



# Raptor Research Foundation Annual Conference

**November 5-10, 2019**

**Fort Collins, Colorado USA**



## SPONSORS

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## Conference Co-Hosts



For 32 years The Rocky Mountain Raptor Program has been inspiring the protection and appreciation of raptors and the spaces where they live through excellence in rehabilitation, research, and education. We are a nationally recognized non-profit rehabilitating over 300 injured, sick, and orphaned raptors annually; providing over 250 formal and informal educational events across Colorado and Wyoming, reaching over 10,000 school kids annually; and contributing knowledge and data to a variety of raptor research

projects. Learn more about the Rocky Mountain Raptor Program at [www.RMRP.org](http://www.RMRP.org).

EDM International is an employee-owned engineering firm with a specialty in avian interactions with electrical infrastructures. EDM works world-wide to understand and prevent negative impacts to biodiversity and productivity resulting from wildlife interactions with power lines, substations, and other industrial infrastructure. EDM manages the Bald Eagle And Golden Eagle Electrocution Prevention In-Lieu Fee Program to offset permitted eagle incidental take. Learn more about EDM at [www.edmlink.com](http://www.edmlink.com) and [www.eaglemitigation.com](http://www.eaglemitigation.com).



Founded in 1966, the 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. The RRF membership, over 1,000 individuals from more than 40 countries, consists of researchers, educators and other like-minded raptor enthusiasts. Learn more about RRF at [www.raptorresearchfoundation.org](http://www.raptorresearchfoundation.org).



## General Conference 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 2019 Raptor Research Foundation Conference includes your welcome packet, the Conference Program Book (Printed and/or PDF) and admission to all Symposia, Plenaries and General Sessions. It also covers the following:

- Wednesday evening Icebreaker
- Thursday evening Poster Session
- Full access to Vendors and Art Show: Thursday, Friday, Saturday
- Coffee breaks each day: Thursday, Friday, Saturday

The registration and information table is situated in the Hilton lobby for the duration of the conference. The table will be open on:

Tuesday	2:00 pm – 9:00 pm
Wednesday	8:00 am – 6:00 pm
Thursday	8:00 am – 6:00 pm
Friday	8:00 am – 6:00 pm
Saturday	8:00 am – 4:00 pm

Vans and shuttles for field trips, workshops, and the Friday evening social event will depart and return from just outside the Hilton's front doors.

### 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 is best 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, and any other RRF-sponsored event, 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 Raptor Research 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. For additional details on the Foundation's expectations, reporting, disciplinary action, and processes, please read the RRF Code of Conduct in the Conference Program Book (page 25).





## General Conference Information

### Hotel & Conference Center Reminders

- The Hilton is a non-smoking facility. Designated smoking areas can be found outside of the hotel.
- Parking is free for daytime conference guests. Parking is \$8 per night for overnight guests and will be added to your bill at checkout.
- Wi-Fi is available in the conference center and sleeping rooms. The Hilton's Tech Area, which is located between the coffee shop and restaurant, has multiple ports for your digital accessories.
- The Spring Creek Grill will be open from 6 am to 10 pm daily for breakfast, lunch, and dinner. The Hilton will host a lunch buffet at the Grill for under \$20 during the conference.
- The Spring Creek Café, featuring Starbucks coffee, pastries, and snacks, will be open from 6 am to 6 pm daily.
- The Hilton hotel's check out time is 11 am.

### **Transportation**

Maxline MAX Bus Rapid Transit (BRT)- serves major activity centers throughout Fort Collins. MAX links with other Transfort bus routes, Park-n-Rides, the city's bicycle/pedestrian trail system. A Maxline bus stop is located just one block away from the Hilton (\$1.25 per ride; day passes for \$3.00 available). Cash and credit cards are accepted in a fare kiosk. The bus runs about every 10 minutes from 5:35 am to 11:35 pm.



Pace Bike Share –Rental Bicycles. Fort Collins is a bike friendly town. Spring Creek bike trail runs adjacent to the Hilton and with the easy grid layout of Fort Collins. The Hilton hosts a Pace Bike Share station in the parking lot. This provides the opportunity to rent a bike for any amount of time. Each bike is equipped with 8 speeds, GPS tracking, a lock, a basket, and lights. Bike rental DOES NOT include a helmet. The cost is \$1.00 for every 15 minutes of ride time. Use promo code BIKEFC, which gives riders \$10 off their first ride. A great option would be to purchase a membership for \$10, which gives you unlimited 30-minute rides during the whole conference (You can cancel anytime).

To learn more, visit the Pace Bike Share <https://ridepace.com/fortcollins/>.

### **Walking & Nature**

We are proud of how Fort Collins has worked to maintain nature corridors throughout the city, providing sanctuaries for raptors and humans alike. If you have a chance during the conference, we encourage you to take a nature break. The Spring Creek Trail runs directly south of the Hilton. Adjacent to the Spring Creek Trail is The Gardens on Spring Creek. This is the City of Fort Collins community botanic gardens. Within your welcome packet you can find a map to restaurants, coffee shops, and a small market within walking distance of the Hilton.

### **Airport Shuttle**

Groome Transportation to and from Denver International Airport recommends making reservations 24 hours ahead of the time for pickup. Make your reservations online or by calling 970-226-5533 to avoid potential delays. Use this link to receive \$5 off or use code RMRP when you call to receive \$5 off. The cost is \$30 – \$55/person one way. Groome will drop off and pickup at the Hilton Hotel, Fernweh Hostel, and Quality Inn. <http://groomefortcollins.hudsonltd.net/res?USERIDENTRY=RMRP&LOGON=GO>



## Welcome

On behalf of the Raptor Research Foundation and our local conference committee, I welcome you to the 53rd annual meeting of our foundation. We are excited AGAIN to share with you the beauty and wildlife of Fort Collins located at the juncture of the Rocky Mountains and Great Plains. We are also home to Colorado State University, a research hub for many natural resource agencies, and host a thriving craft brewery industry. We hope you have a chance to explore northern Colorado on field trips, expand your raptor skillset with a workshop, and network with other RRF members throughout the conference.



Our foundation is thankful for the volunteers that spent endless hours planning this conference for RRF. A special thanks to our committee chairs including Dan Varland (Conference Committee), Julie Garvin (Scientific Program Committee), Joe Eisaguirre, Chris Vennum and Teresa Ely (Early Career Raptor Researcher Committee), Megan Judkins (Website Committee), Travis Booms (Workshop Coordinator), and Clint Boal and Sofi Hindmarch (Awards Committee). Our local conference hosts at Rocky Mountain Raptor Program and EDM International have worked hard to pull off this successful meeting of over 300 conference delegates. Please join me in thanking them including Carin Avila, Lisa Winta, Mike Tincher, and Rick Harness.

We are also grateful for our sponsors and vendors who sustain RRF's mission. Please take time to thank them for their continued support and visit the vendor booths.

I hope you find value in attending RRF conferences. I have attended a dozen RRF conferences over the years and I thrive on the personal friendships I've made, many of which have also led to research collaborations. I look forward to having you in my hometown and talking with you about your raptor research, education, and conservation work.

Sincerely,

Libby Mojica

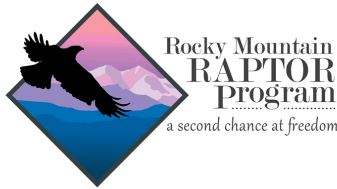
Raptor Research Foundation, President

Certified Wildlife Biologist, EDM International, Inc.





## Welcome



## Welcome to the 2019 Raptor Research Foundation Conference

We at the Rocky Mountain Raptor Program are thrilled to co-host the 53rd Annual meeting and conference of the Raptor Research Foundation. We welcome the RRF researchers, educators, vendors, sponsors, and all those passionate about raptors to our little slice of heaven here in Fort Collins. While in town, not only will you get to see the compilation of the great work that we are all doing in honor of the beloved raptors in our world, but you will also be able to see what makes Fort Collins and Colorado such a great place in which to work and recreate. We have arranged field trips, workshops and networking opportunities with your fellow RRF colleagues that will give you a taste of the "Choice City" of Fort Collins.



The RMRP, now for the second time, has spent many hours with the RRF leadership to ensure that the 2019 conference is informative, fun and well organized. We are thankful for the volunteers that have worked tirelessly helping to plan this conference for RRF. Your conference was made possible by a small cadre of amazing and passionate people - Dan Varland (Conference Committee), Julie Garvin (Scientific Program Committee), Chris Vennum and Teresa Ely (Early Career Raptor Researcher Committee), Megan Judkins (Website Committee), Travis Booms (Workshop Coordinator), Sofi Hindmarch (Awards Committee), and Libby Mojica (RRF President and EDM International Inc.). Here at home we could not have made it all happen without our Co-Host Rick Harness from EDM International Inc. and the amazing staff of Rocky Mountain Raptor Program: Lisa Winta (Assistant Director) , Mike Tincher (Rehabilitation Coordinator), Gail Kratz (Rehabilitation Director), Carrie Laxson (Rehabilitation Assistant), Amanda Burton (Rehabilitation Associate), Jessica Miller (Outreach and Education Coordinator), Bonnie Cleaver (Education Avian Coordinator) and Lynsey Reed (Director of Donor Relations). Thanks to all for banding together for this spectacular conference at the Fort Collins Hilton.

I also want to thank the great Sponsors and Vendors that stepped up to help the 2019 RRF conference take flight. Please be sure to thank them for their efforts and visit the vendor booths.

I hope you find this year's RRF Conference interesting and educational. I welcome you to our town and look forward to learning about the amazing work being done in the effort of research, conservation, education, and preservation of the majestic raptors of our world. Have a wonderful time in Fort Collins.

Sincerely,

Carin Avila

Rocky Mountain Raptor Program, Executive Director  
[www.rmrp.org](http://www.rmrp.org)



## Welcome

November 6, 2019

Welcome to Fort Collins ~

We are delighted you are here as a guest!



We are honored that The Rocky Mountain Raptor Program is co-hosting the Raptor Research Foundation Conference with EDM International in our community.

Fort Collins is fortunate to offer a wide variety of habitats which attract an interesting array of raptors. As a city, stewardship is an important component to our local partners who work hard to maintain, improve and honor our open space and wildlife.

While in Fort Collins we hope you take the opportunity to explore some of the magnificent locations we have to enjoy the great outdoors. This may include visits to Soapstone Prairie Natural Area, Pawnee National Grasslands, the USFWS Eagle Repository, or even Rocky Mountain National Park.

We are also home to fantastic outdoor recreation opportunities, arts and culture, food and craft brewing. Enjoy exploring, learning and make a new memory along the way!

Kindest Regards,

Cynthia Eichler

Cynthia Eichler  
President and CEO  
Visit Fort Collins  
[www.visitftcollins.com](http://www.visitftcollins.com)





## Welcome



**Mayor**  
City Hall  
300 LaPorte Ave.  
PO Box 580  
Fort Collins, CO 80522  
**970.416.2154**  
970.224.6107 - fax  
[fcgov.com](http://fcgov.com)

November 2019

As Mayor of Fort Collins, I take great pride in welcoming you to the 2019 Raptor Research Foundation Annual Conference. Best wishes for a successful meeting!

Fort Collins is proud to be a hub for research and the innovative exchange of ideas. As Mayor of this great City, it is my hope that this conference will provide each of you a robust week of current research, raptor biology, ecology, research techniques, and conservation. Thank you for attending and bringing your expertise to this conference.

I hope our community provides an exciting and remarkable backdrop for your stay. Conference field trips will highlight the natural beauty of our region including outings to Rocky Mountain National Park, the USFWS Eagle Repository, and Pawnee National Grasslands.

Fort Collins is the home to Colorado State University and our historic downtown "Old Town." Ours is a walkable city, and I hope you find time to explore our curated alley ways, outdoor public spaces, and maybe even take time to tinker on one of our many Pianos About Town. Please, enjoy our restaurants and breweries, trails and parks, and Colorado outdoor lifestyle.

The City of Fort Collins is delighted that you have chosen to convene in our community. On behalf of your hosts, Rocky Mountain Raptor Program and EDM International, and the residents of Fort Collins, welcome!

Best Regards,

Wade Troxell  
Mayor



## RRF Board of Directors

### Officers and Directors

**Elizabeth Mojica**  
*President*

**Jim Bednarz**  
*Vice President*

**Joan Morrison**  
*Secretary*

**Jessi Brown**  
*Treasurer*

**Miguel Saggese**  
*Past President*

**Clint Boal**  
*Past President*

**Cheryl Dykstra**  
*Editor-in-Chief, The  
Journal of Raptor  
Research*

**Brian Washburn**  
*Editor, Wingspan  
Newsletter*

**Munir Virani**  
*Southern Hemisphere*

**Jemima Parry-Jones**  
*At Large Outside North  
America*

**Oliver Krone**  
*Eurasian*

**Joel Pagel**  
*North American #1*

**Cindy Kemper**

*North American #2*

**Todd Katzner**

*North American #3*

**Juan Manuel  
Grande**  
*At Large #1*

**Travis Booms**

*At Large #2*

**Rob Bierregaard**  
*At Large #3*

**Lucia Liu  
Severinghaus**  
*At Large #4*

**Lisa Takats  
Priestley**  
*At Large #5*

**Jennifer Coulson**  
*At Large #6*

### Committee Chairs

**Sofi Hindmarch**  
*Awards Committee*

**Clint Boal**  
*Bylaws Committee*

**Travis Booms**  
*Charitable Giving  
Program*

**Cindy Kemper**  
*Code of Conduct  
Committee*

**Dan Varland**  
*Conference  
Committee*

**James Dwyer**  
*Conservation Committee*

**Chris Vennum**  
*Early Career Raptor  
Researchers*

**Teresa Ely**  
*Early Career Raptor  
Researchers*

**Rob Bierregaard**  
*Finance Committee*

**Jennifer Coulson**  
*Legal Committee*

**Julio Gallardo**  
*Membership Committee*

**Carol McIntyre**  
*Nominations Committee*

**Julie Garvin**  
*Scientific Program*

**Miguel Saggese**  
*Strategic Planning  
Committee*

**Munir Virani**  
*Strategic Planning  
Committee*

**Megan Judkins**  
*Website Coordinator*



## Acknowledgements

The 2019 RRF conference was planned over more than a year, with the amount of effort devoted to the holding conference increasing as conference time drew closer. Our sincerest thanks go to all who contributed their time and talents, including the session moderators and committee members identified below. Many hands make light work.

### Code of Conduct Committee

Cindy Kemper, <i>Chair</i>	James Dwyer	Shannon Schlater	Chris Venum
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### Scientific Program Committee

Julie Garvin, <i>Chair</i>	Nate Bickford	Adam Duerr	James Dwyer
Teresa Ely	Pat Kennedy	Matt Stuber	Beth Womack

### Early Career Raptor Research Committee

Chris Venum, <i>Co-chair</i>	Teresa Ely, <i>Co-chair</i>	Joe Eisaguirre
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### Conference Committee

Dan Varland, <i>Chair</i>	Libby Mojica
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### Local Conference Committee

Carin Avila, <i>Co-Chair</i>	Lisa Winta, <i>Co-Chair</i>	Amanda Burton
Bonnie Cleaver	Rick Harness	Justine Josephson-Laidlaw
Gail Kratz	Carrie Laxson	Jessica Miller
Chris Venum	Lynsey Reed	Michael Tinch

### Moderators

Brent Bibles	Nate Bickford	Andre Botha
Adam Duerr	JD Dwyer	Zeka Glucs
Rick Harness	Todd Katzner	Michele Losee
Mark Martell	Hanna McCaslin	Carol McIntyre
Robert Miller	Mary Ann Ottinger	Neil Paprocki
Becki Perkins	Matyas Prommer	Lisa Priestley
Miguel Saggese	Shannon Skalos	Steve Slater
Matt Stuber	Munir Virani	Kathryn Watson

The conference logo was created by Bonnie Cleaver, Educational Avian Coordinator with the Rocky Mountain Raptor Program. Conference registration support was provided by Chris Mulvaney and Crystal Ruiz of the American Ornithological Society and the RRF Treasurer Jessi Brown. Your conference program book was designed by Linda Koepsell of LAK Business Support LLC and Lisa Nelson of EDM, and printed by ColorPro of Fort Collins. Thank you to Todd Katzner for program editing support. Thanks go to the Fort Collins Convention and Visitors Bureau ([www.visitfortcollins.com](http://www.visitfortcollins.com)) for their assistance in planning. We extend our thanks and gratitude to Odell Brewing Co. for providing the beer served at the Poster Session. And, last but not least, we want to thank Fully Promoted for printing of the conference T-shirts.



## Acknowledgements



## Volunteers

Susan Baker	Krista Banks	Sirena Brownlee	Eric DeFonso	Anthony Gilmore
Jessica Gordon	Ryann Gregory	Summitt Liu	Susan Miller	LiAnn Pennington
Hildy Riser	Judy Scherpelz	Beth Stinson	Sara Stokes	TC Walker
Rebecca Boyce	Elan Carnahan	Rita Collins	Stephanie Gobert-Pitt	Kathleen Mascarenas
Anthony Piwinski	Karen Pitzen	Eden Ravecca	Stephanie Tien	Jeff Stark

## Contributing Photographers

Kate Davis      Rick Harness      Dan O'Donnell      Rocky Mountain Raptor Program

*And all additional volunteers that helped to make this conference successful.*







## Conference Sponsors

Warmest thanks to our sponsors who helped in supporting this event.

### Education Level



**WARNER COLLEGE  
OF NATURAL RESOURCES**  
COLORADO STATE UNIVERSITY

#### Warner College of Natural Resources – CSU

[www.warnercnr.colostate.edu](http://www.warnercnr.colostate.edu)

The Warner College of Natural Resources is one of the largest and most comprehensive natural resource colleges in the nation. The Fish, Wildlife, and Conservation Biology department within Warner has an expertise in applied ecology, quantitative methods, and human dimensions in the conservation and management of fish and wildlife. We teach students to think critically about environmental issues, and become ecologically literate citizens with the training to be successful in graduate school and in careers with natural resources agencies, firms, and non-government organizations.



**FISH, WILDLIFE, AND  
CONSERVATION BIOLOGY**  
COLORADO STATE UNIVERSITY

### Buteo Level



#### Cellular Tracking Technologies

[www.celltracktech.com](http://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](http://www.geotrakinc.com)

GeoTrak is a leader in the design and manufacturing of innovative satellite telemetry tracking devices for wildlife researchers around the world.

## GREENJACKET INC.®

#### Greenjacket, Inc.

[www.greenjacketinc.com](http://www.greenjacketinc.com)

Precise-fit Engineered Solution

Greenjacket designs and manufactures dielectric polymer, precise-fit covers to protect power substation and distribution equipment from animal-caused outages, thus increasing system reliability and protecting wildlife. Greenjacket Inc.'s highly qualified multi-disciplinary team includes experienced power linemen, wildlife experts, polymer chemists, tool-and-die experts, and polymer fabricators. Greenjacket is committed to providing the electrical power industry with customized turnkey solutions that mitigate animal-caused outages and improve system reliability and profitability.



## Conference Sponsors



**Kaddas Enterprises, Inc.**  
www.kaddas.com

Kaddas Enterprises manufactures Birdguard™, a product used by power utilities to mitigate animal-caused power outages. Kaddas is ISO 9001:2015 certified, WBENC certified, and 100% Woman Owned specializing in Plastic Thermoforming, Pressure Forming, and Hand Fabrication of Polymer solutions.



**P&R Technologies**  
www.pr-tech.com

P&R Tech is the worldwide leader in power line markers and related safety products for the utilities industry. We introduced our original SpanGuard spherical power line markers in 1960, and many of them remain in service to this day, warning pilots of wires in their flight path. Bird diverters from P&R Tech help utilities save birds, prevent damage, and avoid fines. Independent studies have shown FireFly and BirdMark to be the most effective bird diverters on the market. They are also recommended by the US Fish and Wildlife Service and have a lower installed cost than coils.



**PREFORMED LINE PRODUCTS**  
The connection you can count on.

**Preformed Line Products**  
www.preformed.com

Preformed Line Products (PLP) is committed to protecting wildlife by working with utility companies to design and manufacture wildlife protection products that aid in reducing wildlife mortalities from interaction with electric power distribution lines, structures, and equipment. Additionally, these products reduce customer outages, the resulting revenue losses, and potential regulatory fines on utility companies. PLP also produces similar wildlife protection products for use in electric power transmission systems.



**Wildlife Computers**  
www.wildlifecomputers.com

Since 1984, Wildlife Computers has grown from a core group designing, manufacturing, selling and supporting custom marine tags to the leading provider of advanced wildlife telemetry solutions to the scientific community. Wildlife Computers provides an unsurpassed commitment to quality in the design and manufacturing of our tags. We are constantly evolving with our industry to provide the best products and solutions to meet our changing world.



## Conference Sponsors

### Falcon Level

**AUTOMATIC  
TRAP.COM**

#### **Automatic Trap Company**

[www.automatictrap.com](http://www.automatictrap.com)

Automatic Trap Company Motto: Every Trap Shipped = Less Suffering and a Better World. We believe passionately in eradicating rodents in a safe, humane, and efficient manner. Our vision is to eliminate the preventable suffering of these mammals—and we're one step closer with every trap we ship.

### Kestrel Level



#### **Coastal Raptors**

[www.coastalraptors.com](http://www.coastalraptors.com)

Coastal Raptors is dedicated to providing research and education programs leading to better understanding and conservation of raptors in coastal environments.

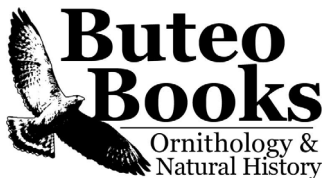


Kate Davis photo ©



## Conference Vendors

Thank you to all of our vendors for their participation! Please stop by and see what they have to offer during the conference.



### Buteo Books

[www.buteobooks.com](http://www.buteobooks.com)

Buteo Books was founded in Vermillion, South Dakota in 1971 by Joyce and Byron Harrell (Byron was the first president of the RRF). Based in Virginia and owned by the Hale family since 1991, Buteo Books maintains the largest inventory of new, used and rare ornithology books in the world.



### Cell Tower Osprey Management

Cell Tower Osprey Management, LLC, supplies the patented Osprey Nest Excluder. This device prevents ospreys and eagles from nesting on cell towers.



### EDM International, Inc.

[www.edmlink.com](http://www.edmlink.com)

EDM International is an employee-owned engineering firm with a specialty in avian interactions with electrical infrastructures. EDM works world-wide to understand and prevent negative impacts to biodiversity and productivity resulting from wildlife interactions with power lines, substations, and other industrial infrastructure. EDM also manages the Bald Eagle And Golden Eagle Electrocutation Prevention In-Lieu Fee Program to offset permitted eagle incidental take by retrofitting poles at high-risk of electrocuting eagles.



### Hawk Migration Association of North America

[www.hmana.org](http://www.hmana.org)

The Hawk Migration Association of North America (HMANA) mission is to advance scientific knowledge and promote conservation of raptor populations through study, enjoyment, and appreciation of raptor migration. HMANA collects hawk count data from almost 200 affiliated raptor monitoring sites throughout the United States, Canada, and Mexico, publishes the semi-annual journal Hawk Migration Studies, provides HawkCount, a near-real-time international database of hawk counts across the continent, and is a driving force behind the Raptor Population Index to promote scientific analysis of hawk count data.



### Nature's Educators/Wings Over Colorado/Mile High Falcons

[www.natureseducators.org](http://www.natureseducators.org), [www.wingsovercolorado.com](http://www.wingsovercolorado.com)

Nature's Educators is a 501(c)(3) fully licensed educational wildlife program to give presentations about wildlife and conservation. **Wings Over Colorado** is a bird abatement company licensed by the U.S. Fish and Wildlife Service. **Mile High Falcons, LLC** is a project licensed by the US Fish and Wildlife Service to breed Prairie Falcons, American Kestrels, Barbary Falcons, and others.





## Conference Vendors

### Nick Dunlop Photography

[www.nickdunlop.com](http://www.nickdunlop.com)

Nick is a wildlife photographer and naturalist whose goal is to capture images and videos of wildlife in natural settings. Nick's primary focus is birds of prey, specializing in Peregrine Falcons and Golden Eagles.



### North Star Science & Technology

[www.northstarsct.com](http://www.northstarsct.com)

North Star provides state-of-the-art technology in global tracking and monitoring applications for wildlife conservation research and related markets. North Star's mission is "to provide expert and dynamic capability, through research and development of products, that will improve the world we live in via the acquisition of information describing the natural world around us." North Star is committed to the development and production of the best satellite tracking equipment in the world.



### Power Line Sentry

[www.powerlinesentry.com](http://www.powerlinesentry.com)

Power Line Sentry provides the highest quality avian and wildlife protection products in the world. We work with leading biologists, manufacturers, engineers and linemen to develop a complete set of products to protect both distribution and transmission structures from outages related to nesting, electrocution, and power line collisions.



### Rocky Mountain Raptor Program

[www.RMRP.org](http://www.RMRP.org)

The Rocky Mountain Raptor Program inspires the protection and appreciation of raptors through excellence in raptor rehabilitation, research, and education.



### TE Connectivity

[www.te.com](http://www.te.com)

TE Connectivity is committed to creating a safer, sustainable, productive, and connected future. As the go-to engineering partner for today's innovation leaders and technology entrepreneurs, TE Connectivity is helping solve tomorrow's toughest challenges with advanced connectivity and sensors solutions.



## Ensure RRF's Future - Become A Legacy Member!

The Raptor Research Foundation has created a new membership level – **Legacy Member**, to recognize those making a planned gift to RRF via will, retirement account, life insurance, or similar means. This elite status acknowledges the substantial contribution these members make to ensure RRF's future. Dedicating even 5% of your estate makes a huge difference to RRF. If you value the networking, comradery, and professional/personal growth that RRF provides, in addition to ensuring future understanding, appreciation, and conservation of raptors worldwide, please consider becoming a **Legacy Member** by including RRF in your estate plans. Learn more at <https://www.raptorresearchfoundation.org/give/> or see Travis Booms, Legacy Manager.



*Leave a Legacy*

Rob Palmer

*The goal isn't to live forever,  
The goal is to  
create something that will.*

~ Chuck Palahniuk

**Planned giving is easy  
Options include:**

---

*Naming RRF as a beneficiary* of a will,  
trust, retirement account, or life insurance  
policy

*Gifts of stock, real estate, IRA distributions*

---

*Creating Endowments or Trusts*

---

*Each situation is unique. RRF works with  
donors to find options that best suit your  
desires.*

Members providing planned gifts join an  
elite membership category

**Legacy Member**


Recognizing their substantial commitment  
to RRF's financial future.

Talk to RRF's Legacy Manager to learn more!

*Include the Raptor Research  
Foundation in your:*


- ~Will
- ~Life Insurance
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## Plenary Speakers

**Ralph (Rocky) Joseph Gutiérrez**, Gordon Gullion Chair - Emeritus, University of Minnesota, Twin Cities and Senior Scientist, Department of Forest and Wildlife Ecology, University of Wisconsin, Madison

R. J. is a Gordon Gullion Endowed Chair Emeritus in Forest Wildlife Research at the University of Minnesota. He is also a Senior Scientist in the Department of Forest and Wildlife Ecology at the University of Wisconsin, Madison. Rocky has been studying wildlife for over 50 years. His primary areas of research are owl ecology and evolution, endangered species conservation, game bird ecology, habitat ecology, sustainable hunting strategies, and conservation conflicts. For the past 40 years his owl studies have been centered on the spotted owl but he has also published papers on Blakiston's fish owls, barred owls, and great horned owls. His studies of the spotted owl have spanned over four decades during which time he and his 29 graduate students who have worked on owls have published over 130 papers on their ecology, evolution, and conservation. Due to his experiences with the long-standing conflict among stakeholders and conservation of the spotted owl, he has expanded his work over the past 15 years to include the study of those conservation conflicts. He has remained active throughout his career in wildlife conservation by serving as President of the Western Section of The Wildlife Society, associate editor for 5 international journals, member of the national board of directors of The Nature Conservancy, trustee of Tall Timbers Research Station, and as a member of many other conservation advisory boards and scientific review committees.



**Gary C. White**, President-Elect, The Wildlife Society and Professor Emeritus, Department of Fish, Wildlife and Conservation Biology, Colorado State University

Gary was born in 1948 (the year of Aldo Leopold's death), growing up on a farm in central Iowa, and graduated with a BS (1970) from the Department of Fisheries and Wildlife at Iowa State University, an MS (1972) in Wildlife Biology from the University of Maine at Orono, and a Ph.D. (1976) in Zoology from the Ohio State University. He spent 1976-77 as a post-doctoral researcher with the Utah Cooperative Wildlife Research Unit at Utah State University. From 1977-84, his position was a scientist in the Environmental Science Group at Los Alamos National Laboratory, and in 1984, Gary moved to the Department of Fishery and Wildlife Biology at Colorado State University. He retired in 2007 and is currently a Professor Emeritus, still maintaining an office and conducting consulting work. Much of Gary's past research involved work with the Colorado Division of Wildlife developing monitoring strategies for prairie dogs and swift fox, and monitoring and modeling of deer, elk, and antelope populations. His personal research time is spent developing and teaching Program MARK; other software packages he's developed include CAPTURE, SURVIV, RELEASE, DEAMAN, and NOREMARK. Gary taught two graduate courses at Colorado State, Population Dynamics and Analysis of Vertebrate Populations. His proudest achievement is receiving The Wildlife Society's 51<sup>st</sup> Aldo Leopold Memorial Award and Medal in March 2000.





## Social Events

### **Icebreaker Social, Atrium**

Wednesday, November 6, 6:00 - 9:00 pm

After visiting the registration table and getting settled into your room, come join us to say “hi” to old friends and make new ones. Cash bar and hors d’oeuvres will be provided.

### **Women in Raptor Research and Conservation Social, Tap and Handle, 307 S. College Ave**

Wednesday, November 6, 9:00 – 11:00 pm

This a networking social for women who work with raptors.

### **ECRR Social, Salons II & I/V**

Thursday, November 7, 4:00 - 5:00 pm

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 new people. Cash bar provided.

### **Poster Session & Reception, Salons II & I/V**

Thursday, November 7, 5:00-8:00pm

Enjoy food and local microbrew Odell Brewing Co. beer while viewing posters and talking to authors about their research. Cash bar provided.



### **Dinner & Margs in the Agave Room at the World-Famous Rio Grande Mexican Restaurant**

Friday, November 8, 6:00 - 9:00 pm

Meet in the front lobby of the Hilton at 5:30 pm for shuttle van service to the Rio or take The Max bus service (the bus stop is one block east from the Hilton). Enjoy the evening of buffet food, the Rio’s Margaritas, and music. The buffet offers you Quesadillas, Empanadas, Guacamole, Salsa, and Build Your Own Taco Bar. The Rio is renowned for its Margaritas... only two allowed! You are responsible for purchasing your own beverages. You have the option to catch the shuttle van back to the Hilton starting at 8:30 pm in front of the Rio/Agave Room or take the Max bus service which stops every 15 minutes from the station on the corner of Mountain Avenue and Mason St (½-block west of The Rio). Pre-registration required.

### **Awards Banquet, Salons II & I/V**

Saturday, November 9, 6:00 – 10:00 pm

Join us for our farewell banquet and awards dinner. The cocktail hour begins at 6pm and banquet at 7pm. A photo booth will be available from 6pm to 8:30pm to take your photo with your fellow researchers in serious or funny poses. Props for fun photos will be provided. Pre-registration required. Cash bar provided.



## Field Trips

### Rocky Mountain Arsenal National Wildlife Refuge and National Eagle Repository and Black Footed Ferret Encounter – from Fort Collins

Wednesday, November 6

*Time:* 8:00 am – 4:00 pm

*Location:* Meet in the Hilton lobby.

Transportation from Fort Collins Hilton to and from Refuge/Repository provided.

Includes boxed lunch and water.



*Rocky Mountain Arsenal National Wildlife Refuge:*

9:30 am – 11:00 am

*National Eagle and Wildlife Property Repository:* 11:30 am - 1:00 pm

*Black-footed Ferret Encounter:* 1:30 pm – 2:30 pm

### National Wildlife Research Center

Wednesday, November 6

*Time:* 1:00 pm – 3:00 pm

*Location:* National Wildlife Research Center, 4101 LaPorte Ave., Fort Collins, CO 80521-2154.

Transportation is not provided.



### Pawnee Buttes National Grasslands

Wednesday, November 6, 2019

*Time:* 7:30 am – 3:00 pm

*Location:* Meet in the Hilton Lobby.

Transportation included to and from the Fort Collins Hilton. Boxed lunch and water included. Please bring any additional snacks or beverages you would like. While you won't be hiking, you will be stepping out of the van to view birds. Please wear footwear and clothing appropriate for the wind and potential winter temperatures on the high plains of Colorado.



*National Eagle Repository and Rocky Mountain Arsenal National Wildlife Refuge – Meeting at Repository – You Provide Your Own Transportation*



### Field Trips

#### National Eagle and Wildlife Property Repository

Wednesday, November 6

*Tour Time:* 1:00 pm – 2:30 pm

*Location:* Meet at the National Eagle Repository, 6550 Gateway Road, RMA, Bldg 128, Commerce City, CO 80022.

#### Behind the Scenes in the Ornithology Collection, Zoology Department, at the Denver Museum of Nature and Science

Wednesday, November 6

*Time:* 9:00 am – 3:30 pm

*Location:* Meet in the Hilton lobby. Transportation included to and from Fort Collins Hilton. Lunch is not included but is available at the museum.

#### Rocky Mountain Raptor Program Facility Tour

Wednesday, November 6

*Time:* 1:30 pm – 3:30 pm

or

Sunday, November 10

*Time:* 9:00 am -11:00 am

*Location:* The Rocky Mountain Raptor Program, 720 E. Vine Dr., Fort Collins, CO 80524. Transportation is not provided.



#### Birding Adventure with Fort Collins Audubon

Sunday, November 10

*Time:* 8:00 am – 1:00 pm

*Location:* Meet in the Hilton lobby. Transportation provided to and from the Fort Collins Hilton. Water and snacks provided – please bring your own sack lunch.

#### Rocky Mountain National Park Visit

Sunday, November 10

*Time:* 8:30 am – 4:00 pm

*Location:* Meet in the Hilton lobby. Transportation, boxed lunch, and water included to and from Fort Collins Hilton. Bring any additional snacks or beverages.







## Workshops

**Wednesday, November 6**

### Full Day Courses

#### **North American Non-Lead Partnership: Non-lead Ammunition Ballistics Testing and Communications Workshop – It's More than the Science**

*Time:* 8:00 am - 5:00 pm

*Location:* Meet at 8:00 am in the Hilton lobby and depart shortly thereafter for a local gun range. Transportation, boxed lunch, and water is provided.

*Instructors:* **Chris Parish**, Director of Conservation for The Peregrine Fund and co-founder of the North American Non-lead Partnership, and **Leland Brown**, Non-lead Hunting Education Coordinator for the Oregon Zoo and co-founder of the North American Non-lead Partnership.

*Clothing and the Weather:* We will be outside at the gun range and it may be windy. In November, temperatures in the Fort Collins area may range between 30 and 70 degrees Fahrenheit. Rain or snow are also possible. Bring clothing suitable for these contingencies!



All too often we find ourselves shocked and dismayed by the general public's response to scientific products and the implications for conservation. If we are to be effective in stimulating behavior that ameliorates the problems defined by science, we have to understand our audience's current beliefs before collectively moving forward with conservation. This workshop will aid those in attendance in better understanding the culture of hunting, how that culture affects decision making, and the ballistics of hunting ammunition. Whether an experienced hunter or a non-hunter, the content of this class will illustrate the importance of understanding the options available to those who

choose to pursue wildlife with firearms. The process of choosing hunting ammunition involves a suite of variables, including tradition, ballistics, availability, and price. How we choose to address these variables when engaging with the hunting public in meaningful conversation has direct correlation to success. We must work to avoid unintended backlash that can result from messaging that misses critical points or beliefs of our audience. This goes beyond just how to encourage change in ammunition use, but is the basis of all conservation efforts: how to connect people with the science that improves conservation.

#### **Harnessing Raptors with Transmitters**

*Time:* 8:00 am - 11:00 am & 12:00 pm - 3:00 pm (11:00-12:00 lunch)

*Location:* Salon VI

*Instructors:* **Trish Miller**, Conservation Science Global, **Daniel Driscoll**, American Eagle Research Institute, and **Vince Slabe**, West Virginia University.

This class will cover the process of attaching transmitters (either VHF, satellite, or GSM) to raptors, from initial thoughts of the bird's welfare to specifics of making harnesses and attaching them to birds. We will discuss and demonstrate several different options and methods for making harnesses. 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.





## Workshops

### Morning Courses



#### **Photographing Raptors**

*Time:* 8:00 am -12:00 pm

*Location:* Salon III

*Instructors:* Photographers **Kate Davis**, [raptorsoftherockies.net](http://raptorsoftherockies.net), **Nick Dunlop**, [nickdunlop.com](http://nickdunlop.com) and **Rob Palmer**, [falconphotos.com](http://falconphotos.com).

Our instructors have a long history of professional photography and all met at the RRF Conference in 2004. Each will bring some insight as to photographing birds in the wild, captivity, and for scientific papers. They will explore techniques, equipment, ethics, and processing images. Nick and Rob will teach secrets for taking great videos and Kate will elaborate on publishing, including tips on making captions.

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

*Time:* 8:00 am - 12:00 pm

*Location:* Salon IV

*Instructors:* **Dan Varland**, Coastal Raptors, and **John Smallwood**, Montclair State University.

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



### Afternoon Courses

#### **All About Permits – Permit Types and Requirements for Raptor Studies and Management**

*Time:* 1:00 pm – 5:00 pm

*Location:* Salon III

*Instructors:* **Brian Millsap**, U. S. Fish and Wildlife Service, **Clint Boal**, Texas Tech University, and **Bruce Peterjohn**, Bird Banding Laboratory, U.S. Geological Survey.

This course will provide participants with an overview of the types of federal and state permits that may be required when studying or working with raptors, as well as the general requirements and procedures for obtaining the necessary authorizations. The course will also cover general requirements and procedures for obtaining necessary Institutional Animal Care and Use Committee (IACUC) approvals for research projects involving raptors. Although specific requirements for permits and IACUC authorizations will vary among states and institutions, participants in this workshop will gain enough background to know when a permit or IACUC approval might be required, what type of authorization they may need to obtain, and the background training and application procedures that might be required to obtain the necessary approvals.



## Workshops

### Raptor Necropsy Workshop

*Time:* 1:00 pm – 5:00 pm

*Location:* Salon IV

*Instructors:* **Michael Tincher**, Rehabilitation Coordinator,  
and **Carrie Laxson**, Rehabilitation Assistant, Rocky Mountain  
Raptor Program.

This class will discuss how to characterize and investigate raptor mortality, associated injuries and disease through a gross necropsy. Instruction will include taking pertinent measurements and collection of appropriate samples for disease and contaminant diagnostics. Permitting, zoonotic diseases, common parasite identification and common causes of raptor mortality will be discussed briefly, but emphasis will be on the practical approach to conducting a necropsy. Proper biosecurity and safety practices will also be discussed. Class will consist of lecture/discussion followed by a practical necropsy session.



*Kate Davis photo ©*



## 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 is best 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, and any other RRF-sponsored event, 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 Raptor Research 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.

### Definitions

**Discrimination** – Treatment or consideration of, or making a distinction in favor of or against, a person or thing based on the group, class, or category to which that person or thing belongs rather than on individual merit. Discrimination can be the effect of some law or established practice that confers privileges on a certain class or denies privileges to a certain class because of race, age, sex, nationality, religion, or handicap (<https://definitions.uslegal.com/d/discrimination/>).

**Harassment** – A course of conduct which threatens, intimidates, alarms, or puts a person in fear of their safety. Harassment is unwanted, unwelcomed and uninvited behavior that demeans, threatens or offends the victim and results in a hostile environment for the victim. Harassing behavior may include, but is not limited to, epithets, derogatory comments or slurs and lewd propositions, assault, impeding or blocking movement, offensive touching or any physical interference with normal work or movement, and visual insults, such as derogatory posters or cartoons (<https://definitions.uslegal.com/h/harassment/>).

### Reporting an Incident

Any attendee who believes that he or she has been subjected to a violation of the Code of Conduct, notices that someone else is being subjected to a violation of the Code of Conduct, or has any other concerns about the appropriateness or professionalism of an individual's behavior at any RRF-sponsored event should contact any member of the Code of Conduct Committee or RRF Board. He or she will not be required or expected to discuss the concern with the person thought to have potentially violated the Raptor Research Foundation Code of Conduct. All allegations will be treated seriously and investigated during the RRF-sponsored event itself to the extent practical, or will be investigated as efficiently as



## Code of Conduct

possible thereafter. Confidentiality will be honored to the extent permitted as long as the rights of others are not compromised.

### Disciplinary Action

Individuals engaging in behavior prohibited by the RRF Code of Conduct 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. Repeat offenders may be subject to further disciplinary action, such as being banned from participating in future meetings. Note that RRF has the authority in its Bylaws to terminate the membership of any member after fair and reasonable consideration all of the relevant facts and circumstances. 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 Code of Conduct Committee Chair, 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.

### Contacts During the Conference



Cindy Kemper, Chair  
cindy.kemper@shaw.ca



JD Dwyer  
jdwyer@edmlink.com



Chris Venum  
Chris.Venum@colostate.edu

The Raptor Research Foundation's Code of Conduct is available at:  
<http://www.raptorresearchfoundation.org/conferences/current-conference/code-conduct/>





## Oral Presentation Abstracts

### Spatial Analysis of Raptor Nesting Distribution: An Evaluation of Four Priority Species in Colorado

**KEVIN AAGAARD** (kevin.aagaard@state.co.us), Colorado Parks and Wildlife, Fort Collins, CO, U.S.A. REESA CONREY, Colorado Parks and Wildlife, Fort Collins, CO, U.S.A. JIM GAMMONLEY, Colorado Parks and Wildlife, Fort Collins, CO, U.S.A.

Our goal is to evaluate the capacity of a large presence-only database of raptor nesting activity in Colorado to inform spatial distribution models for future monitoring and management efforts. We evaluated the relationship between locations of active nests for four focal raptor species of conservation priority in Colorado (Bald Eagle (*Haliaeetus leucocephalus*), Golden Eagle (*Aquila chrysaetos*), Prairie Falcon (*Falco mexicanus*), and Ferruginous Hawk (*Buteo regalis*)) and various explanatory variables relating to land cover, climate, topology, and biology across the landscape. We find that for all four species there is uncertainty regarding the variation in spatial distribution of nesting locations that cannot be explained by the variables considered here. We are still able to demonstrate that several explanatory variables served as useful predictors, though not the same ones for each species (as expected). This evidence will be valuable for crafting future monitoring protocols to better understand the drivers of nest site selection among Colorado raptors. We provide suggestions for alternative variables that would be useful for improving future predictive modeling purposes.

### Conservation Genetics and Genomics of the Swainson's Hawk (*Buteo swainsoni*): A Next-Generation Sequencing Approach

**EMILY V. ABERNATHY** (eabernathy@ucdavis.edu), Department of Animal Science, University of California, Davis, CA, U.S.A. KRISTEN RUEGG, Department of Biology, Colorado State University, Fort Collins, CO, U.S.A. HOLLY B. ERNEST, Wildlife Genomics and Disease Ecology Lab, Department of Veterinary Sciences and Program in Ecology, University of Wyoming, Laramie, WY, U.S.A. CHRIS R. VENNUM, Department of Fish, Wildlife and Conservation Biology, Colorado State University, Fort Collins, CO, U.S.A. JOSHUA M. HULL, Department of Animal Science, University of California, Davis, CA, U.S.A.

The Swainson's Hawk is a highly migratory species that breeds throughout much of western North America. Although historically considered one of Western North America's most abundant raptors, threats such as agricultural conversion and expansion of wind energy have caused considerable declines in Swainson's Hawk populations over the last century. These population declines have led to the Swainson's Hawk being listed as

threatened in many states. Conservation genetics research can help identify management units as well as helping set conservation priorities in vulnerable species. Recent advancements in sequencing technology have enabled the cost-effective and efficient sequencing of the whole genome, which allows for the genome-wide detection of hundreds of thousands of genetic markers. This increased number of genetic markers enhances the power and accuracy of estimating a variety of important parameters and can also provide insights into questions un-answered by previous methods, such as the identification of genomic regions undergoing local adaptation. In this study we sequenced whole genomes at an average coverage of 2-4x across individuals representing the entire breeding range of the Swainson's Hawk with the purpose of investigating population structure, demographic history, and adaptive differences between populations. These results will help scientists and managers make informed decisions about the conservation status of the Swainson's Hawk as well as determining the need for the delineation of specific conservation units.

### Food Provisioning, Prey Composition, and Nesting Success of Ospreys in Northwestern California

**MICHAEL ACADEMIA** (mha23@humboldt.edu), Humboldt State University, One Harpst Street, Arcata, CA, U.S.A.

Piscivorous bird diet and reproductive status are affected by prey species composition and provisioning efforts. During three months of the 2018 breeding season, I observed Ospreys (*Pandion haliaetus*) at a foraging site, the mouth of the Klamath River, and at six nests within northwestern California (Humboldt and Del Norte Counties, USA), to observe the relationship between nesting success and time spent on food provisioning. Prey composition included non-native American shad (*Alosa sapidissima*), salmon and trout (Salmonidae), Pacific lamprey (*Entosphenus tridentatus*), jacksmelt (*Atherinopsis californiensis*), and surfperch (Embiotocidae). Three of the six nests fledged successfully, with productivity measured at 0.83 young per active nest. Successful Ospreys spent more time on food provisioning including successful foraging and prey consumption ( $SD = 18.7$ ,  $SD = 10.3$ ;  $\chi^2 = 1466.7$ ,  $df = 1$ ,  $P\text{-value} < 0.001$ ). Unsuccessful nesters were involved with other activities such as unsuccessful foraging, defense from predators, rest, preening and perching. My study documents the provisioning effort needed for breeding success of Ospreys in northwestern California, which could be applied to research on this species elsewhere. In evaluating the expansion of forage fisheries, managers may use data on prey composition. My study may inform ecosystem-based fisheries management, a holistic management approach that considers trophic interactions.





## Oral Presentation Abstracts

### **Abundance and Nesting Success of Prairie Falcons (*Falco mexicanus*) in the Morley Nelson Snake River Birds of Prey National Conservation Area**

**STEVEN ALSUP** (stevenalsup@boisestate.edu), Raptor Research Center, Boise State University, Boise, ID, U.S.A.  
**JAMES BELTHOFF**, Raptor Research Center and Department of Biological Sciences, Boise State University, Boise, ID, U.S.A.  
**TODD KATZNER**, United States Geological Survey Snake River Field Station, Boise, ID, U.S.A.  
**KAREN STEENHOF**, Owyhee Desert Studies, Murphy, ID, U.S.A.  
**MICHAEL KOCHERT**, United States Geological Survey Snake River Field Station, Boise, ID, U.S.A.

The Morley Nelson Snake River Birds of Prey National Conservation Area (NCA) supports one of the world's highest known densities of nesting Prairie Falcons. The NCA is thought to support ~5% of the global population of Prairie Falcons, and the boundaries of the NCA were established based, in part, on a telemetry study documenting the foraging range of falcons nesting in the Snake River Canyon. Prairie Falcon abundance and reproductive performance has been studied intermittently in the NCA over the past 45 yrs, but no formal surveys have been conducted there since 2003. As a consequence, the Prairie Falcon was identified by agency and university biologists in 2008 as a priority species for monitoring. In summer 2019, we assessed Prairie Falcon abundance in the Snake River Canyon by systematically surveying 50 km of river, in 5 km segments, during two rounds of occupancy surveys. We randomly selected 50 historical nesting territories and documented nesting success to assess reproductive performance. Preliminary results suggest that the number of occupied territories ( $n = 130$ ) were well above those reported within the same 5 km stretches in 2002 ( $n = 85$ ) and 2003 ( $n = 75$ ). However, nesting success per occupied territory (44%) was one of the lowest rates reported (1974 – 1997 average = 63%; 2002 = 58%; 2003 = 42%), and success varied across the four traditional study strata in the NCA. Despite the low reproductive success, because of the large number of nesting attempts, the number of nests that fledged offspring was higher than in earlier surveys. These results highlight the importance of long-term monitoring efforts for the management and conservation of this species.

### **Raptor Migratory Connectivity in the Americas: Linking Peregrine Falcons (*Falco peregrinus*) Wintering in Peru With their North American Natal and Breeding Grounds**

**OSCAR BEINGOLEA**, Lima, Perú. **NICO ARCILLA** (nico.arcilla@aya.yale.edu) Crane Trust, Wood River, NE, U.S.A.

Identifying raptors' wintering areas and migration routes is essential for predicting the consequences of habitat and climate change throughout their annual cycles for conservation. Migratory connectivity, which is defined as

the linking of migratory animals' breeding, migration, and wintering areas, is poorly understood for Peregrine Falcons in the Americas. Despite intense studies on Peregrine Falcon North American breeding grounds and migratory stopover sites, few empirical data are available on the South American wintering areas, including in Peru, where Peregrine populations include both Nearctic migrants and resident birds. Here we use band encounter data collected from 1982-2019 to present the first evidence connecting wintering Nearctic Peregrines in Peru with their natal and breeding territories in North America. We report 209 captures of Peregrines in Peru with natal origins in North America, including banded birds from Alaska, Minnesota, and Nunavut, as well as a captive-bred individual from Nebraska that may represent the longest known migration resulting from a species reintroduction program. We also report new records of wintering Peregrine arrivals in Peru that represent an advance compared to the earliest previously published reports. Peregrines exhibit differential migration, where birds of different ages and sexes exhibit spatial and temporal differences in their migratory behavior. Previous research suggesting that male Nearctic Peregrines average much greater migration distances than females is consistent with the male majority (72%) we found in our sample of Nearctic Peregrines in Peru. Our findings provide new insights into Nearctic Peregrine migratory connectivity and wintering areas, and highlight the success of reintroduction efforts of this species following its extirpation from eastern North America.

### **Spatial Analysis of Bird-caused Fires and Vegetation Cover Types in the United States**

**TAYLOR BARNES** (tbarnes@edmlink.com), EDM International Inc., Fort Collins, CO, U.S.A.

Utility companies are being held liable for fires that begin in Rights-of-Way (ROWs) and spread, causing property damage and loss of life. States like California are grappling with the repercussions of large-scale fires that originated on utility infrastructure, resulting in major civil and class action lawsuits. A recent study looking at the impacts of bird-caused fires in utility ROWs suggests utility companies focus heavily on vegetation management but may overlook animal-caused wildfires. Large-bodied birds are capable of making phase-to-phase contact on power poles, catch fire, and fall to ground level. This phenomenon has been documented on a global scale in the United States (US), South America, Europe, and Australia. This spatial analysis will utilize data originating from a previous study to identify statistically significant clusters of bird-caused fires connected with power poles in the US and the vegetation cover types associated with these events. It is expected that statistically significant clusters of bird-caused fires will be found in the western US and most commonly associated with grassland and shrubland cover types. Fires caused by bird contacts can be mitigated by



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retrofitting power poles to reduce the likelihood of electrocution. Resources available for raptor collision and fire prevention are limited, requiring utility companies to focus mitigation efforts in high-risk areas. Results of this spatial analysis will enhance understanding of bird-caused fires and assist utilities in identifying high-risk areas within service territories for power pole retrofits.

### Developing Massively Parallel Sequencing Multiplexes for Raptors: High Discrimination for Conservation and Forensics Applications.

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Traditionally, studies on population genetics of raptors use microsatellite markers analyzed by capillary electrophoresis (CE). However, advances in massively parallel sequencing (MPS) technology have allowed a greater level of discrimination from these markers by also revealing flanking sequence and repeat structure variation. We developed multiplexes using a novel set of microsatellite markers to target species and individual identification as well as sexing markers (i.e. mtDNA barcodes, short tandem repeats (STRs) & Z/W sex chromosome sequences) for use both on traditional CE and MPS platforms. Initial results suggest high levels of discrimination in these markers. It is envisaged that these multiplexes will serve as an informative tool for those studying population genetics of raptors and their conservation implications. In addition, the multiplexes will also have applications in wildlife crime forensics. Raptor persecution is one of the six priorities for the UK National Wildlife Crime Unit. Shooting and destruction of raptors account for the largest number of incidents reported to the UK Royal Society for the Protection of Birds, with 1,225 incidents between 2010 and 2015 and theft from the wild for sale into falconry is also a big problem. However, securing any prosecution for these crimes is often difficult due to a lack of evidence. The multiplex systems developed here could be used to provide evidence of identity or relatedness, e.g. comparing chicks stolen from a wild nest to alleged captive parents and siblings or linking blood-stained clothing with the trapping or disposal of a specific bird.

### Great Gray Owl Nesting Demographics at the Southern Range-Edge in the Rocky Mountains

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Long-term studies of nesting demographics for Great Gray Owls (*Strix nebulosa*) are rare in North America, and do not exist in the Rocky Mountains of the United States. For the past 7 yrs, we monitored a nesting population of Great Gray Owls in the Jackson Hole Valley of western Wyoming. We observed wide variation in annual nest success from 26 known territories, ranging from nearly 0% to 100%. From 2014 – 2019, we conducted Northern Pocket Gopher (*Thomomys talpoides*) surveys to quantify prey abundance, and we documented snow characteristics within territories from 2015 – 2019 to potentially correlate with nesting demographics. Over the past 5 yrs, it appears that snow conditions may have played a pivotal role in nest initiation while occupancy rates experienced little fluctuation. We documented a range of nesting substrates for this species and wide variation in nest re-use. Compared to historical data in the region, it appears that contemporary productivity may be considerably lower than estimates from the 1980s. Further, recovery data from banding and telemetry suggest that nest-site fidelity for Great Gray Owls may be lower than conventional suppositions for raptors. Inter-territory movements and wide annual fluctuations in productivity indicate that only long-term population monitoring can accurately assess local Great Gray Owl population health.

### A Spatially Explicit Model to Predict the Relative Risk of Golden Eagle Electrocutions

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Electrocution of Golden Eagles (*Aquila chrysaetos*) on overhead power poles is a conservation concern in the western United States. Retrofitting power poles to minimize electrocution risk is one mechanism recommended by the US Fish and Wildlife Service as compensatory mitigation to offset permitted take for Golden Eagles. Because densities of Golden Eagles and power poles vary spatially, identifying where poles should be retrofitted to best meet compensatory mitigation goals is of conservation importance. We developed a model that predicts areas of varying risk of electrocution for eagles based on the overlap between spatial models of exposure and electrocution hazard within the Northwestern Plains



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ecoregion. Risk was unevenly distributed: areas with the highest electrocution risk were rare (1.0% by area), while lowest risk areas were common (53.8% by area). We tested model predictions with independent data consisting of locations of Golden Eagle electrocution mortalities ( $n = 342$ ). Mortalities were distributed among six risk classes proportional to model predictions, with 87.7% of mortalities occurring in the top three risk categories. Prioritizing pole retrofitting in the highest-risk areas could prevent >3x the electrocutions expected by selecting areas at random and would be 87x more effective than retrofitting in the lowest risk areas. Our risk model offers a consistent method to spatially prioritize retrofitting to increase effectiveness of electrocution reduction for Golden Eagle conservation and provides an efficient approach for utilities. This method of quantifying spatial overlap between indices of exposure and hazard is simple, accurate, and can be adapted to various forms of data whenever quantification and visualization of spatial prioritization is desired.

### **Twenty Years of Volunteer Raptor Monitoring: Program Management and the Importance of Engaging Volunteers to Inform Data-Driven Raptor Conservation at a Park System Scale**

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Jefferson County Open Space (JCOS) manages a popular system of 28 parks spanning 22,600 ha along the dynamic wildland-urban interface west of Denver, Colorado. For more than 20 years, JCOS staff and hundreds of volunteers have monitored nesting raptors including Golden Eagles (*Aquila chrysaetos*), Prairie Falcons (*Falco mexicanus*), Peregrine Falcons (*Falco peregrinus*), Red-tailed Hawks (*Buteo jamaicensis*), and Great Horned Owls (*Bubo virginianus*). The monitoring program was built upon twentieth century research on cliff nesting raptors across the Colorado Front Range, including JCOS parks. With the broader goal of guiding wildlife conservation and adaptive management of the park system, the program's objectives are to locate nests and other significant perches, determine active nests through observations, and monitor nest productivity. Important dates throughout the nesting cycle are also recorded to track local phenological timing. The program's success relies on refined research questions, simplified protocols for volunteers, and oversight by JCOS wildlife ecologists. Volunteer retention requires clear instructions for monitoring, fulfilling engagement, and an accessible data entry platform. In 2019, several dozen volunteers again participated in the program, many of whom have been involved for years. Through volunteer engagement, the JCOS Natural Resources team has greatly increased its capacity to monitor raptor nests across the complex landscape of

Jefferson County. As a result, the program generates current and accurate data on nesting raptors to support conservation measures including seasonal and permanent closures, trail reroutes, and educational outreach to diverse recreation groups. Data also inform short- and long-term planning associated with park development and operations and are valuable to JCOS and other agencies for detecting changes in nesting phenology, territory and nest selection and annual success. Finally, this flagship volunteer program creates enthusiastic stewards of park visitors and creates a sense of community for bird enthusiasts from novice birders to experts.

### **Red-tailed Hawk Densities and Hunting Habitat in South-central Nebraska**

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Raptor movement and behavior are strongly influenced by raptors' need to acquire prey. As a result, we would expect species such as Red-tailed Hawks (*Buteo jamaicensis*) to inhabit areas of accessible prey. Red-tailed Hawks have previously been known to hunt in areas of dense vegetation, likely due to the inaccessibility of prey, as well as areas of sparse vegetation, likely due to the absence of prey. In order to examine which habitat characteristics most strongly influence Red-tailed Hawk presence in a highly fragmented, agricultural area, we conducted roadside raptor surveys to determine areas of high and low Red-tailed Hawk use. We then conducted seasonal small mammal trapping and vegetation surveys in those areas. Our results suggest that utility poles and vegetation type effect the accessibility of prey, thereby making overall prey abundance less important. Specifically, we found summer low-use Red-tailed Hawk areas to have denser vegetation that likely physically and visibly obstructed hunting Red-tailed Hawks. However, winter and fall high-use sites reported taller vegetation, which suggests that as long as the vegetation is not too dense, taller vegetation supports a higher quality hunting habitat.

### **Death by Aircraft: A Possible Contributing Cause of the North American Kestrel Population Decline?**

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Bird-aircraft conflicts have become increasingly common since the first bird airstrike occurred in 1912 as air travel becomes more frequent. Some species are more vulnerable to these collisions due to their attraction to the



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large open grasslands that airports often contain. American Kestrels (*Falco sparverius*) have a strong affinity for grasslands and consume large numbers of ground and aerial insects, making them susceptible to airstrikes across North America. Unfortunately, kestrel populations have been in a steady decline since the collection of reliable population trend data began in the 1960s. To examine whether aircraft collisions could be contributing to this decline, we analyzed data on avian airstrikes provided by the Federal Aviation Administration (FAA) website. Between 1995 and 2019, 6,072 kestrels struck by aircraft in the U.S. were reported to the FAA. We sorted the data by state and removed any airports with fewer than 10 kestrel airstrikes since 1995 as a proxy for reporting reliability. Because the data were erratic and airstrikes likely underreported in earlier years, we elected to analyze data between 2009 and 2018. Since 2009, 3,712 kestrels have been struck at airports that we assumed were relatively reliable reporters of airstrikes. We found a significant increase in kestrel airstrike mortalities over the 10-yr span of our analysis ( $R^2=0.62$ ,  $p=0.004$ ). This mortality is also skewed by season, with kestrels being struck significantly more often during the end of the breeding season through fall migration ( $p<0.0001$ ). We hypothesize the steep increase in kestrel airstrikes in July represents juveniles and suggest that airports may be ecological traps for kestrels, limiting recruitment to the breeding population. Because these data likely represent only a fraction of the true number of kestrels killed by aircraft, we suggest that they indicate airstrike mortalities may be a contributing cause of the continental decline of American Kestrels.

### American Kestrel (*Falco sparverius*) Food Habits: Surprises and Unintended Consequences of Conservation Actions

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Nest box programs have been popular methods to enhance populations of American Kestrels, as a species that is in general decline across its North American distribution. In contrast to widespread patterns of decline, Kestrel populations are stable or increasing in the southern Great Plains region. However, this region likely had very low natural presence prior to European settlement, and their current abundance in the region is undoubtedly due to vegetation and structures associated with settlement of the region, but also by direct population enhancement actions such as nest box programs. In 2011 we initiated a nest box program to study Kestrel ecology in short/mixed grass prairies of Texas. One line of inquiry was assessing how population

dynamics may be influenced by regional dietary habits in this area once unoccupied by breeding kestrels. We recorded over 3,100 prey deliveries during the four wk brood-rearing periods at five nest boxes in 2017. Prey delivery rates were high, with an average of 2.65/hr during the fourth wk of brood rearing. The breeding season diet was dominated by reptiles, with Prairie Racerunners (*Aspidoscelis sexlineata viridis*) and Common Spotted Whiptails (*A. gularis*) accounting for 38.3% of prey. The state-threatened Texas Horned Lizard (*Phrynosoma cornutum*), a species receiving substantial conservation attention, accounted for 13.0% of prey deliveries. Mammalian (5.4%), avian (2.3%), and invertebrate (21.0%) prey were used to a lesser extent, but included prey as large as juvenile Eastern Cottontails (*Sylvilagus floridanus*) and Cotton Rats (*Sigmodon hispidus*). Unfortunately, our data suggest negative consequences for other species of concern due to the increasing population trend of Kestrels in the region. Prior to establishing nest box programs, it would be prudent to assess potential negative impacts on local species of conservation concern that may serve as Kestrel prey.

### The Use of Trained Raptors in Field Research

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Falconry is the practice of training raptors as hunting 'tools'. In the course of over 2,000 yrs of practice, countless techniques have been developed for the training, maintaining, and husbandry of various raptor species. Many of these techniques have been adapted for application to raptor conservation efforts, especially husbandry practices for inlab captive rearing, toxicology, and physiology studies. Two studies examined prey selection during hunts with trained hawks, but the application of falconry methods to experimental field studies is rare. More recently, we have applied falconry practices to conduct experimental studies of 1) game bird escape behavior and habitat use in response to different predation threats, 2) raptor selectivity of prey with and without transmitters, 3) the efficacy of captive rear-and-release programs for game birds, and 4) the influence of transmitter weights and attachments of raptor flight. We will review these field studies to demonstrate what can be learned for applied wildlife conservation and management from research involving trained raptors. We will also identify the challenges of using trained raptors for research, and the legal and permitting aspects of such application.





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### Turning the Tide Against the Poisoning of Vultures: Impact and Lessons Learnt from the Wildlife Poisoning Response Training Programme

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Africa's vultures are currently facing a crisis with seven of the 10 resident and breeding species on the continent classified as either endangered or critically endangered according to the IUCN Red List of Threatened Species. The most significant threat that drives the decline of vulture populations across the continent is poisoning in various forms that causes large-scale losses exacerbated by the feeding biology and slow reproductive rate of these birds. The Multi-species Action Plan for the Conservation of African-Eurasian Vultures (CMS Vulture MsAP) recommends a range of actions that can be implemented by range states to combat wildlife poisoning and to reduce its impact on vulture populations. The Endangered Wildlife Trust – Hawk Conservancy Trust partnership has implemented a training programme focused on conservation and veterinary practitioners across southern and east Africa to create awareness, develop response skills and promote planning to combat wildlife poisoning in key areas where this threat is prevalent. We will share information on the measured impact of the implementation of wildlife poisoning response activities in key areas, share insights with regard to the lessons learnt from the more than 70 training workshops conducted between 2015-2019 and provide details of progress to train a network of in-country facilitators to present this training to a much wider audience within target countries.

### Effects of Natural and Anthropogenic Factors on Occupancy and Productivity of Two Arctic Raptor Species on Baffin Island, Nunavut, Canada

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Biotic and abiotic factors affect how animals choose and utilize habitats, resulting in different responses amongst individuals. Occupancy modelling is a robust method for examining how organisms are spatially and temporally distributed in a landscape. In this study, patterns of occupancy and reproductive success are documented in Arctic-breeding Rough-Legged Hawks (*Buteo lagopus*) and Peregrine Falcons (*Falco peregrinus*). Located on Baffin Island, Nunavut, Canada, the 10,000 km<sup>2</sup> study area

encompasses an active iron ore mine, Baffinland Iron Mines Corporation, Mary River Mine site (N71.326, W079.374). Previous analysis focused on examining the effect of distance to anthropogenic disturbance and distance to nearest neighbour on Rough-Legged Hawks and Peregrine Falcons nesting behaviour. The goal of this study is to assess the effects of weather and prey as covariates of nest occupancy and productivity. To account for detection error, we surveyed all known nesting sites three times over two breeding seasons (2018 and 2019). We conducted winter nest counts and snap trapping to estimate relative abundance of small mammals, and distance sampling to estimate avian prey abundance, and used data recorded from two meteorological stations in the study area to examine the effects of weather. Preliminary results show that occupancy and productivity are not affected by distance to disturbance or nearest neighbour distance, including an interaction between these variables.

### Turkey Vultures Modify Foraging Strategies in Response to Anthropogenic Food Subsidies

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Vultures are the only obligate scavengers worldwide. They evolved to find and consume carcasses quickly, which makes them integral to many ecosystems. Their unique ability to rapidly break down carcasses increases nutrient cycling, prevents the spread of diseases, and stabilizes food webs. In the United States, Turkey Vultures (*Cathartes aura*) play a vital role in both removing carrion from the ecosystem and alerting other scavengers to carcass locations. These birds are also frequently seen near anthropogenic food sources (e.g. landfills), but the degree of their behavioral modification in response to non-traditional food sources has not been qualified. Therefore, we used GPS tracking technology to map the movements of eight Turkey Vultures in relation to landfills in the northeastern United States. We found that Turkey Vultures are more likely to spend time in landfills when compared to the null model ( $t = 2.1588$ ,  $p = 0.042$ ) and were also more likely to roost near these food sources ( $t = 49.573$ ,  $p < 0.0001$ ). In addition, we found that the amount of time spent in landfills was independent of home range size or the number of landfills within an individual's territory ( $F_{1,7} = 0.05197$ ;  $p = 0.826$ ). These results suggest that Turkey Vultures are adjusting their behavior to regularly include anthropogenic food sources in their diet and also display a preference for which landfills they visit within their home range. These results could have





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implications for behavioral strategies and movement patterns in the Turkey Vulture in the United States.

### Big Data from Remote Tracking of Raptors: Golden Eagles on Migration in Western North America

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Our ultimate goal was to provide spatial products that reduce possible conflict between conservation of Golden Eagle (*Aquila chrysaetos*) populations and land uses that may impact eagles, such as utility-scale energy development, via targeted habitat management and mitigation strategies. Here we illustrate one approach that we have adopted to draw inference from location data of around 170 Golden Eagles fitted with satellite PTTs, and considered by us as classic long-distance migrants. Because our primary focus here was predicting relative intensity of space use by eagles, during seasons when typical migratory movements tend to occur, we first used movement models to classify portions of eagle satellite tracks into either sedentary or transiting (rapid, directed movements that occur during migration, dispersal, or commuting across home ranges) behaviors. We then used those telemetry fixes classified as transiting as input to Maxent models that sought to project space use across the entire western portion of the eagle's range in North America. Final models were validated by testing how well their predictions of landscape suitability for transiting corresponded to telemetry fixes from transiting eagles not used for model training (~ 10% of total points available). We greatly improved our models through careful screening of covariates, evaluating the density of input points and possibly performing thinning, and specifying the area available for modeling based on the eagles' characteristic movement patterns (i.e. 20 km windows when sedentary, 50 km when transiting). Our final models were intended to become important components of preliminary range-wide risk assessments, in combination with spatially explicit models of breeding habitat and possible threats.

### Diclofenac and other Non-steroidal Anti-inflammatory Drugs: Are Vultures in the Iberian Peninsula at Risk?

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Diclofenac is a non-steroidal anti-inflammatory drug (NSAID) for veterinary use that caused the decline of vulture populations in South Asia in the 1990's. Although veterinary regulations exist in Europe, the licensing of this drug may pose serious concerns for vulture health and the important ecosystem services they provide. This could be especially pronounced in the Iberian Peninsula, which holds 95% of Europe's vulture population. Our goal was to assess the risk of NSAIDs exposure to vultures. To uncover exposure pathways from the use of NSAIDs in livestock to the consumption of their carcasses by vultures at the muladares, we conducted surveys targeting veterinarians and muladares managers, and a literature review. Concurrently, we analyzed drug residues from vultures and livestock carcasses collected in the field. We found 99 relevant scientific articles evaluating the effects of NSAIDs on Old World vultures between 2003 and 2019. Surveys showed that 18% of veterinarians regularly prescribed diclofenac to food animals, and 32% of them did not consider risks to other animals when using NSAIDs. From the muladares managers surveyed, 65% were aware that diclofenac was harmful to vultures. Residue analyses of livestock showed a 3.3% of carcasses containing NSAIDs (1.31% flunixin, 0.65% ketoprofen, 0.65% meloxicam, and 0.65% diclofenac), and 4.4% of vultures presented NSAID residues (2.5% flunixin, 1.3% meloxicam, and 0.63% nimesulide). Results of this risk assessment may guide government and veterinary authorities to institute new management and policy changes regarding veterinary NSAID use with the goal of protecting vultures in the Iberian Peninsula.

### Vultures, Carnivores, Communities and Conflict – Towards Workable Conservation Solutions in Kenya

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Wildlife poisoning is rife in East Africa and is fueled by conflict between people and wildlife. Rapid growth of human and livestock populations around wildlife-rich



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areas has led to depredation of livestock by carnivores, resulting in increasing incidences of retaliatory poisoning whereby carcasses are laced with highly toxic pesticides to eliminate predators. Poisons kill indiscriminately and vultures are disproportionate victims. Poisoning has decimated African vulture populations, and four species are now critically endangered. In order to reduce vulture poisoning triggered by human-wildlife conflict we discuss the results of our efforts in both Northern and Southern Kenya. Our work focuses on tracking vulture movements, identifying poisoning hotspots, developing local capacity to engage with communities, conducting a series of community-wildlife coexistence trainings encompassing creating awareness, wildlife poisoning intervention and demonstrating construction of cheap, predator-proof cattle pens. We are also expanding a growing network of "Vulture Protectors" involving other partners in key areas of Kenya. Since November 2016, we have made progress in reducing vulture mortality in both Northern and Southern Kenya, although poisoning incidents remain unreported in some areas. We present results on how many trainings have been conducted, how many people have been reached and lines of evidence to show that our efforts are working.

### The Consequences of Breeding Phenology and Mismatch on American Kestrel Fitness

#### KATHLEEN R. CALLERY

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Many bird species start their breeding seasons based on environmental cues that indicate the proper climatic conditions and subsequent resource abundance for successfully producing offspring. We observed that the majority of American Kestrels (*Falco sparverius*) in North America have been laying their eggs in a certain climatic window predicted by leaf emergence and bloom burst of indicator plant species; however, there is a recent trend across regions for kestrels to lay eggs after this climatic window. We examined the effects of this mismatch in timing of clutch-initiation on the productivity and survival of breeding birds. Also, we studied whether the degree of hatch-asynchrony within a clutch, and the onset of male incubation behavior, varied with clutch initiation date. Results show evidence that birds within the predictive climate window have both higher productivity and higher apparent survival than birds that lay after the window. This result has important implications for how regional populations of American Kestrels will adapt to climate changes in North America.

### The BSE (Bovine Spongiform Encephalopathy) Is Over: Political and Ecological Aspects of a 20-year Study in Northern Spain

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After the BSE regulations in 2000, La Rioja (5,000 km<sup>2</sup>) was the first region to implement a carcass removal program. Then monitoring, namely for the Eurasian Griffon Vulture (*Gyps fulvus*) was started, and we evaluated the measures against BSE and the effect on vultures. In 1999 there were 819 pairs in the breeding population. Since then, stratified monitoring of breeding colonies showed a steady 10.38% decline from 2000 to 2007 (range :18.44% to 0.44%). There were 707 breeding pairs by the 4<sup>th</sup> regional census in in 2008 (decrease of 13%). Finally, in the 2014 census the breeding population grew again reaching 1,128 breeding pairs. However, the Egyptian Vulture (*Neophron percnopterus*) did not show any population change over this period. There are no breeding Cinereous Vultures (*Aegypius monachus*) or Bearded Vultures (*Gypaetus barbatus*) in the region, but vagrant individuals do occur. Population trends cannot be interpreted without considering political and ecological factors. The highest decreasing rate occurred in 2006–2007, when neighboring regions closed the vulture restaurants. Between 2007 and 2012, the Government of La Rioja established new ones and shepherds were allowed to leave carcasses in open areas (2,130 km<sup>2</sup>; 58.24% of the total extension) under certain conditions. Percentages of livestock types removed were compared against their yearly censuses. All livestock types were removed according to their respective abundances. In 2001 all carcasses were removed, but this number has reduced over time. For the 2014–2018 period, on average 52.8% of the carcasses produced in the region remained available to vultures. We discuss how the different livestock-rearing practices affect food availability for vultures. This is the first long-term study relating the BSE effect on vultures showing how political cooperation, and veterinarians, and nature conservation authorities can solve and manage the situation. This is not the same all over Spain, but in general vultures are now finding enough food compared to the early 2000s.

### Vulture Abundances in Four Ethiopian Habitats, Concerns When Performing Road Counts

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During March 2019, we performed 1,165 km of road counts for vultures in four areas of the Oromia and Afar regions of Ethiopia. We recorded six out of the eight species of vultures inhabiting Ethiopia. The most abundant was Rüppell's Griffon (*Gyps rueppellii*; 33.71 birds/100 km) followed by the Hooded Vulture (*Necrosyrtes monachus*;



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14.24 birds/100 km). Other species recorded were the Egyptian Vulture (*Neophron percnopterus*; 2.51 birds/100 km), the White-backed Vulture (*Pseudogyps africanus*), the Eurasian Griffon (*Gyps fulvus*) and the Lappet-faced Vulture (*Torgos tracheliotos*), with abundances ranging from 0.19-0.21 birds/100 km. We also expressed these in terms of contacts, regardless the number of individuals due to the gregarism of some species. The Rüppell's Griffon occupied all kinds of habitats, while the Hooded Vulture was strongly associated to human settlements. The Egyptian Vulture was concentrated in northern regions. All areas had different carcass management with rubbish dumps or free-ranging livestock available. Counts should be performed according to the target species, accounting for solitary versus congregatory species; and not all at the same time of the year, or during the breeding season when bird detectability is lower. Studies should account for variations in inter-annual abundance avoiding rough comparisons between studies and year. We noted the influence of time of the day ( $p < 0.05$ ), with lower numbers detected in the afternoon. Spatial distribution of food resources is a key point and there is a need for improvement in carcass management while keeping dump sites running. Large vulture concentrations were associated with predictable food sources and low or limited numbers of birds were recorded away from these but close to breeding colonies and roosts. From a cultural perspective, the large majority of Ethiopian Orthodox make the environment safer for vultures due to the lack of, or much reduced, persecution.

### **Trends in Golden Eagle (*Aquila chrysaetos*) Reproduction, Juvenile Survival, Prey Species Abundance and Habitat Characteristics in Utah.**

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Central and Western Utah are home to a resident population of Golden Eagles, whose breeding activity and productivity fluctuates in a cyclical fashion. In this study area, substantial overlapping datasets allow an exploration of the ecological conditions underlying these fluctuations and their resulting consequences to eagle populations in the region. In a long-term nest monitoring dataset, including 3660 territory-years where a status was assigned between 2000 and 2018, average annual rates of verified nesting attempt initiation in the study area ranged from 15.3% (in 2009) to 49.8% (in 2000) per monitored territory. Abundance surveys of Golden Eagles' primary prey item (leporids) were also conducted in the study area from 2011 to 2018, ranging from 1.00 (in 2011) to 20.17 (in 2015) rabbits estimated per square km. Post fledging 1-year survivorship of Golden Eagle young produced in the

study area was also measured through the deployment of 58 satellite transmitters between 2013 and 2018, and ranged from 0% (in 2018) to 100% (in 2017). By comparing these values over time we examine the relationship between prey abundance and reproductive success and post-fledging survivorship for Golden Eagles in the Central Basin and Range ecoregion. We also examine habitat factors such as extant shrub cover, shrub loss due to fire, and environmental conditions, comparing nest territories with consistently high nest initiation (eggs laid in >60% of years checked) with territories where nesting was initiated more rarely (<40% of years checked). We will also discuss our results' implications for Golden Eagle population dynamics and conservation measures.

### **Evidence of Post-Breeding Prospecting in a Migratory Raptor**

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Organisms assess biotic and abiotic cues when deciding where to settle. The availability and reliability of these cues may change over time and can even change significantly within the same season. Therefore, if an individual chooses to prospect for new habitat, the timing of this behavior may play a crucial role in their ability to successfully predict future breeding site quality and increase their fitness. However, especially in migratory birds, this prospecting behavior may be difficult to disentangle from other movements during the pre and post-breeding period. Research focused on prospecting in raptors and migratory animals is lacking, and the majority of information on timing has been reported incidentally. We investigated the fall movements of Flammulated Owls (*Psiloscops flammeolus*) within breeding habitat after fledglings had gained independence and before adults left for migration. From 2013 to 2016 we trapped for owls within a banded breeding population, where all nesting birds and their young have been banded since 1981. We observed large numbers of non-resident owls utilizing breeding habitat during this period, with a trend of mass gain, and a median passage date of 9 September. A significant number of these owls later settled within the study area, and all stable isotope signatures matched local patterns, suggesting that Flammulated Owls may be using this time period to prospect for future breeding sites. Further investigation into the exact timing of prospecting is important because climate change and altered disturbance regimes may lead to phenological mismatch and severely alter a species' ability to select ideal habitat.



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### An Unexpected Backyard Hunter: Home Range Size and Habitat Selection of Barred Owls Along a Development Gradient

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Despite extensive accounts in the literature describing Barred Owls (*Strix varia*) as obligate forest-interior dwelling species, Barred Owls have increasingly been found in urbanized landscapes. To determine if certain habitat characteristics, such as mature neighborhood trees, facilitate the occurrence of Barred Owls in developed regions, we deployed GPS transmitters on 21 breeding Barred Owls in northwestern South Carolina. We targeted territories situated in various degrees of development to examine predictors of territory size and habitat selection along an urban-to-rural gradient. We used high-resolution imagery and LiDAR data to model habitat features such as landcover and tree height at a fine-scale (2-m). We related foraging (nocturnal) locations to habitat features using resource utilization functions (RUFs). We averaged predictions from each individual owl's RUF to generalize selection at the population level. Owl territories in our study region varied from 0.25 km<sup>2</sup> to 4.46km<sup>2</sup>; owl territory size was best predicted by amount of open, treeless areas in the territory such as agricultural fields and large powerlines. Barred Owls demonstrated strong central-foraging tendencies near their nest-site. Across the development gradient, Barred Owls preferred foraging within patches of taller trees and near aquatic features and canopy/forest patch edges. Barred Owl foraging preference for canopy edges increased in territories containing a higher percentage of impervious surface. This is the first resource selection study that utilizes GPS data to examine habitat use of Barred Owls in the context of development. Our results highlight the plasticity of a species previously described as sensitive to development. The presence of this apex predator in urban forests suggests that retaining key habitat features can promote multi-trophic communities even when other aspects of the habitat are dramatically altered.

### Developing Models for Nesting Success of Bald Eagles in Colorado

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Researchers typically use apparent success (the proportion of nest attempts determined to produce fledglings) to measure raptor nesting success, and infrequently use relatively unbiased nest survival models. One factor limiting the use of nest survival models for raptors is that observers often cannot determine with certainty the nesting stage (e.g., egg laying, incubation, chick rearing). We used data largely collected by citizen scientists on 163 nesting attempts at 86 nest sites during 2012-2016 to develop models of nest daily survival rate for Bald Eagles (*Haliaeetus leucocephalus*) in Colorado. In order to use the nest survival model in program MARK, we only used data from nest attempts where the following information was available: the day of the nesting season a nest was found or first checked; the last day a nest was still determined to be active (alive); the last day a nest was checked and known to have fledged young or failed; and the nest fate (successful or failed). The sample of bald eagle nests monitored during our 5-year study period that included this information was only 32% of the total number of nests monitored. We fit models including nest age, weather, and land cover variables and estimated daily survival rate and overall nest success. We are developing models that account for uncertainty in nesting stage. We provide recommendations for standardized monitoring of bald eagle nests that can be easily used by our broad suite of partner observers.

### Nest Depredation's Multiple Effects on a Social Raptor

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Nest depredation may have multiple effects beyond mortality of the adult or young, yet these additional impacts are seldom evaluated. Additional impacts may include the loss of a mate, a biased sex-ratio in adults, starvation of offspring, abandonment of nest sites where depredations occurred, and failure to occupy these sites in following years. When social raptors are the victims, nest depredations may also result in group disruption, colony abandonment, and colony relocation or dispersal. Swallow-tailed Kites (*Elanoides forficatus*) are social raptors that frequently nest in small groups, group-mob predators, roost communally, and hunt together in pairs to large flocks. In the southeastern U.S. the kite's primary nest predators are larger raptors. We studied nest depredation of Swallow-tailed Kites at two southeastern U.S. study areas: Louisiana–Mississippi (N = 561 nests, 1998–2018) and Florida–Georgia–South Carolina (N = 578





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nest, 2010–2018). Study-wide, we detected on-nest depredations of 45 adult kites by large raptors. We attempted to isolate DNA from the remains salvaged from 44 kites. Of the 27 yielding intact DNA, 26 were females. When the timing was known, depredations ( $N = 11$ ) occurred at night, implicating large owls. Evidence left by raptorial predators sometimes implicated Great Horned Owls, but at most nests we could only conclude that a large raptor was responsible. Female kites were the only sex observed incubating eggs ( $N = 19$  nests) and brooding nestlings ( $N = 15$  nests) overnight, and these differential behaviors explain the sex-bias in this nest-focused mortality. We did not find support for a male-biased sex-ratio in adults. Adult depredation resulted in multiple negative carryover effects including nest site vacancy, reduction in breeding group size, and colony abandonment the following year.

### Golden Eagles Shift Primary Selected Prey

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Prey availability varies over time and space, which influences variation in nesting metrics such as nesting success and productivity. Raptor prey species typically increase and decrease in abundance cyclically or remain relatively constant. Specialist and generalist predators are impacted differently by changes to prey abundance, with more variation in nesting metrics among specialists and less variation for generalists. Golden Eagles are a generalist predator but reproductive output is often influenced by cyclic prey populations. We studied Golden Eagles (*Aquila chrysaetos*) in an area with relatively constant occupancy, apparent nest success, and productivity, suggesting a steady prey source. But, historic data from our study area determined White-tailed Jackrabbits (*Lepus townsendii*) and cottontail rabbits (*Sylvilagus* spp.), which experience population cycles, were the primary prey. Given our lack of variation in nesting metrics and historic prey information, we were interested in determining currently selected primary prey species and the influence of prey to reproductive output. During the 2016–2018 nesting seasons, we identified 710 prey items from 12 nests using motion-activated cameras. Richardson's Ground Squirrels (*Urocitellus richardsonii*) were the most commonly selected prey species, comprising 44% across of all prey items, followed by cottontail rabbits at 26%. White-tailed Jackrabbits comprised 4% of all prey items in our current study and Richardson's Ground Squirrels comprised 4% of all prey items historically. Interestingly, in 2016 and 2017 we recorded the highest relative abundance of cottontails in our study area and increased productivity. Our results show Golden Eagles in our study area shifted to a steady prey source but still benefit when the abundance of a cyclic prey species increases.

### First Satellite Telemetry Study of Dispersal, Home Range Size, and Habitat Use by Juvenile Golden Eagles from Mexico

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The Golden Eagle (*Aquila chrysaetos*) is Mexico's national symbol, yet it is an Endangered Species in the country and scientific knowledge to support its management is weak. During 2015 – 2018, we used satellite telemetry to complete the first assessment of dispersal behavior, home range size, and habitat use of Golden Eagles from Mexico during their first year of life. We monitored three Eagles, starting when they were near fledging age in May or June. Beginning in late summer, all exhibited progressive movement from the nest, with an initial exploratory phase followed by a distinct wandering or nomadic dispersal phase; none appeared to be settled by the end of their first year. We used 95% adaptive Local Convex Hulls to estimate home ranges. For all Eagles, monthly home range size during the first 2 mo after tagging (age, 3 – 4 mo) was  $< 1 \text{ km}^2$ . Subsequently, the size of each Eagle's monthly home range increased sequentially, but reached maxima in different months (Male1 –  $2,737 \text{ km}^2$  in January [9 mo of age]; Male2 –  $4,909 \text{ km}^2$  in May [12 mo]; and Female1 –  $1,870 \text{ km}^2$  in April [12 mo]). In all months collectively, the Eagles mostly used grasslands (29 – 64% of individuals' locations), temperate forests (22 – 49%), and cultivated areas (3 – 23%). Golden Eagles we studied ranged over surprisingly large areas late in their first year of life, which in some other studies characterized individuals with low survival likelihood. Although our small sample size limits conclusions, the data are a unique contribution to knowledge of Mexico's Golden Eagles.

### Overwintering Habitat Use by a Secretive Forest Raptor: the Broad-Winged Hawk (*Buteo platypterus*)

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The Broad-winged Hawk is an obligate long-distance migrant that breeds in deciduous and mixed forests in the northern United States and Canada and migrates to tropical regions during austral summer. We used location data from ten females affixed with Argos solar-powered transmitters between 2000 and 2019 in Pennsylvania, Minnesota, and Maryland to calculate home ranges during the overwintering period in Central and South America. We used Kernel Density Estimates in ArcGIS and compared the land cover composition of the home ranges for all individuals. We then used Global Forest Watch data between 2000 and 2018 to calculate tree cover loss greater than 30%, 50%, and 75% as an indicator of deforestation within each home range. Home ranges using the 95% Kernel Density Estimator varied from 27 km<sup>2</sup> to 118,606 km<sup>2</sup>. The most abundant habitat within Broad-winged Hawk overwintering home ranges was evergreen terra firme forests (69.26%) followed by lowland semi-deciduous forests (9.51%), and agriculture and secondary vegetation (8.73%). Of the ten Broad-winged Hawks, nine used areas dominated by forest in their overwintering ranges, and all but one avoided human altered and urban areas. Overall, tree cover loss in all areas used by tracked birds did not exceed 15% of their home range during the period studied, suggesting the birds are selecting areas with low disturbance. These results provide first analysis of the habitat use of Broad-winged Hawks during their overwintering period. Such data are critical to developing conservation goals and strategies for this neotropical migrant given the increasing deforestation occurring in the Amazon rainforest.

### Arctic Raptors Synchronize Their Spring Migration with the Northern Progression of Snowmelt

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Migratory species display a range of strategies at the gradient from the irruptive (facultative) to regular (obligate) movement as a proximate response to changes in the availability of resources. For arctic breeding birds, resources are limited by snow, therefore migrants are expected to follow the northern progression of snowmelt during spring migration to optimize arrival time. We also expect that once arctic migrants reach the Arctic during spring migration, they select for snow-free areas. The process of decision-making during migration as a response to snow conditions is largely unexplored. Based on large-scale Argos and GPS movement data, we compared movement among three top arctic raptor species (the Snowy Owl [*Bubo scandiacus*], the Rough-legged Buzzard [*Buteo lagopus*], and the Peregrine Falcon [*Falco peregrinus*]), representing a gradient from an irruptive to a mixed to a regular migration strategy, respectively. Following spring snowmelt was examined by comparing snow cover conditions at each individual location between the past, present, and future, while movement decisions in the Arctic were assessed using Step Selection Function. Arctic migrants followed the northern progression of snowmelt during spring migration where the Snowy Owl and the Rough-legged Buzzard adjusted their movement decisions more tightly to snowmelt than the Peregrine Falcon. However, arctic species did not show any preference or avoidance of snow cover while in the Arctic. Presumably, arctic raptors used snow cover as a cue during spring migration to avoid arriving too early or too late at the breeding grounds. Considering the rapid environmental change in the Arctic, we expect that the Peregrine Falcon would be the most affected, resulting in a phenological mismatch while the Snowy Owl and the Rough-legged Buzzard would adapt more easily. Our study is an important step towards understanding the proximate cues that species with different migration strategies use in response to environmental conditions.

### Recreation, Fire and Disease Create a Mosaic of Threats for Golden Eagles in Southwestern Idaho

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Sagebrush-steppe ecosystems, and associated wildlife, are vulnerable to multiple stressors, though few studies have examined how threats interact to affect ecosystem dynamics. Wildfire and recreation negatively affect golden eagle (*Aquila chrysaetos*) territory occupancy and reproduction through habitat loss and disturbance. The



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focus of our research is to determine whether wildfire and recreation may have synergistic impacts on the nesting ecology of eagles. We used a before-after-control-impact design and collected data on recreation use and eagle territory occupancy, confirmed egg-laying rates, the number of young fledged and diet in 2017- 2018 at 22 historical eagle territories in southwestern Idaho and compared these data to similar data collected in 2013-2014. In 2015, wildfire burned through 14 territories and 8 territories were unburned. Our results show that motorized and non-motorized recreation shifted after the fire and total recreation volumes were higher in unburned areas than burned areas. Regardless of whether an area had burned, off-road vehicle recreation negatively impacted eagle territory occupancy. However, the effect of pedestrian recreation depended on fire. Regardless of fire, pedestrian use negatively impacted confirmed egg-laying in eagle territories. After the fire, pedestrian use decreased in burned areas which alleviated the negative impact on confirmed egg-laying. Diet differed between burned and unburned territories, but diet diversity and delivery rates were similar across fire and recreation gradients. In burned areas, diets contained less leporids (rabbits and hares) and more sciurids (ground squirrels and marmots). Also, diets included more leporid prey and less rock pigeons (*Columba livia*) in areas with higher recreation use, which may indicate diet shifts in areas with less leporids to eating more rock pigeons, which are vectors for disease. Our results suggest that the effects of recreation overshadow other impacts to eagles, though there remains a mosaic of stressors for eagles across the landscape.

### Non-target Exposure of Toxins to Raptors: Anticoagulant Rodenticides and Ferruginous Hawks

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Anticoagulant rodenticides (ARs) threaten raptors through unintentional secondary poisoning, especially those species that primarily consume rodents. Exposure to ARs in free-living raptor populations has been documented on at least three continents, but patterns and pathways of exposure are not well studied, so potential effects of ARs on raptor populations remain difficult to quantify and mitigate. We evaluated the risk of AR exposure to Ferruginous Hawks (*Buteo regalis*) in portions of the western United States. These hawks inhabit shrub-steppes, grasslands, and deserts, many of which are modified by agriculture, wind power, and oil and gas

development. Rodenticides are often deployed in developed areas to reduce populations of burrowing mammals such as Ground Squirrels (*Urocitellus* spp.) and Prairie Dogs (*Cynomys* spp.), which compose a large proportion of Ferruginous Hawk diet. We collected blood samples from Ferruginous Hawk nestlings from Idaho and Wyoming in two consecutive breeding seasons to be evaluated for prevalence and concentrations of eight different ARs. Each AR has the same mode of action, they deplete clotting factors and increase clotting time. Thus, we also measured blood clotting times of hawks in the field using technology originally designed for human use. We evaluated this field test kit for non-human use and rapid assessment of AR toxicity in raptors with an additional prothrombin time assay. To evaluate the pathway of exposure and the extent that ARs are present on the landscape, we collected and analyzed liver samples from prey items. We also describe the degree to which coagulation assays designed for humans may be useful for raptors, the use of prothrombin time as a biomarker for ARs, and the challenges of blood sampling for AR residues.

### Risk of Golden Eagles Colliding with Wind Turbines in California, U.S.A.

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Golden Eagles (*Aquila chrysaetos*) are in decline throughout much of their North American range and are designated by many state and federal authorities as of conservation concern. Renewable energy poses a threat to eagles through direct mortality from collisions with wind turbines. To better understand the risks of wind-energy development to Golden Eagles in California, we developed a model of risk of collisions with wind turbines. We developed this model based on data collected from tracking > 80 Golden Eagles throughout California (>3.5 million locations). The risk model was developed in two steps. First, we determined where eagles were likely to occur by developing a resource selection function (RSF). We modeled probability of occurrence by comparing land cover and topography between eagle locations and an equal number of random locations throughout the state. Second, we determined the flight altitude of eagles within areas of high occurrence. To do this, we used another RSF to identify conditions in which eagles were most likely to



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fly at the level of rotors of wind turbines. For this RSF, we compared topography, weather, and land cover between locations where eagles were in flight and random locations. Preliminary results suggest that the distribution of Golden Eagles within California was strongly influenced by both topography and land cover. Within areas of high occurrence, eagle flight altitude was at the level of wind-turbine rotors especially in areas of steep topography and topographic positions located at or near ridgelines. By combining these two models, we were able to produce a model and map of risk of turbine strikes to Golden Eagles for the state of California. This model can be used by developers and wildlife managers to both plan future development of wind-energy and assess existing developments.

### Linking Human Impacts with Changes in the Abundance and Diversity of Migrating Raptors Recorded at Hawk Mountain Sanctuary, Pennsylvania

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Investigating the interactive effects of human-induced stressors on wildlife is growing more important with the current trajectory of global environmental change. Migrating raptors are sensitive to environmental variation and are thus model species for identifying ecological “change points”. We developed a hierarchical change-point model implemented in a Bayesian framework to identify the timing of abrupt changes in the assemblage structure of migratory raptors observed at Hawk Mountain Sanctuary from 1946 to 2018. Preliminary analysis suggests that, for all species together, there was a shift in trends around 1978. Prior to 1978, the proportion of observations representing complete migrant species was higher than that of partial migrants. After 1978, partial migrant species were more commonly observed. Factors such as shifts in habitat range, reduced pressure from persecution and inter-specific competition and predation, and recovery from chemical poisoning may have caused these changes. In particular, breakpoint years for individual species occurred in the late 1970s and mid-1980s and abundance of several species known to be affected by DDT increased 4 to 10 yr after it was banned. Moreover, three species of complete migrants showed decreasing trends after their breakpoint. For partial migrants, six species showed declines while seven species showed increasing abundance after their breakpoint. Next steps include quantifying the effects of raptor threats to observed diversity trends before and after the breakpoint. Historical evidence of human impacts to wildlife can help

us understand, forecast, and mitigate future biodiversity issues in a time of rapid global change.

### Modeling Spatial Variation in Density of Golden Eagle Nest Sites in the Western United States

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We developed nest site models for golden eagles (*Aquila chrysaetos*) using >6,500 nest site locations throughout a >3,483,000 km<sup>2</sup> area of the western U.S. We developed models for twelve discrete modeling regions, and estimated relative density of nest sites for each region. Cross-validation showed that, in general, models accurately estimated relative nest site densities within regions and sub-regions. Areas estimated to have the highest densities of breeding golden eagles had from 132–2,660 times greater densities compared to the lowest density areas. Observed nest site densities were very similar to those reported from published studies. Large extents of each modeling region consisted of low predicted nest site density, while a small percentage of each modeling region contained disproportionately high nest site density. For example, we estimated that areas with relative nest density values <0.3 represented from 62.8–97.8% ( $\bar{X}$  = 82.5%) of each modeling area, and those areas contained from 14.7–30.0% ( $\bar{X}$  = 22.1%) of the nest sites. In contrast, areas with relative nest density values >0.5 represented from 1.0–12.8% ( $\bar{X}$  = 6.3%) of modeling areas, and those areas contained from 47.7–66.9% ( $\bar{X}$  = 57.3%) of the nest sites. Our findings have direct application to: 1) large-scale conservation planning efforts, 2) risk analyses for land-use proposals such as recreational trails or wind power development, and 3) identifying mitigation areas to offset the impacts of human disturbance.





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### Unmanned Aircraft Systems (UAS) Enable 3D Viewshed Analyses of Potential Disturbance to Raptor Nesting by Recreational Rock Climbing

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Unmanned Aircraft Systems (UAS) can be safer, less expensive, and less labor intensive than manned aircraft traditionally used in aerial wildlife surveys, and can even yield better data than traditional methods. Consequently, the use of UAS is increasing in wildlife research, but other than installation of line markers to reduce avian collision with power lines, UAS approaches are generally passive, counting individuals for example. We wondered if UAS could be used more actively to help guide proximal conservation decision-making, so we used UAS-sourced photographs to create 3D models of cliffs to conduct viewshed-based assessments of potential disturbance to nesting raptors by recreational rock climbing. Over three missions at two sites (Cathedral Spires Park and Clear Creek Canyon Park), we collected 4,790 UAS photographs from which we constructed two 3D models. At Cathedral Spires Park we identified specific climbing routes likely to cause disturbance to nesting Peregrine Falcons (*Falco peregrinus*). At Clear Creek Canyon Park we identified one climbing area likely to disturb nesting Golden Eagles (*Aquila chrysaetos*), and another that was unlikely to create disturbance. Our findings were useful in providing Jefferson County Open Space (JCOS) with quantitative data on distances and angles from nests to climbing areas, so resource management decisions can be made. This project provides an example of how UAS can be used to actively create products useful in wildlife conservation and management.

### Dispersal and Survival of Red-shouldered Hawks Banded in Southern Ohio, 1996-2018

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We used banding data to investigate dispersal and survival of Red-shouldered Hawks (*Buteo lineatus*) in two study areas in southern Ohio, one suburban and one natural. Of the 2448 nestlings we banded, 167 (6.8%) were encountered (dead or alive) after banding; 163 of these were from the suburban study area. Mean distance from

the natal nest at the time of encounter was  $31.6 \pm 6.2$  km (median = 10.0, range = 0.1–568.6 km,  $n = 163$ ); natal dispersal distance averaged  $16.0 \pm 1.9$  km (median = 9.0, range = 1.4–117.1 km,  $n = 110$ ), and was significantly greater for females than for males. Most hawks dispersed <30 km, but 11 hawks (6.7%) dispersed >100 km from their natal nest. Of these long-distance dispersers, nine (82%) were <2 yr old, suggesting that young birds can wander widely prior to breeding. Dispersal distance differed by sex and age at encounter, with dispersal distance negatively correlated with age at encounter, and females dispersing farther (mean =  $39.8 \pm 12.3$  km) than males (mean =  $22.8 \pm 9.86$  km) and birds of unknown sex (mean =  $33.9 \pm 10.6$  km; all  $P < 0.05$ ). Dispersal direction for all birds followed a uniform distribution ( $P > 0.05$ ); however, dispersal direction of long-distance dispersers was not uniform ( $P < 0.05$ ) but bimodal, with hawks encountered either to the south or to the northeast of the study area. Mean age at recovery was  $2.6 \pm 0.3$  yr (median = 1.5 yr). Apparent annual survival varied between age classes, with young birds (hatch-year and second-year) having lower apparent annual survival (mean =  $0.49 \pm 0.03$ ) than adult birds (mean =  $0.76 \pm 0.03$ ). Banding data provides information on dispersal, survival, and causes of mortality of Red-shouldered Hawks, demographic data that are important for evaluating population trends and the sustainability of urban/suburban populations.

### Linear Features Affect Migratory Movements of Golden Eagles

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Linear features, including roads and railways, have changed how animals move and use habitat, with effects on predator-prey relationships and population dynamics. In large mammal systems, the effects of linear features on individual animal movement have received considerable attention. However, many birds migrate over landscapes replete with such linear features and such effects in birds have received minimal attention. To understand how linear features might alter avian movement, we tracked migratory Golden Eagles (*Aquila chrysaetos*) with satellite telemetry and implemented a modified step selection function (SSF). Our sample consisted of 32 adult eagles tracked for a total of 84 individual migrations from 2014-2017. We found that eagles used and favored areas near roads and railways during migrations but that this effect was stronger during spring migration. We also found that



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eagles' use of linear features varied based on stopover versus migratory behavior, which itself is driven by meteorology. Linear features present mortality risk to animals, but to some migrants, they could also offer hunting and scavenging opportunities.

### **Impact of Indigenous Cultural Knowledge and Community Collaboration in Tackling Vulture Trade and Persecution in Three Southwestern States in Nigeria.**

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Oyo, Ogun and Osun States in Southwestern Nigeria operate markets which trade openly in wildlife parts despite Nigeria being a signatory to the convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES). This trade chain involves the recruitment of local poachers, traditional healers, and market women by foreign or local scouts who pay large sums of money and other benefits to motivate them to pursue this line of business. Consequently, the country has become a major transit and source country for illegal wildlife trade, and at least two surviving species of vultures have become subjects of over-exploitation. Although a variety of techniques are used, the use of poisoned baits mainly laced with tobacco or other toxic chemicals is the most widespread method used by hunters and market women, often killing many vultures in a single location. Vultures are also captured and kept in cages and fed with rice, millet and sometimes raw meat. In 2016, the Foundation adopted diverse traditional knowledge systems, beliefs, and cultures as well as integrated input from major users into our Conservation Action Plan. The success of this project to date can be considered to have grown in leaps and bounds since our initial attempt. We evaluated the potential implications of this project in terms of the effects of inclusive conservation at the grassroots level, the impact of indigenous knowledge on policy, and the success story of the Save the Vulture campaign. The evaluation relied on qualitative data to understand existing regulatory frameworks, and quantitative data which was obtained via interviews, visits to remote communities, immersion in cultural beliefs and practices and market surveys in three states in Nigeria. This provided a practical guide for further research and helped court support for the advocacy component of the project.

### **Feathers Indicate Golden Eagles (*Aquila chrysaetos*) are Lead Poisoned More Frequently and to Higher Levels than is Evident in Blood**

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Lead toxicosis is a significant threat to scavenging raptors worldwide and blood lead is a well-established biomarker to assess lead exposure status. However, blood lead levels provide a narrow snapshot into exposure history, as blood only reflects an individual's lead exposure in the weeks prior to the blood being sampled. We used sequential samples from feathers of Golden Eagles to reconstruct a bird's lead exposure history over the 3-4-mo timeframe during feather growth. We then compared patterns of exposure indicated by blood to those indicated by feathers. Preliminary analysis of blood monitoring data (n = 475) showed that less than 2% of Golden Eagles had recently experienced lead exposure associated with morbidity and mortality (blood lead levels >100 µg/dL). In contrast, feather data (n = 18 feathers) indicated that during the time period of feather growth, ~20% experienced lead exposure associated with morbidity and mortality. Analysis of growing feathers (n = 8) collected from eagles post-mortem imply that 25% were lead poisoned (blood lead levels >50 µg/dL) in the weeks prior to their death. Our data suggest that Golden Eagles are lead poisoned more frequently and at higher levels than previously recognized and they illustrate limitations of blood lead levels in informing about individual- and population-level patterns of lead exposure.

### **Utilizing Acoustic Recording Devices to Monitor Mexican Spotted Owls at Grand Canyon National Park**

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Mexican Spotted Owls (*Strix occidentalis lucida*) are a federally threatened species found in the American southwest from Mexico to Colorado. Grand Canyon National Park in Arizona provides a substantial area of suitable breeding habitat for these owls. Although the park has both suitable inner canyon habitat and appropriate mixed conifer forest habitat on the canyon rim, the inner canyon has been identified as the preferred breeding habitat. All surveys conducted on the North and South Rims from 1991 to 2012 have detected zero breeding Mexican Spotted Owls; however, owls are detected below



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the rim in the inner canyon annually. In 2019 survey efforts at the park transitioned away from active hooting surveys and began utilizing acoustic recording devices as a passive survey method. Acoustic recorders are an inexpensive way to increase the survey efforts of a small staff, while also eliminating the possible disturbance to owls caused by hooting surveys. These acoustic recorders have provided insight to the occupancy and distribution of Mexican Spotted Owls within the inner canyon habitat as well as in the forested habitat on the canyon rim.

### Endangered Black Harriers (*Circus maurus*) in South Africa: What Have We Learned and Where Should We be Moving Forward for its Sustainable Conservation?

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The Black Harrier is a medium-sized bird of prey endemic to southern Africa. Its population has been estimated at less than 1,000 breeding individuals, and the species has recently been upgraded to Endangered by the IUCN Red List. This ground-nesting raptor only breeds in native vegetation, primarily along the south-western South African coast. A decline of the population has been suspected throughout the last four decades, but until recently, the reasons for Black Harrier's scarcity have remained insufficiently explored. Filling this knowledge gap, by investigating Black Harriers' inter-annual requirements, was therefore essential for a sustainable conservation of the species. Using data collected throughout the 2000-2015 breeding seasons we specifically investigated the spatial-temporal variations of breeding phenology and success (n=402 nests), diet composition, and the relationship between those parameters. We also used an eco-toxicological and eco-physiological approach to assess environmental contamination (i.e. PCBs and DDT) in blood of adults (n=23) and nestlings (n=90), in wild individuals, relating contamination levels to habitat characteristics and diet composition. Finally, 13 adults were trapped during 2008-2015 breeding seasons and were fitted either with a GPS-GSM or with a PTT tracker device. The monitoring of those birds for 365 ± 198 d (range: 56-819 d) revealed, for the first time, Black Harrier's migratory patterns, settlement areas and habitat use during the breeding and non-breeding seasons. Despite all of the above, an urgent need

still remains to obtain further information on threats throughout Black Harriers' entire annual-cycle, notably by better defining the causes of mortality (84.6% of the death of tagged adults occurred either during migration or during the non-breeding season), and by assessing juvenile survival for population recruitment, with the ultimate goal of ensuring a sustainable conservation of this endangered species.

### Long-term Ecological Monitoring of the Tundra Ecosystem: Role and Conservation Perspectives for Birds of Prey

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Despite overall low primary production typical of the arctic region, the tundra ecosystem harbors a diverse suite of predator species, all of which exhibit strong numerical and/or functional responses annually. Over the last 25+ years, we have been studying almost every aspect of the tundra ecosystem on Bylot Island (Nunavut, Canada) via the Ecological Studies and Environmental Monitoring Project. By combining annual measures of nest density, reproductive success, diet, and movement for every key species (especially raptors), we have assessed in detail the trophic relationships shaping the tundra ecosystem. Indeed, the predation pressure measured at the site suggests a strong top-down control over lower trophic level species and thus, a critical role for raptors in the tundra food web. In addition, highly mobile and dispersive raptors (e.g., Snowy Owl [*Bubo scandiacus*], Rough-legged Hawk [*Buteo lagopus*]) apparently dampen lemming population fluctuations over a broad continental scale. We have also revealed important resource exchanges among ecosystems (e.g., terrestrial vs. marine) involving key top predators. Facing ongoing pressure associated with climate change and anthropogenic activities, we are assessing how raptor populations are likely to be affected, such as through a decrease in overall habitat availability or the very specific collapsing of nesting structures, or through a decrease in prey populations suffering from the loss of sea-ice or a change in snow cover regime.

### The Roles of Nest Attendants at Harris's Hawk Nests in South Texas

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In south Texas, over half of the breeding groups of Harris's Hawks (*Parabuteo unicinctus*) include at least one auxiliary in addition to a breeding pair. Here, we describe the roles



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of individual group members based on data from cameras deployed at nests during the 2018 and 2019 breeding seasons. Detailed ethograms for each nest were developed to determine which individuals visit the nest and what behaviors they exhibit. Based on data analyzed at five nests, two nests had at least two auxiliaries (both including one juvenile auxiliary) and two nests had no auxiliaries. At all five nests, the breeding female was the most frequent visitor to the nests (70% of all visits,  $n = 220$ ) including prey deliveries (56% of total prey deliveries,  $n = 143$ ). The dominant male made 24% of the visits to nests, of which 92% ( $n = 48$ ) were prey deliveries. The female spent significantly more time feeding chicks (89% of feeding bouts) than the dominant male (9%). Only 3% of all nest visits were by auxiliary group members. However, at a single nest an adult male helper provided 12% ( $n = 41$ ) recorded deliveries) of the prey items compared to the dominant male who delivered 15% of the prey items. Video data demonstrated that hawks at urban nests visited the nests more often, made more prey deliveries, and fed chicks more frequently compared to nests in natural habitats. We suggest that human management (e.g., watering of yards) of urban areas make these environments more stable nesting or hunting territories for Harris's Hawks particularly during drought years than in natural desert areas.

### The Influence of Lead and Organochlorine Exposure on the California Condor Stress Response

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The free-flying population of California Condors (*Gymnogyps californianus*) is frequently exposed to lead via lead-based ammunition ingestion, and recent studies indicate significant co-exposure to organochlorines (e.g., DDE, PCBs) for condors feeding on beach-cast marine mammals. We investigated the influence of contaminant exposure on California Condor glucocorticoid response through comparisons between wild and captive populations and identified modifiers of glucocorticoid release within the wild population. An abnormal glucocorticoid response to stress is associated with reduced reproduction and survival in vertebrates. We assessed the glucocorticoid response to routine trapping

and handling events through measurement of plasma corticosterone and urate glucocorticoid metabolites (GCM) in serially collected samples. Comparison of peak urate GCM levels showed wild California Condors exhibited higher responses to handling-associated stressors ( $2250 \pm 1440$  ngg<sup>-1</sup> dry wt,  $n = 27$ ) than captive condors ( $907 \pm 489$  ngg<sup>-1</sup> dry wt.,  $n = 6$ ,  $U = 28$ ,  $p = 0.003$ ). Multiple linear regression models and an information theoretic approach (AIC<sub>c</sub>) identified several extrinsic variables (e.g., time captive in flight pen before sampling) negatively associated with plasma corticosterone and urate GCM levels in wild California Condors, which explained ~25% of glucocorticoid variation. By accounting for these extrinsic variables we found that behavioral variables associated with increased lead and organochlorine exposure risk were positively associated with GCM levels, explaining an additional 15% of glucocorticoid variation among wild condors. Our findings suggest that exposure to environmental contaminants may lead to higher stress-induced glucocorticoid levels in wild California Condors, and that accounting for variables associated with handling protocol is essential for assessing the impact of environmental stressors such as contaminants on the California Condor stress response. This work addresses a critical knowledge gap regarding how long-term contaminant exposure impacts California Condor physiology and has implications for other scavenging species exposed to lead-based ammunition and organochlorine contaminants worldwide.

### Integrating Conservation and Criminology to Inform Strategies to Combat Wildlife Trafficking

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Transnational environmental crime (TEC) has become the largest financial driver of social conflict in the world with implications for peace and security. Wildlife trafficking is one form of TEC that generates severe harm to the natural and human environment, unsustainable development and human security. Africa's vultures already face myriad harms as nature's most important scavengers; they are increasingly caught in the crosshairs of the global wildlife trafficking and TEC crisis. Intentional and unintentional poisoning associated with human-wildlife conflicts, belief-based use, and direct poaching activities remain problems for vultures across the African continent. We use conservation criminology to consider wildlife trafficking





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and vultures in the Greater Limpopo Transfrontier Conservation Area. In terms of conservation biology and natural resource management integration, we considered which vulture species are of conservation concern, the key drivers of conservation threats, impact of the scope and scale of threats, public attitudes and values, among other relevant factors. We then considered the standard 25 situational crime prevention strategies and tactics. We used an iterative, mixed methods approach to achieve our objective of designing a situational crime prevention strategy for vultures in the Great Limpopo Transfrontier Conservation Area, concentrating on poisoning events. Beyond the established situational crime prevention approach, our methods resulted in five additional tactical opportunities under the umbrella of a new strategic pillar. Thus, we synthesized 30 strategies and tactics that could be implemented to effectively reduce the opportunities for illegal poisoning of vultures, and possibly other raptors and scavengers, in the study area. Tools created from our effort have the potential to be adapted to other contexts, such as in the KAZA, where in June 2019, the largest recorded vulture poisoning ever--over 500 individual vultures--was recorded.

### Human-Predator Conflicts in Northwestern Argentina: the Particular Case of the Andean Condor

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Human-predator conflicts are complex to solve as scientific, economic, moral and cultural perspectives confront. Cattle breeders traditionally blamed Andean Condors (*Vultur gryphus*) for killing newborn sheep and calves. However, scientific knowledge affirms that Andean Condors are scavengers, as their tarsi are not powerful enough to kill. This assertion is repeated by environmental authorities and general information sources. Only some reviews mention that they may kill newborn mammals. To assess human-predator conflicts in the tropical forests of the Yungas of Jujuy and Salta provinces, northwestern Argentina, we performed 115 interviews to a variety of local settlers from park rangers to cattle breeders. We asked them if they had conflict with any species of wildlife or knew other people that could have it. We conducted 55 raptor point counts to evaluate raptor abundance in the area. We identified 2172 raptors of 26 species. The Andean Condor was the fourth most abundant raptor accounting for almost 11% of identified birds. The most

cited conflictive species was the Andean Condor (32%), even above Cougar (*Puma concolor*) (27%) and Jaguar (*Panthera onca*) (16.5%). Almost 50% of interviewed said Condors kill calves although not all mentioned it to be a conflict. They said Condors jumped on and pushed calves to the ground where they would peck them to death. According to them, Condors would also kill adult cows by scaring and making them fall from cliffs. We collected some believable reports of the first described behavior and there are similar findings in Ecuador. Our data suggest the existence of a strong conflict surrounding the Condor in northern Argentina. The species slow demography and wide action range make it highly vulnerable to human persecution. Therefore, instead of denying Condor attacks, a serious reassessment of this conflict in the area would be needed to secure the species conservation.

### Great Gray Owl Home Range and Habitat Selection During the Breeding Season

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Habitat change is increasing across landscapes, with largely unknown consequences for under-studied raptor species. Identifying the resource requirements of such species during key stages such as breeding is therefore critical for effective management. Throughout the Rocky Mountains, older-aged montane and sub-alpine forests are changing rapidly due to wildfire, disease and beetle outbreaks, drought, climate change, logging and development. Great Gray Owls (*Strix nebulosa*) are associated with older-aged, boreal forest habitats, and studies conducted outside of the Rocky Mountains suggest that they respond negatively to the loss of key habitat elements. We quantified breeding-season home-range attributes and habitat preferences of adult Great Gray Owls across multiple spatial (home-range and within-home-range level) and temporal (nesting and post-fledging; day versus night) scales in western Wyoming, USA. In 2018 and 2019, we outfitted adult male owls ( $n = 16$ ) with GPS remote-download transmitters and collected hourly location data throughout the breeding season (1 May – 15 September). Using 50% and 95% kernel density estimates (KDE), mean core area was 1.77 km<sup>2</sup> and mean home-range size was 8.65 km<sup>2</sup> (SE = 8.30) in 2018 ( $n=6$ ). Mean core and home-range areas using dynamic Brownian bridge analyses were 1.08 km<sup>2</sup> (SE = 0.28) and 5.54 km<sup>2</sup> (SE = 1.64), respectively. Resource selection analyses incorporated both remotely sensed and microsite habitat data. We conducted microsite habitat surveys at used and



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available points within 95% KDE home ranges using a stratified random sample design (n=398). Determining core and home-range areas as well as important foraging and post-fledging habitat requirements for Great Gray Owls will enable managers to adequately conserve this species and their associated habitat during the nesting season. Additionally, an understanding of home-range size and resource selection can improve density estimates and areas of potential breeding habitat for Great Gray Owls.

### Testing the Utility of Step Selection Functions to Evaluate Winter Resource Selection of Golden Eagles at Multiple Spatial Scales in Yellowstone National Park

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Understanding species habitat relationships is fundamental to conservation. As such, wildlife management is best accomplished with current knowledge on how species interact with available resources. Resource selection occurs across multiple spatial and temporal scales. Importantly, these two dimensions of scale are not independent and the scale at which we measure the effect of resources on selection is question dependent. Selection on the scale of an individual's home range is commonly of high interest in demographic studies. Using telemetry data, we often analyze selection through a used/available design, with home range estimates and resource selection functions (RSFs). Step selection functions (SSFs), unlike RSFs, incorporate movement to constrain availability and match the scale at which animals are selecting habitats, thus estimating selection at a finer scale. The use of SSFs has been of growing popularity in resource selection studies involving terrestrial mammals, but these tools are rarely used with data from territorial raptors. We compared the utility of SSFs and traditional RSFs to evaluate resource selection of five Golden Eagles (*Aquila chrysaetos*) tracked at 1-hour intervals with GPS telemetry in Yellowstone National Park. Preliminary analyses suggest that coefficient estimates for multiple parameters were nearly equal between models, indicating that both selection models measured resource selection at similar scales. These results suggest, in contrast to work with mammals, there is little difference between the performance of an RSF and SSF when telemetry data are at 1-hr intervals. They also suggest that for rapidly moving birds of prey, the scale at which resource selection is estimated may be different when telemetry data is collected at shorter time intervals, and such data may be more appropriate for SSFs.

### Seasonal Variation in Calling Rates of Forest Owls from Passive Acoustic Recordings in the Oregon Coast Range

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Passive acoustic recording and analyzing technologies have emerged as a potential solution to some logistical challenges of bird surveys. We deployed one automated recording unit (SM2+ Recorder by Wildlife Acoustics) at each of five active Northern Spotted Owl (*Strix occidentalis*) activity centers in the central Oregon Coast Range. A total of 19,160 2-hr recordings were made from 2014 through 2018. We analyzed data with Kaleidoscope software for semi-automated species detection from audio files. Effective detection distance testing shows site level variation related to vegetation density and topography with nominal detection distances < 200 m. Six owl species were detected at all five sites across the 5-yr period (1,786 recording days). We most commonly detected Northern Pygmy Owl (*Glaucidium californium* -343 distinct days), Barred Owl (*Stix varia* -333 distinct days), Northern Spotted Owl (253 distinct days), and Great Horned Owl (*Bubo virginianus* -189 distinct days). Four owl species were heard calling on the same day at the same site on 23 occasions and five owls were heard at the same site on the same day twice. These results can be used to develop an efficient sampling framework in the future.

### Effects of Nest Boxes on American Kestrel Landscape Occupancy Varies Across Michigan Fruit-growing Landscapes

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Populations of the American Kestrel (*Falco sparverius*) have been declining in North America for the last several decades. Along with being a conservation concern, this trend could negatively affect agricultural operations. American Kestrels (hereafter, kestrels) can provide valuable ecosystem services via pest control in fruit crops, through the consumption and deterrence of pest species. Landscape enhancements, such as nest boxes, can attract kestrels to particular places in a landscape. However, we lack information on the ecological contexts in which landscape enhancements are most likely to attract pest-detering vertebrates and result in reduced abundance of crop pests. Our previous work showed that nest boxes can attract kestrels to cherry orchards in northern Michigan. To investigate if providing nest boxes could increase kestrel presence in another fruit production region, we



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installed nest boxes in or near blueberry growing operations in western Michigan in 2015 and 2016 and constructed an occupancy model to investigate the effect of nest boxes on kestrel presence, along with other factors that could influence kestrel presence and detection. We found that, unlike our previous work in cherry orchards, nest boxes did not increase kestrel presence. However, we did find the presence of a box in neighboring sites had a positive influence on kestrel occupancy. Thus, the effect of nest boxes on kestrel occupancy varies from one landscape to another, potentially because some landscapes have more high-quality hunting habitat than others.

### Collision Avoidance by Wintering Bald Eagles Crossing a Transmission Line

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Collision with electric lines is a global conservation concern for many birds but raptor species are generally thought to have a low risk of line collision. Collision risk at electric lines is not well understood for Bald Eagles (*Haliaeetus leucocephalus*) with only incidental reports of collisions in the literature. Line collisions reported for Bald Eagles predominantly occur where lines intersect movement corridors around foraging, roosting, or nesting areas. During five winters from 2014-2018, we monitored 602 Bald Eagle crossings of a 230/500 kilovolt transmission line at the Delaware River to determine collision risk. Eagles successfully crossed the line by flying predominantly below the wire zone. There was no difference in flight heights for immature or adult eagles crossing the line. Wire marking protocols within the electric industry are primarily focused on marking the top plane of wires to assist birds flying above the wires. Additional development of wire marking options for energized conductors could further reduce collision risk for eagles and other bird species flying below wires. Overall, collision risk appears to be low for Bald Eagles making localized movements across transmission lines.

### Seasonal Time-energy Allocation of an Island-restricted Falconid, the Striated Caracara, Using a Low-cost, Open-source Inertial Movement GPS Logger

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Animals need adaptive strategies to cope with seasonal changes in prey availability to survive and reproduce. Strategies include migrating to more productive resource patches, prey-switching, or reducing metabolic needs. Human settlements can disrupt spatiotemporal patterning in resource availability and effectiveness of adaptive strategies. While research suggests populations dependent on human subsidies can experience decline and local extirpations, few have examined individual level impacts of human subsidies on an animal's energy balance. We investigate time-energy allocation and activity budgets of Striated Caracaras, an IUCN Near-Threatened Falconid in the Falkland Islands that must cope with winter resource scarcity in an ecosystem recently impacted by humans. We used accelerometer-GPS dataloggers deployed on 24 caracaras on Saunders Island to examine seasonal differences in overall dynamic body acceleration (ODBA, gravitational g), a proxy for energy expenditure, and to estimate behavioral states using hidden Markov models. Our results suggest that on a daily scale, caracaras overwintering at a settlement worked 20% harder than caracaras in summer at a natural resource patch (24-hr ODBA: winter  $2848.07 \pm 577.26$  g; summer  $2380.85 \pm 435.65$  g [ $\bar{x} \pm SD$ ]). During daytime, caracaras spent twice as long in the high activity state (winter  $99.0 \pm 45.2$  min, summer  $44.1 \pm 26.1$  min) and traveled greater cumulative daily distances (winter  $23.75 \pm 7.50$  km, summer  $10.94 \pm 3.29$  km). Winter daily ranges were 13 times larger than summer ranges (95% KDE: winter  $8.34 \pm 11.04$  km<sup>2</sup>, summer  $0.64 \pm 0.49$  km<sup>2</sup>). We emphasize that even with subsidies, caracaras on Saunders work harder in winter to obtain enough energy to survive. Many island species will face increased seasonal food fluctuations in response to environmental change and human population expansion. We suggest conservation managers consider these results for targeting their efforts to maximize the benefit to the caracaras during a critical life stage.

### Of Lemmings and Squirrels: Prey Switching in Arctic Peregrine Falcons (*Falco peregrinus tundrius*)

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Given the potential for climate change to modify species' ranges and phenology, understanding interspecific interactions in biological communities in the Arctic is essential. At the high point of their population cycles,



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microtine rodents can reduce predation pressure from top arctic consumers on alternative prey. Conversely, during microtine population crashes, predation pressure becomes concentrated on alternative prey, which can result in reduced reproductive success and impact population dynamics in the prey. We studied a population of Arctic Peregrine Falcons from 2015-17 near the community of Rankin Inlet, Nunavut, Canada, using remote cameras placed at nests to document prey deliveries during brood rearing, and simultaneously estimated small mammal abundance. Past research has indicated that Peregrine Falcons in this study area consume an unusually high proportion of their diet as small mammals. In 2016 and 2017 the relative abundance of microtines was high compared to 2015. Peregrine Falcon diet analysis indicated that a significantly larger proportion of the diet was made up of Arctic ground squirrels (*Urocitellus parryii*) when microtine abundance was low. Coincident with declines in squirrels as a proportion of Peregrine Falcon diet, microtine rodents significantly increased as a proportion of the diet when their populations were high. Distance sampling data for Arctic ground squirrels across the three years of study indicated that their populations were significantly higher in the years with higher microtine abundance. While not definitive due to the low number of years of study, we document evidence of a possible indirect relationship between microtine rodents and Arctic ground squirrels, mediated through Peregrine Falcon predation. Given concern over possible dampening of microtine rodent cycles in some Arctic study areas, such indirect relationships have the potential to influence future population dynamics of various species preyed by Peregrine Falcons and other top arctic consumers.

### Spatial Patterns in Circadian Rhythm and Migration Candidate Genes of American Kestrels

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The adaptive potential of migratory birds to respond to seasonal changes driven by climate change likely depends on variation in genes that influence the timing of events in the annual cycle, such as migration. American Kestrels (*Falco sparverius*) from genetically distinct populations have responded differently to climate change over the past 30 years. In western North America, kestrels show shorter migration distances associated with warmer

winters. However, in eastern North America, there are no significant changes in Kestrel migration distances. We examined spatial patterns of candidate gene variants to determine whether there is a genetic basis for this difference. We identified variants in previously identified candidate genes involved in migration and circadian rhythm pathways and gene-climate associations using sequence data from 287 Kestrels sampled across North America. Next, we designed a single nucleotide polymorphism (SNP) assay to genotype Kestrels and screened 764 breeding American Kestrels. We found a longitudinal cline in allele frequencies of SMAD2, a gene associated with the circadian entrainment super pathway. Preliminary results support the hypothesis that the genetic composition of populations plays an important role in facilitating adaptation to climate.

### Assessing Nestling Survival Among Peregrine Falcons Breeding in the Arctic: Is Inclement Weather Increasing Food Limitation?

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A long-term project being conducted on a population of Peregrine Falcons (*Falco peregrinus*) breeding near Rankin Inlet, Nunavut, Canada, has chronicled a steady decline in annual productivity over 30 years. By documenting the direct effects of summer rainfall on nestling mortality, a recent study on this population suggested that an increasing frequency of heavy rainfall may partially explain the observed declines. If the lower trophic communities that falcons rely on as prey are also affected by rainfall, reductions in food availability may be further limiting peregrine breeding success. The intent of this project was to determine if the Rankin Inlet population is generally food limited, and to determine if food limitation varied according to yearly precipitation. To answer these questions, we implemented a food supplementation experiment over five breeding seasons (2013 – 2017). After nestlings hatched each year, randomly selected broods periodically received an amount of commercially produced Common Quail (*Coturnix coturnix*) that correlated to 50% of the brood's age-specific energetic demand. Overall, food supplementation resulted in higher nestling survival, and more consistent growth between years. Although general increases in nestling survival among food supplemented broods were observed, the benefits of supplemental food varied according to hatch order within the brood, and hatch date within the season. Second and third hatch nestling survival increased the most from supplemental food, while first and last hatch nestling survival probabilities remained relatively unchanged. Nestlings hatching proximate to the population's yearly median date exhibited the most pronounced effect from supplemental food, and, lastly, nestlings receiving supplemental food exhibited increased





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survival during bouts of inclement weather. These results increase our understanding of how food limitation interacts with a number of factors to shape yearly productivity among peregrines breeding in the arctic, and provides further evidence that heavy rainfall affects nestling survival both directly and indirectly.

### Can California Ground Squirrels Reduce Predation Risk to Burrowing Owls?

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In northern California, USA, western Burrowing Owls (*Athene cunicularia hypugaea*) use burrows in active California ground squirrel (*Otospermophilus beecheyi*) colonies for nesting and protection. Ground squirrels have well-developed, anti-predator alarm-calling behavior, but the potential benefits of such alarm calling to Burrowing Owls has not been examined. The objective of this study was to assess the rate and types of predator interactions experienced by Burrowing Owls and the extent to which they may benefit from alarm calls given by California ground squirrels. At Moffett Federal Airfield in urban Santa Clara County, California, we detected 177 approaches by predators, four of which resulted in predation events on owls. The rate of predator approach during diurnal periods, as determined by direct observation, was 0.93/hr. Ground squirrels called in response to predator approaches before owls did 66% of the time, which was approximately proportional to the abundance of ground squirrels and Burrowing Owls. When squirrels called first, an estimated 75% of owls exhibited alert responses, including alarm calling, running to the burrow, and scanning, indicating that owls benefited from ground squirrel alarm calls in response to approaching predators. Our research suggests that healthy ground squirrel populations may provide important predator alert services to Burrowing Owls, especially in the context of increasing populations of urban predator species.

### How Nest-site Characteristics Affect the Breeding Success and Nest Attendance Rates of Arctic Gyrfalcons in Western Alaska.

#### MICHAEL T. HENDERSON

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Habitat quality is defined at various spatial scales and areas that are optimal at all scales are disproportionately responsible for maintaining populations. At the smallest scale, suitable nest-site characteristics can protect breeding raptors and their offspring from harsh weather and potentially increase breeding success, but it remains unclear if this is true for Arctic specialists such as Gyrfalcons (*Falco rusticolus*). Additionally, breeding adults incur substantial costs from the physical shielding of eggs and nestlings, particularly in the Arctic, and it is possible that protective nest-site properties can decrease nest attendance rates, thus lowering costs of breeding. Our objective was to quantify Gyrfalcon nest-site characteristics and assess how they affect the breeding success and nest attendance rates for Gyrfalcons on Alaska's Seward Peninsula. We closely monitored breeding success ( $n = 57$ ) and nest attended rates ( $n = 13$  nests and 30,849 observations) by installing motion-activated cameras. We found that nest-sites that were more exposed to the elements, measured in the horizontal plane, were correlated with a reduced probability of hatching and fledging (providing hatch occurred), as well as decreased overall productivity. The negative effect of horizontal exposure on fledging probability and overall productivity was greatest at sites that were also more exposed in the vertical plane, although this interaction did not affect hatching probability. Productivity was more than doubled in nests that provided a refuge in which nestlings could seek shelter, such as a crevice or an overhang. Additionally, nest attendance rates were higher in nests that were more exposed in the horizontal plane, particularly when nestlings were two to three weeks old. The compounding effects of nest exposure suggest that the nest-site is likely a relevant scale of habitat quality for Gyrfalcons and may become increasingly important as the Arctic continues to experience more precipitation and severe storms.

### Raptors Nesting on Cellular Communications Towers: Challenges and Opportunities

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Many species of raptors construct nests on anthropogenic structures in habitats that are lacking naturally protective substrates (such as trees or cliffs). For example, raptors readily nest on utility poles, bridges, and buildings. Raptors are also adopting cellular communications towers, as more are constructed throughout the country. Federal and state laws protect nesting birds. However, conflicts between the telecom industry and tower-nesting birds are occurring. Approximately 7,500 of the 110,000+ cell towers in the U.S. support nesting birds. Although data are incomplete, it appears that Ospreys (*Pandion haliaetus*) are the most commonly nesting raptor on cell towers. Other raptors nesting on cell towers include Bald Eagles (*Haliaeetus leucocephalus*) and Red-tailed Hawks (*Buteo jamaicensis*).



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Florida appears to have the most tower nests, followed by the mid-Atlantic, Great Lakes, and Pacific Northwest regions. Protecting tower-nesting raptors (on the one hand) and solving human/wildlife conflicts (on the other hand) requires coordination between wildlife agencies and the telecom industry -- which is composed of tower owners, cellular service providers, and tower-climbing contractors. An informal consortium of companies is beginning to develop "best practices" at a national scale to protect nesting raptors while simultaneously keeping pace with equipment repairs and rapid upgrades to 5G technology. Several examples illustrating actions to solve nesting raptor-tower conflicts will be discussed. The continental populations of some raptor species that nest on cell towers are growing; thus conflicts with industry are likely to increase.

### Road Mortality in Barn Owls: Identifying Temporal and Spatial Hotspots in the Fraser Valley of British Columbia

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For species intersecting with human impacted landscapes, the relative importance of direct mortality effects versus the indirect loss or degradation of habitat are poorly understood. Recent work suggests that direct mortality of birds in human-altered landscapes has been greatly underestimated and can lead to decline in local populations. For example, in Canada, collisions with buildings, transmission lines and vehicles are estimated to kill more than 30 million birds and represent three of the four top sources of human related mortality. To better understand the magnitude and mitigations for road mortality, we examine the impacts on Barn Owls (*Tyto alba*), a Threatened Species in Western Canada. Barn owls are especially vulnerable to road mortality because they occur in agricultural landscapes and utilize grassy habitats, including grassy road margins to hunt their favored prey, voles. To evaluate the factors predicting road mortality, we analyzed 21 yr (1998-2018) of systematic road surveys across a 60 km section of highway in the Fraser Valley of British Columbia. Overall, 0.64 Barn Owls were killed/yr/km of highway, ranging from 6 to 70 killed per yr. Barn owl road mortality varied seasonally and was the highest between November and March and mean minimum monthly temperature had a significant effect on road mortality. Barn owls were more frequently killed on the highway in areas where there was more highway associated grass, such as grassy verges. Suitable foraging habitat bordering the highway did not predict road mortality. It is not clear if highway mortality influenced the distribution of breeding pairs; the productivity of Barn Owls in the area was not correlated to land use or distance

to highway. However, band returns revealed that, on average, nest sites with Barn Owl highway mortality were significantly closer to the highway, when compared to sites that had no highway associated mortality.

### Juvenile Dispersal Movements of Eastern Imperial Eagles in the Western part of the Breeding Range

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Satellite tracking became a frequently applied method for the study and conservation of raptors during the last decade, although the data derived from different projects are rarely analyzed together. Similarly, globally threatened Eastern Imperial Eagles (*Aquila heliaca*) have been tracked from several projects in eight countries in the western part of their distribution range from 2008 to 2018, although these data were never compared. In contrast to the majority of the populations of the species, those in Central-Europe, the Balkans, Anatolia and the Caucasus are thought to be mostly resident. In the present study, our aim was to give an overview of these extensive tracking studies and to show the large-scale dispersal movements of immature imperial eagles from the different resident populations of the species. All together, we gathered data from 171 satellite-tracked individuals, of which tags provided more than 1.5 million locations from the individuals' dispersal movements. The following number of eagles were tagged in the different countries: Hungary (74, 2011-2018), Austria (26, 2011-2018), Bulgaria (25, 2008-2014), Georgia (15, 2016-2018), Asian Turkey (11, 2017-2018), Czech Republic (7, 2017-2018), Slovakia (6, 2017-2018), Macedonia (5, 2013), European Turkey (2, 2009). Both GPS-Argos and GPS-GSM type tags were used. The overview of the dispersal movements of immature imperial eagles showed that the original theory that these populations were resident was right in general, although a small fraction of individuals still showed clear southward migratory movements during their first winter. Also, site fidelity and natal philopatry was very high, as only a very small fraction of the individuals moved temporarily to the territory of other breeding populations and, in all cases, they returned to the natal population if they survived their journey.



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### Coordinated Statewide Flammulated Owl Surveys in Wyoming: Expanding the Species Range

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The Flammulated Owl (*Psiloscops flammeolus*) is a small, insectivorous, neo-tropical migrant owl that breeds in forested habitats of western North America. The Flammulated Owl is a Species of Greatest Conservation Need in Wyoming due to its largely unknown distribution and population status in the state. Most range maps do not include Wyoming as breeding habitat and breeding season records of Flammulated Owls in Wyoming were limited to the western slope of the Sierra Madre Mountains prior to 2016. From 2016–2017, we conducted nighttime call-back surveys at 179 locations across Jackson Hole, Wyoming, resulting in 35 detections from an estimated 23 nesting territories. In 2019, we implemented a coordinated statewide survey to document the species' range across the state. We used a combination of national- and state-scale deductive models of potential owl habitat and expert opinion to select a sample of 10×10-km grids to survey with a combination of nocturnal call-back routes and passive acoustic recorders from mid-May through the end of June. In 2019, we documented multiple individuals across the western, central, and southern portions of the state including five mountain ranges where the species had not previously been detected during the breeding season. Our initial results expand the known range of the Flammulated Owl by >150 km and suggest this species likely breeds throughout most of Wyoming's mountain ranges.

### Habitat Use and Vocal Activity of Barred Owls (*Strix varia*)

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Habitat use is a key aspect in understanding and conserving species, and one aspect of habitat use is a location from which to call. For cryptic species, it can be difficult to determine which attributes from the landscape are selected for broadcasting calls. One species that may use certain landscape attributes for calling is the Barred Owl, but relationships between habitat use and call rate

are poorly understood. By examining audio data from 11 autonomous recording devices (ARUs) between the months of March–June, we described Barred Owl temporal activity and created models to best describe the relationship between call frequency and landscape attributes. We hypothesized that there would be a positive relationship between call rate and percentage of forested habitats, percentage of water, and mean distance to roads. We evaluated how land cover attributes influenced call rates at two different spatial scales. Barred Owls vocalized primarily between the hours of 0400–0500 with a peak in activity between 21 April and 3 May 2018. We found weak relationships between call rate and landscape attributes, likely caused by relatively low sample sizes of ARUs used in this study. Future studies evaluating relationships between Barred Owl call rate and habitat use should include larger sample sizes and a broader temporal window in their methodology.

### Artificial Nests Facilitates the Breeding Success of Gyrfalcons

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In Norway the Gyrfalcon (*Falco rusticolus*) breeds almost exclusively in nests built by other cliff-nesting birds. The dependency of other species to conduct breeding may represent a vulnerable factor for the falcons. We have provided 14 artificial nests in established and potential nesting cliffs for Gyrfalcons. The falcons readily accept the artificial nests. Engineering artificial nests intended for cliff-nesting raptors in remotely located cliffs might be challenging. We have developed a method that requires a minimum of tools and hardware for the purpose. The framework and platform will last for decades, but the nests themselves are prone to wear and tear, and thus requires maintenance and refurbishing. We try to minimize the demand for refurbishing through the modelling. The artificial nests have proven attractive also to other cliff-nesting birds, and are regularly used by Ravens (*Corvus corax*) and Rough-legged Buzzards (*Buteo lagopus*) when not occupied by falcons. The nest-building habit of these species is very beneficial for the quality and durability of the nests, and reduces the need for long-term human involvement. Breeding success for Gyrfalcons in artificial nests is similar to, or better than in natural nests. The artificial nests probably reduces the impact of negative factors such as nest-failure from predation and inclement weather and suggests that nests might be a limiting factor for the breeding success of Gyrfalcons.



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### Gyr Falcon Dietary Plasticity in a Changing Tundra Ecosystem

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Phenological shifts occur at different rates across taxa in response to climate change, leading to mismatches between linked trophic levels. The degree to which specialist predators can adjust their foraging strategy to mitigate the negative impact of phenological mismatch remains unclear. We studied a population of sub-Arctic breeding Gyr falcons (*Falco rusticolus*) – traditionally considered a ptarmigan (*Lagopus spp.*) specialist– to quantify patterns in reproductive success and dietary strategy as a function of reproductive phenology. We installed motion-activated cameras during the brood-rearing period on Alaska's Seward Peninsula, collecting dietary, morphometric, and phenological data for 48 breeding attempts from 2014 – 2018. Gyr falcon productivity positively correlated with earlier reproduction. Diet shifted from primarily ptarmigan and shorebirds during the early breeding season to Arctic ground squirrels (*Urocitellus parryii*) and passerines later in the breeding season, consistent with seasonal patterns in prey availability. Nestlings at late-breeding nests consumed higher percentages of atypical prey (e.g. jaegers, gulls, and seabirds). Our results suggest improved nestling body condition for both early-breeding dietary specialists and late-breeding dietary generalists. Thus, earlier breeding individuals are better timed with their peak optimal prey availability (on which they may specialize), whereas late breeding individuals compensate for mismatch between hatch date and prey availability by increasing diet breadth at little detriment to nestling body condition. This behavioral adjustment to a more generalist diet may mitigate the adverse effects of phenological mismatch, and dietary plasticity may thereby serve as a mechanism of resilience to climate change.

### A Falconers' Role in Raptor Rehabilitation: A Blueprint for Success

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California Foundation for Birds of Prey (CFBP) is a non-profit organization dedicated to the conservation and rehabilitation of raptors. Over 200 raptors are seen on an annual basis. Currently, CFBP has two programs that go beyond the common rehabilitation efforts. The first

program is the CFBP Free Flight Program. This program utilizes general and master falconers for evaluation of raptors needing special handling or flight training. The second program is the Golden Eagle (*Aquila chrysaetos*) Free Flight program focusing on fledgling Golden Eagles. Strict requirements must be met before any raptor is placed with a falconer. The falconer's role is to evaluate the raptor's free flight and ability to survive in the wild, or the potential role of a non-releasable raptor as an educational ambassador. All raptors entering this program are maintained under CFBP with the proper paperwork approved by US Fish & Wildlife Service (Region 8) and the California Department of Fish & Wildlife. To date over 110 raptors of various species and 42 eagles have entered this program. The details of this falconry based program and achievements of raptors entering the program will be presented.

### Home Range, Habitat Selection and Nesting Ecology of Urban Merlins in Winnipeg, Manitoba

#### JUSTINE JOSEPHSON-LAIDLAW

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Urban landscapes are thought to provide an environment conducive to enhanced productivity and distribution in Merlins (*Falco columbarius*), as observed across North America. In the city of Winnipeg, however, there is a paucity of research on the Merlin, even though local rehabilitation centers and other efforts have recorded a significant Merlin presence. The objectives of this study are to provide baseline data to better understand the species-specific habitat utilization while generating insight into the spatial ecology of urban Merlins. We assessed nest site selection using Resource Selection Functions (RSF), limiting factors, and virus transmission in the urban environment from previous rehabilitation records and necropsied samples of juvenile Merlins from a mass mortality that occurred during the 2018 breeding season, as well as nesting density using Nearest Neighbor Distance (NND) methods, and assessed the home range of four breeding males fitted with PinPoint-75 VHF transmitters. The information from this study will be used to develop an all-encompassing model for Merlins in an urban environment.

### Back to the Old Days: the Advantage of a Sharp Eye in Today's Ecology

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Small-sized raptors molt all flight feathers (primaries, secondaries, and rectrices) in a single annual molt cycle. Medium-to-large-sized raptors are unusual in not doing so and they only replace some feathers during each active period of molt, giving rise to the appearance of molt waves. As a result, molt waves can be recognized by the simultaneous presence of feathers corresponding to different generations with new and old feathers identified by their wear, color, shape, and pattern. In Accipitriformes, the primaries are replaced distally (outwards) from the innermost (p1) to the outermost (p10) and are the most accurate means to assign individuals to a given age-class because a new molt wave is initiated at primary 1 at the start of every annual molt cycle, regardless of whether all primaries were replaced or not in the previous cycle. Therefore, the ability to correctly assign individuals to the corresponding age-class and to understand the plumage sequence (overall coloration and pattern) has important implications for the understanding of life history traits. Following this theoretical approach, I have been assigning age-class to individuals by direct observation for over a decade of field-work across the Southern Cone of South America using field photography as a tool (5000 individuals, 200,000 photos). The aim of this presentation is (1) to show how to assign age-class to individuals by direct observation using molt waves of flight feathers, and (2) to highlight the importance of applying the correct nomenclature to assign individuals to a given age-class. I will discuss how this ability to assign age-class to individuals by direct observation can be helpful to assess ecological concepts such as color-polymorphism, delayed plumage maturation, and population ecology.

### What We Know about Raptor Migration within South America

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Bird migration in South America is a complex phenomenon, with masses of birds moving on several axes during a given season. This diverse spectrum of movements has been sorted into three migration systems: *Nearctic-Neotropical* includes species that breed in the Nearctic region and overwinter in South America; *Neotropical-Intra-tropical* includes species that breed in tropical and subtropical latitudes and overwinter within the tropical belt; and *Austral-Neotropical* includes species that breed in the austral temperate zone and overwinter north of the breeding range within South America. Given this complexity, there is still much to learn about bird migration in the continent, particularly how birds adjust their annual movement to this fast-changing world. Diurnal raptors represent an excellent model group to investigate bird migration in South America because of the 96 species found in the continent; 45 (47%) exhibit

seasonal movements. Therefore, studies to map their major migration routes and their wintering ranges remain fertile ground for future research. The aim of this presentation is (1) to review the current knowledge of raptor migration within South America, and (2) to present novel data collected systematically regarding the wintering distribution (and its fluctuation between winters) and seasonal abundances (summer vs. winter) of raptors, in several locations across the Austral Temperate Region of the Argentinean Andes. Finally, I will present several suggestions regarding future research lines to enhance our understanding of raptor migration in South America.

### Assessing Population-Level Consequences of Anthropogenic Stressors on Raptors

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Human activity influences raptors. However, the ecological and conservation significances of these influences depend on population-level consequences and are thus difficult to predict. This difficulty arises partly because of information gaps and partly because the data on stressors are usually collected in a count-based manner (e.g., number of dead birds) that is difficult to translate into rate-based estimates important to infer population-level consequences (e.g., changes in mortality rates). Ongoing methodological developments can provide information to make this transition. Here we synthesize tools from multiple fields of study to propose an overarching, spatially explicit framework to assess population-level consequences of anthropogenic activity on birds of prey. A key component of this process is using ecological information from affected birds to upscale from count-based field data on individuals to rate-based demographic inference. The five steps to this framework are (1) process planning; (2) field-based measurement of the effect of human activity on individual raptors; (3) characterizing the location and size of the populations of origin of affected raptors; (4) demographic modeling for those populations; and (5) assessing the significance of human-induced changes in demographic rates. We detail these steps and then illustrate their application for a raptor impacted by collision with wind turbines. In our example, we use stable hydrogen isotope data to infer a “catchment area” describing the geographic origins of affected individuals as the basis to estimate population size for that region. Surprisingly, these examples reveal unexpectedly large



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risks from wind for this species, despite the fact that it is common and widely distributed. This study illustrates key aspects of the framework but also important areas for subsequent theoretical and technical development to make it more broadly applicable.

### **Managing High-quality Cliff-nesting Raptor Habitat Using Citizen Science, an Adaptive Seasonal Closure Framework, and Public Support near Boulder, Colorado, U.S.A**

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The City of Boulder Open Space and Mountain Parks (OSMP) received 6.3 million visits in 2017, 30% more than Rocky Mountain National Park, but is 5 times smaller. As Colorado's Front Range experiences one of the fastest-growing human populations in the United States, local land management agencies like OSMP are becoming increasingly challenged in balancing the dual mandate of conserving habitat and providing recreational opportunities. A constructive model to achieve this balance may exist in OSMP's management of a linear series of sandstone slabs—the Flatirons—which are approximately 11 km in length and offer excellent rock-climbing opportunities, but also support a dense population of nesting falcons and eagles (1 nesting pair / 1 km). To protect raptor habitat and provide climbing access, OSMP annually closes approximately 10% of accessible rock formations. Managing closures includes temporal and site-specific spatial restrictions at 11-14 nesting areas, a dedicated group of volunteers who log thousands of hours each year, and visitor education and outreach. Volunteers are paramount to the success of the program as they provide timely data on raptor nesting status which drives our adaptive management process. Closures are lifted on unoccupied sites if cliff-nesting raptors are not observed on territory by 15 May. Management at this temporal scale helps build and maintain support from the local climbing community, which recognizes that our raptor habitat management model aligns with our multi-purpose charter. Since seasonal closures and nest monitoring were first initiated in 1986, nesting success and productivity levels of Golden Eagles (*Aquila chrysaetos*), Prairie Falcons (*Falco mexicanus*), and Peregrine Falcons (*Falco peregrinus*) have exceeded those of other raptor populations in the western United States. Conservation of both nesting and foraging habitat, and the effort of volunteer monitors, allow OSMP to support a dense population of cliff-nesting raptors in an exurban landscape.

### **VultureNet: Connecting Technology and Organisms in the Internet of Wildlife™**

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Connected networks are an integral part of our everyday lives. Whether it's the watch on your arm uploading data to the web or your phone turning on a connected device in your home, we use these networks every day. Until now, wildlife networks have been designed to work within a single platform, where every device had to either send its data to the network directly, via Argos, cellular, etc., or data were manually collected or downloaded. We developed a system, VultureNet, that integrates multiple networks to collect animal movement data. VultureNet is an integral part of the larger Internet of Wildlife™ concept that works across platforms. Tags on larger organisms can receive and send data; tags on small birds, like passerines and small falcons or accipiters can transmit data to a vulture or eagle tag as it passes by. The large tags in-turn transmit these data to a server and are thus made available to the researcher. This kind of intelligent data mesh network enables the tracking of organisms that are too small to carry telemetry units capable of transmitting data long distances or transmitting data to larger networks. It also allows the collective network to work together toward data collection to lessen the need of costlier infrastructure specific to a tag, like satellites. Within VultureNet we have begun to deploy transmitters on vultures that are now collecting data from smaller tags. Early results indicate Argos-quality fixes can be achieved from VultureNet tags localizing smaller transmitters on the ground. This will revolutionize how data are collected and how researchers and wildlife are able to work together to answer big questions and ultimately help conserve species world-wide.

### **Falconry and Traditional Ecological Knowledge: The Crossroads of an Ancient Culture and the Genesis of Raptor Conservation**

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As my Red-tailed Hawk (*Buteo jamaicensis*), Guinevere looked around, I kissed her on the back of the head and then ten seconds later she left my glove for the last time. She flew to the forest edge landing on a branch and



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waited for me to catch up as she had done many times over the past two seasons; however, this time I did not follow her. I watched her through my binoculars and tears; she continued to wait for me. Finally, confused and impatient, she gave up launching herself into the sky heading toward me. She circled overhead a few times and then she was gone. I never saw her again. The relationship I had with Guinevere was one that many falconers have with their birds throughout the long history of falconry. This ancient practice facilitates a unique relationship between raptors and humans through mutual respect and trust. For over four thousand years, falconry remains steeped in tradition and it is through this traditional knowledge of raptor behavior and hunting techniques passed down through generations as oral narratives, the falconer gains a rare glimpse into the behavioral ecology of this secretive predator. No scientist can gain such intimate knowledge without the partnership of falconer and raptor. Falconry has had a long, historical thread woven into the conservation of raptors. There is some disparity in using traditional ecological knowledge (TEK) to solve ecological problems; nonetheless, raptor conservationists have been drawing on the traditional ecological knowledge of falconry and combining the knowledge gained from traditional science to address raptor conservation issues. Some of our foremost raptor scientists have been falconers. My purpose here is to assemble the relationship between the traditional ecological knowledge of falconry and beginnings of raptor conservation.

### Multi-scale Habitat Suitability Model for Golden Eagles (*Aquila chrysaetos*) in Arizona

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Since the early 19<sup>th</sup> century species extinction rates have increased due to anthropogenic pressures. In order to combat potentially declining populations, an examination of a species' distribution spatially and temporally is central to the understanding of how a population uses the landscape. Utilizing multi-scale habitat suitability models (HSMs) to evaluate a species' behavioral ecology is an effective approach. For this study the Golden Eagle (*Aquila chrysaetos*) was the focal species with the study site including all areas of Arizona except for the Navajo/Hopi Nations. All nest site location data were obtained by the Arizona Game and Fish Department during surveys conducted between 2011-2018 as well as available historical data beginning in 1973. There were 190 presence points (i.e., nest sites) comprised of documented nesting activity such as two adults present at the nest or

an adult incubating. We created 5,000 pseudo-absence points at least 10 m apart that covered the entire study area. There were 22 habitat covariates (five climate that were further divided into seasons providing 14 total, three topographic, four habitat and two human). In order to find the scale at which Golden Eagles responded to each predictor, we executed Random Forests in R as a regression with these parameters: 2,000 trees (number of bootstrap repetitions) for five scales (400 m, 800 m, 1,600 m, 3,200 m, 6,400 m radii). Each optimized scale was chosen for the main model. A test for multicollinearity removed seven covariates leaving 15 for the final model. The two most important covariates in the final model were slope and aspect with agriculture and sage as the two least important. The resulting habitat suitability map showed a majority of the suitable habitat occurring along the Mogollon Rim and the North and South Rim of the Grand Canyon National Park.

### Integrating Remote Sensing and Citizen Science to Study the Environmental Context of Returning Avian Predators

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Urbanization causes the simplification of natural habitats, resulting in animal communities dominated by exotic species with few top predators. In recent years, however, many predators such as hawks, and in the US, coyotes and cougars, have become increasingly common in urban environments. Hawks in the *Accipiter* genus are recovering from widespread population declines and are increasingly common in urbanizing landscapes. Our goal was to identify factors that determine the occupancy, colonization and persistence of *Accipiter* hawks in a major metropolitan area. Through a novel combination of citizen science and advanced remote sensing, we quantified how urban features facilitate the dynamics and long-term establishment of *Accipiter* hawks. Based on data from Project FeederWatch, we quantified 21 years (1996–2016) of changes in the spatiotemporal dynamics of *Accipiter* hawks in Chicago, IL, USA. Using a multi-season occupancy model, we estimated Cooper's (*Accipiter cooperii*) and Sharp-shinned (*Accipiter striatus*) Hawks occupancy dynamics as a function of tree canopy cover, impervious surface cover and prey availability. In the late 1990s, hawks occupied 26% of sites around Chicago, but after two decades, their occupancy fluctuated close to 67% of sites and they colonized increasingly urbanized areas. Once established, hawks persisted in areas with high levels of



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impervious surfaces as long as those areas supported high abundances of prey birds. Urban areas represent increasingly habitable environments for recovering predators, and understanding the precise urban features that drive colonization and persistence is important for wildlife conservation

### Wintering Space Use of an Irruptive Species South of the Tundra

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During the non-breeding season, intraspecific competition can be an important mechanism for population regulation. Such competition may result in social hierarchies, where dominant individuals, or those with a higher social ranking, maintain good quality habitats. For example, dominance relationships (relative competitive abilities) can cause differences in the home ranges and habitat use by individuals of different ages and sexes. Thus, an animal's social rank can influence movements, with lower ranked individuals constrained to forage in low quality habitat. The Snowy Owl (*Bubo scandiacus*) is known for its nomadic behavior, exhibiting unpredictable and highly variable movements during both the breeding and non-breeding seasons. We analyzed fine-scale telemetry data (GPS-GSM) from over 50 Snowy Owls tagged in eastern and central North America from 2013- 2019, comparing home range size and habitat use according to land cover attributes to determine if there is a correlation between habitat suitability and social hierarchies. Assuming females are dominant to males and adults to juveniles, we predict that juvenile males will occupy lower quality habitat with larger home ranges than adult females. By studying the overwintering behavior of Snowy Owls, we will shed light on key aspects of an irruptive species in a poorly studied stage of their life cycle.

### Raptor Breeding Distributions Shifting Northward Faster Than Other North American Migratory Birds

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There is widespread evidence that species distributions are shifting in response to global change, and it is commonly hypothesized that warming temperatures and

climate niche constraints are the primary drivers of these shifts. Northward shifts in wintering distributions have been observed for many migratory birds, including raptors. However, shifts in breeding distributions are heterogeneous and inconsistent with climate niche hypotheses. We studied shifts in breeding distribution centroid for 73 migratory bird species, including 8 raptor species, coinciding with the advancement of anthropogenic climate change and assessed whether distribution shifts were correlated with life history traits, including diet and migration. We examined latitudinal shifts in breeding distribution from 1994-2017 across eastern, western, and central regions using Breeding Bird Survey data. Overall, 55% of regional shifts were northbound and 45% were southbound. However, among raptors, 73% of shifts were northward and only 27% of shifts were southward. Diet was the strongest predictor of shift direction across all species because raptors as a group tended to show the most northward shifts. Shifts in centroids were not explained by trends in abundance, suggesting that centroid shifts were not attributable to population declines or increases at distribution margins. Competition for nest sites and mates and the benefits of early nesting may drive northward raptor shifts, in both breeding and wintering distribution, more than in other migrants. Overall, life history is an important component of breeding distribution shifts, and more work is needed to understand drivers of heterogeneous distribution shifts.

### What is a Raptor? A New Definition of Raptors and Birds of Prey

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Species considered raptors are subjects of monitoring programs, textbooks, scientific societies, and legislation. Yet, no standard definition for the synonymous terms 'raptor' or 'bird of prey' exists. Groups including owls, vultures, and shrikes are variably considered raptors based on morphological, ecological, and taxonomic criteria depending on the authors. We review various criteria previously used to delineate raptors and we present a definition that incorporates current understanding of bird phylogeny. For example, hunting live vertebrates has been largely accepted as an ecological trait of raptorial birds, yet not all species considered raptors are raptorial—e.g., Palmnut Vulture (*Gypohierax angolensis*)—and not all raptorial birds are considered raptors—e.g., some





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Charadriiform seabirds. Acute vision, hooked beak, and sharp-taloned feet are the most commonly used morphological characters for delineating raptors; however, using those characters as criteria causes confusion because they can be vague and exceptions are often made. Old World vultures, for example, are in the family Accipitridae along with hawks and eagles and thus are often considered raptors despite their lack of sharp talons. We define raptors as species within orders that evolved from raptorial core landbirds (Telluraves) in which most species maintained raptorial lifestyles. Raptors are therefore all species within Accipitriformes, Cathartiformes, Falconiformes, and Strigiformes. Importantly, we highlight that seriemas (Cariamiformes) should also be considered raptors. Our definition combines phylogeny, morphology, and ecology, while avoiding ambiguity of owls, vultures, and shrikes. Establishing a common definition of raptors should improve interpretability across studies and lessen ambiguity of research and management recommendations.

### Using Falconry and Anthropology to Mitigate Human-Wildlife Conflict, Promote Eagle Conservation, and Understand How Humans and Eagles Think About One Another

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Hominins have been thinking about eagles for a long time, from the selective pressure of eagle predation on Australopithecines, to symbolic feather and talon use by Neanderthals, to the veneration of eagles as symbols of power across modern human cultures and the tradition of falconry. Falconry is a complex intersubjective relationship between man and raptor. The ethos of falconry, and that it necessitates an understanding of the world from the raptor's perspective, lends itself toward the development of conservation values and is an important perspective in raptor research. Anthropology can serve as a bridge between culture and biology, helping traditional ethnornithological knowledge and scientific research to inform one another. An example of this kind of interdisciplinary research is a recent study of genetic samples taken from dozens of Golden Eagles (*Aquila chrysaetos*) that were flown by falconers and at the annual Golden Eagle Festival in Bayan-Olgii, Mongolia, to determine gene flow between different eagle populations in Eurasia. Other partnerships between falconers and biologists utilize applied anthropology. Among Wyoming ranchers, so called 'problem eagles' that have been positively identified as killing livestock by USDA officials are permanently placed with falconers. With Crowned Eagles (*Stephanoaetus coronatus*) in Durban, South Africa, falconers similarly take for falconry eagles that are in danger of being killed.

Falconers also assist in the ringing of chicks and nest monitoring, as well as the rehabilitation of young eagles in need of extended hunting experience prior to release. These falconer-biologist partnerships are instrumental in mitigating human-wildlife conflict, education, and in research that can arise. Ultimately the way humans and eagles think about each other is important for both falconers and biologists and informs our understanding of how to conserve the natural world.

### Bottom-up Processes Drive Reproductive Success in Golden Eagles in Interior Alaska

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Identifying the drivers of population dynamics, particularly in the context of predator-prey relationships, is a central goal of the field of population ecology. Understanding the relative role of top-down versus bottom-up drivers is of particular interest in understanding ecosystem dynamics. Our goal was to explore predator-prey relationships in a boreal ecosystem in interior Alaska using multispecies long-term monitoring data. We used 29 yrs of field data collected from 1988 – 2016, and a dynamic multistate site occupancy modeling approach to explore the trophic relationships between Golden Eagles (*Aquila chrysaetos*) and their two primary prey species available early in the nesting season, Snowshoe Hare (*Lepus americanus*) and Willow Ptarmigan (*Lagopus lagopus*). We found that Eagle reproductive success, measured as the number of fledglings produced, began to slow prior to the Hare peak and then increased prior to the start of the recovery of the Hare population. In addition, Eagle reproduction quickly began to recover in apparent response to the increase phase of the Ptarmigan cycle, without controlling the Ptarmigan population. Our results illustrate that Eagle reproductive success in our study area is largely controlled by bottom-up forces rather than predation by Eagles acting to limit Hare and Ptarmigan populations through top-down mechanisms. Although we previously identified the relationship between Eagle reproductive success and prey abundance in our study area, here we established that prey populations are likely driving Eagle population dynamics through bottom-up processes. The key to this insight was our focus on Eagle vital rates (i.e. fledglings produced) rather than overall abundance (i.e. number of Eagles in study area). Our work suggests that more detailed investigations of vital rates (i.e. reproduction) may reveal unexpected relationships between prey resources and predator populations, possibly providing more conclusive evidence of the directional drivers (i.e. top-down vs. bottom-up) in a variety of predator-prey systems.



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### Golden Eagle Nest Monitoring and Mitigation Actions at Surface Coal Mines in Northeastern Wyoming and Southeastern Montana: Long-term Summaries, Case Studies, and Mitigation Recommendations

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The surface coal mining region in northeastern Wyoming and southeastern Montana (Powder River Basin) contains a dense concentration of Golden Eagle (*Aquila chrysaetos*) nesting territories. Over time, various approaches have been employed to avoid, minimize, and mitigate potential impacts to occupied Golden Eagle nesting territories from active coal mine operations. Such efforts have included: 1) relocation of unoccupied nests within a known nesting territory to maintain or increase spatial buffers between nesting sites and advancing mine operations; 2) relocation of occupied nests to train specific territorial pairs to adopt artificial nest structures for incremental movements to create or maintain buffers from active mine operations; and 3) installation of supplemental nesting sites (e.g., artificial platforms) to create alternative nests within a known nesting territory, or potentially entice a new territorial pair into a given area. Extensive monitoring of some pairs also has documented high levels of acclimation to and tolerance of proximate mine operations, precluding the need for physical mitigation measures, such as nest manipulations. This summary describes 40 yr of monitoring and mitigation data collected for a combined total of nearly 300 Golden Eagle nests and man-made nesting sites created to support territorial pairs at surface coal mines in the Powder River Basin. The summary includes comparisons of occupancy and production rates among natural, mitigated, and supplemental nesting sites; case studies of active (nest manipulation) and passive (enhanced monitoring) efforts used to help maintain known Golden Eagle nesting territories; and recommended strategies and platform designs for successful mitigation actions.

### Rehabilitation of the Golden Eagle: A Free Flight Conditioning Program

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The Committee for Eagle Rehabilitation Excellence (CERE) has been established to address the specific needs of the Golden Eagle (*Aquila chrysaetos*) entering raptor rehabilitation centers. Representatives from select falconry organizations, eagle rehabilitation centers, avian veterinarians, eagle biologists, and the Native American Community form the working group of this committee. The goal of this committee is to make recommendations for the medical evaluation, husbandry, conditioning requirements, and rehabilitation techniques for each age group to enhance their chance of survival once released back to the wild. The defined age groups are nestling, fledgling, subadult and adult Golden Eagles. The fledgling age group is considered the most vulnerable once released back to the wild. Without proper flight conditioning and hunting skills, their chance of survival is limited. For this age group a detailed fitness and conditioning program is being developed. Utilizing free flight conditioning with a master falconer, investigating the use of training with lures connected to specialized drones, and a 6 – 7 mo training program with specific benchmarks to achieve is the basis of this program. Data collected with the Marshall's telemetry and GPS equipment, including vertical and horizontal speed, altitude, and recovery of flight dynamics in real time will serve as guidelines to determine if and when the Eagle in training is suitable for release. Flight data from trained adult falconry Eagles will be used for baseline comparison. Survival data with the use of satellite telemetry of these trained fledglings will be compared to fledglings conditioned without the ability for free flight and limited to creance or flight chamber conditioning prior to release.

### Short-Eared Owl (*Asio flammeus*) Population Dynamics in the Western United States

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The Short-eared Owl is an open-country species that breeds in the northern United States and Canada, and has likely experienced a long-term, range-wide population decline. However, the cause and magnitude of the decline are not well understood. Population monitoring of Short-eared Owls is complicated by the fact that the species is an irruptive breeder with low site fidelity, resulting in large shifts in local breeding densities. It is critical to implement monitoring at a scale needed to detect regional changes in distribution that likely occur annually. We recruited 622 community-scientists to survey at study sites across the eight western states during the breeding season. We surveyed 368 transects and detected Short-eared Owls on 57 transects. We performed multi-scale occupancy modelling and maximum entropy modelling to identify population status, habitat and climate associations. We



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found that the probability of detecting Short-eared Owls was impacted by day-of-year, time-of-day and wind conditions. We most often found Short-eared Owls in stubble agriculture areas with lower levels of grazing. Cropland at the transect scale was a predictor in site occupancy. Our MaxEnt analysis found that Short-eared Owls have a climate association that puts them at great future risk, primarily their apparent preference of landscapes with higher relative precipitation and moderate seasonality. Our results demonstrate the feasibility, efficiency, and effectiveness of utilizing community scientists to achieve a robust sampling methodology across the broad geography of the western United States.

### Flight Behavior of Golden Eagles in Wyoming: Implications for Wind Power

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Wind power generation is one of the fastest growing sources of alternative energy. However, industrial scale wind development has both direct and indirect effects on wildlife. With an installed capacity of 1,488 MW in Wyoming, there is an established history of negative turbine-wildlife impacts, especially on Golden Eagles (*Aquila chrysaetos*). Understanding flight behavior in relation to weather variables is an important component of conservation and management of Golden Eagles at wind facilities. Since June 2017, we have trapped 90 Golden Eagles and tagged 44 of them (20 adults and 24 sub-adults) with GSM/GPS telemetry units. The units were programmed such that when the birds were in flight, they collected high temporal resolution GPS data (<7 s) at least 3 days per week. As of Jun 2019, we have collected >5 million GPS locations. We collected high resolution flight data on 4,465 eagle days and used these preliminary data to understand how eagle flight behavior was influenced by time of day, time of year, and wind and thermal conditions. Preliminary analysis showed that Golden Eagles flew the most during mid-day, flying on average 22.4±9.8 min from 1100-1200h. They flew the least during the morning (0700h=6.1±2.4 min) and evening (1800h=5.6±2.0 min). Such information will assist in predicting the presence of eagles within a wind facility and understanding when Golden Eagles may be at risk for collision with wind turbines.

### Breeding Ecology of Endangered Egyptian Vulture (*Neophron percnopterus*) in Gangetic Plains of Uttar Pradesh, India

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We studied the breeding biology of the globally endangered Egyptian Vulture in the Gangetic Plains of Uttar Pradesh India. The study is one of the first attempts to document the breeding ecology of the Egyptian Vulture in the Gangetic Plains. We identified and monitored breeding sites between 2014 and 2018. We located nesting sites in the districts of Unnao, Lakhimpur-Kheri, Gonda and Raebareli on the basis of information obtained from local people and the forest department. Field visits of potential breeding sites and foraging sites also helped in identification of breeding sites. Identified nests were monitored for reproductive success and nest substrate use. The reproductive success parameter was further used to assess quality of nest sites selected. Nest site selection was assessed on the basis of characters of selected and non-selected substrates. Along with nest material and nest site selection, the selection of suitable nest substrate can be critical and essential to the survival and persistence of endangered species. Preference for nest sites is identified. Nesting on tall and ancient temples was found to be safer and successfully adapted than the other nesting substrates. The nests on painted temples were left abandoned. The maximum number of nests was observed at temples followed by trees, water tanks and electric towers. These results suggest that Egyptian vultures prefer to nest at safe, tall and natural old places where they camouflage with the surroundings easily. The nesting substrate may be an important factor driving the distribution of Egyptian Vultures. Identification of breeding sites and their protection are important for the conservation of this endangered species.

### A Multi-State, Time-Removal Model for Population Dynamics of Cliff-Nesting Raptors

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Cliff-nesting raptors present considerable challenges for population estimation due to their sparse distribution across remote landscapes and the multiple occupancy states (e.g., unoccupied, occupancy without breeding, breeding occupancy) through which we observe their nesting territory dynamics. To increase the efficiency and spatial inference of surveys, we developed two versions of a multi-state, time-removal model: one for long-term monitoring studies and the other for population inventories or single-season surveys in which there is no prior knowledge of nest locations. We focused our development of these methods in the context of a combined aerial and ground-based survey approach, which permits efficient surveying at landscape scales. The approach, however, is also applicable to designs restricted to ground-based surveys. For long-term monitoring of species with alternate nests, we formulated a version of the model that accounts for state uncertainty at the territory level caused by a failure to observe all nests within a territory. Simulations based on the long-term monitoring model indicated adequate (near nominal) coverage and low relative bias ( $<0.05$ ) for nearly all parameters. In the simulation study for the inventory model, population size estimates showed negligible bias for a survey duration of 90 minutes. We applied our approach to a long-term study of Golden Eagles (*Aquila chrysaetos*) in Alaska and demonstrated that the maximum effort spent on any nesting territory could be reduced by up to almost 90% of that recommended by standard protocols.

### Intergeneric Hybridization of a Vagrant Common Black Hawk and a Red-shouldered Hawk

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Natural, intergeneric hybridization is exceedingly rare in raptors. To date, the only intergeneric hybridization report in which both parental species were probably of wild origin involved a Black Kite (*Milvus migrans*) and a Common Buzzard (*Buteo buteo*). In 2012, L. Hug observed a juvenile hawk interacting with a banded adult female Common Black Hawk (*Buteogallus anthracinus*), in Sonoma County, California, USA, and speculated that the juvenile was a hybrid. Hug's observations and a disparity of expert opinions on the parentage of the juvenile prompted S. Moore, who had been monitoring the Common Black Hawk since 2005, to initiate a 2-yr breeding study. We report on the nesting efforts of this Common Black Hawk in 2013 and 2014. The Common Black Hawk's 2013 nesting attempt failed during incubation before the mate was identified. In 2014, the Common Black Hawk bred with an adult male Red-shouldered Hawk (*Buteo lineatus*). This pair fledged one hybrid offspring. Evidence of

hybridization included observations of the pair engaging in aerial courtship ( $n = 2$ ), copulation ( $n = 2$ ), and simultaneous nest attendance ( $n = 2$ ), as well as the offspring's intermediate physical characters and vocalizations. The hybrid offspring's natal plumage included buffy-colored down and a dark eye-patch, similar to that of Common Black Hawks. Whereas the hybrid's juvenal plumage most strongly resembled that of a Common Black Hawk, its morphology was more intermediate between the two parent species. This hybridization event appears to be an example of the desperation hypothesis, whereby a rare vagrant, unable to secure a conspecific mate, settled on a locally abundant species of raptor. Dietary overlap of the two parental species (e.g., crayfish, amphibians) and strong associations with aquatic habitats may have facilitated this pairing and hybridization event.

### Survival and Causes of Mortality Among Pre-breeding Age Golden Eagles in the United States Southern Plains

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The United States Southern Plains (SP) region provides extensive habitat for Golden Eagles (*Aquila chrysaetos*), especially local non-breeding and dispersing or overwintering individuals. Direct impacts of humans (e.g., effects of ongoing energy development in the region) on eagles using these habitats are not well understood. During 2015-2018 we used satellite telemetry to document survival of 29 Golden Eagles produced in the SP, starting at the eagles' late nestling stage (~7 wk old). Ten (34.5%) of the eagles died at their nests just before or during fledging, mostly due or likely due to parasitism by Mexican chicken bugs (*Haematosiphon inodorus*; MCBs). Only 11 (37.9%) of the eagles lived beyond their first year. Based on a multi-state Bayesian model, the estimated first-year survival rate was 0.45 (median; interquartile range = 0.39-0.51), roughly two-thirds of the usual survival rate. Causes of mortality among 15 SP Golden Eagles that lived beyond the fledging period plus seven we tagged as nestlings in adjoining regions that died after moving to the SP included power line electrocution (10), poisoning or shooting (4), power line collision (1), wind turbine collision (1), winter exposure-starvation (1), and likely MCB parasitism (1); causes of four of the losses were unknown. Action to improve Golden Eagle survival in the SP could





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first focus on reducing electrocution risk, given its apparent broad extent and the marked effectiveness of standard corrective measures. The extent of MCB parasitism at nests should be further evaluated; control of the parasite may be a cost-effective means of offsetting losses of Golden Eagles elsewhere.

### What Happens with the Harpy Eagle in Venezuela?

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In Venezuela, the Harpy Eagle (*Harpia harpyja*) is considered a Vulnerable species. Since 1989 several organizations have developed the Harpy Eagle Conservation Program in eastern Venezuela with an investment around a million dollars. Program lines of actions are: environmental education, eagle monitoring, nest protection, the study of population dynamics of harpy eagle prey, "reintroduction" of rehabilitated eagles, and habitat change surveillance. Until 2015 the program registered 93 nest and has tracked 30 eagles using radio and satellite telemetry, and "reintroduced" nine individuals. Unfortunately, the information produced by the program has not been published. We also do not know the effectiveness of the actions undertaken or the current state of Harpy Eagle conservation in Venezuela. I used published information and data derived from remote sensors to infer the situation of the species at country level and establish a baseline for future assessments of the conservation status. Forest lost in the area of program implementation (AIP) has been 290 km<sup>2</sup> between 2001-2014. I estimate that until 2012 there were 296 pairs of harpy eagles in an area of occupation of 23,403 km<sup>2</sup> in the AIP. I propose a critical review of the program to evaluate and rethink its goals and scope to optimize resources and effectively contribute to the conservation of the species with revised, published and cited results.

### Population Recovery of Peregrine Falcons in Central Norway in More Than Forty Years Since the DDT-ban: the Role of Pollutants and Prey

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The breeding population of Peregrine Falcon (*Falco peregrinus*) in Norway was almost exterminated by the early 1970's. Long-term monitoring of breeding pairs has been conducted since 1976 up to the present. Peregrines remained at stable low numbers until the early 1990's. Starting around 2000, numbers began to increase steadily,

and current numbers have now reached what we believe are historical population levels from the pre-DDT era. However, the productivity has decreased over time on the coast, the former stronghold of the population, while we see an expansion of range and increasing numbers of Peregrines nesting in the fjords and in inland valleys. The levels of environmental pollutants in eggs of the Peregrines have dropped sharply over the last few decades, and contaminant levels now seem to be below critical levels. Eggshells were relatively thin throughout the 1970s, 1980s and 1990s, but have increased to almost normal levels during the last two decades. The data indicate that reduction in levels of organochlorine pollutants, especially DDT, have been the main factor in explaining the recovery. The low breeding success of the coastal-breeding Peregrines is believed to be caused by declining numbers of colonial seabirds and other prey species.

### Detection of Two Emerging Pathogenic Gammaproteobacteria *Wohlfahrtiimonas chitiniclastica* and *Ignatzschineria* spp. in a Turkey Vulture (*Cathartes aura*) from Southern California

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The bacteria *Wohlfahrtiimonas chitiniclastica* and *Ignatzschineria* spp. (Phylum Proteobacteria, Class Gammaproteobacteria) are aerobic, non-spore forming, non-motile gram-negative rods recently considered as emerging pathogens for humans and animals. We report the identification of these microorganisms in the cloaca of a Turkey Vulture trapped and sampled at Anaheim Lake, Orange County, southern California, U.S.A. We used PCR to amplify the 16S rRNA gene with broad-range bacterial primers, and next generation sequencing and bioinformatics to identify approximately 20% of the sequences as Gammaproteobacteria most closely related to *Wohlfahrtiimonas chitinoclastica* and to a cluster that includes the genus *Ignatzschineria*. We subsequently confirmed this discovery with several sets of newly designed PCR primers. To our knowledge, none of these sequence types have been found in previous microbiome characterizations or isolated from turkey vultures. Scavenger species are an important part of the epidemiology of several pathogenic and non-pathogenic microorganisms. By consuming carcasses, scavengers



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decrease the risk of exposure to other predators and scavengers, contribute to the dispersion of pathogens and non-pathogenic microorganisms to distant geographic areas, and can act as reservoirs or vectors for microbial taxa. Both genera are considered zoonotic, but human infection has only been linked with exposure to flies and maggots, and not by direct exposure to an infected vertebrate. The potential role of turkey vultures and scavengers in the epidemiology of these pathogens needs future study. The potential risk of exposure to these and other pathogens warrants caution when working with scavenger species.

### Impacts of Complex Mixtures Including Endocrine Disruptors and Metals

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Complex mixtures of environmental chemicals pose an ongoing risk to wildlife. Birds may be exposed to a spectrum of these environmental chemicals, including endocrine disrupting chemicals (EDCs) as well as legacy chemicals as they migrate and reside in a variety of ecosystems. Exposure to complex mixtures have the potential for short-term toxicity and long-term impaired physiological function; and may also coincide with exposure to metals, thereby potentially exacerbating deleterious effects of the environmental chemicals. Vulnerability to chemical exposure varies with species and life stage. Birds provide unique clades of organisms that reflect both regional and global health, particularly the migratory populations. Moreover, effects of EDCs may not correspond to risk as assessed by toxic equivalents. This presentation will describe responses of birds, at individual and population levels, to anthropogenic stressors, particularly exposure to complex mixtures associated with industry and urbanization pressures as well as in the context of impacts of habitat loss and climate. Metrics of health will be considered as key indices for ascertaining the health of avian populations; these metrics will be considered in the context of Adverse Outcomes Pathways. We will also discuss the availability of retrospective data to ascertain changes over long time periods and for development of a predictive tool for managers.

### Using Individual Animal Movements to Aid Global Conservation: a Case Study of Red-footed Falcon (*Falco vespertinus*)

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Red-footed Falcons are long-range trans-equatorial migrants wintering in southern Africa. The conservation of the species is identified as a priority, however conservation planning is highly challenging due to its high mobility. These falcons utilize communal roosts in the non-breeding season, thus making a considerable proportion of the population vulnerable to localized threatening factors. One of the key components of Red-footed Falcon conservation is to identify the location of roosts throughout the distribution range. Here we show how individual movement patterns of 28 satellite-tagged birds (5g PTTs, Microwave Ltd.), sampled across the world breeding population (Italy, Hungary, Romania, Russia and Kazakhstan) helped identify a total of 915 potential night roost sites. We used the data of the tracked individuals to classify potential conservation hot-spots and to establish and alert an international network to assess local/regional threatening factors. Our results indicate that there are three global hot-spot regions; a) Black Sea coastal area in fall; b) Central Angola in winter; and c) West-Africa in spring. The pattern of movement data indicated that in March, before the onset of spring migration, the population connectivity might drastically weaken compared to the distribution previously detected in the wintering grounds. Individual tracking data suggested a conservation bottleneck in Angola, where the majority of tracked birds potentially roosted in a confined area, regardless of their breeding origin. The group of researchers visiting the area made an amazing discovery, far beyond their hopes.

### Differential Migration in Rough-legged Hawks (*Buteo lagopus*)

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Migration is ubiquitous in animals, but we know surprisingly little about the mechanisms that govern migratory decisions. For example, many birds have differential migration whereby one sex migrates longer distances than the other. Sex-specific migration behavior is common in birds, but the underlying causes remain a topic of continued debate. In North American Rough-legged



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Hawks, adult females winter at higher latitudes than adult males (i.e., males migrate longer distances), a pattern that is opposite of what occurs in most other birds. Although multiple hypotheses have been proposed to explain this particular pattern, the mechanism(s) responsible for sex-specific differential migration are not known. To determine the mechanism(s) underlying sex-specific differential migration in the Rough-legged Hawk, we used a Net Squared Displacement (NSD) approach to calculate a suite of migration statistics for 50 adult hawks that completed  $\geq 1$  migratory trips between wintering and breeding ranges. We trapped and deployed GPS transmitters on hawks on the wintering and breeding grounds, and during migration, primarily in western North America. We sexed adult hawks based on a combination of morphometric measurements, plumage details, and movement behavior on the breeding grounds. We describe the patterns of sex-specific differential migration observed in North American Rough-legged Hawks and propose a suite of mechanistic hypotheses to explain the underlying cause of these patterns.

### **Does this Radio Transmitter Make Me Look Delicious? A Field-informed Agent-based Modeling Approach to Understanding Transmitter Impacts on Raptor Selection of Prey**

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Radio telemetry is a widespread and important tool in wildlife research, and is often used to investigate cause-specific survival of prey species. Although the potential negative influences of attaching radio transmitters to volant species has been questioned, we found no experimental study of predatory selection of transmitted birds. We investigated the potential impacts of transmitters on a selection of Northern Bobwhite (*Colinus virginianus*) by trained Harris's Hawks (*Parabuteo unicinctus*). The hawks pursued quail in paired trials in which one quail was fitted with a transmitter and the other was not. We observed the Harris's Hawk pursue quail fitted with transmitters in 64% of the trials ( $n = 53$ ). Based on a conditional logistic regression model, we found no evidence of influence of quail age or sex, wind speed, trial number, or left- or right-side placement of quail in left or right release boxes on raptor selection of the quail. However, we found presence of transmitter attachment on the quail to increase the likelihood of selection by a hawk ( $P \leq 0.026$ ). We then used an agent-based modeling approach to investigate population impacts of increases in the rate of selection of quail by hawks. We found depredation of transmitted individuals in a simulated local population of quail increased by 3% as selection for quail with transmitters increased from 50% to 64% to 80%.

Additionally, numbers of hawks in simulations interacted with the rate of selection for quail with transmitters, with greater numbers of hawks increasing the rate of predation on transmitted quail as transmitter selection rates increase. Our model, informed by a field study with trained raptors, indicates a potential bias of cause-specific mortality reports for Northern Bobwhite in telemetry-based research.

### **Prey Selection by Accipiters During Migration Using DNA Barcoding**

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Diet analysis of birds of prey has been an interesting field of study since a long time ago. Various methods including prey remains, pellet analysis, video recording, and gut content analysis have been done over time. Although many factors influence prey selection, it's been logistically challenging to collect more information on prey identity. Most of the studies have been conducted during the breeding period. However, almost 60% of the birds migrate between their breeding and wintering ground every year that is an essential part of their life cycle. This migration allows birds to track the food resources and favorable conditions, and yet not many studies have been performed on prey selection during migration. Hence, I am interested in using DNA barcoding technique to assess the prey selection by migratory hawks. There is high energy demands during migration, so would that affect the prey selection? In this study, I compare the genetic sequences from prey feathers or remains trapped in the talons or beaks of hawks banded at Cape May banding station to reference samples from GenBank to determine prey eaten. I am focusing mainly on Sharp-shinned Hawks (*Accipiter striatus*) and Cooper's Hawks (*Accipiter cooperii*) mainly because of the high number that migrate along the East Coast. As per the preliminary results, European Starlings (*Sturnus vulgaris*) and Rock Pigeons (*Columba livia*) have been identified as the most common prey of Cooper's Hawks, while American Robins (*Turdus migratorius*) seem numerous in the diet of Sharp-shinned Hawks. In addition, I will be comparing data of prey availability in the region with the prey selected by the hawks during migration. Despite the challenges, this tool can be very valuable in gaining insights on feeding ecology of these migratory hawks.

### **Alternative Habitat Use Techniques of Common Kestrels (*Falco tinnunculus*) in Two Habitat Types**

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Bird of prey species can apply different habitat use strategies, adapting to conditions and available prey species in different habitats. We have been studying breeding male Common Kestrels' habitat use in two different habitats in Hungary by analyzing satellite-tracking results and nest box occupancy. Results show that birds tagged in grassland habitat used the area more evenly than those tagged in an intensive agricultural area; however, they may not even breed in years of shortage of prey. Grassland kestrels used less area than those in an agricultural area in year of abundant prey. Kestrels nesting in an agricultural area had larger territories and used them unevenly, always exploiting the most abundant prey source, and nest occupancy did not change much through the years. We hypothesize that grassland kestrels take advantage of abundance of prey in good years, however their breeding success is lower in bad years. Kestrels in agricultural areas at the same time have less abundant, but relatively constant, prey supply they can rely on. Thus, their breeding success does not change through the years. The project is going to be continued in the coming years to support or contradict the hypothesis.

### Differences in Migration Patterns of Central and East European and East Asian Meta-populations of Saker Falcons (*Falco cherrug*)

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Saker Falcon is a Eurasian, partial migratory species with large distribution range, of which individuals show a wide range of migration patterns from being sedentary to being long distance migrants. Despite several satellite-tracking studies of this species across its distribution range in recent years, migratory behavior of various meta-populations has not yet been fully described. We analyzed satellite tracking data of 90 juveniles (1cy) and 54 adult (breeder) Saker Falcons tagged in Central and Eastern Europe, and in East Asia between 2007 and 2019. We compared migration timing, distance, course and position of wintering areas (WA) to temporary settlement areas (TSA) or eyries before the start of migration. Results suggest different migration strategies of European and East Asian Saker Falcons. All tracked juveniles started

migration both in Europe and Asia; however, the migration distance varied from <100 km to >3000 km. European juvenile sakers migrated in a southwest direction (210° on average) regardless of the position of the last TSA before migration, showing a comb-like parallel pattern across Europe. Juveniles tagged in Asia showed a funnel-shaped migration pattern towards the Tibetan Plateau. Satellite tracking data suggest that the Altai Mountains – shared by Russia, Mongolia, China and Kazakhstan – divide the different migration patterns. Females of the European population tended to migrate farther, and only females crossed the Mediterranean Sea. We did not find a sex-specific migration pattern in the Asian population. Adult sakers migrated partially in both populations: some did not migrate, some migrated relatively short distances. Some sakers showed the classical long-distance migration pattern every year, whereas others did not migrate every year, possibly depending on availability or access to prey. Migrating adults used the same WAs in subsequent years.

### Lead Exposure in Southern Californian Turkey Vultures (*Cathartes aura*) Before Full Implementation of the 2019 Lead Ammunition Ban

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The consumption of spent lead ammunition in carcasses is an important source of lead for obligate and facultative scavenging raptors. The state of California announced a program aimed to eliminate lead ammunition by requiring the use of non-lead ammunition for hunting game species by 2019. Concerns exist about compliance to this program and how this prohibition will be monitored. The use of Turkey Vultures as sentinels may be a convenient strategy to assess compliance and the reduction in the risk of lead exposure to wildlife. Comparing prevalence of acute exposure to lead and their levels in Turkey Vultures before and after the banning will help to assess effectivity and compliance. Between 2016 and 2017 we investigated 108 turkey vultures >6 mo old to determine blood lead concentration and prevalence of exposure in southern California using the LeadCare® II Blood Lead Analyzer. Out of 108 Turkey Vultures tested, 51 (48%) showed evidence of lead exposure in blood samples. Of the 51 exposed, blood lead concentrations ranged from 3.3 to 33 mg/dL, with an average of 8.4 ug/dL. Southern California vultures appear to have a high prevalence of acute lead exposure. We anticipate a significant decrease in the prevalence of lead blood levels and changes in the source of this element in Turkey Vultures if the ban on lead ammunition is effective.





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### California Condor Nest Management in Southern California

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The California Condor (*Gymnogyps californianus*) was first reintroduced to southern California in 1996 after a period of extinction in the wild. Reintroduction of this cathartid vulture has continued in this and other parts of the former range, and the world population today nears 500, with over 60% of the birds flying free. However, none of the populations are yet self-sustaining. Lead poisoning remains the most significant mortality factor for all wild flocks, and population growth is maintained through release of captive-bred individuals and intensive management of each flock. Low nest success, largely due to anthropogenic factors, including microtrash ingestion, had also been a limiting factor of the southern California population's growth since the onset of breeding in 2002. In response, the Santa Barbara Zoo and United States Fish and Wildlife Service initiated a formalized nest management program in 2007. A two-pronged approach of monitoring and intervention has facilitated adaptive management while increasing nest success. Here we present the methodology and results of 12 yrs of systematic nest management in this population, including an increase in apparent nest success from a 2002-2006 mean of 6.5-12% to a program mean of 53% (2007-2018), above that of the historic and recent historic populations.

### Development of an Inexpensive Motion-Activated Camera to Document Prey Delivery to Nest Boxes

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Visually documenting prey delivery to avian nest boxes can be challenging as human presence can alter behavior of the birds. Utilizing commercial motion-activated wildlife cameras can be costly as well as ineffective as trigger-rates

are often too slow to capture footage of the bird before it has entered the nest box. We have developed an inexpensive motion-activated camera that can be programmed to save footage from before a motion event, thus capturing footage before the bird enters or perches on a nest box, allowing us to identify prey items being brought to the nest. The cameras were built using Raspberry Pi Zero Headless Boards and compatible video camera modules and were programmed using Python. The cameras were utilized during the 2019 breeding season by an American Kestrel (*Falco sparverius*) Nest Box Program and a Barn Owl (*Tyto alba*) Nest Box Program in the central valley of California to monitor prey deliveries to the nestlings. We compared the image quality, trigger rate, and cost of this new camera with different commercial motion-activated wildlife cameras at different price points. We have detailed the process of assembling and programming the cameras, the success of the diurnal and nocturnal field trials and the comparisons with other field cameras.

### Differences in Breeding and Nonbreeding Red-tailed Hawk Home Range Size Throughout the Breeding Season

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Breeding and nonbreeding raptors likely use space very differently throughout the breeding season. We used GPS transmitter location data to assess the breeding season home range size of breeding and nonbreeding Red-tailed Hawks (*Buteo jamaicensis*). For breeding Red-tailed Hawks, we further refined the analysis of home range sizes to the early-, mid-, and late-breeding season. We found two types of nonbreeding Red-tailed Hawks: migrant and resident nonbreeders. Breeders reported significantly smaller breeding season home ranges than both migrant and resident nonbreeders. Breeders had the largest home range during the late-breeding season period, which corresponded with the fledgling and post fledgling periods. Although no differences were detected in the early-, mid-, or late-breeding season home ranges of resident or migrant nonbreeders, they both demonstrated a pattern of decreasing home range size throughout the breeding season. These reported differences among breeding and nonbreeding Red-tailed Hawks encourage future research concerning movement strategies of nonbreeders, differences in space-use, habitat selection, and their role in ensuring population stability.



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### Effects of Prey Super Abundance on Intraspecific Behavior in Eastern Red-Tailed Hawks (*Buteo jamaicensis borealis*)

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I will study the intraspecific behavior of Red-tailed Hawks (*Buteo jamaicensis*) in a super abundant prey area close to Cornell University's campus while concurrently developing a morphometric pattern for determining sex of the eastern Red-tailed Hawk. The location will be Reynolds Game Farm, New York's only pheasant production facility. It stocks 4,750 birds in the beginning of the season. According to the New York State DEC (NYSDEC), who owns and operates the farm, there are 500 pheasants killed by Red-tailed Hawks every year. The Reynolds Game Farm presents an area of prey super abundance throughout the year which leads to an interesting, unnatural lab setting for a behavioral study. During initial observations, as many as 65 Red-tailed Hawks have been sighted in the vicinity of the Game Farm at one time, making this location potentially important for the regional population of Red-tailed Hawks. The NYSDEC is interested in collaborating on this project. The main goals are to determine: 1) if kleptoparasitism occurs between Red-tailed Hawks, 2) if there is a dominance hierarchy between hawk age- and sex-classes, and 3) if the Red-tailed Hawks foraging at this location are resident, migrating, or dispersing. While banding and marking these Red-tailed Hawks, we will also take necessary morphometric measurements to determine the sex without performing DNA analysis.

### Changes in Distributions and Habitat Associations of Bald Eagles and Osprey During Their Recovery, 1970-2017

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Habitat associations of a recovered species may not mirror associations when population numbers are much lower. New occurrence predictions rely heavily on the current distribution, however the flexibility of recovering populations may create a mismatch between modeling distributions and new occurrences. We examined Bald Eagle (*Haliaeetus leucocephalus*) and Osprey (*Pandion haliaetus*) habitat associations from their near extinction to their successful recovery and attempted to predict new occurrence events based on distributions. We documented all occurrences of both species from 1970-2017 from 3693 North American Breeding Bird Survey routes. We calculated the percent landcover type and January Minimum Temperature within a 19.7 km radius of

the center of each route. We also calculated the distance from conspecific and heterospecific source populations in the previous decade. We constructed single-species logistic regressions to predict distributions and new occupancies in each decade and evaluated model accuracy using Area Under the Curve (AUC). We predicted distributions for Bald Eagles and Osprey for each decade of recovery with a minimum accuracy of 85%. Our prediction accuracy for new occupancies each decade beginning in 1980 declined from 94% to 74% for Bald Eagles and from 88% to 78% for Osprey. From 1980 to 2017 we found habitat use shifted, as Bald Eagles (95% CI= [0.5, 3.09]) and Osprey (95% CI= [0.2, 1.53]) both colonized routes with less water. Despite the high accuracy of our species distribution models, we were unable to predict newly occupied routes accurately. This indicates that the ability to predict new occurrences is largely independent of the ability to predict distributions. We suggest that the reduction in accuracy of our models over time reflects broadening habitat associations for both Bald Eagles and Osprey. Our results demonstrate the mismatch between distributions and new occurrences and highlights the flexibility of recovering populations.

### Webcams as an Untapped Opportunity to Conduct Citizen Science: Six Years of the American Kestrel Partnership's KestrelCam

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Hundreds of zoo-based or wildlife webcams have become available during the past twenty years, mostly with the goal of educating the public. However, there has been virtually no peer-reviewed research that evaluates the education, conservation, or scientific impact of webcams. Here, we provide one of the few examples of a webcam used for citizen science, and the only test of efficacy for crowd-sourced data collection using webcams. The Peregrine Fund streamed six seasons of American Kestrel (*Falco sparverius*) nests using the same nest box from 2012 through 2017 and viewers input observations into an online portal. We analyze trends in participant and kestrel behavior and test for sources of bias in this citizen scientist-generated dataset by independently reviewing a subset of recordings to determine accuracy of viewer-logged data. Citizen scientists logged a maximum of approximately 5.25% of all footage, but with an accuracy of 88%. Although number of participants declined yearly, on average, participants became more engaged. Sources of bias were related to people's daily activity periods (i.e., less participation at night) and activity within the nest box (i.e., less participation when there were no birds in the box). This citizen scientist-generated dataset generally corroborated the literature regarding American Kestrel



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biology. Researchers may be cautiously optimistic that datasets generated by citizen scientists can provide valuable information on a given system or study species. Given the ubiquity of webcams and their potential competition for conservation dollars, more research evaluating any aspect of their impact or application is sorely needed.

### Overview of Raptor Populations Declines and Conservation Intervention in Botswana

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In the face of habitat loss and poisonings raptor populations have suffered massive declines. Human wildlife conflict and poaching have been the main drivers of large mortalities of raptors, especially vultures. Until recently, raptor population monitoring and research on this topic has been rare, resulting in a limited understanding of the extinction risks faced by raptors. Raptors Botswana conducted road and nests surveys to determine population trends and breeding success of some raptors in Botswana. Some vultures were fitted with transmitters to understand their ranging patterns. Almost all raptors showed drastic declines in the last 20 years and breeding success of some vulture species was very low. High mortality of adult vultures and bone deformities of cape vulture fledglings were some of the key factors leading to low breeding success. Campaigns on strict agrochemicals legislation, education and awareness, promotion of alternative human wildlife conflict mitigation strategies, establishment of poison response teams and reinforcing anti-poaching effort are key intervention tactics to address the extinction risks faced by raptors. All stakeholders are needed to pull resources together and help the vanishing raptor populations.

### Effects of Wildfire and Forest Restoration on Northern Goshawks in Northeast Washington

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Forest managers in the fire-prone landscapes of western North America are faced with a management conundrum in balancing wildfire risk reduction with conservation of habitat for forest wildlife. The Colville Northern Goshawk Project was initiated in June 2016 to provide information that can help land managers develop silvicultural and landscape management approaches that balance multiple resource objectives. Our project is focused on the Kettle

Range and adjacent portions of the Colville National Forest in northeastern Washington State. This area has experienced a variety of landscape disturbances over the last 20 years, including approximately 21,100 ha of timber harvest, 38,500 ha of fire risk reduction activities (e.g. controlled burns), and 6 large wildfires that impacted approximately 48,000 ha. Our project has three components: 1) Distribution: We have conducted systematic landscape-scale call surveys for breeding goshawks to quantify the distribution of breeding territories in relation to past disturbances. 2) Genetics: We have collected found genetic material (primarily molted feathers) from breeding territories for genotyping to evaluate relatedness between individuals and individual persistence at territories. 3) Movement: We have deployed solar-powered GPS location logging-telemetry tags on 23 goshawks (15 females and 8 males) to quantify space use and movement related to forest structure and past disturbance. Since 2016 we have conducted systematic surveys for breeding goshawks across approximately 26,400 ha, submitted over 700 genetic material samples to the USFS National Genomics Center for Wildlife and Fish Conservation resulting in the identification of 126 individual goshawks, and we have recorded over 60,000 GPS telemetry locations from 23 goshawks (15 females and eight males) for analyzing habitat selection and foraging movement patterns. This presentation will provide a project update and summary of preliminary findings through August 2019.

### Migration, Home Range Size, and Habitat Selection of Breeding and Wintering Female Northern Harriers (*Circus hudsonius*) in Suisun Marsh, California

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Northern Harriers are a ubiquitous raptor species found across wetland and grassland habitats in North America. Harriers are declining across much of their range and surprisingly little is known about their movement ecology and habitat selection. In California, over 90% of wetland and grassland habitats have been lost due to conversion to agriculture and development. In Suisun Marsh (hereafter Suisun), suitable marsh habitat is additionally threatened by invasive plant species and rising tides. Because Suisun is the largest contiguous brackish water marsh on the west coast and supports large populations of Harriers, determining home range size and habitat selection in this area is important to informing Harrier management. We deployed GPS-GSM backpack transmitters on adult



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wintering (n=20) and adult breeding females (n=10) in Suisun in 2018 and 2019 (January–July). Wintering females migrated to breeding areas across five western states. Home range sizes were comparable to home ranges of breeding females in Suisun, but habitat selection varied, with females selecting a mix of agricultural and marsh habitat. One female migrated 20,953 km (round-trip) breeding north of the Arctic Circle in Alaska before returning to Suisun, making this the longest distance migration documented for a Harrier. Wintering females returned to Suisun, showing targeted selection of flooded marsh and undisturbed grassland habitats. Females breeding in Suisun revealed an average home range size of 5.58 km<sup>2</sup> (99% KDE, n=3, 2018); selected dry managed marsh, tidal marsh and grassland habitats; and remained in their general home ranges year round. These results reveal the presence of both resident and migratory populations in Suisun, important migration corridors through the Sacramento Valley, wintering site fidelity in Suisun, and demonstrate targeted selection of remnant marsh, agricultural and grassland habitat for both breeding areas, wintering areas, as well as stopover locations during migration.

### Interspecies Nest-Placement Tolerance and Niche Partitioning of Nesting Riparian Raptors in the Trans-Pecos Region of Texas

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Riparian woodlands in desert landscapes are important areas for wildlife conservation. Three raptors, the Common Black Hawk (*Buteogallus anthracinus*), Gray Hawk (*Buteo plagiatus*), and Zone-tailed Hawk (*Buteo albonotatus*) are state listed as threatened in Texas and are riparian zone obligate or semi-obligate species. Other raptor species, such as the Cooper's Hawk (*Accipiter cooperii*) and Swainson's Hawk (*Buteo swainsoni*) may also occupy riparian zones. As top trophic level predators with different food habits, this group of species may serve as indicators of biological community health of riparian zones. However, little information is available as to 1) their presence and distribution in the Trans Pecos region of Texas, 2) nearest neighbor distances, and 3) comparative nesting habitat selection in riparian systems. We surveyed for nesting raptors in accessible riparian systems across Jeff Davis, Brewster, and Presidio Counties, Texas during 2018 and 2019 breeding season. This included a total of ~30 linear kilometers of riparian zones searched across 12 sampling areas. We determined nesting attempts by 10 Common Black Hawk pairs, nine Cooper's Hawk pairs, 14

Gray Hawk pairs, and 26 Zone-tailed Hawk pairs. We conducted vegetation surveys to quantify nest tree and riparian site characteristics at each nest site. Preliminary data from 2018 suggests Zone-tailed Hawks selected for nest trees with a greater dbh compared to both Cooper's Hawks and Gray Hawks. Zone-tailed Hawks also placed nests significantly higher in trees than both Cooper's Hawks and Gray Hawks, with Zone-tailed Hawk nest placement being consistently along riparian corridor edges. Our preliminary data suggest nesting habitat partitioning among raptor species within the same riparian woodland areas. We will present final data analysis after including the ongoing data collection from 2019.

### Ecological Correlates of Lead Exposure of Facultative and Obligate Avian Scavengers in Eastern North America

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Lead poisoning of scavenging birds is a global issue. However, the drivers of lead exposure for avian scavengers have been studied from the perspective of individual species, not cross-taxa assemblages. We analyzed blood (n = 285) and liver (n = 226) lead concentrations from a community of 6 facultative and 2 obligate avian scavenger species in eastern North America to identify ecological correlates of tissue lead concentrations that might provide insight into assemblage-wide patterns of exposure. Preliminary results suggested species and individual age were significant ( $\alpha < 0.05$ ) predictors of blood lead concentrations of facultative scavengers, and species, but not age, were significant predictors of liver lead concentrations. Facultative avian scavengers exhibited higher blood and liver lead concentrations during the fall and winter months than during spring and summer (blood: winter median = 12.93 µg/dL vs 4.40 µg/dL in summer,  $p = < 0.001$ ; liver: winter median = 4.25 ppm vs 0.32 ppm in summer,  $p = < 0.001$ ). Likewise, during summer months, obligate scavengers had substantially higher liver lead concentrations than did





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facultative scavengers (median = 1.76 ppm vs 0.22 ppm;  $p = < 0.001$ ). These data suggest that feeding ecology of avian scavengers is tightly tied to the degree to which they are exposed to lead and also highlights the importance of ecological and behavioral variation in determining lead exposure. This work suggests that species- and season-specific variation in foraging behavior may predict broad-scale and assemblage-wide patterns in relative lead exposure of avian scavengers.

### Use of Camera Traps to Describe Eagle Behavioral Patterns at Roadkill in the Western United States

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Eagle species in North America regularly scavenge on roadkill during fall and winter months, putting them at greater risk of vehicle strikes themselves. As part of a larger “eagle vehicle strike” study in Oregon, Utah, and Wyoming, we successfully deployed motion-sensitive cameras 209 times for an average of 18.3 days/deployment over 3 fall and winter seasons (Oct 2016–Mar 2019) to investigate eagle use of roadkill carcasses. Cameras were deployed near carcasses of 13 mammal species, ranging in size from cottontail (*Sylvilagus* spp.) to elk (*Cervus canadensis*), but deer (*Odocoileus* spp.) accounted for 73.6% of deployments. The majority (58.2%) of carcasses receiving camera traps were within 4 meters of the road (range 0–25 meters). Overall, 43.1% of camera deployments captured one or more eagles feeding on carcasses, and we captured 2.03 million pictures including 91,461 eagle photos (4.5% of all pictures). A final review of all eagle photos will be completed prior to the conference and will allow us to characterize eagle flushing responses to passing vehicles, with the ultimate goal of providing recommendations for safe roadside carcass relocation. We will also summarize eagle behavior at carcasses, including seasonal and diurnal patterns of carcass use, factors influencing length of foraging bouts, and interactions between eagles and other scavengers. Finally, we will provide camera deployment recommendations based on camera failures, issues, and thefts experienced during this study.

### Ancient Splinting Techniques: A Modern Solution to Minimizing Invasive Veterinary Care in Raptors

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Surgical installation of external fixators to repair a raptor’s broken leg or wing bones, although warranted in some cases, has several notable drawbacks. The surgery itself is risky due to a raptor’s heightened sensitivity to general

anesthesia. Penetrating the skin, muscle, and bone can introduce infection despite the best of precautions, and can require daily handling of the bird to clean the surgery site. Lastly, the surgery lengthens the healing process, requiring a longer period of reduced mobility which can greatly stress even captive raptors, and much more so wild raptors that have come into a wildlife rehabilitation center. A splinting technique, developed by falconers over thousands of years, perfected by Morley Nelson and further honed by Jerry Ostwinkle (founder of the Arizona Raptor Center), is a minimalist procedure that produces excellent results in terms of rapid, quality healing in the affected bone and reduced stress for the raptor, all accomplished with nominal financial expenditures.

### Resource Use of Apex Raptors: Implications for Siting Energy Development in Sagebrush Steppe and Prairie Ecosystems

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There is an urgent need to understand ecological responses of avian species to the rapidly expanding human footprint of conventional and renewable energy development in sagebrush steppe and prairie ecosystems. The Ferruginous Hawk (*Buteo regalis*) and Golden Eagle (*Aquila chrysaetos*) are two such avian species of conservation concern in Wyoming, an area that represents the most intact sagebrush steppe region remaining in North America. To understand these species’ use of habitat relative to energy development, we built resource selection functions using a spatially representative sample of occupied nesting territories collected in 2010–2011 and remotely sensed environmental variables across an extensive study area (186,693 km<sup>2</sup>). We used the resulting resource selection maps to evaluate spatial overlap between the nesting habitats of these sympatric raptor species, as well as overlap of predicted habitat with potential development of oil/gas and wind energy resources. Remotely sensed variables were very effective in modeling patterns of nest-site selection based on five-fold cross validation ( $>0.93$  Spearman-rank correlation) and validation with an independent dataset of nests collected from 2000–2009. Topographic roughness and intermediate levels of spring precipitation were the strongest drivers of differences in habitat use between Ferruginous Hawks and Golden Eagles. We did not detect a strong signal of avoidance of energy infrastructure by



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either species at current levels of development, and both nested closer than expected to gravel/dirt roads associated with oil and gas infrastructure. However, extensive overlap of nesting habitat most selected by Ferruginous Hawks and Golden Eagles with areas of actual and potential energy development suggest both species will be exposed to future development. We suggest rigorous monitoring of long-term trends in occupancy, productivity, and distribution is warranted for populations of Ferruginous Hawk and Golden Eagle exposed to energy development.

### Climatic Constraints on Laggar Falcon Distribution Predicts Multi-directional Range Shifts Under Future Climate Change Scenarios

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Determining a species geographic range is important for conservation planning, yet this information is lacking for many raptors. In rapidly changing environments, defining current and predicting future distributions can define priority areas for monitoring and research. The Laggar Falcon (*Falco jugger*) is a rare and under-studied raptor resident across the Indian sub-continent, categorized as Near-Threatened, with populations potentially in rapid decline. Using a Species Distribution Modelling framework, we update current distribution and predict future distribution based on two future climate change scenarios for 2050. Our current distribution model had high predictive accuracy, and defined core areas of high climatic suitability in western India and south-east Pakistan. Three bioclimatic variables contributed 79.83% to model prediction: mean temperature of the wettest quarter (50.08%), precipitation seasonality (17.56%), and precipitation in the driest month (12.19%). Projecting our model into a lower emissions climate change scenario for 2050 resulted in up to 6% mean gain in suitable climate space, but a 5% mean loss in suitable climate by 2050 in a high emissions scenario. All future predictive models showed similar multi-directional range movements within the current predicted core range. Based on these results, Laggar Falcon distribution may not be adversely affected by climate change. We recommend directed population surveys and monitoring based on current model predictions to areas of highest climate suitability, which are likely where Laggar Falcons will persist into the near future. Regular monitoring and research will enhance our knowledge for this raptor, whilst contributing further data to improve our model predictions.

### Using Autonomous Recording Units to Survey for Forest Raptors Over Large Areas: A Safer, More Effective Method

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Conventional surveys and monitoring of forest raptors generally relies on conspecific call-back surveys. For species such as Northern Goshawks (*Accipiter gentilis*), these surveys are typically conducted late in the nestling and/or fledgling periods, which generally precludes documenting occupancy in inactive or failed territories. Nighttime call-back surveys for forest owls can be hazardous for field personnel, particularly when conducted with over-snow travel. Alternative occupancy surveys, like pre-dawn acoustical surveys, are highly effective but generally prohibitive over large expanses. We have been testing and using SoundScout automated recording units to document occupancy of sensitive forest raptors in western Wyoming for the past four years. We have documented a nearly 100% detection probability of Great Gray Owls (*Strix nebulosa*) using this method, compared to a 60% occupancy rate using callback surveys. We are currently testing the effectiveness of recorders at various nesting stages to callback surveys for Northern Goshawks. We have developed protocols to simultaneously survey for Northern Goshawks, Great Gray Owls, Boreal Owls (*Aegolius funereus*), Northern Pygmy Owls (*Glaucidium californicum*), and Northern Saw-whet Owls (*Aegolius acadicus*). We also have used recorders to successfully survey for Flammulated Owls (*Psiloscops flammeolus*). In addition to using recorders at known territories to document occupancy, we have conducted 258 recorder deployments to annually survey 36.8 km<sup>2</sup> of proposed forest treatment areas in western Wyoming from 2016-2019. We have found that recorders offer a safer, cost-effective, and more accurate survey method for forest raptors over large landscapes. We suggest that use of recording devices become standard protocol for surveying forest raptor species, such as Northern Goshawks, Great Gray Owls, and Flammulated Owls.

### Year-round Northern Saw-whet Owl Movements Through a Banding Station in Central Alberta, Canada

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The year-round movements of Northern Saw-whet Owls (*Aegolius acadicus*) was investigated at a banding station



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in central Alberta, Canada. Mist nets with audio-lures have been set in the fall (September to early December) since 2014 near Ministik, Alberta (53°22.78'N, 112°55.47'W). We have captured between 85 and 273 Northern Saw-whet Owls each fall. Nets have not been run at other times of the year. Spring migration has been documented in the Great Lakes region in May and June, and juvenile dispersal has been observed in eastern parts of their range. In fall 2015, we began netting in September and continued to run through one full year to determine if a spring migration of returning owls or a summer movement of young was occurring. Through the winter only a couple of owls were captured; however, in spring 2016 we captured 38 Northern Saw-whet Owls between 25 February and 4 May. We found summer movements of 32 hatch-year owls still in juvenal plumage from 4 July to 11 August 2016. In 2017, we captured 10 Northern Saw-whet Owls between 13 February and 27 March and 14 between 15 February and 02 April, 2019. We will also present results collected in summer and fall 2019. The evidence found to date suggests that Northern Saw-whet Owls in Alberta are partial migrants, showing some true migration, some nomadism, and some year-round residency.

### Immunity and Sub-Lethal Lead Exposure in Golden Eagles Nestlings

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Lead exposure remains a threat to many avian species across the United States with numerous studies documenting direct mortality from acute lead poisoning. In cases of high lead levels, linking exposure to direct mortality may be straight forward; however, the effects of chronic or low-level exposure are much more difficult to assess and can have numerous physiological consequences. We sampled nestlings under the premise that immunological development may be impaired in nestlings exposed to lead with the potential for life-long implications. In addition to immunosuppression, lead exposure has been shown to disrupt neurological and reproductive function, cause organ damage, and result in muscular paralysis. Here we examine the potential sub-lethal effects of lead exposure on the immune system of Golden Eagle (*Aquila chrysaetos*) nestlings. Blood samples were obtained from nestlings (n=96) across northern

California, central Oregon, and southwest Idaho in 2015. Samples were used for lead analysis and to quantify measures of constitutive immunity (bacterial killing ability and hemolytic-complement activity assays). Preliminary results suggest that individuals with blood lead levels of 0.03 [g/g and above, a level expected to cause physiological impairment in lead-sensitive species, had lower hemolytic-complement activity than individuals with levels below this threshold. Our results will enhance our understanding of non-lethal exposure to environmental toxicants—a poorly understood issue.

### Perspectives on Conservation: A Survey of North American Falconers Association Members

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Conservation succeeds through participation. Raptor conservation is no different and necessitates the inclusion of perspectives from multiple stakeholder groups. Falconers represent stakeholders with consistent and direct experience with raptor ecology and natural history. As such, their perspectives on conservation policy and practice are imperative. Here, we present results from the 2018 North American Falconers Association (NAFA) Conservation Committee Survey. The purpose of this study was to identify conservation priorities and preferences among NAFA members. In December 2018, a web-based survey, using the NAFA membership directory as a sampling frame (n = 2,587), was implemented to assess members' perspectives and perceptions on raptor, habitat, and prey species conservation. A total of 443 completed questionnaires were returned (17.1% response rate). Of respondents, 65.9% were aged 55 or older; 84.4% were male; and the largest proportion of respondents (23.1%) were from the intermountain west region of the U.S. In terms of respondents' perspective on what conservation is, 90% indicated that conservation is both managing species and habitat. Habitat conservation was prioritized above raptor and prey species conservation, with 82.3% of respondents indicating this was their most important conservation concern. In this regard, respondents indicate they perceived prairie (94.4%), wetland (88.1%), small pond (76.2%), and forest (73.7%) habitat as being in decline. Interestingly, most respondents indicate they were perceiving declines in hunting land access, which may relate to perceptions of declining habitat. Falconry practice, regional, sociodemographic differences were apparent and will also be presented. Overall, this study presents a diversity of perspectives on raptor, habitat, and prey species conservation among an important stakeholder group to forward raptor conservation discussions and actions. Moreover, this study (and similar others) allow leadership the ability to understand what is



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important for their members and how to guide conservation for the stakeholder group.

### Comparing Management Programs to Reduce Red-tailed Hawk–Aircraft Collisions at O’Hare International Airport

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Wildlife–aircraft collisions (wildlife strikes) pose a serious safety risk to aircraft. Raptors (i.e., hawks and owls) are one of the most frequently struck guilds of birds within North America. Although raptors [most notably red-tailed hawks (*Buteo jamaicensis*)] are commonly managed at most airports and military bases, there is no scientifically valid information available regarding comparisons of the efficacy of raptor management programs for reducing raptor–aircraft collisions. Therefore, we conducted a study to examine the efficacy of 2 integrated wildlife damage management programs implemented at Chicago’s O’Hare International Airport (ORD). The first raptor management program occurred during August 2010 – June 2013 (Phase I) and was characterized by intensive and sustained live-trapping and translocation efforts. The second raptor management program occurred during July 2013 – November 2016 (Phase II) and involved live-trapping and translocation of specific age classes and increased levels of lethal control. Compared to Phase I, there were 37% fewer red-tailed hawk strikes (41 in Phase I and 26 in Phase II) and 67% fewer damaging red-tailed hawk strikes (6 in Phase I and 2 in Phase II) during Phase II. Our findings demonstrate that airport wildlife management decisions based on scientific data and biological information can aid in reducing wildlife strikes, financial losses, and ultimately airport liability while increasing human safety. The decision matrix regarding the components of an airport raptor management program involves a variety of biological, geographic, logistical, economic, and socio-political variables. This study represents an important scientific foundation for informing such management decisions.

### Flight Characteristics of Migrating Swainson’s Hawks Across a Variable Landscape: Swainson’s Hawk Migration

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Swainson’s Hawks (*Buteo swainsoni*) are migratory raptors that travel between western North America and Argentina annually. Our current knowledge of Swainson’s Hawk migration comes from on-the-ground observations, band recovery efforts, and satellite telemetry. We equipped 24 adult Swainson’s Hawks with solar-powered GPS Platform Transmitter Terminals to explore migration characteristics, use high resolution location data to evaluate long-suspected behaviors, and describe novel information about this species. We used terrain and wind characteristics to explore patterns of location, time, speed, and flight height to address eight a-priori questions. The migratory corridor is a mixture of rainforest, grasslands, and croplands, with a variety of topographic regions. Average velocity of migrating hawks was  $13.6 \pm 17.6 \text{ kmh}^{-1}$ , with a maximum of  $120.7 \text{ kmh}^{-1}$ . Average flight height was  $244 \pm 431 \text{ m}$  above ground, with a maximum of 9749 m. Birds were able to achieve high speeds at high altitudes, though most high speeds occurred below 2000 m above ground. Speed and height data indicated a diurnal travel pattern, with hours between 1800 and 0700 being roosting periods. Most travel occurred at low wind speeds ( $0 - 1 \text{ ms}^{-1}$ ), but birds achieved faster velocities at higher wind speeds ( $2 - 6 \text{ ms}^{-1}$ ). Higher flight speeds and altitudes at lower elevations and over smooth terrain support a thermal-soaring migration hypothesis, while lower speeds and altitudes at high elevations and over rugged terrain support a slope-soaring hypothesis. Describing migration for this species using GPS technology can help us understand how other species migrate, especially long-distance migrants that soar on thermals and slopes and travel across a variety of landscapes. It may also provide insights as to potential conflict with anthropogenic activities and areas that would especially benefit from conservation planning.

### Raptor Research and Natural History Museums in the Digitization Age: Resources for Researchers, Banders, Conservationists, Agencies, and Educators

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Natural history museums are repositories of information, expanding from the physical specimen outwards to data available on a wide range of topics including a species’ movement, behavior, health, and morphology. The most common types of collections considered in museums are skins, skeletons, eggs and nests, animals and parts in fluid, and tissues. In addition, museums may include collections of archival media, contained within historic and modern field notes and recorded observations. Traditionally, retrieving information from museums was time consuming and potentially prohibitive to researchers. However, with the advent of collection digitization the information from museums has become accessible globally through online repositories. This introduces new opportunities for





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researchers who work with birds of prey, as a vast field of data is now available for exploration and use. As museum collections can provide information on species of raptors across wide areas of geographic space and time, data can be gathered that can augment occurrence and sighting data from banding and migration sites. Some other potential uses include information on the reproductive state of raptors in conjunction with physiological measurements, study of diet differences between species in the same landscape, and as aids for teaching how to identify species in flight and in the hand. In this talk I will go over the types of scientific material that are available at natural history museums, how researchers can find this information online through the different kinds of databases (i.e. data aggregators: GBIF, iDigBio, and Vertnet and collection management systems: Arctos), what types of data can be retrieved from each, and how to correctly cite museum data. Lastly, I will introduce how raptor researchers can contribute to collections, and the benefits to archiving your samples and specimens with a natural history museum.

### **Towards a Full Annual Biogeography of the Flammulated Owl**

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Avian research is generally biased towards studies performed during the breeding season (summer) in the Northern Hemisphere. However, non-breeding phases of an organism's life cycle may comprise the majority of an individual's lifetime, and conditions experienced during one phase may interact with outcomes during other phases. Therefore, it is critical to consider an organisms' full annual cycle when examining, for example, population demography, evolution of life-history traits, or seasonal migrations. The flammulated owl is one such species whose non-breeding biology and ecology is only poorly understood despite being listed as a U.S. Forest Service Sensitive Species and Partners in Flight "Yellow Watchlist" species. Flammulated owls are known to occur during at least some portions of the year from Central America to southwestern Canada, including much of the western portions of the U.S.A. and Mexico. Originally thought to be non-migratory, at least some populations were suspected

to migrate based on indirect evidence (e.g., non-detection during winter, high rates of gene flow, clinal morphology, fall vagrancy, fall fat loading, etc.). More recently, light-level geolocators provided the first and only direct evidence of migration in four individuals that were tracked from central Colorado to south-central Mexico. Despite the recent advances made in clarifying the migratory status of Flammulated Owls, we still lack clear delineation of the species' range at all times of the year. To address the limited understanding of the species' biogeography, we here present new information regarding the spatio-temporal distribution of the species across its entire range. Specifically, we combine a review of available occurrence records from multiple extant databases and movement tracks acquired using archival global positioning system (GPS) devices to both characterize the spatial extent of occurrences across the annual cycle and begin to define the structure of migratory connectivity for migratory population.

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

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Ferruginous Hawks are the largest North American buteo, and are avian apex predators known to inhabit grassland and shrub steppe ecosystems in 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 Department of 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



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reproductive performance of Ferruginous Hawks in southern Idaho. To better understand the characteristics of southern Idaho's breeding population, we established a long-term collaborative monitoring program in 2016 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. From 2016–2019 we monitored 80 breeding territories and documented territory occupancy and productivity between March and July. We used multivariate generalized linear models with model selection procedures to evaluate the relative importance of ecological attributes and human disturbance agents on Ferruginous Hawk nesting success. Preliminary results indicate that success is higher for nesting attempts on transmission towers than for attempts on free-standing platforms or natural substrates. Additionally, percent shrub cover and distance to buildings are important predictors of territory occupancy. Here, we present the results of our monitoring effort and preliminary models, and we discuss their implications for Ferruginous Hawk breeding ecology and management.



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### Differential Migration in Raptors: A Review of Hypotheses and Evidence (Poster #1)

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Many migratory raptor species exhibit differential migration, which is defined as sex- and/or age-based differences in migratory movements. In some raptors breeding at high latitudes, for example, adults may depart the breeding grounds as soon as juveniles gain independence, and may migrate faster than juveniles. In species breeding in more temperate latitudes, on the other hand, adults, particularly the sex responsible for territory defense (usually the males) may migrate later than juveniles due to a possible advantage gained by adults defending their breeding territories for a longer period. Many different hypotheses have been proposed to explain the ecological and evolutionary factors driving differential migration. The feeding efficiency hypothesis, for example, states that females migrate before males in autumn because the larger prey they hunt is scarcer than the smaller prey that is optimal for males, and juveniles migrate earlier than adults because they are less efficient predators who must synchronize their migratory patterns more tightly with those of their avian prey. The social dominance hypothesis, on the other hand, predicts that larger birds (usually females) force smaller birds (usually males) to migrate farther and earlier in autumn. Here, we review the current state of evidence for hypotheses attempting to explain differential migration in raptors and other birds, with an emphasis on Peregrine Falcon (*Falco peregrinus*) migration in the Americas. Research indicates that Peregrine Falcon males and females use different staging areas, flyways, and wintering areas. Banding and tracking studies show that average migration distances may differ greatly between sexes, with some males migrating nearly twice as far as females to their respective wintering grounds, and juvenile males migrating nearly four times as far as juvenile females. Using these and other empirical findings, we examine the evidence for existing and emerging hypotheses about differential migration and suggest priorities for future research.

### The Effects of Weather on Breeding Northern Goshawks (Poster #2)

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The Northern Goshawk (*Accipiter gentilis*) is a secretive forest raptor that serves as an indicator species for most of

the forests in North America. Fairhurst and Bechard (2005) predicted that low temperatures in February and March, combined with heavy precipitation in April, would result in reduced breeding success and territory occupancy in the Northern Goshawk in northern Nevada. After observing lower than average occupancy and productivity in Northern Goshawks in the Minidoka Ranger District of the Sawtooth National Forest in Idaho during the breeding season of 2019, we launched a study using concepts from Fairhurst and Bechard's paper to investigate the impact of the year's cold and wet springtime weather on the goshawks in our study area. We evaluated the effects of cumulative precipitation over three time periods between January and May; mean monthly temperature, mean daily low temperature, and minimum temperature during the incubation period (the month of May); and Average Snowpack Depth in the second and third week of April (8 – 22 April 2019), a time corresponding to the expected egg-laying period within the study area. We found that cumulative precipitation from March through May, the minimum temperature in May, and snowpack depth from 8-22 April 2019 are correlated with observed breeding success rates of Northern Goshawks in the Minidoka Ranger District of the Sawtooth National Forest over the past 9 yrs.

### Site Fidelity and Pairing Behavior in a Wintering Population of American Kestrels in North Texas (Poster #3)

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The American Kestrel (*Falco sparverius*) is North America's most common falcon, however data from the Breeding Bird Survey, raptor migration counts, and occupancy of nest boxes indicate that breeding populations have been steadily declining for decades. Researchers of this species have suggested that this decline may be related to survivorship or changes influencing their wintering ecology, which has received limited study. We began investigating the wintering ecology of American Kestrels in North Texas in December 2016. Here, we report our findings related to annual return rates, the degree of site fidelity, and observations of wintering pair behavior. We captured kestrels using bal-chatri traps and marked birds with anodized bands with a unique two-character code. Throughout the winters of 2016-17, 2017-18, and 2018-19 we visited locations where we previously marked kestrels and recorded their presence and made general observations. After our first winter, we documented that at least 12 of 19 marked birds (63%) returned to our study area the following year, and after the second winter we resighted at least 21 of the 58 marked birds (36%). The distance from the original capture location to the re-encounter location the next winter averaged 269 m in 2017-18 with a range of 22 to 989 m ( $n=12$ ) and 292 m in



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2018-19 with a range of 4 to 875 m ( $n=21$ ), indicating strong winter site fidelity. During the 2018-19 winter season, at least 31 birds exhibited obvious pairing behavior, including copulations and courtship feedings. These observations may suggest that some American Kestrels participate in temporary “winter romances” that may confer some survival advantage or that they could reunite both on their breeding and wintering territories.

### Age and Environmental Effects on Flight Performance of California Condors (Poster #4)

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The flight behaviors of avian scavengers depend on a complex array of physiological, social, and environmental factors. As long-lived animals age, the ways in which they interact with their environment often change. This is, in part, because the experience and knowledge that comes with age often increases the effectiveness and efficiency of daily social behaviors and physical performances. California Condors (*Gymnogyps californianus*), a long-lived scavenging species, are a valuable model for observing avian learning behavior. Condors rely on thermal and orographic uplift to subsidize extended bouts of soaring flight, and their soaring flight performance is expected to improve as condors age. We used high-frequency telemetry data collected in August 2016 to examine 5,964 flight segments, each >30 sec in length, collected from five California Condors, and we calculated the climb rate (altitude gained per unit of time) of each segment as an indicator of flight performance. We evaluated 1,066 – 1,444 flight segments per bird, and we associated these segments with data on condor age, topography, land cover, and weather variables. Preliminary results suggested climb rates averaging between 1.16 meters/sec and 1.29 meters/sec for each condor and non-statistical comparison suggested that average climb rate of the youngest bird was lower than average climb rates of older birds. Preliminary evaluation of flight segments also suggested climb rate was strongly influenced by the external environment the bird experienced. Our study describes how age and environmental factors affect condor flight performance, and it provides insight into avian learning behavior. Finally, because flight performance influences risk that birds face, it has potential consequences for development of conservation management plans.

### Conservation of the Everglade Snail Kite in Light of Everglades Restoration (Poster #5)

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The Comprehensive Everglades Restoration Plan was authorized by Congress in 2000 as a plan to “restore, preserve, and protect the south Florida ecosystem while providing for other water-related needs of the region, including water supply and flood protection.” It is the largest hydrologic restoration project ever implemented in the United States, comprising over 60 separate project components. Lake Okeechobee is considered the “liquid heart of the Everglades” and management of surface water into and out of the lake requires consideration of flood control, water supply, navigation, fish and wildlife enhancement, and recreation. In recent years, Lake Okeechobee has also served as one of the most productive wetlands, in terms of reproduction, for the federally endangered Everglade Snail Kite (*Rostrhamus sociabilis plumbeus*; Snail Kite). Increases in Snail Kite activity on Lake Okeechobee are likely a response to favorable precipitation patterns and habitat conditions, along with an increase in apple snail (the Snail Kite’s primary prey) abundance and availability. However, some challenges exist with the conservation of the Snail Kite and the implementation of the water management plan for Lake Okeechobee (i.e., Lake Okeechobee Regulation Schedule). Specifically, the management of water levels in Lake Okeechobee requires coordination among state and federal regulatory agencies that strive to balance the needs of the people of south Florida with the desire to maintain the ecological integrity of the lake which is crucial to the recovery of the Snail Kite. Rapid and extreme fluctuations in water stages in Lake Okeechobee have negatively affected the Snail Kite, but these fluctuations are not entirely within the control of human management. We present and discuss the relationship between Lake Okeechobee regulatory decisions and the effects of water depth, wetland stage, and rates of recession and ascension on Snail Kite reproduction.

### Habitat Segregation by Gender in a Wintering American Kestrel (*Falco sparverius*) Population in North Central Texas (Poster #6)

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Populations of American Kestrels have been recently declining in several regions of the United States. A possible explanation for this decline is loss of suitable habitat, including habitat in the wintering range. Understanding how American Kestrel habitat is used and partitioned within a population is necessary before informed conservation actions can be designed and implemented for this species. Previous studies indicate that higher quality winter habitat of this species is skewed toward female occupation. In this study, we identified and measured winter American Kestrel territories in Denton County, in North Central Texas to determine if females occupied sites with greater proportions of open-grassland habitat than males. Based on repeated observations, we documented six male and eight female winter territories and measured the area of habitat types that occurred within a 1-ha circular plot centered on the centroid of all recorded locations of each individual. Based on previous literature, we considered open grassland as the best foraging habitat for American Kestrels. Less suitable foraging habitats included forests, buildings, and mowed lawns. We found that the estimated centroids of female kestrel territories contained an average of 84% of open-grassland habitat whereas male territories averaged 35% of this habitat; this difference was significant  $t = 2.36$ ,  $p = 0.03$ . When forest habitat was compared, Males used 9.96% while females were not found in forest habitats. These results suggest female Kestrels wintering in North Texas occupied areas with higher quality foraging habitat than males. The mechanism resulting in this gender segregation of habitat use is unknown, but maybe female dominance and successful defense of these higher-quality sites from males could be a factor.

### Do Kestrels Care? A Continental Scale Analysis of Orientation and Nest Box Occupancy by American Kestrel (Poster #7)

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The American Kestrel (*Falco sparverius*) breeds across much of North America in readily use nest boxes. Previous studies have investigated the relationship between American Kestrel box occupancy and box entrance orientation in North America and found differing results. Professional and citizen scientist across continent have installed thousands of nest boxes for used by kestrels

during the breeding season. Many have shared their data regarding nest box characteristics (e.g. location, nest box orientation, height, etc.) and occupancy The Peregrine Fund's American Kestrel Partnership (AKP). We analyzed AKP data to determine if there was an association between box occupancy by kestrels and box entrance orientation. Preliminary findings suggest that, at the continental scale, kestrels used boxes in proportion to their orientation for all orientations except the southeast. At the continental scale, American kestrels occupied southeast facing boxes significantly less than expected based on their availability. The underlying driver of this pattern is unclear in deserves further investigation.

### Breeding Schedules of Burrowing Owls in Idaho: Have Nest Initiation Dates Changed with an Evolving Climate? (Poster #8)

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Under climate change, distributions of bird species are changing, the behavior of some birds and their primary prey are becoming mismatched, and migration times are shifting. In certain species, migration distances are predicted to increase by thousands of kilometers with the evolving climate, whereas in others migrations may shorten. Among the most prominent effects of climate change on birds is that egg-laying is occurring earlier, including in species of raptors. For instance, in Idaho clutch initiation dates in American Kestrels (*Falco sparverius*) have advanced by almost a month since 1987 (Heath et al. 2012. J. Avian Biol. 43:376-384). Burrowing Owls (*Athene cunicularia*) are a species of conservation concern in North America whose reproductive biology is affected by weather. One example is reduced reproductive success associated with extreme rainfall events in some Burrowing Owl populations in Canada (Fisher et al. 2015. J. Appl. Ecol. 52:1500-1508). Understanding the potential effects of a changing climate on Burrowing Owls is therefore important for conservation and management of this species to help mitigate population declines. We made use of long-term data (1997 – 2019) collected from Burrowing Owls breeding in the Morley Nelson Snake River Birds of Prey National Conservation Area (NCA) to explore temporal changes in breeding phenology and analyzed how annual variability in weather influenced clutch initiation dates. We also investigated potential differences in the effects of climate change between human-modified agricultural and natural shrub-steppe areas as Burrowing Owls breed in both types of environments in the NCA.



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### **An Updated Status Report on the Ferruginous Hawk (*Buteo regalis*) in Western Kansas - Where Drones and Landowners Collide (Poster #9)**

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The Ferruginous Hawk is the largest *Buteo* species occurring in Kansas, found in grasslands and shrub-steppe, nesting along bluffs, buttes, rock outcrops, isolated trees and some human-built structures. In the state of Kansas, the Ferruginous Hawk is listed as a Species of Greatest Conservation Need, Tier II. A previous study on Ferruginous Hawk nesting in Kansas during the years of 1979 to 1987, with sporadic nest visits from the 1990s to 2000, revealed that the most productive nest sites were found in infrequently visited areas. These sites were also characterized by being inaccessible to predators, placed on rocky ledges and the surrounding landscape composed of over 50% rangeland. We are currently revisiting these historic nest sites to get an updated status report of the species in western Kansas, beginning in summer 2019. We contacted landowners with a historic nest site on their property to ask for access. When a nest was found we flew a drone above the nest to determine if it was active or inactive. During flight, photographs were captured of the nest contents, including eggs/chicks, and videos were obtained for surrounding habitat analysis and site comparison. If chicks were present, we attempted to determine their numbers, possible hatch date and egg lay date. So far approximately 20% of the visited historic sites are currently active with an average of two chicks each. These sites were all placed on rocky ledges or columns in areas of over 50% rangeland. The findings of this study will be used by Kansas Department of Wildlife Parks and Tourism to determine the best conservation practices for the persistence of the Ferruginous Hawk, with landowners playing a key role via their rangeland management practices. This study can provide a model for the use of drones in nest surveys of species of conservation need.

### **Addressing the Human Dimension in Human-Raptor Interactions (Poster #10)**

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Are raptor researchers prepared to handle the onslaught of human-related conservation problems facing raptors in the 21<sup>st</sup> century? The Raptor Research Foundation supports scientifically its position championing the need

for an integrated, cross-disciplinary, socio-ecological approach to resolving today's human-related raptor conservation problems. Where human activities or infrastructures are involved, it is not enough to study the raptors themselves, as this defines only one dimension of the conservation problem. When human conflicts over raptor conservation arise, raptor researchers must also consider human dimensions. The human dimension warrants consideration in virtually every conservation problem, from raptor persecutions, to reintroductions, to providing land management recommendations that benefit raptors. Conflicts over raptor conservation usually involve competing interests over land uses or resources, humans using raptors as natural resources, or human health and safety. The human dimension impacts the conservation of a diverse array of raptors ranging from New and Old World scavenging vultures and condors to hawks and eagles to owls and falcons. Resolving these conflicts involves changing human behaviors towards wildlife. Changing human behaviors is often a multi-step process that includes studying wildlife ecology and behavior, economics, human perceptions, and cultural contexts, engaging stakeholders in identifying solutions, and assessing the effectiveness of implemented conservation strategies. Moving forward, raptor conservationists might consider the following approaches: collaborating with sociologists and economists, receiving training specific to wildlife conflict management, developing a centralized database for anthropogenic-based raptor conservation projects, and developing theoretical models of human-raptor conflicts. Conflictive situations involving raptors and humans present an increasing global threat to raptor populations. The Raptor Research Foundation maintains that including the human dimension in conflict resolutions will improve tolerance towards raptors and facilitate the coexistence of raptor and human populations.

### **Birds Across Borders: Building a Community of Ornithology (Poster #11)**

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Around the world, birds influence our lives, cultures, and connections to one another. While humanity divides itself by political and cultural borders, birds don't see these human divisions, but instead see a unified and connected



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natural world. Why shouldn't humanity do the same? Birds Across Borders (BAB) is an initiative working towards connecting students and professionals with birds and nature. Raptors in particular are used to teach about and spark a passion for birds and nature. BAB has worked in the past with the first graders of STEM School Highlands Ranch to teach them about migratory and endangered birds, incorporating monitoring of fourteen kestrel nest boxes. Future plans for the BAB initiative involve expanding to more schools and tracking Swainson's hawk migration via GPS tracking systems. This initiative will then collaborate with students and professionals located along the hawks' migration route to educate and build community. To further raptor conservation efforts, BAB also plans on using citizen science resources like eBird to monitor kestrels using the existing nest boxes. This initiative is working to bring an awareness of raptors into schools to connect students of all ages with nature and the world around them. BAB envisions a place where students from one community can connect with students from another community and find common ground thanks to a shared interest in raptors.

### Can Offspring Sex Ratios Help Explain Patterns of Female-biased Road Mortality in Barn Owls? (Poster #12)

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Wildlife-vehicle collisions (WVC) kill billions of vertebrates and invertebrates every year. Among birds, rates of WVC are particularly high for Barn Owls (*Tyto alba*), with Barn Owl road mortality reported globally. One of the world's highest roadway mortality rates for Barn Owls occurs along Interstate 84 (I-84) in Idaho, U.S.A. Barn Owl road mortality studies frequently find juvenile owls are killed in greater numbers than adults. Explanations for this pattern include the possibility that juveniles simply outnumber adults because of the age structure of the population and are killed in proportion to their abundance. Another common pattern is that female Barn Owls outnumber males in WVC. Boves and Belthoff (2012) reported 1.4 times more females than males in Idaho, and Moore and Mangel (1996) found dead females 2.8 times more frequently than males in California. One potential explanation for this pattern is that both males and females are vulnerable to road mortality, but females outnumber males on the landscape and are killed in proportion to their abundance. More females than males on the landscape could arise if offspring sex ratios are not 1:1, i.e., brood sex ratios are biased toward females. We tested the hypothesis that the female-biased sex ratios frequently observed in Barn Owl WVC is related to

offspring sex ratios that are skewed toward daughters. To do so, we monitored a nest box population of Barn Owls in southern Idaho during 2019, captured and counted nestlings, and obtained blood samples with which we confirmed the sex of nestlings using molecular analysis of DNA. We present results concerning overall sex ratio of nestlings as well as average sex ratio per brood in relation to the hypothesis that female-biased road mortality is related to a larger number of females than males produced in nests.

### Examination of Climate Effects on Host-Parasite Dynamics in Burrowing Owls and Fleas (Poster #13)

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Ectoparasites of raptors include lice (Order Phthiraptera), ticks (O. Ixodida), flies (O. Diptera), and fleas (O. Siphonaptera). One interesting host-parasite relationship occurs between Western Burrowing Owls (*Athene cucularia hypugaea*) and *Pulex irritans* (Family Pulidae), the so-called human flea. Fleas are hematophagous insects that sometimes infest birds, but this association is unusual because *P. irritans* typically parasitizes mammals such as carnivores, ungulates, and rodents. Moreover, the association between Burrowing Owls and *P. irritans* occurs only in the Pacific Northwest of the United States, even though both species have broader distributions. Molecular studies confirmed that *P. irritans* feeds from Burrowing Owls, so owls are not simply a phoretic host for *P. irritans*. Although this association was first reported in the early 1900s, important aspects remain poorly understood. For instance, factors that influence spatial and temporal variation in flea prevalence and intensity including climate effects have rarely been examined. Because fleas are susceptible to desiccation, are there more fleas present in years with higher rates of precipitation and in years with cooler temperatures? And does climate affect host-parasite relationships similarly in human-modified landscapes including agriculture similarly as in non-agricultural lands? Our poster explores these questions and others using long-term data about flea prevalence and intensity collected between 1997-2019 from a population of Burrowing Owls breeding in the Morley Nelson Snake River Birds of Prey National Conservation Area, Idaho, U.S.A.

### Golden Eagle Use of Water Features in the West Desert of Utah (Poster #14)

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Golden Eagles (*Aquila chrysaetos*) are a species for which there is some conservation concern. Previous research has covered many aspects of Golden Eagle ecology, but little is known regarding their use of water. It has been assumed that raptors get their water exclusively from prey and therefore do not need to drink, but anecdotal observations suggest otherwise. Our objective is to quantify the use of water by Golden Eagles and document their temporal use and behavior at these water sources. We used remote cameras beginning in 2010 to photograph wildlife at water sources in Utah's west desert. We collected over 3.5 million photos from 90 natural springs and 26 artificial water developments. From these we sorted approximately 15,000 photos of eagles into visitation events recording behavior, age class, and number of individuals in a given photo. In our analysis we looked at how usage rate varies by age and season, as well as recording behavior at water sources (drinking, bathing, or other). Initial results indicate that eagles use these water features often for both drinking and bathing. Birds stayed for a minimum of 3 sec and a maximum of over 5 hrs at a single water feature. Usage was highest in the summer months when temperatures were hottest. There was a strong bias towards adult birds (five years or older) using water features over sub-adults and juveniles. Finally, most (>99%) visitation events contained only one bird, although there were up to three observed at one time. Use of natural springs and wildlife developments by Golden Eagles could have important implications for how both eagles and water features are managed in arid environments – particularly as availability of water is reduced in coming decades.

### **Bald Eagles and Seabirds: New Evidence Reveals Predation Events on an Endangered Alcid, the Marbled Murrelet (*Brachyramphus marmoratus*), and Other Species Along the Central Oregon Coast (Poster #15)**

#### **MARIE-SOPHIE GARCIA-HERAS**

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Marbled Murrelet populations have declined across much of their range, especially in the Pacific Northwest, and the

species is currently listed as endangered according to the IUCN. This elusive seabird forages in nearshore waters and nests in adjacent mature forests, yet adult mortality is poorly understood. Raptors (e.g., Bald Eagles [*Haliaeetus leucocephalus*; hereafter "eagles"] and Peregrine Falcons [*Falco peregrinus*; hereafter "falcons"] are known to prey on seabirds, and therefore have the potential to impact local populations. During the 2017-2019 breeding seasons, we captured 190 adult Murrelets off the central Oregon Coast and attached VHF-telemetry tags to monitor inland movements to nest sites and marine space use. Most Murrelet fatalities we documented (51.5%, 17 of 33) were suspected to be caused by raptor predation based on a combination of physical damage to carcasses (e.g., plucked feathers and flesh) and tracking of tags from missing Murrelets to areas near raptor perch sites and nests. This was the case in 2017 and 2018 when four out of 12 and nine out of 15 raptor-related Murrelet fatalities, respectively, were suspected. In 2019, tags from four out of six confirmed fatalities were tracked to four distinct eagle nests, prompting us to collect prey remains in August of 2019. We found that 85% of the prey items recovered in and adjacent to eagle nests were identified to seabirds (91% Common Murres [*Uria aalge*]) followed by mammals (6%), shellfish (6%), and fish (3%). Given marked increases in coastal eagle populations and direct observations of eagles taking adult Common Murres at colonial nest sites, we hypothesize that raptor predation pressure on Murrelets and other seabirds along the Oregon Coast may be substantial and that additional research is needed to better understand the dynamics of "seabird-raptor" interactions and their impact on seabird demography.

### **Disturbance Indicator Monitoring Methods and Results: A Colorado Case Study for Nesting Bald Eagles (*Haliaeetus leucocephalus*) (Poster #16)**

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ERO Resources Corporation (ERO), on behalf of the City and County of Broomfield, has monitored a pair of nesting Bald Eagles in Broomfield, Colorado since February 2018. The objective of monitoring was to record any adverse behavioral reactions to human disturbance from construction activities near an active Bald Eagle nest and implement corrective actions as needed. The Bald Eagle nest is located approximately 183 m from the edge of a residential apartment complex currently under construction. Construction activities were monitored year round with monitoring intensity based on the sensitivity of the nesting phase for the 2019 breeding season that includes: (1) courtship and nest initiation; (2) egg laying/incubation; (3) brooding/caring for nestlings; (4) fledging; (5) post-fledging; and (6) dispersal and early





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courtship. Based on a literature review and consultation with local experts, ERO developed a monitoring strategy with identifiable “disturbance indicators” to support any corrective action decisions affecting construction activities. Disturbance indicators are a series of behaviors that were evaluated by professional biologists using professional judgment and experience to determine when an individual or group of disturbance indicators truly rise to a level that warranted a work stoppage or modification. Applying this approach, construction activities were temporarily stopped or modified on three occasions. Implementing this monitoring strategy through two complete Bald Eagle nesting cycles allowed construction activities to continue and the Bald Eagles to successfully fledge young each year. ERO will prepare a poster presentation that summarizes survey methods and results, including observed behaviors, indicators of disturbance, and other environmental conditions affecting nesting behavior.

### Genetic and Morphometric Sex Determination of Swainson’s Hawk Nestlings (Poster #17)

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In avian taxa lacking sexually dimorphic plumage, determining nestling sex can be difficult, especially when the sexes exhibit morphometric overlap, as in most species of raptors. The ability to accurately assign sex prior to fledging can provide insights into many important ecological and demographic processes. Studies involving nestling development, brood sex ratio, life-history and senescence, post-fledging survival, and recruitment are all enhanced by accurate sex assignment. Yet for many species, the nestling period represents the only time to collect individual-based data prior to recruitment, as many sub-adult life stages are often unobservable and natal dispersal behavior may vary by sex. While morphometrics alone are often enough to distinguish sex of fully developed individuals, prior to fledging several factors may complicate sex assignment at the time of initial handling, such as hatch order, brood size, and physical stunting. Here we examined the reliability of various morphometric measurements to assign sex to nestling Swainson’s Hawks (*Buteo swainsoni*) of various ages banded between 2008 and 2018. We used molecular techniques to assign sex to 120 nestling Swainson’s Hawks. In addition, we used individuals initially marked as nestlings, but later observed breeding (i.e. recruits). Using nestling morphometric data, we sought to determine which metrics provide the highest assignment accuracy and the minimum age at which sex determination could be made. The use of morphometric and molecular techniques

for sex assignment are proven methods to elucidate basic features of biology, yet they provide information that can greatly enhance our understanding of life history and ecology.

### Fitness Correlates of Among-Individual Variation in Nest Defense Behavior in Arctic Peregrine Falcons (*Falco peregrinus tundrius*) (Poster #18)

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Predation of eggs and nestlings is a main contributor to nest failure in many bird species. Thus, birds have developed ways to mediate predation such as inconspicuous nests, distracting predators through aerial or vocal displays, and nest defense behavior. Our study site, Rankin Inlet, is home to one of the world’s largest breeding densities (i.e., >25 breeding pairs) of Arctic Peregrine Falcons. This high breeding density allows the execution of studies that can focus on the adaptive significance of complex behavioral traits, such as nest defense behavior. Currently, we lack understanding of between-sex variation (e.g., male vs female) in nest defense behavior for many raptor species, including Peregrine Falcons. To advance our understanding of the causes and consequences of variation in nest defense behavior in Peregrines, we assessed whether nest defense varied between sexes, varied across nest stages (e.g., egg laying, incubation, provisioning), and if nest defense predicts provisioning rates. To do this, we scored nest defense during egg laying, incubation, and provisioning stages of the nesting cycle. We also deployed motion-activated cameras at active nest sites to score provisioning rates, which have been shown to link personality (i.e., consistent among-individual variation in behavior) to fitness correlates (i.e., reproductive success). However, we are aware of only one study that has examined the consequences of nest defense behavior and provisioning behavior in a raptor species. We will utilize data from two field seasons, 2018 and 2019, in the analysis that will be conducted upon return from this field season.

### Diet Comparison of Groups and Pairs of Breeding Harris's Hawks (*Parabuteo unicinctus*) in South Texas (Poster #19)

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The Harris's Hawk, a uniquely social hawk species, often breeds and hunts cooperatively in groups typically consisting of a dominant breeding pair and one or more auxiliary helpers. How and why these birds form social groups is not completely understood, but one hypothesis is that the ability to hunt cooperatively may benefit groups with a higher hunting success rate or facilitate the capture of larger prey than an individual hawk could catch on its own. To determine whether hawks breeding in these cooperative groups have a foraging advantage over non-cooperative pairs, we video recorded prey deliveries at nests of three breeding groups and two breeding pairs in Cameron County, Texas. In contrast to the diets of Harris's Hawks in New Mexico and Arizona which depend heavily on lagomorphs, we documented mostly avian (58 birds) and rodent prey items (48 rodents), and only two lagomorphs ( $n = 145$  prey items recorded). Groups and pairs did not differ significantly in prey diversity or the frequency of prey deliveries. However, the two urban nests received predominantly avian prey (56%,  $n = 91$ ), while the three nests in more natural habitats received predominately rodent prey (70%,  $n = 54$ ). The nests in urban areas also received prey deliveries at higher frequencies than the nests in more natural areas. These results suggest that habitat composition, particularly habitat changes associated with urbanization, may have stronger effects than group size on the diets of Harris's Hawks in South Texas.

### **Abundance, Distribution, and Habitat Selection of Breeding Mississippi Kites in Southern Illinois (Poster #20)**

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Mississippi Kites (*Ictinia mississippiensis*) are neotropical migrant raptors that breed throughout the American Southeast and Great Plains. Within the Mississippi Alluvial Valley, they underwent a dramatic population decline in the early 1900's attributed to the loss of nesting habitat due to changing agricultural practices, but have experienced an increase in abundance and reoccupation of historic range since the 1950's. Despite this, the Illinois Endangered Species Protection Board lists Mississippi Kites as Threatened. Extensive anecdotal evidence, including reports from State and Federal personnel, social media, and eBird suggests that the abundance of kites has continued to increase in southern Illinois, potentially warranting de-listing the species. To determine the status of Mississippi Kites in Illinois and identify factors influencing potential population growth and range expansion, we are conducting foot, road, and ATV surveys for nesting kites in 10 southern Illinois counties. In 2019, we trapped, banded, and radiotracked kites to determine home-range size and locate unknown nesting locations. We will use behavioral data, nest locations, and nest-site

vegetation data to build a Species Distribution Model estimating the amount of suitable nesting habitat in the region. Using home-range estimates and results from distribution modelling, we will establish a current minimum baseline of Mississippi Kite abundance in southern Illinois. We will also explore including molecular sexing and fecal dietary analysis. The results of this study will inform decisions regarding the conservation status of Mississippi Kites in Illinois, as well as determine the factors influencing kite population dynamics in the region.

### **Using Citizen Science Data to Evaluate Differences in Wintering Distribution of Adult and Immature Broad-winged Hawks (*Buteo platypterus*) (Poster #21)**

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Despite the Broad-winged Hawk being one of the most easily observed North American raptors during migration, much is still unknown about its distribution within the winter range and whether winter distribution differs by age or sex class. Some raptor species display differences in winter range by age or sex class and such differences can have implications for conservation. To examine winter distribution patterns of adult and immature Broad-winged Hawks, we examined 1,123 sightings reported in eBird by citizen scientists and entered in the years 2000-2017 during the months of December through February. When all winter records were pooled, the mean latitude of immatures was significantly farther north than adults. However, for birds wintering south of the United States, there was no significant difference between mean wintering latitudes of adults and immatures. Most of the four United States regions with wintering Broad-winged Hawks had notably greater number of immatures than adults; most strikingly the Gulf Coast region showed only 6% adult sightings (191 immatures, 12 adults). Florida eBird records displayed the greatest proportion of adults of all US regions, 46% (87 adults, 103 immatures). The distribution of eBird sightings within Mexico and Central America showed heavy overlap of both age classes while records from South America showed slightly more adult sightings although the difference was not significant. Age distribution within Central and South America could vary by habitat or elevation, as sightings of adults appeared more concentrated within higher elevation central regions of Central and South America. Immature sightings were more diffuse, with many sightings in lowland regions, although further analysis is needed. eBird data appears to be a useful tool for examining winter range in raptors, and could inform knowledge of habitat and elevation associations.



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### **Collaboration Across the Geographic Range and Annual Cycle of a Widespread, Migratory Raptor (American Kestrel; *Falco sparverius*) Enhances Scope and Scale of Phenology Research (Poster #22)**

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With climate-change-induced seasonal shifts, the ability of individuals to alter phenology to match resource availability can have implications for their survival and breeding success. However, for migratory and widespread species, understanding the magnitude and impacts of phenology shifts can be challenging. Populations may have differential genetic adaptive potential, individuals may face different environmental conditions across space and time, and year-round, range-wide studies are often logistically infeasible. Here, we describe the collaborative research network comprising the Full Cycle Phenology Project, which seeks to understand the causes and consequences of phenology shifts in American Kestrels across their range. American Kestrels are a well-studied, widespread raptor with variable migratory strategies, and have experienced differential population trends and differential responses to climate change across their range, making them an ideal model species for large-scale phenology research. Through partnerships with citizen-scientists, long-term researchers, and Department of Defense biologists, we are assembling a comprehensive, continental-scale dataset of kestrel nest records, counts at migration monitoring sites, eBird observations, and feather samples for genetic analyses. Consequently, information collected during all stages of the annual cycle and across North America has expanded the scope and spatial scale of phenology research questions that can be addressed. Results from this and other collaborative efforts will help to inform a simulation model to forecast the impacts of future climate change scenarios on kestrel phenology.

### **The Wisconsin Red-shouldered Hawk Telemetry Project: Tracking the Phantoms (Poster #23)**

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Recent developments in technology have allowed us to study Red-shouldered Hawk (*Buteo lineatus*) movements at an unprecedented level. Solar powered GPS transmitters (loggers) were used to track breeding and migratory movements of five Red-shouldered Hawks during 2018 and 2019. Loggers were deployed on two females in central Wisconsin, and two males and one female in northeast Wisconsin. The summer breeding range for all five hawks was determined. Temporal/spatial locations from three of these hawks revealed southward and northward migration routes and wintering site data. Hawks left their breeding range during late October or early November and returned in mid-March. Migration distance to wintering site varied from 118 km to 1,224 km. Migration flights to winter grounds and return flights to breeding sites averaged 24.5 km/day and 73.5 km/day respectively. The longest migration was to northern Alabama. This is the first yr of a multiyear study.

### **Plumage Variation in Nestling Barn Owls: Patterns of Pheomelanin and Eumelanin Pigmentation Differ Between Males and Females (Poster #24)**

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Higher vertebrates synthesize two forms of melanin: eumelanin and pheomelanin. Eumelanin is responsible for dark colors and is found in virtually all animal groups, whereas pheomelanin is the pigment underlying reddish and chestnut colorations and is only synthesized in birds and mammals. The plumage of Barn Owls (*Tyto alba*) contains both types of melanin, including spots composed of eumelanin and the absence or presence pheomelanin, which influences whether owl body feathers are white or varying degrees of reddish brown, respectively. We were interested in the extent to which both forms of melanin varied in nestling owls, if and how melanin pigmentation differed between sex classes of nestling Barn Owls. Thus, we quantified plumage in nestling Barn Owls within a nest box population in southern Idaho, U.S.A. during the 2019 breeding season. We indexed overall spot pattern and quantified spot density in six body regions (breast, abdomen, right and left flank, and right and left wing). Additionally, for the breast and abdomen, we calculated average spot diameter from photographs of each owl. Pheomelanin was indexed on an ordinal scale in the six body regions using comparisons to Munsell color chips. Finally, we used molecular techniques to confirm nestling sex using DNA obtained from blood. Our poster describes characteristics of pheomelanin and eumelanin pigmentation in nestling Barn Owls of both sex classes and results of statistical analyses designed to assess the



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accuracy of assignment of sex class from plumage characteristics.

### Seasonal Movements of Crested Caracaras in Arizona – Preliminary Data (Poster #25)

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In 2017, we began attaching GPS/GSM transmitters to Crested Caracaras (*Caracara cheriway*) in southern Arizona with the goal of determining their seasonal movements and habitat use. Two birds tagged thus far have provided the first such data collected for this population. The fledgling we tagged then released at a Santa Cruz Flats farm field in November 2017 to date has traveled over an area of more than 14,500 km<sup>2</sup> foraging mainly in alfalfa and recently disked cotton fields and in irrigated cattle and sheep pastures. It has used the Flats almost year round. The nestling we tagged at a nest in the Altar Valley in June 2018 moved mostly throughout her natal area through October then dispersed from her natal area in December but continued to return occasionally to her natal area into March 2019. During the past year she traveled throughout an area of approximately 8000 km<sup>2</sup> foraging in Sonoran Desert Scrub and a commercial pecan grove before succumbing in May 2019, cause unknown. Both caracaras typically foraged in a particular area over multiple consecutive days then generally roosted in Sonoran Desert Scrub adjacent to that foraging area, over multiple nights. Similar to roosting behavior of caracaras in Florida, these tagged caracaras traveled among a network of consistently used roosts throughout the study area. Though both caracaras traveled widely, their use areas did not overlap, and the Altar Valley nestling never visited the Santa Cruz Flats, whereas almost half the locations received from the older caracara were from that area.

### Don't Let the Bed Bugs Bite: Ectoparasites of Ferruginous Hawk Nestlings on Natural and Artificial Substrates (Poster #26)

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Parasitism can incur fitness costs on host species, and the abundance of parasites in a nest can inhibit nestling development or survival. Raptors have evolved a variety of behaviors to combat ectoparasites including alternative nest-building within territories and incorporating allelopathic vegetation into nesting material. In areas where local environmental conditions increasingly surpass a species range of tolerance, the negative fitness

consequences of parasitism are magnified. The Uinta Basin in northeast Utah serves as a key breeding area for Ferruginous Hawks (*Buteo regalis*). The Uinta Basin is also undergoing continued rapid habitat alteration associated with oil and natural gas extraction. Widespread disturbance of known nesting habitat for Ferruginous Hawks has spurred management actions, including the installation of artificial nesting structures (ANSs). Preliminary data suggest that ANSs have high occupancy; however, birds using these sites do not appear to move their nests from one year to the next and reuse the same location annually, which in turn could affect parasite load. In order to determine what effect nest site selection may have on ectoparasite prevalence for Ferruginous Hawk nestlings in the Uinta Basin, we collected ectoparasites from nestlings in nests on natural substrates and ANSs by dust ruffling and offer a preliminary assessment of parasite communities and abundance for the two nest types. Additionally, we captured aerial images of nests to quantify percentages of green vegetation on each nest type.

### Phylogeography of the Northern Saw-Whet Owl (*Aegolius acadicus*) (Poster #27)

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Knowledge of phylogeographic patterns of avian species informs the understanding of evolutionary processes and provides evidence for applying conservation strategies when necessary. Species that exhibit high levels of latitudinal and longitudinal movement typically exhibit little to no geographical population structure at the genetic level. The Northern Saw-whet Owl is a common but secretive owl of North America whose population structure and migration patterns are just becoming understood. Northern Saw-whet Owls exhibit both short distance and long distance longitudinal movements as well as latitudinal movement of hundreds of miles during annual migration. Such high levels of movement suggest that Northern Saw-whet Owls should possess an absence of genetic structure across their range but a comprehensive investigation is lacking. We used mtDNA regions cytb and ND2 to examine the population genetic structure of migrating Northern Saw-whet Owls collected from eight states in the U.S. Individuals from each state were assigned to "East coast", "Midwest", or "West coast" regions. Preliminary results provide no evidence of a population structure among geographic regions for either gene. For cytb, all of the variation in genetic diversity was found among individuals regardless of the state or region. For ND2, approximately half of the variation in genetic diversity was accounted for by the state of capture and the other half of the variation was found among individuals regardless of the state or region. Tajima's D for both gene regions were negative, suggestive of a postglacial





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population expansion. The absence of well-defined phylogeographic structure is likely due to the population's current movement patterns (migration and dispersal) and a past population bottleneck due to the most recent glacial maximum.

### Research and Rehabilitation: An Important Partnership (Poster #28)

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Rehabilitation facilities have the potential to provide a vast sampling pool to the research community due to the sheer numbers of animals they admit each year. These facilities are frequently overlooked as research partners. The Rocky Mountain Raptor Program (RMRP) has a three-prong mission which includes rehabilitation, education and research. RMRP gathers data to expand our own knowledge of raptors in rehabilitation and improve our rehabilitation protocols and success. In addition, the RMRP feels strongly about partnering with others to expand raptor knowledge on a greater scale. We will explore some of the research projects that the RMRP has been, or is involved in, to highlight the endless opportunities that might be available for a rehabilitation-research community partnership.

### Golden Eagle Mortalities and Injuries at Wind Energy Facilities in the United States (Poster #29)

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As part of the United States' pursuit of renewable energy, the wind energy industry has continued to grow and expand, with an estimate of about 56,000 wind turbines installed by the end of the first quarter of 2019. The growth of the wind energy industry in the United States has raised concern about the effect of lethal collisions at wind energy facilities on Golden Eagles (*Aquila chrysaetos*). We present information collected by the U.S. Fish and Wildlife Service on documented mortalities and injuries of Golden Eagles at wind energy facilities in the United States between 2013 and 2019. A search of sources available to us resulted in 263 records of Golden Eagle mortalities or injuries at wind energy facilities from 18 states during this time span. Most of these records were actual mortalities of Golden Eagles. We will provide a

summary and analysis of these records including their geographic distribution and a breakdown by month and year. Because most of these records are incidental finds, and not the result of systematic searches, we do not know how this total relates to the actual number of Golden Eagles taken at wind energy facilities, other than that our figure is a known minimum. Our data document that this is a widespread mortality factor for this species, but we acknowledge we do not yet understand the effects of wind energy on Golden Eagles at the population level. Also, mortality associated with the wind energy industry is but one of many mortality factors for Golden Eagles in the United States. Given the continued rapid expansion of wind energy, however, we project that the frequency of Golden Eagle mortalities at wind energy facilities will increase.

### Spatial Models, Risk Analyses, and Other Information Resources for Golden Eagles in the Western United States Are Now Publicly Available Online (Poster #30)

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Conservation and management of Golden Eagles (*Aquila chrysaetos*) has gained importance in recent years as rapid expansion of energy development, combined with anthropogenic sources of mortality and habitat alteration, may be causing declines in Golden Eagle populations in the western U.S. These concerns, coupled with protection of Golden Eagles under the Bald and Golden Eagle Protection Act (Eagle Act, 16 U.S.C. 668a-668d) which prohibits the "take" of eagles without a Service-issued permit (50 CFR Parts 13 and 22), have generated an urgent need for new information and analysis tools to support implementation of the Service's Eagle Conservation Plan Guidance (ECPG) and other eagle conservation programs. The Service established the Western Golden Eagle Team (WGET) in 2013 to help meet the information needs of Golden Eagle conservation and management in the western U.S. (Regions 1, 2, 6 and 8). WGET collaborates with state and federal land management agencies, tribes, industry and research institutions to develop conservation strategies, decision support tools, and information resources to support project siting, evaluation of project proposals, planning of mitigation efforts, and land management planning. Our decision support tools are intended to inform siting of energy development projects (ECPG Stage 1) and land management planning, as well as identification and spatial prioritization of mitigation opportunities (ECPG Stage 4). The WGET website provides open access to



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spatial models, risk analyses, and information resources on Golden Eagle distribution and movement, management and mitigation, ecoregional strategies, and risk analysis tools. Spatial data, white papers, and other information resources are publicly archived for download on ServCat (<https://ecos.fws.gov/ServCat/Collection/Profile/1088>).

### Prey Biomass and Availability as Factors Influencing the Distribution of Hawaiian Short-eared Owls (Poster #31)

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Raptors provide critical ecosystem services as the top-down regulators of the systems in which they occur. Only one native raptor, the Hawaiian Short-eared Owl or Pueo (*Asio flammeus sandwichensis*) provides these services across all the main Hawaiian Islands. Considered an ancestral guardian and once common on the islands, the Pueo is currently state-listed as endangered on O'ahu. A limiting factor for raptor populations, especially owls, is prey availability. Models of predator-prey relationships assume a direct correlation between prey capture and prey density. However, prey density may not be the only predictor of raptor foraging selection as habitat characteristics strongly impact the effort necessary to detect and capture prey. Information regarding potential prey - rodents, passerines, invertebrates - and habitat characteristics across a variety of systems in Maui will provide insights to whether Pueo presence is more closely associated with vegetation structure, prey biomass, or a combination of these factors. So far results indicate Pueo prefer to hunt in open pasture and shrubland systems that contain lower total prey biomass but the highest density of house mouse (*Mus musculus*), in comparison to dense forest systems that contain higher total prey biomass and rat (*Rattus* sp.) populations. An increased understanding of the Pueo's foraging habits will inform conservation efforts and lead to strength and persistence of the population across the state of Hawai'i.

### Aging Nestling Cooper's Hawks (*Accipiter cooperii*) (Poster #32)

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The ability to accurately age nestling raptors is important to biologists, wildlife rehabilitators, and bird watchers alike. For researchers, nestling age can be a deciding factor in determining when to enter a nest for tagging or sampling, as well as for estimating the onset of incubation, determining reproductive success, and tracking changes in phenology. Land managers and law enforcement officers often base guidance regarding human-raptor conflicts or

requests for nest relocation on nestling age estimates made by biologists. Wildlife rehabilitators use this information to make decisions regarding returning chicks to nests, dietary needs, and expected behavioral development. And birdwatchers not only maintain their own records but often contribute to citizen science by reporting observations on public sites like eBird. Despite the importance of this metric, limited resources exist for accurately aging raptor chicks. Prior to feather development, differentiating between *Accipiter* species can be extremely difficult. Nestling sizes at the edge of documented ranges (e.g., female Sharp-shinned vs male Cooper's Hawk) can overlap and feather development is very similar. *Accipiter* ageing and identification continues to be a challenge after feather development. Using photographs taken across several years both in captivity in New Mexico and at a nest in the wild in Vermont, we developed a photographic guide, showing relative age for nestling Cooper's Hawks. We describe age-specific behaviors up to fledging to assist field-based observers in estimating nestling age.

### Conservation Letters: Call for Papers (Poster #33)

**KRISTIN K. MADDEN**, U.S. Fish and Wildlife Service, Albuquerque, NM, U.S.A. **STEVEN J. SLATER**, HawkWatch International, Inc., Salt Lake City, UT, U.S.A. **GENEVIEVE C. ROZHON**, GHD Inc., Eureka, CA, U.S.A. **MEGAN MURGATROYD**, FitzPatrick Institute of African Ornithology, University of Cape Town, Rondebosch, Cape Town, South Africa. **JAMES F. DWYER**, EDM International, Inc., Fort Collins, CO, U.S.A.

The Raptor Research Foundation's (RRF) Conservation Committee is producing summaries of the best available science on selected issues impacting raptor conservation. This poster features the first two Conservation Letters in the Journal of Raptor Research (JRR), with JRR waiving page charges. "Raptor Persecution", published in 2019, focuses on the potentially significant impacts of direct persecution at local, regional, and global levels. The authors explore the reasons behind persecution, population impacts, and strategies for curbing persecution globally. "Raptor Persecution: Raptors and Overhead Electrical Systems" is scheduled for publication in 2020. The authors focus on raptor interactions with overhead electrical systems, which have the potential to negatively impact individual birds, species, and populations, primarily in the form of electrocutions. This Conservation Letter provides a scientific review of these interactions and concludes by highlighting lessons learned and potential solutions. Teams of authors for Conservation Letters include students and early-career raptor researchers, and also include international authors and authors whose first language is not English because those authors know the raptor conservation issues of their home areas. Conservation Letters summarize a topic of conservation concern, how the best available science suggests that



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concern is likely to impact raptor populations if it continues as-is, and solutions. For Conservation Letters to become the impactful resource we envision, we need more. To write Conservation Letters, we need Committee Members to serve as authors and co-authors on manuscripts. This is a great opportunity to expand your writing skills, work with a variety of international coauthors, and most importantly, contribute to raptor conservation. This poster will provide examples and provide opportunities for you to reach out and get involved. If you are interested in co-authoring a Conservation Letter, please email (jdwyer@edmlink.com).

### Investigation of Microsite Characteristics and Behavioral Influences on Parasite Abundance in Nestling Golden Eagles across Western Utah (Poster #34)

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Evidence shows parasites have an aggregate frequency distribution, where only a handful of individuals in the host population are affected. The impacts on those hosts vary in severity but in many avian species, parasites can affect energy expenditure, body condition, and even survival. A better understanding is needed on factors that contribute to parasite abundance and why particular individuals in a population are more susceptible to loading. To date, the majority of parasite sampling on Golden Eagle (*Aquila chrysaetos*) nestlings has been done by manual examination, a technique best suited for slow moving or stationary species of parasites. In our study, we applied the dust-ruffling technique; a method that has been shown to have a higher rate of return than manual examination. In addition to sampling for parasite richness, intensity, and abundance, we will be examining abiotic factors (temperature and relative humidity) of the nest site with iButton data loggers. We will also be monitoring nests with camera traps to document adult attendance, anti-parasite behavior, and prey selection and availability. By monitoring behavior and nest site characteristics, we hope to identify specific variables that contribute to host selection. In the spring of 2019, a small pilot effort was completed on eight Golden Eagles; results are being analyzed. In 2020 and 2021, a large scale effort at ~50 Golden Eagle nests will take place across western Utah. This research will further refine parasite sampling techniques on large raptors and provide insights into how microsite characteristics influence parasite frequency.

### Citizen Science Data Reveal Trends and Associations with Temperature of Abundances of Raptors Wintering in Pennsylvania (Poster #35)

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Evaluation of population trends is the most pressing research need for many species of conservation concern. Road counts for birds of prey are often conducted by citizen scientists and these counts are useful for monitoring long-term trends and examining annual variations in abundance. We examined data from 2,155 road surveys conducted from 2001–2018 by citizen scientists participating in the Pennsylvania Winter Raptor Survey. We identified trends in abundance, quantified annual variation, examined associations with temperature, and identified correlations between abundances of species. Citizen scientists recorded over 85,000 individuals of 14 species of raptors. Bayesian state-space models suggested that abundances of wintering Bald Eagles (*Haliaeetus leucocephalus*) and Red-shouldered Hawks (*Buteo lineatus*) increased over the course of the study. Species whose abundance varied the most over the duration of the study (CV > 5.0) were Rough-legged Buzzard (*Buteo lagopus*), Red-tailed Hawk (*Buteo jamaicensis*), Northern Harrier (*Circus hudsonius*), Turkey Vulture (*Cathartes aura*), and American Kestrel (*Falco sparverius*). Yearly changes in abundances of American Kestrels and Red-tailed Hawks were negatively associated with changes in winter temperature, whereas yearly changes of Rough-legged Buzzards were positively associated with winter temperature. Abundance of these species was therefore correlated such that American Kestrels and Red-tailed Hawks increased during years when Rough-legged Buzzards decreased. These data are consistent with the hypothesis that during harsh winters, Rough-legged Buzzards increase in abundance in Pennsylvania because they move farther south from their Arctic breeding grounds, and American Kestrels and Red-tailed Hawks decrease because they leave their Pennsylvania breeding grounds. Our results highlight the utility of road surveys by citizen scientists to monitor raptors over large areas and long timespans to provide critical information necessary for raptor conservation.



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### **Provisioning Behaviour in Peregrine Falcons (*Falco peregrinus tundrius*): Within and Across Years (Poster #36)**

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In altricial birds, breeding adults typically adjust their provisioning effort in response to the needs of their young. Their decisions are influenced by a trade-off between self-care and brood success. Resolution of this trade-off is dependent on factors including climatic conditions (temperature, precipitation), prey availability, and brood value. Here we use long-term provisioning and climate datasets for a breeding population of Peregrine falcons at Rankin Inlet, Nunavut. We examine how parents respond to brood demand (brood size, nestling age) and if there are fundamental differences between their response in harsh and benign years by asking 1) what is the parental response to brood demand across the entire chick rearing period (i.e., from hatching to fledging)? And 2) how do year-to-year variations in environmental conditions influence provisioning decisions? Motion-sensitive cameras were deployed in accessible, occupied Peregrine nests. Distance sampling and snap trapping transects were used to estimate prey availability and small mammal abundance. Environmental data was collected using an on-site weather station. Post 2019 field season, data extraction from motion-sensitive nest cameras for type, size and amount of delivered prey, time between provisioning visits, and nest attendance will be completed for three breeding seasons. We predict that parents will increase provisioning effort (i.e., increase visitation rates, deliver larger prey items) as a function of brood size, and nestling age. However, capacity of parents to respond to increased nestling demand will likely be reduced in environmentally challenging years, as parents are further constrained by the inclement weather.

### **Improving Lead Exposure Diagnosis Using Bone Lead Concentrations in California Condors (*Gymnogyps californianus*) (Poster #37)**

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Lead (Pb) poisoning is a global problem among avian species, including the endangered California Condor. Condors are highly monitored and frequently Pb poisoned,

and thus may serve as a model species to investigate Pb exposure biomarkers. In humans, biomarkers of cumulative Pb exposure, such as bone Pb levels, have been associated with negative health effects. However, in large avian species, there are currently no well-validated biomarkers for cumulative Pb exposure. In this work we investigated for free-flying condors whether life history and monitoring variables that have been associated with increased Pb exposure risk, such as number of days a condor was free flying, were associated with bone Pb concentrations. Significant correlations (Spearman's Rho 0.51 to 0.77,  $P < 0.001$ ,  $df = 27$ ) were found between multiple bone regions (femur epiphysis distal, tibiotarsus epiphysis proximal, tibiotarsus diaphysis) and the monitoring variables, such as number of days a condor was free-flying, lifetime integral of blood Pb concentration, and lifetime peak of blood Pb concentration. The correlations between the tibiotarsus diaphysis Pb concentration and the number of days a condor was free flying as well as lifetime integral blood Pb was higher than correlations between the other bone regions tested. Overall, these findings may inform California Condor management practices by validating bone Pb levels as biomarkers for cumulative Pb exposure in deceased condors, and the identified monitoring variables as surrogates for cumulative Pb exposure in free-flying Condors. The development of validated biomarkers for long-term cumulative Pb exposure is a step toward better understanding the relationship between Pb exposure and negative health outcomes in scavenging avian species.

### **Relative Importance of Sources of Mortality in Female Cooper's Hawks in Northcentral New Mexico, U.S.A (Poster #38)**

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From 2011 to 2017 we radio-tagged or color banded 230 female Cooper's Hawks (*Accipiter cooperii*) in Albuquerque, New Mexico, U.S.A. The hawks dispersed widely over central New Mexico, settling in urban and exurban habitats up to 46 km from Albuquerque. The 117 radio-tagged hawks were relocated weekly, and we recorded re-sightings of the 113 color-banded hawks at nests annually. All radio-tagged hawks recovered dead were examined to determine the cause of death. We used a Bayesian multistate capture-recapture model to estimate survival rates and, for radio-tagged hawks that died, probabilities of the different causes of mortality. Radio-tags provide a relatively unbiased sample of fatalities because cause of death does not affect recovery probability. Thus, we believe our results are representative of the frequency of mortality factors in the population. We





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were able to determine the cause of death for 81% of the radio-tagged Cooper's Hawks that died and were recovered. Collisions were the leading cause of death in first-year (HY) and older (AHY) hawks, accounting for 49% of HY and 28% of AHY deaths. HY female collisions were relatively evenly distributed among vehicles (16% of total deaths), windows (11%), fences (11%), and electric distribution lines (11%). Collision deaths of AHY females were mostly with electric distribution lines (26%). Other causes of death were electrocution (11% HY, 12% AHY), secondary poisoning (5% HY, 16% AHY), intraspecific fights (8% HY, 12% AHY), predation (8% both age classes), gunshots (8% HY, 4% AHY), entrapment in buildings (5% HY, 4% AHY), starvation (3% HY, 8% AHY), and disease (3% HY, 8% AHY). Mean annual survival overall was 39% and 74% for HY and AHY females, respectively. Our study population grew by a mean of 8% annually during this study, thus the mortality incurred by these various factors was sustainable.

### Breeding-sites of the Northern Goshawk Indicate High Year-round Species Richness for Birds in an Urban Ecosystem (Poster #39)

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Rapid urbanization has resulted in the dramatic loss of biodiversity around the world, and urban planning, which considers biodiversity conservation, is urgently needed. Comprehensively measuring biodiversity is often impossible owing to lack of ecological knowledge or socioeconomic constraints, but identification of species that live in high biodiversity areas ('indicator species') and conservation of their habitat as a proxy for wider biodiversity has been broadly endorsed. In this study, I demonstrate the value of raptors as indicator species in urban ecosystems by using the Northern Goshawk (*Accipiter gentilis*) as a model. The eastern part of Kanagawa, Japan was selected as the survey area. The proportion of built-up area in this site was 72.7%. Between 2014 and 2018, we identified 41 goshawk breeding sites. We used bird species richness as a proxy for biodiversity, and we measured species presence within 500 m of the breeding sites using line census techniques from January to February 2019 (winter) and from May to June 2019 (breeding season). We surveyed within 4 h of sunrise and repeated three times on each site. We also surveyed a control group of 50 sites, which contained as similar as possible habitat proportions as the breeding-sites of goshawk. To clarify the relationship between bird biodiversity levels and the two habitat groups, we constructed a generalized linear model with bird species number as a response variable in each season, and the presence/absence of goshawk breeding-site as a single covariate. Consequently, in both seasons, we found a significant positive relationship between bird species richness and goshawk presence. Indeed, goshawk

presence explained a large proportion of the model variance (73.6% in winter, and 71.4% in the breeding season) and conclusively indicates that conservation of goshawks will preserve high year-round urban biodiversity.

### Winter Pairing Behavior of American Kestrels (*Falco sparverius*) in North-central Texas (Poster #40)

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The American Kestrel is a territorial bird of prey that migrates to and from its breeding grounds each year. According to literature, kestrels generally pair in the spring and early summer on their breeding grounds. However, over multiple years we have observed several kestrels exhibiting the unusual behavior of winter pairing in north-central Texas. We hypothesized that some American Kestrels may pair in the winter as an adaptation to improve their over winter survival. Specifically, we suggest that pairs may be dominant over single kestrels, and thus, have access to better foraging habitat and opportunities. To evaluate this hypothesis, we trapped, banded, uniquely marked, and observed both single and paired kestrels ( $n = 65$  birds). We found that paired kestrels had an average of 5.60 foraging attempts per hour observation ( $n = 6.72$  hrs of observation) compared to unpaired kestrels that had 2.54 attempts per hour ( $n = 17.37$  hrs of observation). Also, kestrel pairs had a 67% success rate per forage attempt ( $n = 84$ ) and single unpaired kestrels had a success rate of 50% ( $n = 52$ ). These data suggest that winter pairing may increase a kestrel's food intake compared to a single kestrel thus aiding in winter survival. Further, we estimated that males in pairs have a 54% foraging success rate ( $n = 32$ ) compared to 50% when single ( $n = 22$ ). Females had a 52% success rate when paired ( $n = 52$ ) and 53% when single ( $n = 30$ ). Overall, these data seem to support our suggestion that winter pairing behavior may be an adaptation to facilitate improved opportunities to forage and gain access to higher quality habitat, especially for male kestrels, but further observations are needed to test this hypothesis.

### Diet and Provision Rates of American Kestrels in Natural Environments and Pampean Agroecosystems (Poster #41)

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Argentinean agroecosystems have suffered a marked process of agriculture expansion and intensification in the



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last decades. The substitution of natural habitats by crops can completely alter food abundance and availability for raptors. We searched for changes in diet composition and in parental investment of American Kestrels (*Falco sparverius*) in areas of intensive agriculture, traditional agriculture and natural semi-arid forests of central Argentina. We analyzed video recordings at 30 nest boxes during the nestling period in the 2017 breeding season (n = 97.5 hours). Diet diversity was greater in agricultural areas than in the Caldén forests, suggesting a functional response in the species diet. Although no statistical differences were found in the frequency of consumption of the main prey items among study areas, the relationships observed match those of previous diet analysis in the area. The biomass contribution to nests did not vary between areas. However, the provision rate was higher in agricultural areas and lower in the Caldén forest. Males and females showed a differential provision rate that changed with nestling age, where females contributed more towards the end of the breeding season. These results suggest a role division between sexes. In addition, the reproduction in agricultural areas demanded a greater parental investment, possibly due to lower availability of the most suitable prey and a diversification of the diet including less profitable items. Further studies are needed to quantify the possible costs to adults of this higher parental investment in agricultural lands and to analyze if these costs are also transferred to nestlings.

### Testing for Anticoagulant Rodenticide Poisonings in the California Spotted Owl Using a Non-invasive Technique (Poster #42)

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Illegal marijuana cultivated on public lands have been a conservation challenge since the 1990s due to both diversion of natural stream flows for irrigation and presence of a variety of chemical compounds applied to the landscape. There is growing evidence and concern that marijuana cultivation poses a risk to many top predators due to the unregulated use of second generation anticoagulant rodenticides (ARs) in forest ecosystems. In the Pacific Northwest, ARs used at these sites have been shown to have negative effects to predators such as the state-listed Pacific fisher (*Martes pennant*) and Northern Spotted Owl (*Strix occidentalis caurina*). The most common approach to measuring AR exposure in wild populations of owls is to collect a liver sample from a dead individual. However, this approach may underestimate exposure rates because there may be sub-lethal exposure that is not detected. Here, we develop a pilot study that addresses AR exposure in live California Spotted Owls and

focus on potential sub-lethal exposure by sampling owl pellets – a non-invasive approach for determining AR exposure. We collected pellets from 21 different nests/locations of breeding Spotted Owls in four different counties of northwestern California. Pellets were dissected to determine diet before being tested for ARs by a third-party laboratory. The results of this pilot program will provide an alternative approach for determining AR exposure in a wild population of conservation concern.

### Use of Unmanned Aircraft Systems to Cost Effectively Monitor Golden Eagle Nesting (Poster #43)

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Dugway Proving Ground (DPG), located in west-central Utah, is a U.S. Department of Defense (DoD) test site for chemical and biological defensive testing; it is also home to multiple breeding pairs of Golden Eagles (*Aquila chrysaetos*). The presence of an eagle nest has the potential to stop military testing and training due to potential nest disturbance. It is therefore vital to DPG and similar DoD installations to fully understand the location and status of active eagle nests on military lands. Using Unmanned Aircraft Systems (UAS) and Small Unmanned Aircraft Systems (sUAS), it may be possible to obtain accurate locations and status updates of eagle nests on DoD lands more efficiently than can be accomplished on foot. In order to test this new technology, we designed a blind study conducting weekly Golden Eagle nest surveys on DPG during the 2019 and 2020 nesting seasons to compare the effectiveness of three “survey systems”: 1) a ground-based human observer, 2) a commercially available sUAS, and 3) one or more military-grade UAS platform(s). During our pilot season, the sUAS observation team proved most efficient at locating active nests, identifying one active nest in 15d, and a second in 56d. The UAS team was the most efficient nest observer, taking an average of 8min to determine an accurate nest status and spending an average of 22min per territory visit. The ground-based team was the most effective at accurate aging of chicks. The sUAS team was the most effective at locating previously unknown nests, finding three new nests in two territories. Though this is only our pilot year, both sUAS and UAS platforms show promise as potential tools for monitoring nesting raptors effectively and efficiently.



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### **Influence of Drought on Nest Phenology of the Burrowing Owl Throughout the Great Plains Region (Poster #44)**

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The Burrowing Owl (*Athene cunicularia*) is a species of national concern in the United States, with the most pronounced declines in the Great Plains. We have observed both advances and delays in nesting along with increasing variation in nest initiation dates. We propose that climate change, specifically the occurrence of prolonged drought, is a contributing factor to the apparent delays. Using a long-term dataset that spans a latitudinal gradient from South Dakota to northern Mexico and includes 1,848 nests, we evaluated the influence of climatic events and weather patterns throughout the Burrowing Owl's annual cycle on nest initiation dates using multinomial logistic regression. We found moisture conditions during the winter and migratory period to have the greatest influence on timing of nesting. Our results suggest years with more intense drought on winter and migratory grounds increased the probability of nests initiating late relative to early. Using fitted values from the multinomial regression we developed predicted probabilities, where above normal "wet" conditions on the winter and migratory grounds increased the probability of nests initiating early. Amounts of rainfall can affect food availability, where drought may decrease food abundance resulting in delays in the ability of individuals to meet energetic demands required for migration. How climate change will impact Burrowing Owl phenology is important in light of increasing drought within the Great Plains and declining owl population trends.

### **Differences in Migration Patterns of Central and East European and East Asian Meta-populations of Saker Falcons (*Falco cherrug*) (Poster #45)**

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Saker Falcon is a Eurasian, partial migratory species with a large distribution range, of which individuals show a wide range of migration patterns from being sedentary to being long-distance migrants. Despite several satellite-tracking studies of this species across its distribution range in recent years, migratory behavior of various meta-populations has not yet been fully described. We analyzed satellite tracking data of 90 juveniles (1cy) and 54 adult (breeder) Saker Falcons tagged in Central and Eastern Europe, and in East Asia between 2007 and 2019. We compared migration timing, distance, course and position of wintering areas (WA) to temporary settlement areas (TSA) or eyries before the start of migration. Results suggest different migration strategies of European and East Asian Saker Falcons. All tracked juveniles started migration both in Europe and Asia; however, the migration distance varied from <100 km to >3000 km. European juvenile sakers migrated in the southwest direction (210° on average) regardless of the position of the last TSA before migration, showing a comb-like parallel pattern across Europe. Juveniles tagged in Asia showed a funnel-shaped migration pattern towards the Tibetan Plateau. Satellite tracking data suggest that the Altai Mountains – shared by Russia, Mongolia, China and Kazakhstan – divide the different migration patterns. Females of the European population tended to migrate farther, and only females crossed the Mediterranean Sea. We did not find a sex-specific migration pattern in the Asian population. Adult sakers migrated partially in both populations: some did not migrate, some migrated relatively short distances. Some sakers showed the classical long-distance migration pattern every year, whereas others did not migrate every year, possibly depending on availability or access to prey. Migrating adults used the same WAs in subsequent years.

### **Migration and Demographics of Northern Saw-whet Owl (*Aegolius acadicus*) in Autumn in the Ozark Highlands (Poster #46)**

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The Northern Saw-whet Owl is a small forest owl of northern North America. During fall migration, the species is widely captured at banding sites in eastern North America and the Great Lakes region, though the extent of their nonbreeding distribution remains poorly understood. Several exploratory studies outside the species' currently accepted range have resulted in captures during fall migration. In the Ozark Highlands ecoregion of the central United States, their status has been considered vagrant during the nonbreeding season based on scattered historic records. Since 2010, Northern Saw-whet Owls have been captured successfully in the Ozark Highlands. We sought to assess fall migration and demographics of 412 Northern Saw-whet Owls captured at four sites in the Ozark Highlands of Missouri ( $n = 292$ , 2 sites), northern Arkansas ( $n = 81$ , 1 site), and eastern Oklahoma ( $n = 39$ , 1 site). Northern Saw-whet Owls were captured from mid-October to early-December. Capture rate varied among sites, as well as latitudinally. Irruptive movements were observed during two sampling years, resulting in an increase in overall capture rate and an increase in the proportion of hatch-year owls captured. A strong female bias was observed in all years. In an attempt to explain variation in Northern Saw-whet Owl captures, log-linear modelling was used to consider 12 models incorporating three variables: sex (F, M), age class (AHY, HY), and migration type (irruption, non-irruption). An AIC approach was used to assess model support. Results suggested regional demographic trends in Northern Saw-whet Owl migration were most affected by interactions between age and migration type, sex and migration type, and age and sex. Based on band recoveries, Northern Saw-whet Owls captured in the region appear to pass through the western Great Lakes. This study establishes the Northern Saw-whet Owl as a regular fall migrant through the Ozark Highlands.

### Are Mississippi Kite Attacks on Urban Pedestrians Associated with Nesting Phenology? (Poster #47)

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Birds that have adapted to urban landscapes often display changes in their behavioral responses to human disturbance. This habituation may also result in a decreased wariness and secrecy around their nest and an increased inclination to engage in aggressive nest defenses. Aggressive defense of nests has been noted among Mississippi Kites (*Ictinia mississippiensis*), a raptor that has become a common and abundant urban nesting

species in towns and cities across the Southern Great Plains. Defensive behaviors include swoops at, and occasional physical contact with, humans who venture close to nests. Depending on location, previous research found aggressive responses in 16-20% of experimental trials. However, the influence of nestling ontogeny on nest defense by adults has not been assessed. We examined Mississippi Kite responses to pedestrians in public green spaces in Lubbock, Texas. We assessed responses during each wk of nestling development to explore possible increases or attenuation of aggressive behaviors. During our experiments, we first conducted a 'baseline' trial in which the trial pedestrian replicated the most common human traffic pattern in the area (e.g., walking on a nearby sidewalk, walking from a parking lot to a building). Our experimental trial then consisted of a trial pedestrian approaching the nest on a random selected bearing from a 60m start point, walking directly under the nest, and continuing on another 60 m to the end point. An observer recorded behavior of the adult(s) during the baseline and experimental trials. Responses were recorded on a scale of 0 (no response) to 5 (physical contact). As this study is currently ongoing, the results of this experiment at 20 Mississippi Kite nests in 2019 are pending.

### Estimating Lengths of Telomeres Extracted from Different Source Tissues of American Kestrels (Poster #48)

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Telomeres are repeat bases on DNA that shorten with age and exposure to stressors. Telomere length is used as a metric of fitness, stress and longevity in basic and applied wildlife research. In birds, most telomere research is based on DNA extracted from blood samples; however, blood collection may be considered invasive and require specialized training. Alternatively, tissue attached to the tips of feathers may provide a source of genomic DNA, and feather collection may be considered less intrusive than blood collection. However, it is not clear whether telomere lengths are consistent across these different tissue types in American Kestrels (*Falco sparverius*). We compared relative telomere lengths of DNA extracted from paired feather and blood samples from 12 American Kestrels wintering in Boise, Idaho. We determined relative telomere lengths by quantitative polymerase chain reaction (qPCR). Results indicate that there is no significant correlation between relative telomere length estimates obtained from blood and feather samples in individual birds. In general, the lack of correlation is likely





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the result of the mixture of cell types around feather follicles as well as their inconsistent collection by feather plucking. Overall, the results of this study suggest that tissue type should be considered when making comparisons across studies of telomere lengths, and that feather collection may not be an alternative source of DNA for longitudinal studies that have collected blood.

### **Variable Hawk (*Geranoaetus polyosoma*) is a Rare Nesting Species in Southern Continental Patagonia, Santa Cruz Province, Argentina (Poster #49)**

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The variable hawk is widely distributed on both sides of the Andes Mountains in South America. In Argentina, variable hawks inhabits northwestern, central and southern parts of the country, but current information on its breeding distribution and conservation status for most of Argentine provinces is lacking. Raptor nest surveys in Santa Cruz province, southern continental Argentine Patagonia, during the breeding season of 2008-2011 revealed only four active nests (2 in 2008 and 2 in 2010), plus one additional nest (2011) with evidence of have been used earlier in the breeding season. Additional ornithological surveys in Santa Cruz province between 1994 and 2018 revealed two other nests (one in 2002 and one in 2004). Results of our surveys suggest that the variable hawk breeds in very low number in southern continental Patagonian steppes, grasslands and coastal biomes of Santa Cruz province. This low number of nesting pairs supports previous reports and observations on the rarity of the species in this province and contrast with results from northeastern Patagonia, where it breeds at high densities. Reasons for variable hawk low breeding abundance in southern continental Argentine Patagonia are not clearly understood, but both natural (low prey diversity and abundance) and anthropogenic causes (direct persecution and poisoned baits) seem to be likely factors and may have important conservation and ecological implications for this species in this region. New censuses and nest surveys are needed to monitor variable hawks' population in southern continental Patagonia and understand the causes for its low breeding abundance.

### **Prevalence of Non-target Species in an American Kestrel (*Falco sparverius*) Nest Box Program and Effectiveness of Abatement Methods Targeting European Starlings (*Sturnus vulgaris*) (Poster #50)**

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To study colonization and occupancy rates of nest boxes as a conservation tool, we installed and monitored 56 American Kestrel nest boxes in spring and summer of 2018 and 88 nest boxes in 2019 in the Central Valley of California. The prevalence of non-target species was higher than expected while American Kestrel occupancy was lower than expected. European Starling nests were present in 46.4% of the boxes in 2018 and 43.1% in 2019 and American Kestrels occupied just 10.7% of the nest boxes in 2018 and 11.4% in 2019. Boxes were also occupied by Western Screech-Owls (*Megascops kennicottii*, 1.8% of the boxes in 2018 and 1.1% in 2019) with additional occupancy by Ash-throated Flycatchers (*Myiarchus cinerascens*), House Wrens (*Troglodytes aedon*), Wood Ducks (*Aix sponsa*), and small mammals. Due to the high occupancy of European Starlings in the nest boxes and to reduce impacts to American Kestrel from competing European Starlings, we implemented management practices to limit European Starling nest success. Nest removal, egg removal, and egg addling (all used in 2018) proved to be ineffective methods for management as European Starlings would rebuild nests, relay eggs, and 57.4% of eggs addled hatched. In 2019 we oiled almost all eggs found and this proved to be effective in limiting hatch success as well as reducing the likelihood that the adults would reinitiate nesting attempts. European Starling hatching success in 2018 was 81.0% while hatching success in 2019 was 29.4% (all eggs hatched were not oiled).

### **Protocol-adherence Behaviors of Citizen Scientists Working with the American Kestrel Partnership (Poster #51)**

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Citizen scientists can aid researchers interested in tracking continental-scale patterns due to their potential to collect data across vast geographic expanses, given that they adhere to established protocols. The American Kestrel Partnership (AKP) is a citizen science-based project of The



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Peregrine Fund that aims to gain a greater understanding of demographic trends in the widespread but declining falcon, American Kestrel (*Falco sparverius*). AKP partners across North America are asked to follow protocols regarding installing and consistently monitoring nest boxes. Here, we analyze some of the protocol-adherence behaviors of AKP's citizen scientists. Specifically, we summarize data on the AKP's nest box records for several nest box characteristics, including nest box orientation, mounting surface (e.g., tree, pole, building, etc.), land ownership (i.e., public vs. private land), bedding type, if boxes were cleaned annually, and presence and type of predator guards. We also analyze box-monitoring behaviors and their relationship to the number of boxes a partner owned (i.e., <10 vs. >10 boxes). From 2012 to 2018 the number of registered boxes increased steadily over time from 100 to over 3,000. We found that most nest boxes were installed according to AKP's basic guidelines (i.e., holes oriented toward the south-southeast, containing wood shavings) and most (85%) were cleaned annually. On average, partners that owned ten or more boxes were more likely to monitor their boxes each year since box installation. Regardless of installation year or the number of boxes a partner owned, however, we found that box monitoring decreased steadily with each year since installation. This study elucidates the tendencies of AKP's citizen scientists and informs program managers on topics that may require alternative communication strategies.

### **Genetic Diversity of Northern Goshawks (*Accipiter gentilis*) in Ashley National Forest, Utah and Gene Flow with Adjacent Forests (Poster #52)**

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The Northern Goshawk ranges from Alaska to Mexico in the Americas, inhabiting a variety of forest types with habitat fragments separated by up to several hundred kilometers. They are partial migrants, with individuals at higher latitudes more likely to migrate. While adults tend to have high nest site fidelity, juveniles have been observed dispersing great distances. These long natal dispersal distances help to connect distant populations and contribute to the genetic diversity and health of the populations they join, mitigating the risk of inbreeding in small populations. In this study, we focus on the Northern Goshawks in Ashley National Forest (ANF) in Northeastern Utah and populations in adjoining states. The purpose is to explore the amount of genetic diversity within the ANF, as well as the level of connectivity and gene flow with adjacent populations. DNA is being collected in the form of blood, fecal samples, and loose feathers, and will be sequenced using RADseq.

### **Reproductive Success Increases with Age in American Kestrels, Especially in Breeding Males (Poster #53)**

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Age-related differences in reproductive success have been well documented in many species of birds. The experience gained through successive breeding attempts can improve survival skills, foraging abilities, access to resources through social dominance, and familiarity with each stage of reproduction. In this study we examined 669 nesting attempts by American Kestrels (*Falco sparverius*) from a population that bred in nest boxes in northwestern New Jersey from 1995 to 2018. We tested the hypothesis that older kestrels would have greater nesting success than those during their first reproductive attempt. Clutch size, hatching rate, and the number of chicks that survived to fledging varied significantly and positively with age for both male and female breeders. These trends were associated with the date of clutch initiation and amount of parental attentiveness. Older birds initiated clutches earlier than those in their first breeding attempt and were more likely to be observed in the vicinity of the nest site, especially during the incubation and nestling periods. The relationship between age and breeding success was much more pronounced in males than in females. This difference is consistent with the behavioral role that each sex has during a breeding attempt. After laying a clutch, the female performs most of the incubation and she broods the young chicks. In contrast, the male provides food to the female prior to and during egg laying and throughout incubation, and to the entire family until the chicks no longer are brooded by the female. Pairs in which both adults were older had significantly greater nesting success than mixed or young pairs, and we never observed an older female paired with a male in his first reproductive attempt.

### **Hello, is it Me You're Looking For? Northern Goshawk Nest Occupancy Cycles in the Ashley National Forest (Poster #54)**

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The Northern Goshawk (*Accipiter gentilis*) is currently listed as a sensitive species and management indicator species by the U.S. Fish and Wildlife Service. As top tier predators, they are often sensitive to changes in their habitat making their population data pertinent to forest management. The Ashley National Forest in Northeastern Utah has been conducting annual nesting season surveys



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of the Northern Goshawk for 27 consecutive years to assess the frequency of nest occupancy and nest success in identified historic territories. Our population data suggests a 2 to 4-yr cycle in fledgling success. We also identified a cycling of the occupied nest territories, and a decrease in the trendline of both fledgling success as well as nest site occupancy. We will discuss possible drivers of the identified trends and environmental factors that could be impacting our population.

### **Incorporating Biotic Interactions at Macro-Scales Improves Species Distribution Models for the Harpy Eagle: Implications for Conservation Planning (Poster #55)**

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Explaining species distributions and identifying environmental constraints on species' ecological niches is a central goal in conservation biogeography. A current paradigm in biogeography states that climate regulates species distribution at macro-scales and that biotic interactions are unimportant due to the large extent and the inherent noise in coarse-grain data. Species Distribution and Ecological Niche Models are spatial and statistical modelling methods used to correlate the underlying environmental data from known species occurrences, predicting biogeographical patterns and determining environmental processes regulating distribution. However, this spatial information is lacking for many rare and threatened raptors, particularly in tropical regions. The Harpy Eagle (*Harpia harpyja*) is a Neotropical raptor of conservation concern, with a broad but sparse distribution across Central and South America. Currently Harpy Eagles face threats from habitat loss and persecution and are categorized by the IUCN as Near-Threatened. Using a point process modelling framework, we show that climatic and topographical predictors can largely explain Harpy Eagle geographical distribution, but that incorporating predator-prey interactions improves model predictive power at macro-scales. In a climate-topography model, Climatic Moisture Index was the most important predictor explaining Harpy Eagle distribution, contributing 61.85% to model prediction, followed by minimum temperature of the warmest month contributing 14.77%. In a climate-topography-biotic model three-toed sloths (*Bradypus spp.*) were the most important biotic predictor, contributing 70.77% to model prediction, followed by Climatic Moisture Index contributing 13.58%.

Assessing Harpy Eagle distribution in environmental space revealed the influence of similar climatic variables to geographical space, but also that seasonal rainfall patterns may determine Harpy Eagle occurrence. This study provides fundamental biogeographical information on distribution and abundance for the Harpy Eagle useful for conservation planning, and that even at continental scales the asymmetric nature of Harpy Eagle distribution can be detected within its main prey distributions.

### **A Methodology for Systematic Mapping in Raptor Biology (Poster #56)**

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The current state of raptor biology consists of a small handful of raptor species representing the majority of cited research, while a large portion of species have virtually gone unstudied. With over 500 raptor species globally, limiting our knowledge base is an impediment to conservation efforts. Alleviating this knowledge gap requires a collated database of raptor research to expedite the literature review process. As such, The Peregrine Fund and collaborators are developing a systematic mapping protocol for raptor species to better inform stakeholders of the current state of raptor research per species. Using the RepOrting standards for Systematic Evidence Syntheses (ROSES) protocol guidelines, a methodology for systematic mapping of raptor species was constructed and the stages described: stakeholder engagement; objective of the review; methods; searches; screening and inclusion criteria; critical appraisal; data extraction; data synthesis and presentation; and declarations. This method results in the synthesis of a comprehensive body of evidence pertaining to the raptor species in question. Furthermore, this method allows for an objective and repeatable standard of information extraction with the broader goal of creating a centralized database of raptor literature to act as a reference tool for conservation efforts. Preliminary efforts involving the California condor (*Gymnogyps californianus*) resulted in 255 literature items identified of which 165 were extracted as a PDF, while the screening process remains ongoing. Future research directions include using the California condor as a test species for our mapping protocol and as a proof-of-concept to inform subsequent raptor species mapping endeavors.



## Poster Session Abstracts

### Relationships between Migratory and Resident Burrowing Owls in Northern California (Poster #57)

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Western Burrowing Owls (*Athene cunicularia hypugaea*) are year-round residents at low elevation (0-18 m) breeding sites in Santa Clara County, California, U.S.A. Burrowing Owls have also been anecdotally documented during winter in this region at non-breeding sites, but the relationship between Burrowing Owls seen in winter and resident birds has not been previously determined. The objective of this study was to assess the spatial and temporal associations between resident Burrowing Owls and Burrowing Owls observed in winter. During four years of trapping and banding owls in winter and summer in Santa Clara County, we found Burrowing Owls each winter at high elevation sites (approximately 80-260 m) where birds were not known to breed. We never resighted a banded resident bird at a high-elevation winter site. Similarly, no birds banded in winter at high elevation were resighted during the breeding season either at any of the breeding sites or at the sites where they wintered. Besides wintering at high elevation sites, additional owls joined resident birds at the low elevation breeding sites each winter and then disappeared before the next breeding season. Eight Burrowing Owls we banded in one winter were seen the next winter, but were not observed in the intervening summer in Santa Clara County. Also, we captured a bird in winter that had been banded as a juvenile the previous summer in British Columbia. These findings show Burrowing Owls in this region exhibit partial migration, in which owls from other parts of the range winter with resident birds—as well as wintering in other areas of the region—but then leave to breed elsewhere. This migration pattern may have implications for the persistence of this and other resident Burrowing Owl populations.

### Influence of Nestling Number on Foraging Habits of Ferruginous Hawks in the Morley Nelson Snake River Birds of Prey National Conservation Area, Idaho (Poster #58)

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U.S.A. **TODD KATZNER**, U.S. Geological Survey, Boise, ID, U.S.A.

Reproductive output of wildlife is often influenced by diet, and as such it is important to quantify diet to further understand its influence on demography and ecology. Ferruginous Hawks (*Buteo regalis*) are a large raptor associated with grasslands and colonial rodents. Clutch size of these birds is generally up to six nestlings, although there is substantial inter-nest and inter-annual variation in reproductive output. We used motion sensitive digital videography to measure diet and reproductive output of Ferruginous Hawks in southwestern Idaho. Preliminary analysis suggests that the most common prey species brought to nests were Piute Ground Squirrels (*Urocitellus mollis*) and Kangaroo Rats (*Dipodomys* spp.). Other taxa brought to nests included snakes, lizards, birds, and unidentified small mammals. Total biomass of prey delivered differed by the number of nestlings, however biomass per nestling did not vary. There was also evidence that the diet of these hawks changed over the course of the nesting season by species and abundance of prey. Next steps for this project are to identify characteristics of diet associated with variation in reproductive output of Ferruginous Hawks. This study will provide insight in how this declining species may be influenced by the rapid changes occurring within grassland and shrub-steppe habitats.

### Who Gets the House? Spatial Consequences of Mate Turnover Amongst Swainson's Hawks (Poster #59)

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Monogamous breeding behavior is the predominant reproductive strategy amongst avian taxa and is assumed to increase reproductive success. Selecting a reliably suitable mate in familiar territory provides birds the greatest chance of successful reproduction compared to birds seeking adequate resources in novel habitat with an unproven mate. Despite the apparent advantages of mate philopatry, instances of divorce or mortality cause some birds to form new pair-bonds. This mate turnover, be it obligate or facultative, has potential impacts on individual reproductive fitness via relocation of nesting site concordant with future pairing. This provides evidence for which sex is responsible for specific site selection within an established territory, under the assumption that if the distance was small the new mate would have had no preference in selection and simply acquiesced to the survivor. We investigated these spatial consequences of mate turnover within a population of Swainson's Hawks





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(*Buteo swainsoni*) in northern California. Using individually marked birds, we tracked pair formations and disintegrations over a thirty-year span. We hypothesized that the birds who lost a mate due to mortality would retain the original territory. In cases of divorce we predicted sex would determine which individual of the pair would retain the original territory. Investigating the spatial consequences of mate turnover in regards to sex specific breeding site selection allows us to better understand the dynamics of reproductive behavior in Swainson's hawks and how the species adapts to disruptions in normal monogamous pairing.

### Merlin Brood Sex Ratios: Influences of Parents, Nest Mates, and Populations (Poster #60)

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Population-level estimates of offspring sex ratios typically approximate equity whereas biased ratios within nests are not uncommon. In sexually dimorphic raptors, the costs and relative fitness benefits of rearing male and female progeny vary with changing environmental circumstances. This may lead to substantial deviations from balanced investment in offspring of a particular sex by individual parents. Based on a 13-year dataset for breeding Merlins (*Falco columbarius*) in Saskatoon, Saskatchewan, we used a model selection approach to assess the influence of parental and nest-mate features on within-nest sex ratio during the nestling phase. Along with brood size for each nest (n=140), models incorporated data on putative parental male age (known from banding) and size (wing chord) along with parental female age (either first-time or experienced breeder) and size. We also assessed the population-level offspring sex ratio based on a 19-yr dataset during an initial period of population growth (8 yr, 10 to 21 pairs) and then fluctuation (11 yr, between 24 and 33 pairs). Models including the brood size of the nest and age of the putative male parent received the strongest support ( $\Delta AIC < 2$ ). Following Trivers and Willard's (1973) prediction, as brood size increased there was a higher proportion of male offspring (the smaller, cheaper sex to produce). Likewise, older male parents were associated with a lower proportion of males in the brood; older males with greater experience presumably can supply more food and so support more female offspring in the nest. While there was no drop in the number of young per nest as the overall merlin population increased, there was a significant increase in the proportion of male offspring produced; overall population density may adversely affect the capacity of males to provide sufficient food to support female offspring.

### Spatial Modeling of American Kestrel Breeding Phenology Across the Continental U.S.A. (Poster #61)

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Phenology—the seasonal timing of life-history events—is a critical aspect of a species' natural history. Breeding phenology is particularly important, and has major individual fitness and population consequences. Climate change is impacting the phenology of many bird species, but we still have a limited understanding of the environmental drivers of breeding phenology and how timing varies spatially. American Kestrels (*Falco sparverius*) are extensively monitored across North America, and are undergoing population declines in some portions of their breeding range. Using continental-scale data obtained from professional and community science nest box programs (American Kestrel Partnership and Cornell NestWatch), we related the timing of egg-laying in kestrels to a suite of climate and ecological variables. We modeled breeding phenology within a Bayesian framework using integrated nested Laplace approximation, which provides a computationally efficient means of accounting for the spatial dependence across nest box locations. We found that first egg dates were correlated with each other within a range of approximately 500 km, and the spatial pattern in breeding phenology was complex and did not exhibit a simple latitudinal cline. Start-of-spring date, derived from vegetation phenology, had the strongest effect on the timing of breeding. Such spatial analyses can provide insight into the patterns and drivers of breeding phenology, and highlight community science programs as an important source of data for avian phenological research.

### An Examination of Extra-Pair Paternity Rate in a Suburban Population of Red-Shouldered Hawks in Southwestern Ohio, USA (Poster #62)

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Advances in genetic techniques in the last 20 yrs have revealed that fewer than 25% of all socially monogamous bird species studied practice true genetic monogamy. Among raptor species studied, genetic monogamy seems



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to prevail in most. However, it should be noted that relatively few species have been studied (<25), and even fewer which occupy human-dominated landscapes (<5). The highest extra-pair paternity (EPP) rate was found in an urban population of Cooper's Hawks (*Accipiter cooperi*) in Milwaukee WI, with 34% (15/44) of the broods within that population containing extra-pair young. It is unclear, however, how much the effects of their environment played a role in this breeding strategy being implemented, and how many other species in human-made systems behave similarly. It is clear, though, that EPP rates can vary widely between species, indicating the need for further examination in order to develop a better understanding of the drivers behind this strategy, and, ultimately, effects of EPP on breeding performance. Preliminary work has been conducted to determine if EPP occurs in the Red-shouldered Hawk (*Buteo lineatus*) population in the suburban area of Cincinnati OH, with breeding age and nestling individuals trapped, color banded, and sampled just prior to and during two breeding seasons between December 2017 and June 2019. Initial observations suggest that conditions may be present that promote the occurrence of extra pair copulation, with birds previously banded in a known territory later observed or re-trapped while attending a nest in a different territory. Whether this may just be due to fluidity of individuals across territories between years or territory boundaries having greater overlap during the winter, laboratory analysis of the blood samples collected from these individuals, as well as samples collected from the broods attended to by these individuals, could reveal whether or not EPP occurs in this population.



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## Conference Agenda

Thursday, November 7			
	Salon VI/IV	Salon III	Salon II
8:00 am	Welcome		
8:20 am	Leaving a Legacy <b>Dan Varland</b>		
8:40 am	Plenary: When a Conservation Conflict Comes Full Circle - And Why This Is So <b>Rocky Gutiérrez</b>		
9:40 am	Break	Break	Break
	<b>Andersen Award Session</b> Brent Bibles	<b>Falconry Symposium I</b> Nathan Bickford	<b>Migration</b> Robert Miller
10:00 am	Linking Human Impacts with Changes in the Abundance and Diversity of Migrating Raptors Recorded at Hawk Mountain Sanctuary, Pennsylvania <b>Patricia Dumandan</b>	Red-tailed Hawk densities and hunting habitat in south-central Nebraska <b>Nate Bickford</b>	Differences in Migration Patterns of Central and East European and East Asian Meta-populations of Saker Falcons ( <i>Falco cherrug</i> ) <b>Matyas Prommer</b>
10:20 am	Flight Characteristics of Migrating Swainson's Hawks Across a Variable Landscape <b>Katheryn Watson</b>	The Use of Trained Raptors in Field Research <b>Clint Boal</b>	What We Know about Raptor Migration within South America <b>Matias Juhant</b>
10:40 am	Does this Radio Transmitter Make Me Look Delicious? A Field-informed Agent-based Modeling Approach to Understanding Transmitter Impacts on Raptor Selection of Prey <b>Rebecca Perkins</b>	Perspectives on Conservation: A Survey of North American Falconers Association Members <b>Kenneth Wallen</b>	Raptor Migratory Connectivity in the Americas: Linking Peregrine Falcons ( <i>Falco peregrinus</i> ) Wintering in Peru with their North American Natal and Breeding Grounds <b>Nico Arcilla</b>
11:00 am	Developing Massively Parallel Sequencing Multiplexes for Raptors: High Discrimination for Conservation and Forensics Applications <b>Jordan Beasley</b>	Using Falconry and Anthropology to Mitigate Human-Wildlife Conflict, Promote Eagle Conservation, and Understand How Humans and Eagles Think About One Another <b>Lauren McGough</b>	Big Data from Remote Tracking of Raptors: Golden Eagles on Migration in Western North America <b>Jessi Brown</b>
11:20 am	Non-target Exposure of Toxins to Raptors: Anticoagulant Rodenticides and Ferruginous Hawks <b>Ariana Dickson</b>	Falconry and Traditional Ecological Knowledge: The crossroads of an ancient culture and the genesis of raptor conservation <b>Michele Losee</b>	Year-round Northern Saw-whet Owl Movements Through a Banding Station in Central Alberta, Canada <b>Lisa Priestley</b>
11:40 am		A Falconers' Role In Raptor Rehabilitation: A Blueprint For Success <b>Vickie Joseph</b>	Differential Migration in Rough-legged Hawks ( <i>Buteo lagopus</i> ) <b>Neil Paprocki</b>
12:00 pm	Lunch	Lunch	Lunch





## Conference Agenda

Thursday, November 7			
	Salon VII/IV	Salon III	Salon II
	<b>Advances in Raptor Research Methods</b> Steve Slater	<b>Falconry Symposium II</b> Nathan Bickford	
1:20 pm	Assessing Population-Level Consequences of Anthropogenic Stressors on Raptors <i>Todd Katzner</i>	Ancient Splinting Techniques: A Modern Solution to Minimizing Invasive Veterinary Care in Raptors <i>Jamaica Smith</i>	
1:40 pm	VultureNet: Connecting Technology and Organisms in the Internet of Wildlife™ <i>Michael Lanzone</i>	Rehabilitation of The Golden Eagle: A Free Flight Conditioning Program <i>David Mikesic</i>	
2:00 pm	Testing the Utility of Step Selection Functions to Evaluate Winter Resource Selection of Golden Eagles at Multiple Spatial Scales in Yellowstone National Park <i>David Haines</i>	Falconry Panel Discussion	
2:20 pm	Back to the Old Days: The Advantage of a Sharp Eye in Today's Ecology <i>Matias Juhant</i>	<b>Contaminants, Conflict, and Conservation</b> Matt Stuber Feathers Indicate Golden Eagles ( <i>Aquila chrysaetos</i> ) are Lead Poisoned More Frequently and to Higher Levels than is Evident in Blood <i>Todd Katzner</i>	
2:40 pm	Artificial Nests Facilitates the Breeding Success of Gyrfalcons <i>Kenneth Johansen</i>	Immunity and Sub-Lethal Lead Exposure in Golden Eagles Nestlings <i>Christopher Vennum</i>	
3:00 pm	<b>Genomics, Systematics, and Taxonomy</b> Becki Perkins What is a Raptor? A New Definition of Raptors and Birds of Prey <i>Christopher McClure</i>	Human-Predator Conflicts in Northwestern Argentina, the Particular Case of the Andean Condor <i>Juan Grande</i>	
3:20 pm	Conservation Genetics and Genomics of the Swainson's Hawk ( <i>Buteo swainsoni</i> ): A Next-Generation Sequencing Approach <i>Emily Abernathy</i>	Endangered Black Harriers ( <i>Circus maurus</i> ) in South Africa: What Have We Learned and Where Should We Be Moving Forward for its Sustainable Conservation? <i>Marie-Sophie Garcia-Heras</i>	
4:00 pm			<b>ECRR Reception</b>
5:00 pm			<b>Poster Reception</b>



Friday, November 8			
	Salon VI/IV	Salon III	Salon II
8:00 am	Announcements		
8:20 am	Plenary: Lessons I Have Learned <b>Gary White</b>		
9:20 am	Break	Break	Break
	<b>Vulture/Condor Symposium I</b> Munir Virani/Andre Botha	<b>Impacts of Energy Development on Eagles</b> Rick Harness	<b>Foraging Behavior and Prey Selection</b> Michele Losee
9:40 am	Impacts of Complex Mixtures Including Endocrine Disruptors and Metals <b>Mary Ann Ottinger</b>	Survival and Causes of Mortality Among Pre-breeding Age Golden Eagles in the United States Southern Plains <b>Robert Murphy</b>	American Kestrel ( <i>Falco sparverius</i> ) Food Habits: Surprises and Unintended Consequences of Conservation Actions <b>Clint Boal</b>
10:00 am	Lead Exposure in Southern Californian Turkey Vultures ( <i>Cathartes aura</i> ) Before Full Implementation of the 2019 Lead Ammunition Ban <b>Miguel Saggese</b>	Risk of Golden Eagles Colliding with Wind Turbines in California, USA <b>Adam Duerr</b>	Of Lemmings and Squirrels: Prey Switching in Arctic Peregrine Falcons ( <i>Falco peregrinus tundrius</i> ) <b>Kevin Hawkshaw</b>
10:20 am	Ecological Correlates of Lead Exposure of Facultative and Obligate Avian Scavengers in Eastern North America <b>Vincent Slabe</b>	Flight Behavior of Golden Eagles in Wyoming: Implications for Wind Power <b>Tricia Miller</b>	Food Provisioning, Prey Composition, and Nesting Success of Ospreys in Northwestern California <b>Michael Academia</b>
10:40 am	The Influence of Lead and Organochlorine Exposure on the California Condor Stress Response <b>Zeka Glucs</b>	Collision Avoidance by Wintering Bald Eagles Crossing a Transmission Line <b>Jeff Luzenski</b>	Golden Eagles Shift Primary Selected Prey <b>Ross Crandall</b>
11:00 am	Detection of Two Emerging Pathogenic Gammaproteobacteria, <i>Wohlfahrtiimonas chitiniclastica</i> and <i>Ignatzschineria</i> spp., in a Turkey Vulture ( <i>Cathartes aura</i> ) from Southern California <b>Miguel Saggese</b>	A Spatially Explicit Model to Predict the Relative Risk of Golden Eagle Electrocutations <b>Geoffrey Bedrosian</b>	Seasonal Time-energy Budget of an Island Restricted Falconid, the Striated Caracara, Using a Low-cost, Open-source Inertial Movement GPS Logger <b>Katie Harrington</b>
11:20 am	The BSE (Bovine Spongiform Encephalopathy) is Over: Political and Ecological Aspects of a 20-Year Study in Northern Spain <b>Alvaro Camina Cardenal</b>	Golden Eagle Nest Monitoring and Mitigation Actions at Surface Coal Mines in Northeastern Wyoming and Southeastern Montana: Long-term Summaries, Case Studies, and Mitigation Recommendations <b>Gwyn McKee</b>	Effects of Prey Super Abundance on Intraspecific Behavior in Eastern Red-tailed Hawks ( <i>Buteo jamaicensis borealis</i> ) <b>Andrew Schmalfuss</b>
11:40 am	Turkey Vultures Modify Foraging Strategies in Response to Anthropogenic Food Subsidies <b>Alexis Brewer</b>	Energy and Eagles Panel Discussion	
12:00 pm	Lunch	Lunch	Lunch



Friday, November 8			
	Salon VI/IV	Salon III	Salon II
	Vulture/Condor Symposium II Mary Ann Ottinger/ Andre Botha	Anthropogenic Impacts – Disturbance Todd Katzner	Breeding Behavior Katheryn Watson
1:20 pm	California Condor Nest Management in Southern California <b>Estelle Sandhaus</b>	Effects of Natural and Anthropogenic Factors on Occupancy and Productivity of Two Arctic Raptor Species on Baffin Island, Nunavut, Canada <b>Ashton Bradley</b>	Nest Predation's Multiple Effects on a Social Raptor <b>Jennifer Coulson</b>
1:40 pm	Vulture Abundances in Four Ethiopian Habitats: Concerns When Performing Road Counts <b>Alvaro Camina Cardenal</b>	Unmanned Aircraft Systems (UAS) Enable 3D Viewshed Analyses of Potential Disturbance to Raptor Nesting by Recreational Rock Climbing <b>James Dwyer</b>	The Roles of Nest Attendants at Harris's Hawk Nests in South Texas <b>James Bednarz</b>
2:00 pm	Overview of Raptor Population Declines and Conservation Intervention in Botswana <b>Moses Selebatso</b>	Recreation, Fire and Disease Create a Mosaic of Threats for Golden Eagles in Southwestern Idaho <b>Caitlin Davis</b>	Abundance and Nesting Success of Prairie Falcons ( <i>Falco mexicanus</i> ) in the Morley Nelson Snake River Birds of Prey National Conservation Area <b>Steven Alsup</b>
2:20 pm	Impact of Indigenous Cultural Knowledge and Community Collaboration in Tackling Vulture Trade and Persecution in Three Southwestern States in Nigeria <b>Yemisi Fawibe</b>	Effects of Wildfire and Forest Restoration on Northern Goshawks in northeast Washington <b>Peter Singleton</b>	Trends in Golden Eagle ( <i>Aquila chrysaetos</i> ) Reproduction, Juvenile Survival, Prey Species Abundance and Habitat Characteristics in Utah <b>Eric Chabot</b>
2:40 pm		Breeding Ecology and Habitat Suitability of Ferruginous Hawks ( <i>Buteo regalis</i> ) in Southern Idaho <b>Jamie Yurick</b>	Great Gray Owl Nesting Demographics at the Southern Range-edge in the Rocky Mountains <b>Bryan Bedrosian</b>
3:00 pm	Break	Break	Break
	Vulture/Condor Symposium III Mary Ann Ottinger/ Andre Botha	Anthropogenic Impacts – Mortality Matt Stuber	Citizen Science/Science Communication Zeka Glucs
3:20 pm	Vultures, Carnivores, Communities and Conflict – Towards Workable Conservation Solutions in Kenya <b>Ralph Buij</b>	Death by Aircraft - A Possible Significant Cause of the North American Kestrel Population Decline? <b>Kelsey Biles</b>	Raptor Research and Natural History Museums in the Digitization Age: Resources for Researchers, Banders, Conservationists, Agencies, and Educators <b>Elizabeth Wommack</b>
3:40 pm	Turning The Tide Against The Poisoning of Vultures: Impact and Lessons Learnt From the Wildlife Poisoning Response Training Programme <b>Andre Botha</b>	Comparing Management Programs to Reduce Red-tailed Hawk–Aircraft Collisions at O'Hare International Airport <b>Brian Washburn</b>	Webcams as an Untapped Opportunity to Conduct Citizen Science: Six Years of the American Kestrel Partnership's KestrelCam <b>Sarah Schulwitz</b>
4:00 pm	Integrating Conservation and Criminology to Inform Strategies to Combat Wildlife Trafficking	Road Mortality in Barn Owls: Identifying Temporal and Spatial Hotspots in the Fraser Valley of British	Managing High-quality Cliff-nesting Raptor Habitat Using Citizen Science, an Adaptive Seasonal Closure



Friday, November 8			
	Salon VI/IV	Salon III	Salon II
	<b>Mary Ann Ottinger</b>	Columbia <b>Sofi Hindmarch</b>	Framework, and Public Support Near Boulder, Colorado, USA <b>William Keeley</b>
4:20 pm	Vulture/Condor Panel Discussion	Use of Camera Traps to Describe Eagle Behavioral Patterns at Roadkill in the Western United States <b>Steven Slater</b>	Twenty Years of Volunteer Raptor Monitoring: Program Management and the Importance of Engaging Volunteers to Inform Data-Driven Raptor Conservation at a Park System Scale <b>Chelsea Beebe</b>
4:40 pm	Vulture/Condor Panel Discussion	Spatial Analysis of Bird-caused Fires and Vegetation Cover Types in the United States <b>Taylor Barnes</b>	Developing Models for Nesting Success of Bald Eagles in Colorado <b>Reesa Conrey</b>

Saturday, November 9			
	Salon VI/IV	Salon III	Salon II
	<b>Habitat Selection and Modeling I</b> Neil Paprocki	<b>Climate Change</b> Mark Martell	<b>Speed Talks I</b> Miguel Saggese
8:00 am	An Unexpected Backyard Hunter: Home Range Size and Habitat Selection of Barred Owls Along a Development Gradient <b>Marion Clement</b>	The Consequences of Breeding Phenology and Mismatch on American Kestrel Fitness <b>Kathleen Callery</b>	Coordinated Statewide Flammulated Owl Surveys in Wyoming: Expanding the Species Range <b>Nathan Hough</b>
			Habitat Use and Vocal Activity of Barred Owls ( <i>Strix varia</i> ) <b>Emma Houpt</b>
8:20 am	Great Gray Owl Home Range and Habitat Selection During the Breeding Season <b>Katherine Gura</b>	Spatial Patterns in Circadian Rhythm and Migration Candidate Genes of American Kestrels <b>Julie Heath</b>	Breeding Ecology of Endangered Egyptian Vultures ( <i>Neophron percnopterus</i> ) in Gangetic Plains of Uttar Pradesh, India <b>Shivangi Mishra</b>
			Resource Use of Apex Raptors: Implications for Siting Energy Development in Sagebrush Steppe and Prairie Ecosystems <b>Zach Wallace</b>
8:40 am	Wintering Space Use of an Irruption Species South of the Tundra <b>Rebecca McCabe</b>	Gyrfalcon Dietary Plasticity in a Changing Tundra Ecosystem <b>Devin Johnson</b>	Prey selection by Accipiters During Migration Using DNA Barcoding <b>Anisha Pokharel</b>
			Development of an Inexpensive Motion-activated Camera to Document Prey Delivery to Nest Boxes <b>Jessica Schlarbaum</b>
9:00 am	Integrating Remote Sensing and Citizen Science to Study the Environmental Context of Returning Avian Predators <b>Jennifer McCabe</b>	Long-term Ecological Monitoring of the Tundra Ecosystem: Role and Conservation Perspectives for Birds of Prey <b>Gilles Gauthier</b>	Intergeneric Hybridization of a Vagrant Common Black Hawk and a Red-shouldered Hawk <b>Jennifer Coulson</b>
			Preliminary Results of RADseq Genetic Study Question Taxonomic Status of <i>Falco cherrug</i> and <i>Falco rusticolus</i> and Confirms Status of the "Altai Falcon"



Saturday, November 9			
	Salon VI/IV	Salon III	Salon II
			<b>Matyas Prommer</b>
9:20 am	Migration, Home Range Size, and Habitat Selection of Breeding and Wintering Female Northern Harriers ( <i>Circus hudsonius</i> ) in Suisun Marsh, California <b>Shannon Skalos</b>	Short-Eared Owl ( <i>Asio flammeus</i> ) Population Dynamics in the Western United States <b>Robert Miller</b>	Diclofenac and other Non-steroidal Anti-inflammatory Drugs: Are Vultures in the Iberian Peninsula at Risk? <b>Irene Bueno</b> Utilizing Acoustic Recording Devices to Monitor Mexican Spotted Owls at Grand Canyon National Park <b>Kirsten Fuller</b>
9:40 am	Break	Break	Break
	<b>Habitat Selection and Modeling II</b> Adam Duerr	<b>Nest Site Selection</b> Shannon Skalos	<b>Speed Talks II</b> Miguel Saggese
10:00 am	Multi-scale Habitat Suitability Model for Golden Eagles ( <i>Aquila chrysaetos</i> ) in Arizona <b>Michele Losee</b>	Spatial Analysis of Raptor Nesting Distribution: An Evaluation of Four Priority Species in Colorado <b>Kevin Aagaard</b>	Climatic Constraints on Laggar Falcon Distribution Predicts Multi-directional Range Shifts Under Future Climate Change Scenarios <b>Luke Sutton</b> What Happens With the Harpy Eagle in Venezuela? <b>Adrián Naveda-Rodríguez</b>
10:20 am	Effects of Nest Boxes on American Kestrel Landscape Occupancy Varies Across Michigan Fruit-growing Landscapes <b>Melissa Hannay</b>	Modeling Spatial Variation in Density of Golden Eagle Nest Sites in the Western United States <b>Jeffrey Dunk</b>	Arctic Raptors Synchronize Their Spring Migration with the Northern Progression of Snowmelt <b>Teja Curk</b> Dispersal and Survival of Red-shouldered Hawks Banded in Southern Ohio, 1996-2018 <b>Cheryl Dykstra</b>
10:40 am	Overwintering Habitat Use by a Secretive Forest Raptor: the Broad-winged Hawk ( <i>Buteo platypterus</i> ) <b>Sandra Cuadros</b>	Home Range, Habitat Selection and Nesting Ecology of Urban Merlins in Winnipeg, Manitoba <b>Justine Josephson-Laidlaw</b>	Raptor Breeding Distributions Shifting Northward Faster Than Other North American Migratory Birds <b>Hanna McCaslin</b> First Satellite Telemetry Study of Dispersal, Home Range Size, and Habitat Use by Juvenile Golden Eagles from Mexico <b>Robert Murphy</b>
11:00 am	<b>Acoustics and Vocalization</b> Lisa Priestly Seasonal Variation in Calling Rates of Forest Owls From Passive Acoustic Recordings in the Oregon Coast Range <b>Matthew Hane</b>	Raptors Nesting on Cellular Communication Towers: Challenges and Opportunities <b>Blake Henke</b>	
11:20 am	Can California Ground Squirrels Reduce Predation Risk to Burrowing Owls? <b>Lynne Trulio</b>	How Nest-sites Characteristic Affect the Breeding Success and Nest Attendance Rates of Arctic Breeding Gyrfalcons in Western Alaska <b>Michael Henderson</b>	
11:40 am	Using Autonomous Recording Units	Interspecies Nest-placement	





Saturday, November 9			
	Salon VI/IV	Salon III	Salon II
	to Survey for Forest Raptors Over Large Areas: A Safer, More Effective Method <i>Allison Swan</i>	Tolerance and Niche Partitioning of Nesting Riparian Raptors in the Trans-pecos Region of Texas <i>Caroline Skidmore</i>	
12:00 pm	Lunch	Lunch	
	<b>Movement and Dispersal</b> Hanna McCaslin/Matyas Prommer	<b>Population Dynamics</b> Carol McIntyre	
1:20 pm	Linear Features Affect Migratory Movements of Golden Eagles <i>Joseph Eisaguirre</i>	Population Recovery of Peregrine Falcons in Central Norway in More than Forty Years Since the DDT-ban: The Role of Pollutants and Prey <i>Torgeir Nygård</i>	
1:40 pm	Juvenile Dispersal Movements of Eastern Imperial Eagles in the Western Part of the Breeding Range <i>Matyas Prommer</i>	Assessing Nestling Survival Among Peregrine Falcons Breeding in the Arctic: Is Inclement Weather Increasing Food Limitation? <i>Erik Hedlin</i>	
2:00 pm	Evidence of Post-breeding Prospecting in a Migratory Raptor <i>Max Ciaglo</i>	A Multi-state, Time-removal Model for Population Dynamics of Cliff-Nesting Raptors <i>Stephen Lewis</i>	
2:20 pm	Towards a Full Annual Biogeography of the Flammulated Owl <i>Scott Yanco</i>	Bottom-up Processes Drive Reproductive Success in Golden Eagles in interior Alaska <i>Carol McIntyre</i>	
2:40 pm	Differences in Breeding and Nonbreeding Red-tailed Hawk Home Range Size Throughout the Breeding Season <i>Nate Bickford</i>	Changes in Distributions and Habitat Associations of Bald Eagles and Osprey During Their Recovery, 1970-2017 <i>Jennifer Schneiderman</i>	
3:00 pm	Using Individual Animal Movements to Aid Global Conservation: A Case Study of the Red-footed Falcon ( <i>Falco vespertinus</i> ) <i>Peter Palatitz</i>		
3:20 PM	<b>RRF Business Meeting</b> (All welcome)		
6:00 PM	<b>Cocktail Hour &amp; Banquet</b>		



## HILTON HOTEL MAP



<b>Conference Registration</b> <b>Information</b> <b>Hotel Registration</b> <b>Art Show</b>	<b>Lobby</b>
<b>Icebreaker</b> <b>Vendors and Art Show</b>	<b>Atrium</b>
<b>ECRR Reception</b> <b>Poster Session</b> <b>Banquet</b>	<b>Salons I/V, II</b>
<b>Plenary and Concurrent Sessions</b> <b>Business Meeting</b>	<b>Salons II, III, VI/IV</b>
<b>Workshops</b>	<b>Salons III, IV, VI</b>
<b>Board Meetings</b>	<b>Legends Room</b>

# Conference at a Glance

## Tuesday, November 5

8:00 am - 5:00 pm	RRF Board Strategic Planning Meeting	Legends Room
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## Wednesday, November 6

8:00 am - 5:00 pm	RRF Board Meeting	Legends Room
8:00 am - 5:00 pm	Field Trips and Workshops	See Pages <a href="#">20-24</a>
6:00 pm - 9:00 pm	Icebreaker Reception	Atrium
9:00 pm - 11:00pm	Women in Raptor Research and Conservation Social	Tap and Handle

## Thursday, November 7

8:00 am - 9:40 am	Welcome, Leaving a Legacy: Dan Varland & Plenary Speaker: Rocky Gutiérrez	Salons VI/IV, III, II
8:00 am - 5:00 pm	Vendors & Art Show	Atrium
10:00 am - 12:00 pm	Andersen Award Session	Salon VI/IV
10:00 am - 2:20 pm	Falconry Symposium	Salon III
10:00 am - 3:40 pm	General Sessions	Salon II, III, VI/IV
4:00 pm - 5:00 pm	ECRR Reception	Salons II, V/I
5:00 pm - 8:00 pm	Poster Sessions & Reception	Salons II, V/I

## Friday, November 8

8:00 am - 9:20 am	Announcements & Plenary Speaker: Gary White	Salons VI/IV, III, II
8:00 am - 5:00 pm	Vendors & Art Show	Atrium
9:40 am - 5:00 pm	Vulture/Condor Symposium	Salon VI/IV
9:40 am - 5:00 pm	General Sessions	Salons II, III
6:00 am - 9:00 pm	Dinner Social at the Rio's Agave Room	See Page <a href="#">19</a>

## Saturday, November 9

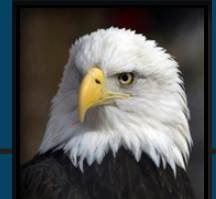
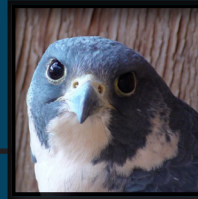
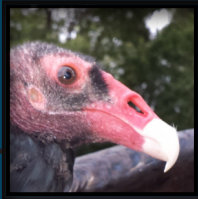
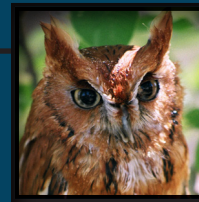
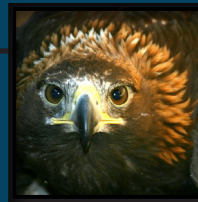
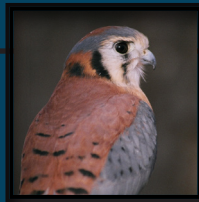
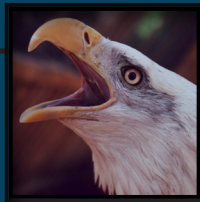
8:00 am - 2:00 pm	Vendors & Art Show	Atrium
8:00 am - 3:30 pm	General Sessions	Salons II, III, VI/IV
3:20 pm - 5:00 pm	RRF Members Business Meeting	Salons VI/IV
6:00 pm - 7:00 pm	Cocktail Hour	Salons II, I/V
7:00 pm - 10:00 pm	Awards Banquet	Salons II, I/V

## Sunday, November 10

8:30 am - 4:00 pm	Field Trips	See Pages <a href="#">20-21</a>
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