:00 am	J. Nelson, Incorporating Data in the Classroom	L. Thompson, Hooded Vulture Breeding Ecology	T. Regan, Use of GPS Dataloggers to Examine Behavior and Resource...
9:20 am	A. Carter, Distance Education at Hawk Mountain Sanctuary	T. Styhl, Development of Osprey Nestlings	T. Ting, Short-eared Owl in Winter
9:40 am		Break	
	Innovations in Raptor Education Symposium II (N. Wayment)	**Breeding Behavior of Raptors II (C. Vennum)**	**Habitat Use II (T. Miller)**
10:00 am	S. Wilson, Connecting Human and Raptor Migration	A. Shreading, Osprey, Telemetry	S. Poessel, Weather Influences of California Condor Flight
10:20 am	H. Ware, Using Transmitters as an Outreach Tool	C. McIntyre, Movements of Pre-Breeding Migratory Eagles	K. Harrington, Inter Island Movements of Striated Caracaras
10:40 am	L. Goodrich, The Pennsylvania Farmland Raptor Project: Conserving Farmland...	M. Mika, Breeding and Foraging in Flammulated Owls	J. Tischendorf, Monitoring the Wintertime Occurrence of Gyrfalcons in Montana
11:00 am	G. Garber, Monitoring Raptor Populations in Central New Mexico – A Citizen...	J. Shonfield, Owl Vocal Activity	A. Franke, Priorities for Gyrfalcon Research
11:20 am	S. Schulwitz, Citizen Science: American Kestrel Partnership	K. Gura, Accuracy of Methods to Estimate Occupancy of Owls	H. McCaslin, Environmental Correlates of Dispersal Trends
11:40 am	R. Miller, Citizen Scientist Survey of Short-eared Owls	W. Clark, Natural Hybrids Occur in Raptors	M. Lanzone, Eagle Flight Behavior using GPS and Accelerometry Data
12:00 pm	Lunch		

CONFERENCE SCHEDULE

SATURDAY, NOVEMBER 11

	Canyons	Arches	Bryce
	Innovations in Raptor Education Symposium III (E. Brown)	**Raptor Demographics I (B. Millsap)**	**Population Monitoring I (B. Robinson)**
1:20 pm	S. Mehus, A Wintering Golden Eagle Survey Citizen Science Project	D. Haines, Golden Eagles, Yellowstone National Park	J. Tischendorf, Southernmost Breeding Ospreys in the Western Hemisphere
1:40 pm	M. Virani, GRO App as a Citizen Science Tool for Global Raptor Conservation	C. Boal, Survival of Fledgling Golden Eagles	C. Muench, Evaluating Long-Term Turnover of Northern Goshawks
2:00 pm	C. Adams, Strategies for Successful Citizen Science	J. Brown, Golden Eagle Movements	M. Judkins, Genomic Insights into Bald Eagle Ecology
2:20 pm	L. Priestley, Alberta's Nocturnal Owl Monitoring Program	S. Mullican, Amer. Kestrel Survival and Productivity in TX	M. Brinkmeyer, The American Kestrel Genoscape Project
2:40 pm	E. Katzner, Providing Good Welfare for Education Raptors	V. Morandini, Age of First Breeding and the Extinction Risk	M. Ferrer, Reintroducing Endangered Raptors
3:00 pm	Break		
	Innovations in Raptor Education Symposium IV (N. Wayment)		
3:20 pm	T. Sproat, Behavioral Ecology in Training and Managing Raptors		

Photo by Jeremy Halka

SPEAKERS INDEX

NOTES

PARTICIPANT DIRECTORY

Name	Affiliation
Manabu Abe	Raptor Japan
Dan Abeyta	US Forest Service
Steven E. Alsup	Birds of Prey NCA Partnership
Kate Atkins	NaturEner
Brian Barber	UW Biodiversity Institute
Chris P. Barger	Alaska Dept. of Fish and Game
Joe Barnes	Nevada Dept. of Wildlife
Jacqueline Barry	Columbia University
James C. Bednarz	University of North Texas
Bryan Bedrosian	Teton Raptor Center
Geoffrey Bedrosian	U.S. Fish & Wildlife Service
Douglas A. Bell	East Bay Regional Park District
Patrick C. Benson	Univ of the Witwatersrand/Univ of Maryland
Richard O. Bierregaard	Academy of Natural Sciences
Karen Blaugrund	
Peter H. Bloom	Bloom Biological, Inc.
Clint W. Boal	USGS Texas Cooperative Research Unit
Travis L. Booms	Alaska Dept. Fish & Game
Ryan Bourbour	University of California, Davis
Andrew C. Bradshaw	San Francisco State University
David Brandes	Lafayette College
Michaela Brinkmeyer	Boise State University
Julie Brown	HMANA
Jessi L. Brown	University of Nevada, Reno
Erin Brown	Hawk Mountain Sanctuary
Evan R. Buechley	Univ of Utah / HawkWatch International
Ralph Buij	Wageningen University
Susan E. Burchardt	Woodland Park Zoo
Ron Van Den Bussche	Oklahoma State University
James M. Butch	USGS//MU
Kathleen Callery	Boise State University
Julia Camp	Coconino National Forest
Jason D. Carlisle	WEST, Inc.
Adam Carter	Educator
Eric Chabot	HawkWatch Interntional
Joni Clapsadle	Intermountain Bird Observatory
Kathleen E. Clark	NJ Fish & Wildlife
William S. Clark	
Marion Clement	Clemson University
Michael W. Collopy	University of Nevada, Reno (Emeritus)
Kevin E. Corwin	Raptor Education Fdtn
Joseph Dane	HawkWatch Interntional
Kate P. Davis	Raptors of the Rockies
Caitlin Davis	Boise State University
Edward A. Deal	Seattle Cooper's Hawk Project
Matthew Delgado	Humboldt State University
Michael Detloff	Wings and Talons
Joseph DiDonato	Wildlife Consulting & Photo
Thomas Dietsch	
Rob Domenech	Raptor View Research Inst
Ben Dudek	Boise State University
Adam E. Duerr	Bloom Research Inc.
Leah Dunn	Birds of Prey NCA Partnership
James F. Dwyer	EDM International
Cheryl Dykstra	Raptor Environmental
Daly Edmunds	Audubon Rockies
Joseph M. Eisaguirre	University of Alaska Fairbanks
David H. Ellis	Retired
Teresa Ely	Golden Gate Raptor Observatory
Debby Farley	

Name	Affiliation
Jane Ferreyra	HMANA
Dan Fitzgerald	Cellular Tracking Technologies
Kate Fleming	Delaware Division of Fish and Wildlife
Cristina Frank	Pepco Holdings
Alastair Franke	Arctic Raptors Project
Kirsten Fuller	Hawk Mountain Sanctuary
Gail L. Garber	Hawks Aloft, Inc.
Julie C. Garvin	Tetra Tech, Inc.
Enrique González	Doñana Biological Station (CSIC)
Laurie J. Goodrich	Hawk Mountain
Arthur W. Green	
Zoey Greenberg	Hawk Mountain Sanctuary
Emma Gregory	Boise State University
Katherine Gura	Teton Raptor Center
David B. Haines	University of Montana
Carole E. Hallett	Pacific Habitat Services
Eric Hallingstad	WEST, Inc.
Scott Hampton	NaturEner
Annette Hansen	HawkWatch Interntional
James Harper	BLM Retired
Katie Harrington	Hawk Mountain Graduate Student
Fawn Harris	West Sound Wildlife Shelterr
Richard S. Hatfield	University of Kentucky
Shawn Hawks	University of Iowa
Kevin Hawkshaw	University of Alberta
Christine Hayes	Boise State University
Julie A. Heath	Boise State University
Ambar Vázquez Heijnen	Univ Autonoma de Guadalajara México
Judith L. Henckel	
Michael Henderson	Boise State
Charles J. Henny	USGS (Emeritus)
Jessica L. Herzog	University of Alaska Fairbanks
Al J. Hinde	
Sofi Hindmarch	Fraser Valley Conservancy
Katsui HIRAI	
Shiao-yu Hong	PhD Candidate, TAIWAN
Nathan Hough	Teton Raptor Center
Brent Houskeeper	
Stephanie Hudon	Boise State University
Thomas B. Hudson	Intermountain Bird Observatory
Anjolene Hunt	Boise State University
Melissa Hunt	USGS
Frank B. Isaacs	Oregon Eagle Foundation
Kenneth Jacobson	Arizona Game and Fish Department
Mackenzie Jeffress	Nevada Department of Wildlife
Kenneth Johansen	Norway
Michael P. Jones	University of Tennessee
Megan Judkins	Grey Snow Eagle House
Gregory Kaltenecker	Boise State University
Todd E. Katzner	US Geological Survey
William H. Keeley	City of Boulder Open Space & Mtn Parks
Jeff W. Kidd	Kidd Biological, Inc.
Nina J. Kidd	Kidd Biological, Inc.
Lloyd F. Kiff	
Hanna Kim	Boise State University
John S. Kirkley	Univ. of Montana - Western
Michael N. Kochert	U.S. Geological Survey
Kevin J. Kritz	U.S. Fish & Wildlife Service
Michael J. Kuehn	Bloom Research, Inc.
Zeka E. Kuspa	UC Santa Cruz

PARTICIPANT DIRECTORY

Name	Affiliation
Justine Josephson-Laidlaw	University of Manitoba
Keith LaSage	GeoTrak, Inc.
Diana L. Leiker	APLIC
Kurt L. Licence	Arizona Game and Fish Department
Li-Chen Lin	
Mike Lockhart	Wildlands
Pascual López-López	University of Valencia, Spain
Iain MacLeod	Squam Lakes Natural Science Center
Kristin K. Madden	USFWS
Julie Mallon	University of Maryland
Alan Marsh	Lotek Telemetry
Mark S. Martell	Tetra Tech
Audrey M. Martin	
Breanna Martinico	University of California, Davis
Rebecca A. McCabe	Hawk Mountain Grad Student McGill Univ
Kyle McCarty	Arizona Game & Fish Department
Christopher J. McClure	The Peregrine Fund
Michael McCrary	Bloom Research
Andrew J. McGann	Cellular Tracking Technologies
Katherine McGinn	Colorado College
David McGuire	
Carol McIntyre	National Park Service
Scott Mehus	National Eagle Center
Elizabeth Meisman	Humboldt State Univ / Boise State Univ
Shea Meyer	Salt River Project
Markus Mika	University of Wisconsin La Crosse
Erica A. Miller	NJ Div Fish & Wildlife
Robert Miller	Intermountain Bird Observatory
Trish Miller	Conservation Science Global
Elizabeth K. Mojica	EDM International
Kara Moran	Boise State University
Joan L. Morrison	Trinity College
Dave H. Mossop	Yukon College, Can.
Carly Muench	University of Montana
Shea Mullican	Texas Tech University
Lisa Murphy	University of Pennsylvania
Maureen Murray	Tufts University
Haruki Natsukawa	Yokohama National University
Janet Nelson	HawkWatch Interntional
Gerald J. Niemi	U of Minnesota-Duluth
Cameron J. Nordell	Contracting Ecologist
Torgeir Nygard	Norwegian Institute for Nature Research
David Oleyar	HawkWatch Interntional
Nicole Tomes-Orlale	
Kristi Overgaard	Wordsetter Editorial Services
Alexandre Paiement	Arctic Raptors
Jason Palframan	NaturEner
Neil Paprocki	HawkWatch Interntional
Christopher N. Parish	The Peregrine Fund
Paul Parker	HawkWatch Interntional
Dusty Perkins	College of Western Idaho
Sharon Poessel	USGS
Theresa L. Pope	Utah Division of Wildlife Resources
Casey Pozzanghera	Boise State University
Charles R. Preston	Draper Natural History Museum
Chuck Priestley	STRIX Ecological Consulting
Lisa Priestley	STRIX Ecological Consulting
Mark Prostor	Arctic Raptors, Inc.
Mitchell L. Pruitt	University of Arkansas
Sarah Ramirez	Teton Raptor Center
Tempe Regan	Boise State University
Mark Resendes	
Gisele Miglioranza Rizzi	UC Santa Cruz
Paul M. Roberts	HMANA
Gary Roemer	New Mexico State Univ.
Genevieve Rozhon	Humboldt State University, GHD
Megan Ruehmann	Eagle Environmental Inc.
Gary Santolo	CH2M
Karen Savarino	GeoTrak, Inc.
Amanda Schluter	Hawk's Aloft INC
Nina Schoch	Adirondack Center for Loon Conservation
Sarah E. Schulwitz	The Peregrine Fund
Lucia Severinghaus	Academia Sinica, Taiwan
Julia Shonfield	University of Alberta
Adam Shreading	Raptor View Research Inst
Steven J. Slater	HawkWatch Interntional
John A. Smallwood	Montclair State University
Doug Smith	Yellowstone - National Park Service
Jeff P. Smith	H.T. Harvey & Associates
Dale W. Stahlecker	Eagle Environmental, Inc.
Karen Steenhof	Murphy, Idaho
Ryan L. Steiner	University of Minnesota Duluth
Justin Streit	SWCA Environmental Consultants
Ty Styhl	University of Idaho
Allison Swan	Teton Raptor Center
Ted Swem	US Fish and Wildlife Service
Mathieu Tétreault	Université du Québec à Rimouski
JF Therrien	Hawk Mountain
Scott E. Thomas	Kidd Biological Inc
Lindy Thompson	University of KwaZulu-Natal
Michael C. Tincher	Rocky Mountain Raptor Program
Tih-Fen Ting	University of Illinois - Springfield
Jay Tischendorf	American Ecological Research Institute
Kassandra Townsend	College of Western Idaho
Natalie Turley	Idaho Power
Danielle Vaguine	University of North Texas
Dan Varland	Coastal Raptors
Chris Vennum	Colorado State University
Prabha Venu	San Jose State University
Munir Z. Virani	The Peregrine Fund
Zach Wallace	Wyoming Natural Diversity Database
Erika L. Walther	Environmental Science Associates
Meghan Warren	Teton Raptor Center
Brian E. Washburn	USDA Wildlife Services
Jesse Watson	HawkWatch Interntional
James W. Watson	WA Dept. Fish & Wildlife
Katheryn A. Watson	Texas Tech University
Nikki Wayment	HawkWatch Interntional
David K. Webb	St. Clair County Community College
Ann Wegman	Cincinnati Museum Center
Joseph Weldon	BLM
Arnaud Van Wettere	Utah State University
Hillary M. White	U.S. Fish & Wildlife Service
Becky Williams	Utah State University Uintah Basin
Jacque Williamson	Brandywine Zoo
Mary Jo Willis	Denver Zoo
Step Wilson	GGRO
Jason M. Winiarski	Boise State University
Elizabeth A. Wommack	Univ of Wyoming Museum of Vertebrates
Brian Woodbridge	U.S. Fish & Wildlife Service
Laura Young	Golden Gate Raptor Observatory

Conference Code of Conduct

The Raptor Research Foundation hosts an annual conference to exchange and disseminate scientific information on birds of prey including ecology, behavior, evolution and conservation. Because effective exchange of ideas can only be accomplished in a friendly and open environment, it is fundamental to ensure that conference attendees treat each other with courtesy and respect in all interactions, including face-to-face, written, or electronic. For this reason, RRF places special care and emphasis on provisioning and ensuring a safe, hospitable and productive environment for everyone attending its annual meeting, regardless of ethnicity, nationality, religion, disability, physical appearance, gender, age, or sexual orientation. We take this aspect of our mission very seriously and expect all conference attendees to behave courteously, respectfully, and professionally to each other, to RRF employees and representatives, to conference volunteers, exhibitors and local meeting venue staff.

RRF expects conference attendees to be able to engage in open discussions free of discrimination, harassment, and retaliation. We strongly believe that a community where people feel uncomfortable, threatened, or under discriminatory scrutiny is neither healthy nor productive. Accordingly, RRF strictly prohibits any degree of intimidating, threatening, or harassing conduct during our conferences, as well as in any other written or personal communication involving any activity of the Foundation. This policy applies to speakers, staff, volunteers, exhibitors, and attendees. Conference participants violating these rules may be sanctioned, expelled from the conference, or expelled from RRF at the discretion of the RRF Board of Directors.

Reporting an Incident

Any attendee who believes that he or she has been subjected to harassment, notices that someone else is being harassed, or has any other concerns about an individual's behavior should contact any member of the RRF Board. He or she will be not required or expected to discuss the concern with the alleged offender. All complaints will be treated extremely seriously and investigated during the conference itself, unless reported after its completion. Confidentiality will be honored to the extent permitted as long as the rights of others are not compromised. Maximum sensitivity to the discomfort of the harassed participant will be favored by assigning the lead of the complaint-management, whenever feasible, to a Board member as capable as possible to comprehend the sensitivity of the issue at stake, (e.g. cases of sexual harassment will be led by a Director of the same gender; cases of discrimination against a minority by a minority, foreign Director, or Director with experience working abroad etc.).

Disciplinary Action

Individuals engaging in behavior prohibited by this policy as well as those making false allegations of harassment will be subject to disciplinary action. RRF leadership may take any action they deem appropriate, ranging from a verbal warning to ejection from the meeting or activity in question without refund of registration fees, to expulsion from the Foundation in case of membership, and the reporting of their behavior to their employer. Repeat offenders may be subject to further disciplinary action, such as being banned from participating in future meetings. Note that RRF has the right in its Bylaws to terminate the membership of any member. Disciplinary action will apply to all offenders participating in the conference, from non-RRF members to Board Directors.

Retaliation Is Prohibited

RRF will not tolerate any form of retaliation or attempt at dissuasion against individuals who file a complaint or assist in the investigation, either by the original offender, or by any individual on his/her behalf, or by the Board member who receives the initial complaint. Retaliation is a serious violation of this policy and, like harassment or discrimination itself, will be subject to disciplinary action.

Questions & Appeal

Any questions regarding this policy should be directed to the RRF Board or the local conference Committee, which will re-direct it to the Board of Directors. In the event that an individual involved in any reported incident is dissatisfied with the disciplinary action, he or she may appeal to the RRF Board, which will privately discuss the issue and vote for a decision.

Anonymous reporting on our website: http://www.raptorresearchfoundation.org/contact/ A Board member will respond as quickly as possible.

Investigation Procedure

1) Whenever possible, the situation will be dealt with informally and in real time by approaching the offender and communicating a warning to the offender to immediately cease the behavior, without revealing the identity of the complainant and after approval about this procedure by the complainant.
2) Should this not be enough, and previous approval by the complainant, the RRF Board will name one or two impartial investigators, considered to be sensitive to the delicacy of the task and capable to assess it professionally.
3) Any named investigator who believes they have a conflict of interest should not serve as an investigator.
4) The investigator(s) will request an official written letter of complaint from the complainant (documenting the nature of the harassment and/or discrimination, with detailed information including times, places, nature of incident(s), and comments made). Supporting documentation (emails, notes, posts, etc.) and statements from witnesses should be submitted with the letter.
5) In most cases, the complainant will be interviewed first and the written complaint reviewed. If the complainant has not already filed a formal complaint, he or she should be asked to do so.
6) The details of the complaint should be explained to the alleged offender by the investigator.
7) The alleged offender should be given a reasonable chance to respond to the evidence of the complainant and to bring his or her own evidence.
8) If the facts are in dispute, further investigatory steps may include interviewing those named as witnesses.
9) If, for any reason, the investigator(s) is in doubt about whether or how to continue, he or she will seek appropriate counsel (from the RRF Board, legal—if approved by the RRF Board, etc).
10) When the investigation is complete, the investigator(s) will report the findings to the RRF Board. The Board will determine how to proceed and if a report should be submitted to the offender's employer.

Thank you for your understanding and professionalism during the annual RRF conferences.

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