

**BOISE**

**IDAHO**



**Raptor Research Foundation  
Neotropical Raptor Network**

**2021**



**Neotropical  
Raptor  
Network**



**THE  
PEREGRINE  
FUND**

Conserving Birds of Prey Worldwide

# CONFERENCE HOSTS



## THE PEREGRINE FUND

Conserving Birds of Prey Worldwide

When founded 50 years ago by Tom Cade at Cornell University, **The Peregrine Fund's** mission was to save the Peregrine Falcon from extirpation in the United States. Almost 30 years later in 1999 we celebrated success when the species was removed from the U.S. Endangered Species list. The recovery of the Peregrine Falcon was one of conservation's greatest success stories, one that embodied the tenacity, teamwork, and collaborative partnerships that we practice every day.

Today, our mission is global and includes all raptor species. We are responding to 21st Century conservation challenges with a new strategic plan based on the conviction of our founders—"...we will succeed by using science to inform decisions and by not accepting failure as an option"—so that by the year 2050 we will have helped create a vision of success in which bird of prey populations and their ecosystems thrive; we have enriched the lives of local communities where we work and improved their future; we have earned the reputation to serve as global experts on birds of prey and their conservation; and raptors are valued by all people. Our strategy centers on achieving four major outcomes, to:

- Save species facing imminent extinction
- Sustain landscapes of special conservation value to raptors
- Tackle landscape level threats affecting multiple species, and
- Inspire people to value raptors and take action, to include developing raptor conservation leaders worldwide.

Since inception, we have worked on behalf of more than 100 species in 65 countries worldwide, we have trained and supported over 130 professionals in raptor ecology and conservation, and over a million people have been inspired by our education and outreach programs at the World Center for Birds of Prey in Boise and elsewhere.



## Neotropical Raptor Network

**The Neotropical Raptor Network** is a membership-based organization that aims to enhance the capacity and effectiveness of people working with raptors in the Neotropics. Its goal is to aid the research and conservation of Neotropical raptors by promoting communication and collaboration among biologists, ornithologists, raptor enthusiasts, and other conservationists working in the Neotropics. We achieve our goal by hosting an online discussion forum, publishing a newsletter twice per year, and organizing conferences.

Neotropical Raptor Network Conferences have been held at intervals since the inaugural conference in Panama in 2002 when the idea for a Neotropical network was first proposed by an enthusiastic audience. Since then conferences have been held in Iguazu, Argentina in 2006, Bariloche, Argentina in partnership with the RRF in 2013, and in Costa Rica in 2016. We are looking forward to welcoming you virtually in October 2021 for the 5th Neotropical Raptor Conference! "We encourage participants from Latin America to join us for this virtual conference for the camaraderie and inspiration that comes from gathering together to share experiences.

*Click logos to visit Co-hosts' webpages.*



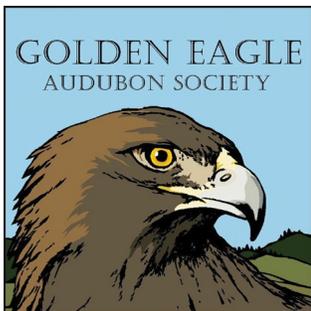
**BOISE STATE UNIVERSITY**  
**INTERMOUNTAIN BIRD OBSERVATORY**

The Intermountain Bird Observatory had its humble beginnings over 25 years ago studying bird migration along the Rocky Mountains of southwest Idaho. Our model of combining research and education has since spread through the western United States and internationally. We accomplish our mission by impacting human lives and contributing to conservation through a unique combination of cooperative research, education, discovery of the natural world, and community engagement. An award-winning, hands-on model of community-based environmental education has become our signature activity as we feel strongly that public awareness and conservation are closely linked.



The **U.S. Geological Survey (USGS)**, a bureau of the Department of the Interior, is the Nation's largest water, earth, and biological science and civilian mapping agency. The USGS provides reliable scientific information to describe and understand the Earth; minimize loss of life and property from natural disasters; manage water, biological, energy, and mineral resources; and enhance and protect our quality of life.

USGS science at the Forest and Rangeland Ecosystem Science Center – or FRESC – in Boise, Idaho focuses in part on raptors and raptor ecology. A top priority is continued contribution to the many long-term datasets focused on local raptor species. We also assess threats to and provide scientific information to support management decisions for Golden Eagles, Prairie Falcons, Northern Spotted and Barred Owls. Finally, we also seek to understand population-level consequences to raptors from human activities. Our research efforts are primarily focused in the western U.S., but we also collaborate on efforts in Europe, Asia and Australia.



**Golden Eagle Audubon Society (GEAS)** was founded in 1972 by a group of birders who wanted to provide opportunities for community connection and birding in the Treasure Valley and beyond. The GEAS mission expanded over the years to include conservation of public lands and the protection of birds and their habitats, citizen science, educational programs for youth and adults, and the New Roots Program for refugee youth. Today, GEAS not only serves as an important source of scientifically grounded information in the community, but has greatly expanded our program offerings and mission.

GEAS partners with dozens of organizations, schools, business, libraries, governmental agencies—and a core group of dedicated volunteers—to achieve our mission. In 2017, Mayor Dave Bieter of Boise recognized GEAS with the City's Good Neighbor Award for its active role in making Boise a better place to live.



The **Birds of Prey NCA Partnership (BOPP)** is an Idaho 501(c)(3) non-profit organization, whose mission is to support the Morley Nelson Snake River Birds of Prey National Conservation Area through science, education, outreach and partnerships. We envision a community-supported national conservation area that sustains resilient ecological communities, protects cultural resources and provides diverse, responsible recreation opportunities. Our approach in achieving our mission is to provide unique opportunities to engage the public and bring awareness to the NCA.

# GENERAL CONFERENCE INFORMATION

## Welcome to the 2021 Raptor Research Foundation joint virtual Conference with the Neotropical Raptor Network!

On behalf of The Peregrine Fund and our conference co-hosts Boise State University, Intermountain Bird Observatory, Golden Eagle Audubon, Birds of Prey National Conservation Area Partnership, and USGS Idaho, we are pleased to have you join us for another great, yet unique, RRF Conference. Though we hoped to host this event in-person in Boise, Idaho, we are equally excited to connect with you virtually, ensuring the safety of our attendees, staff and volunteers.

## TABLE OF CONTENTS

Virtual Presentation Guidelines	5
Raptor Research Foundation	7
Acknowledgments	8-9
Conference Sponsors	10-11
Vendors	12
Welcome to RRF Conference 2021!	16-17
Virtual Workshops	18-19
Plenary Speakers	20-23
Symposia	24-27
Conference Schedule & Abstracts Portal	28-29
Code of Conduct	30-31

## Scientific Program

This year's scientific program is one for the record books! It is the first ever virtual Raptor Research Foundation annual conference, enabling global participation by raptor specialists from around the world. The program is also the largest to date, with over 250 oral presentations and more than 50 posters. We kick off on Saturday October 9th with the first day of the symposium Lead in Wildlife and virtual workshops. The full scientific program begins on Sunday, October 10th and continues through Tuesday, October 12th. The scientific program portion of each day will run from approximately 08:45 to 17:00 US Mountain Time. A record-busting nine symposia are included. There will be up to four live concurrent sessions each day, organized using Zoom and designated break-out rooms. General sessions cover a wide array of topics including:

- **Advances in Raptor Research Technology**
- **Biology and Ecology**
- **Climate Change, Implications to Raptor Habitats and Ranges**
- **Complications of Urban Development and Raptor Injury**
- **Energy Development Successes and Challenges**
- **Species Conservation and Population Status Updates**



**GO TO CONFERENCE  
SCHEDULE**

**GO TO ABSTRACTS**

# RRF VIRTUAL PRESENTATION GUIDELINES

- Regular session talks will be up to 12 minutes in length plus 2-3 minutes for questions.
- Presenters of pre-recorded talks are encouraged to attend live to answer questions and engage in discussion panels.
- Pdf files of posters will be available for viewing in addition to a live poster session on Sunday October 10 from 18:00-21:00.
- The preferred presentation format for slides is Microsoft Powerpoint using widescreen format (16:9 ratio).
- Posters are recommended to be a single slide designed in landscape format.
- All presenters must register for the virtual conference.
- As you begin to prepare you oral presentation, please consider reviewing this open access [article from \*The Condor\*](#) on how to make your presentation compelling and more effectively communicate your findings to other scientists.
- Oral and poster presentations should be prepared in English.
- Your presentation should reflect the information presented in your accepted abstract.
- Please avoid marketing specific products or services.
- To the extent feasible, please identify potential management or conservation implications from the research you are presenting.
- Keep in mind that while some meeting attendees may be familiar with your topic, the audience will be composed of researchers from a variety of fields, arenas, and backgrounds.
- Design your poster in such a way as to highlight your take home message and convey this information to readers who are viewing from a computer monitor or mobile device.
- All presenters and audience members shall adhere to the RRF Code of Conduct

*Presenters can contact the Scientific Program Committee about their abstract at [rpf2021@peregrinefund.org](mailto:rpf2021@peregrinefund.org).*



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**James Dwyer**  
Conservation Chair

**Megan Judkins**  
Website Coordinator

**Julio Gallardo**  
Membership Chair

# ACKNOWLEDGMENTS

Thank you to all who contributed your time and talents, including the session moderators and committee members identified below. We recognize that many of you, particularly those on the Local Committee, performed tasks outside of your job description for many months (years!) to turn the idea of this conference into reality. In the most challenging year we've lived through together as a society, each of you exhibited patience and resilience and did what you needed to do to ensure the success of this conference. We asked each of you all sorts of special requests when it came to planning and re-planning this conference during the global pandemic. You rose to the occasion with professionalism, competence, and grace. To everyone that had a hand in planning for the success of this conference, you were and are fantastic team mates. For your unwavering support the local committee chairs, co-chairs and the entire leadership of the Raptor Research Foundation extend our deepest gratitude and appreciation.

## Local Conference Committee

**David L. Anderson**  
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**Erin Katzner**  
Virtual Conference  
Management

**Daniel Young**  
Program Book Design

**Alicia Leacox**  
Chief of SWAG

**Sarah Schulwitz**  
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**Amy Siedenstrang**  
Logo Design

**Marta Curti**  
Neotropical Raptor  
Network Coordinator

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Field Trip & Transportation  
Coordinator

**Michael Henderson**  
Workshop Co-coordinator

**Neil Paprocki**  
Workshop Co-coordinator

**Jessica Gordon**  
Volunteer Coordinator

**Taylor Rollison**  
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**Matthew Danihel**  
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Communication

**Craig Lochner**  
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**Kit Stevens**  
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**Heather Meuleman**  
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Sarah Schulwitz | Deborah Shalders | Vince Slabe

Matt Stuber | Russell Thorstrom | Mike Tincher

Kim Titus | Munir Virani | Beth Wommack



Munir Virani

# Symposia

## ***Lead in Wildlife***

Co-Chairs: Rick Watson | Todd Katzner | Mark Pokras

## ***Conservation of Eurasian Steppe Ecosystems with a Focus on Top Avian Predators***

Co-Chairs: Rick Watson | Todd Katzner

## ***The Barred Owl Invasion of Western North America***

Chair: Phil Detrich

## ***Global Priorities for Raptor Ecology and Conservation***

Co-Chairs: Evan Buechley | Chris McClure

## ***Global Solutions for Raptor Fatalities on Power Lines***

Co-Chairs: Rick Harness | James Dwyer

## ***The Human/Raptor Interface in Archaeological Research and its Multidisciplinary Potential***

Co-Chairs: Jonathan Dombrosky | Katelyn Bishop

## ***The Full Annual Cycle of the American Kestrel: Knowledge Gaps and Conservation Needs***

Co-Chairs: Jim Bednarz | Kelsey Biles | Jean-Francois Therrien | Anjolene Hunt

## ***Prairie Falcons: What We Know and What We Don't Know***

Chair: Karen Steenhof

## ***Raptor Propagation for Conservation – Past, Present and Future***

Chair: Beau Parks

# Moderators

Rob Bierregaard

Lisa Priestley

Clint Boal

Michelle Willette

Sandy Boyce

Trish Miller

Julie Garvin

Michael Academia

Mark Martell

Renzo Piana

David L. Anderson

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Todd Katzner

Jim Bednarz

Katelyn Bishop

Phil Detrich

Jonathan Dombrosky

James Dwyer

Cheryl Dykstra

Rick Harness

Anjolene Hunt

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## Wings to Fly Committee

Rick Watson | Sarah Schulwitz | Jennifer McCabe

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## Cover Photography Credits

Angel Muela (left) | Andrew Orr (center) | Marta Curti (right)

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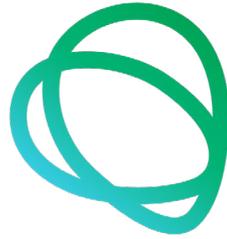
## Falco Sponsors | \$1,000



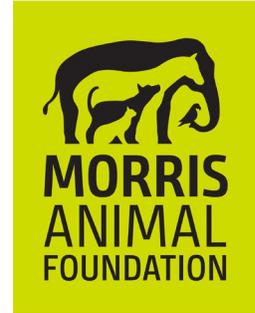
Thanks and gratitude to the sponsors of this year's conference.

# Symposium Sponsors |

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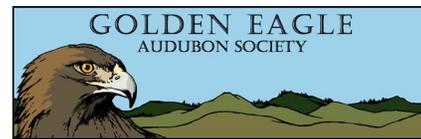
# Travel Awards | \$10,000 – \$1,000



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**MOHAMED BIN ZAYED**  
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EMIRATES FALCONERS' CLUB



Joan Morrison

Michael Dupuy

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Matthew Danihel



Ron Dudley



Jim Shane



Ryan Phillips



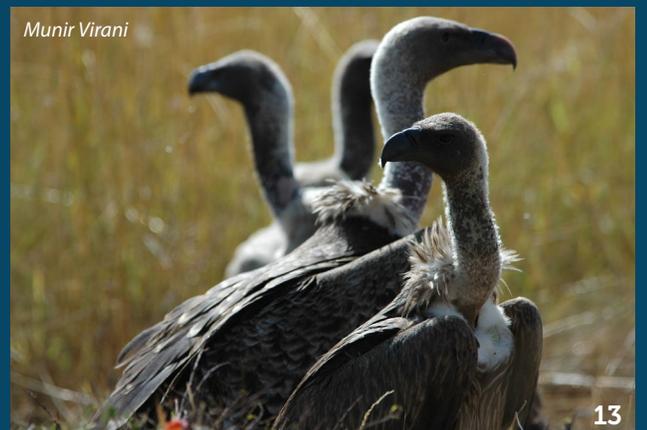
Cal Sandfort



Mary Koutsakis



Kilii Yuan



Munir Virani



## الجمعية الإماراتية لصياد الطيور الجارحة EMIRATES FALCONERS' CLUB

The Emirates Falconers' Club (EFC) was established in 2001 under the auspices of the late His Highness Sheikh Zayed Bin Sultan Al Nahyan as the first Arab falconers' club in the United Arab Emirates. The late Sheikh Zayed envisioned the EFC as a bridge between the ancient heritage of falconry and the new and future generations of falconers.

As the first of its kind, it encouraged coordination between all falconers in the region and successfully built a community among all the clubs in the region.

As the first Arab falconers' club to preserve falconry, it highlights the sector's historical legacy with all its unique characteristics. The EFC serves as an important networking and intellectual platform for poets, writers and artists, various segments of content creators and professionals who love falconry, including enthusiasts of traditional hunting methods.

Throughout the years, the EFC has taken great strides towards, and achieved significant developments in its quest to transfer ancestral heritage in the falconry field to future generations, serving the falconers of the UAE and the Gulf and preserving falcons and birds of prey from extinction.

Some of its notable endeavors include raising awareness about sustainable practices and the ethics of falconry. It also aims to promote falconry and preserve this authentic Arab heritage through various awareness programs set to promote sound principles of falconry in hunting, training, nutrition, diseases and prevention. By promoting sustainable hunting practices and the ethics of falconry as a reflection of an authentic Arab heritage, it has successfully facilitated a balance between hunting activities and wildlife protection and has restored the ecological balance of nature by a number of means, including the prevention of overhunting by providing abundant quarry, bred in captivity, for the restocking of natural resources and for falcon training.

The EFC also organizes youth training on the basic practices of falconry and holds periodic meetings to allow beginners to develop their capabilities and learn more about sustainable hunting. The club provides material and logistical assistance to scientific institutions, scientists, researchers and specialists in the field of falcon breeding, its prey, safeguarding and the protection of its natural environment or areas of spread, to create a mechanism for communication and cooperation with parties of common interest, whether governmental, international organizations, civil society organizations or individual institutions.

The EFC is the proud organizer of the Abu Dhabi International Hunting and Equestrian Exhibition and the International Festival of Falconry in Abu Dhabi.



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# WELCOME TO RRF 2021

On behalf of the Raptor Research Foundation and our local conference committee at The Peregrine Fund, I welcome you to the 55th annual meeting of our foundation. We have overcome many planning challenges in the past 2 years and are excited we can welcome you to a virtual platform for this meeting.

RRF is thankful for our amazing volunteers who made this event possible for RRF and NRN members and the broader raptor community. A special thanks to our committee chairs including Dan Varland (Conference Committee), Julie Garvin (Scientific Program Committee), Chris Vennum and Teresa Ely (Early Career Raptor Researcher Committee), Megan Judkins (Website Committee), Neil Paprocki (Workshop Coordinator), and Sofi Hindmarch (Awards Committee). The Peregrine Fund has done a fantastic job planning both our cancelled in-person meeting and our current virtual meeting. Please join me in thanking David Anderson, Rick Watson, Sarah Schulwitz, Erin Katzner, Jennifer McCabe, Marta Curti, Michael Henderson, and Daniel Young. We are also grateful for our sponsors and vendors who sustain RRF's mission through their support of this conference.



Sincerely,  
**Libby Mojica**  
**Raptor Research Foundation, President**





**W**elcome to the 2021 Raptor Research Foundation (RRF) and Neotropical Raptor Network (NRN) Conference! The Peregrine Fund is proud to have the opportunity to bring this program to you, and while we wish we were able to host you here in Boise, Idaho, we're thrilled to be able to connect our scientific community virtually.

The Peregrine Fund and the Raptor Research Foundation have shared many historical wins for conservation of birds of prey over the past 50+ years. Because of RRF and these annual meetings, we are able to come together to share advances in our understanding of our natural world and the raptors with whom we share our planet. We hope that this virtual meeting will provide a platform for contributing knowledge, connecting over a virtual happy hour, and continuing the work that we do collaboratively as a field.

I would like to thank you, the RRF and NRN members, for the opportunity to host you at the 55th annual meeting of the Raptor Research Foundation. I'd like to thank the RRF Board of Directors and Conference Committee for all of their incredible support as we planned this event. I also need to thank my team here at The Peregrine Fund and our co-hosts throughout the community for their tenacity and adaptability in organizing both an in-person and virtual meeting as we determined the safest way to come together. We are all incredibly grateful for the sponsors and vendors who have supported this meeting and committed funds to ensure that it is successful.



Sincerely,  
**Rick Watson, Ph.D.**  
**The Peregrine Fund, Retired President & CEO**



# VIRTUAL WORKSHOPS

Workshops at an RRF or NRN conference provide an excellent opportunity to develop or hone your skills as a raptor researcher! We are excited to present five different workshops in our 2021 virtual format. Please address questions to Neil Paprocki or Michael Henderson by emailing [rrf2021@peregrinefund.org](mailto:rrf2021@peregrinefund.org).

- All workshops will be held on Saturday, October 9, 2021 except for Total Canopy Access for Raptor Biologists which will be held October 21, 2021.
- All workshop times are local Mountain Time (Boise).
- There will be no maximum class size for any of the virtual workshops.
- All workshops will be offered at no additional cost to those who register for the conference.
- Links to attend all workshops will be provided to all who register for the virtual conference.

## OCTOBER 9 WORKSHOPS

### Harnessing Raptors with Transmitters

*Instructed by Tricia Miller (Conservation Science Global Inc.)*

**8:00 - 10:00 MT**

This will be a live and interactive virtual workshop that will cover the different types of transmitters available for tracking raptors and the different types of attachment methods. We will address the costs and benefits of each of these as well as considerations for a bird's welfare.

### Writing & Peer Review

*Instructed by Julie Garvin (Tetra Tech), James Bednarz (University of North Texas), Cheryl Dykstra (Raptor Environmental), & Joan Morrison (Trinity College)*

**10:00 - 12:00 MT**

A wise Ph.D. advisor once said "It's not science unless it's published". Publishing a manuscript or peer-reviewing for a respected journal is often an arduous, time-consuming, and sometimes confusing process. This workshop will discuss that process and help you become a better writer and peer-reviewer — whether you are involved in your first or fortieth manuscript. Topics that will be explored include **1. Authorship** — who's in, who's out, and when to address; **2. Manuscript Writing** — how to construct a well-organized manuscript, writing and grammar tips; **3. Publishing in the Journal of Raptor Research**; **4. Peer-review** — how to conduct a peer-review, and how to respond to peer-review feedback.

### Field and In-Hand Raptor Identification

*Instructed by Bryce Robinson (Cornell University), Jesse Watson (HawkWatch International) & Neil Paprocki (University of Idaho)*

**12:00 - 15:00 MT**

Accurate and precise raptor identification is a basic but foundational skill set that should be in every raptor researcher's toolbox. This class will focus on both field and in-hand raptor identification. The first section of the course will focus on raptor field identification, and the basic skills needed to become an expert in raptor

ID (i.e., species shape, flight style, plumage). The second section will focus on in-hand ID, with a specific focus on molt and its use in aging raptors. Workshop participants will learn how to use the new HawkWatch International In-hand Guide to Diurnal North American Raptors. This virtual workshop will be live.

## Techniques for Handling, Auxiliary Marking & Measuring Raptors after Capture

Instructed by Dan Varland (Coastal Raptors) & John Smallwood (Monclair State University)

12:00 - 15:00 MT



This workshop will begin with an overview of the value of auxiliary marking raptors for scientific research, followed by factors to consider when selecting a marking program. Next will be an overview of the permitting process for auxiliary marking, with a focus on the process in use with the North American Bird Banding Program (Canada and the USA). The workshop will continue with photos and information that **1.** demonstrate proper techniques for handling and measuring raptors; **2.** describe the types of auxiliary markers in use for raptors, including butt-end and lock-on leg bands, feather imping, inks and dyes, and patagial markers; and **3.** show the tools and techniques used to apply these auxiliary markers.

## OCTOBER 21 WORKSHOP

### Total Canopy Access for Ecologists

Lead by David L. Anderson (The Peregrine Fund), Robert Miller (Intermountain Bird Observatory), Zeke Willard (Idaho Tree Preservation), Kevin Van Brunt (Eden Tree Service) & Joshua Chavez (Chavo Tree Care)

12:00 - 15:00 MT

Forest canopies are a major source of regional and global biodiversity, yet remain understudied due to difficulty of access. Many raptor species nest in trees, and nests can be found anywhere in a tree crown, near the bole, outer branches, and the highest branches. Rope-based access methods are affordable and transportable, thus providing the most practical solution for unbiased and replicable sampling in forest canopies. However, recent research has revealed a generally low level of expertise among ecologists in rope-based canopy access methods. Using a virtual platform, expert climbers will demonstrate multiple techniques for canopy access with ropes, describing the advantages and limitations of each in terms of efficiency, mobility, safety and cost. Topics will include selection of proper equipment approved for tree climbing; differences between mountaineering and tree-climbing methods and equipment; common errors that put climbers at risk; and techniques for accessing all parts of the canopy including branch tips. The course is meant to introduce raptor biologists to concepts and methods that may be new to them and to provide enough information for participants to make informed choices on methods most suitable to their needs, and seek continued training as needed. The course will be co-organized by The Intermountain Bird Observatory of Boise State University, and City of Boise Parks and Recreation. Professional tree climbing instructors from arboriculture and science will lead the course. No prior experience in tree climbing is necessary. Following the live presentation there will be a virtual Q&A session.



# PLENARY SPEAKERS

*Sunday, October 10 | 9:00 - 10:00 MT*

## Raptor Research, Ecology, and Conservation in Idaho: a Reflection on the Past and a Vision for the Future

*by Karen Steenhof*

**S**tudies of raptors in Idaho have set the standards for research on birds of prey throughout the world. Comprehensive research on raptors did not begin in Idaho until the 1960s when concerns about livestock depredations led Congress to recommend inventories of Golden Eagles in the western U.S. Gary Hickman conducted surveys of eagle populations in southwestern Idaho for the Division of Wildlife Services from 1966-1968. His studies laid the groundwork for one of the longest-term data sets on raptors in North America. Idaho State University and the University of Idaho's Cooperative Wildlife Research Unit sponsored graduate studies of several raptor species throughout the state in the early 1970s. Much of the work focused on the Snake River Canyon, where subsequent studies, led by Michael Kochert and funded by the Bureau of Land Management (BLM), provided the justification for what is now the Morley Nelson Snake River Birds of Prey National Conservation Area (NCA). During the 1970s and 1980s, Morley worked with Idaho Power Company to demonstrate that power transmission/distribution could be compatible with raptor protection. In 1984, The Peregrine Fund relocated its western breeding operation to Idaho and established the World Center for Birds of Prey in Boise. Soon after that, Boise State University established the Raptor Research Center, which included the Master of Science Raptor Biology program. The Idaho Army National Guard funded research on raptors, their prey, and their habitats within the NCA during the 1990s, and they continue to support important research in cooperation with BLM. Conservation efforts throughout the state have led to dramatic increases in populations of Peregrine Falcons and Bald Eagles statewide. Climate change and increasing human populations are the new challenges facing raptors. Recent studies in Idaho have investigated how raptors respond to rising temperatures, wildfire, and increased recreational activity on public lands. These studies will suggest which species are resilient and which may need management intervention to maintain populations.

**Karen Steenhof** is a retired Research Wildlife Biologist. She received a B.S. in Wildlife Biology from Colorado State University and an M.S. in Wildlife Ecology from the University of Missouri. Karen began working for the BLM's Snake River Birds of Prey Research Project in 1977, where she was involved with several studies of cliff-nesting raptors, particularly Prairie Falcons, Golden Eagles, Red-tailed Hawks, and Ferruginous Hawks in what is now the Snake River Birds of Prey National Conservation Area. She played a key role in preparing the 1979 Special Research Report for the Secretary of the Interior, which provided the justification for what became the final conservation area boundaries. As a Research Wildlife Biologist for the Boise District BLM, the National Biological Service's Raptor Research and Technical Assistance Center, and Snake River Field Station, Karen was involved in raptor research projects in and near the Birds of Prey Area for more than 30 years. Her studies included long-term Golden Eagle reproduction, effects of a new 500-kV transmission line on raptors and ravens, American Kestrel population ecology, effects of National Guard activities on raptors, and long-range Prairie Falcon movements as detected by satellite telemetry. After her retirement from the US Geological Survey in 2008, Karen has continued to be involved in Golden Eagle and Prairie Falcon monitoring, management, and research. Ms. Steenhof is an avid equestrian and now lives in Owyhee County, Idaho.



Monday, October 11 | 9:00 - 10:00 MT

## Bird scavengers from Latin America: Their Ecology, Conservation and Contributions to People

by Sergio Lambertucci

**S**cavenger birds in Latin America, such as vultures and condors, vary markedly in their ecology and conservation status. Some are currently the most abundant avian scavengers in the world, others are scarce but widely distributed. A few decades ago many aspects of their ecology and conservation were almost unknown, but population decreases were expected considering the increase in human impacts. I will present updated knowledge on their ecology and conservation, but I will also discuss their important role in the environment that is fundamental for human and ecosystem well-being. Scavenger bird traits make them highly sensitive to population changes given their low demographic response, particularly in condors. Threats associated with increases in anthropogenic change are negatively affecting some scavenger species, keeping populations at a steady decline. Decreases are mainly associated with direct and indirect persecution, lead poisoning, and collision with human-built structures, but they are also caused by several other problems including cultural threats, and competition with invasive species, among others. Those threats impact the species differently throughout their distribution producing unknown consequences at local, and even regional scales. Contrarily, some other species take advantage of humanization but not without costs. Contrasting human perceptions about these birds often ignore the fundamental role they play in the ecosystem that cannot be easily replaced by humans. Their role is becoming better known by scientists, but not by many lay people. This, in association with fake news and misinformation can negatively affect the scavenger bird populations and hinder the contributions they provide. In this conference I will highlight the importance of maintaining large populations of these species, and will introduce several conservation actions needed that could help to reduce population declines.



**Sergio Lambertucci** is Principal researcher at CONICET (the Argentine Research Council) and lecturer of Ecology and Conservation Biology at the Universidad Nacional del Comahue (UNCo) in Argentina. He is the head of the Research Group on Conservation Biology (GrInBiC) at I NIBIOMA (Research Institute in Biodiversity and Environment) and investigates general aspects of ecology and conservation of species, particularly birds of prey. His interests are mainly related to environmental problems caused by anthropogenic impacts and the desire to promote measures that enable the better coexistence between people and nature based on scientific evidence. His studies range from the impacts of habitat fragmentation, pollutants, or persecution of wildlife, to human-perceptions about fauna. With his group he carries out studies on trophic ecology, movement ecology, toxicology, genetics, isotopes, and the identification of areas of conservation

importance for wildlife, among others. He has studied Andean Condors for more than 2 decades in southern South America, has published more than one hundred scientific papers in international journals, and has mentored more than a dozen PhD and Postdoctoral students.

Tuesday, October 12 | 9:00 - 10:00 MT

## Raptor Conservation Worldwide

by Rick Watson & Chris McClure

**S**uccessful conservation usually takes a multidisciplinary approach. In this presentation I demonstrate how saving raptor species through captive breeding and release and other techniques is effective only with research to identify the cause of decline and species' response to management, and working to develop sustainable solutions with stakeholders. I use examples from The Peregrine Fund's experience over 50 years of putting conservation into practice to develop the idea of the multidisciplinary approach and cite examples of recovery of critically endangered species such as the Aplomado Falcon, California Condor, and Ridgway's Hawk, forensic research to discover a new cause of mortality among vultures in South Asia, and community-based conservation solutions with stakeholders in Madagascar and Panama. *-Rick Watson*

Despite many conservation successes, raptors are more threatened than most other groups of birds. Indeed, more than half of raptor species have declining global populations and 18% are threatened with extinction. The future of raptor conservation therefore depends on global collaboration in science-based conservation. Toward this goal, The Peregrine Fund has launched the Global Raptor Impact Network (GRIN)—a tool to enhance collaboration and conservation impact of the raptor research community. The GRIN mobile app allows researchers to collect their own data while contributing to a global effort to monitor the world's raptors. GRIN staff and partners are developing analyses of species' population trends and geographic distributions to aid in conservation assessments. GRIN is also developing systematic reviews, detailed bibliographies, and online accounts that will summarize the state of knowledge for each raptor species. We hope that GRIN will benefit the entire raptor research community and aid in the collaboration necessary to help raptor populations thrive in the Anthropocene. *-Chris McClure*



**Chris McClure** Born and raised in Columbus, GA, Chris McClure received a Bachelor's degree from the University of Georgia in 2005 studying Environmental Economics. Subsequently, he began working for The Peregrine Fund as a hack site attendant, releasing endangered Northern Aplomado Falcons in west Texas. It was during that summer that Chris realized that he wanted to be a professional ornithologist. After an internship at Hopper Mountain National Wildlife Refuge working with California Condors, Chris entered graduate school at Auburn University in 2007. His PhD work focused on methods to better monitor and study birds. Chris then accepted a postdoctoral research position at Boise State University where he helped pioneer a new method to experimentally assess the effects of road noise on wildlife. In 2014, he began work at The Peregrine Fund as director of the American Kestrel Partnership and Quantitative Ecologist. After three years, Chris became The Peregrine Fund's Director of Global Conservation Science, where he oversees all of the research and monitoring conducted by the organization. Chris's research focuses on methods to better monitor, study, and manage birds, and on conservation of the world's raptors. He has published roughly 90 peer-reviewed articles and is Associate Editor for the Journal of Raptor Research. He is affiliate faculty at Boise State University and an honorary researcher at the University of Witwatersrand in South Africa. Importantly, Chris is spearheading the Global Raptor Impact Network, an effort to monitor the world's raptors.

# PLENARY SPEAKERS contd.



**Rick Watson** Born in South Africa, raised in Great Britain, and naturalized as a citizen of the United States for the last quarter century, Rick's mixed accent often elicits the question "...where are you from?" "Triangulate from each of those countries, and that places me about mid-Atlantic," is how he replies. It's a location that pleases his sense of global citizenship and speaks to his commitment to conservation around the world.

Rick earned his Bachelor's degree in Marine Zoology in the UK, his Doctoral degree in Raptor Ecology in South Africa, and completed a Post-doctoral study on insect ecophysiology in Namibia. He was hired by The Peregrine Fund in 1990 to establish the Madagascar Project to study and conserve three of the world's most endangered birds of

prey. This work led to the establishment of a 520,000 acre national park, Madagascar's largest, to protect their rain forest habitat and an innovative community-based conservation project to protect >500,000 acres of wetlands, mangroves and forest for the endangered Madagascar Fish Eagle.

From a focus on Madagascar, Rick expanded The Peregrine Fund's operations to the African continent, establishing new projects which included Bearded Vulture reintroduction to Kenya, raptor conservation and local capacity building in Zimbabwe, Kenya, Uganda, and Ethiopia, Crowned Eagle research in Ivory Coast, kite research in the Cape Verde islands, and many others. By the turn of the Millennium, Rick's influence had become truly global, with projects added in Asia (Philippine Eagles, diclofenac poisoning of *Gyps* Vultures in South Asia, Cinereous Vultures in Mongolia, and Javan Hawk Eagles in Indonesia) and the Neotropics (Harpy Eagles, Ridgway's Hawks, and Orange-breasted Falcons among others).

Rick's accomplishments are never achieved alone; his life's mantra "...give others the credit, build teams, and develop local capacity to work sustainably..." has served him well. With >30 graduate students and many more technicians shouldering the work, and now the entire Peregrine Fund staff and volunteer force as well, his vision for the future of The Peregrine Fund's global impact looks to the next species in need, the next critical habitat to save, and the next landscape-level threat to tackle while engaging people to become supporters and beneficiaries of conservation focused on birds of prey. His life's adventures, passion and over four decades of working in pursuit of raptor conservation around the world, have been shared and supported by his wife, Christine, and their two children, Ben and Heather.



# SYMPOSIA

## Lead in Wildlife Symposium

*Co-Chairs: Rick Watson, Todd Katzner & Mark Pokras*

The Lead in Wildlife Symposium focuses on the science, policy, and mitigation actions underway surrounding issues related to anthropogenic sources of lead impacting wildlife around the world. The symposium will feature oral and poster presentations by global experts in the science, philosophy, and action surrounding the anthropogenic sources of environmental lead contamination. This symposium will promote communication among experts, inform stakeholders, and engage a global audience regarding a major environmental and human health risk. In doing so, our ultimate objective is to foster cohesion and galvanize momentum among stakeholders that will be necessary for solving the issues associated with anthropogenic sources of environmental lead contamination.

## Conservation of Eurasian Steppe Ecosystems with a Focus on Top Avian Predators

*Co-Chairs: Rick Watson & Todd Katzner*

Extensive anthropogenic alteration of steppe ecosystems throughout the world leaves parts of Eurasia and central Asia with some of the world's last remaining large expanses of intact steppe habitat. Consequently, central Asia has become the sole remaining stronghold for populations of many steppe species, including avian top predators. It is a crucially important area for biodiversity conservation. The goal of this symposium is to create an international exchange of knowledge about the steppe ecosystem, threats, and challenges to its structure and function by using a focus on birds of prey as top predators and indicators of ecosystem health. Outcomes are expected to be shared with improved knowledge, and links and partnerships among participants built for future collaborations on research, education and conservation action to preserve the world's largest remaining steppe ecosystems as a globally important heritage.

## The Barred Owl Invasion of Western North America

*Chair: Phil Detrich*

The Barred Owl (*Strix varia*) is a common native species in eastern North America. As of 1900, the species was not known to occur west of the Great Plains. As of 2020, Barred Owls were resident in the western U.S. states of Montana, Idaho, Washington, Oregon, California, and southeastern Alaska; and in the western Canadian provinces of Alberta and British Columbia. Barred Owls have completely occupied the range of the Northern Spotted Owl (*Strix occidentalis caurina*) (NSO) and are now extending southward into the range of the California spotted owl (*S. o. occidentalis*). The Barred Owl is recognized as one of two primary threats to the NSO, which is listed as threatened under the U.S. Endangered Species Act. Based on NSO recovery goals, a pilot research program has removed over three thousand Barred Owls in the NSO range, and hundreds more have been removed on private lands under permitted programs in northern California. In this symposium, authorities on Barred Owl biology and management will address the history, ecology, and controversies of this remarkable invasion. Subjects will include demographic impacts to the NSO; effects on other wildlife taxa; habitat relationships; and the progress, legality, and ethics of control attempts. Discussion will consider options for potential comprehensive management.

# Global Priorities for Raptor Ecology & Conservation

*Co-Chairs: Evan Buechley & Chris McClure*

Raptors serve critical ecological functions, are particularly extinction-prone and are often used as environmental indicators and flagship species. Two recent papers provided the first systematic, global syntheses of the conservation status of and threats to all raptors (McClure et al. 2018), as well as a framework by which to prioritize research and conservation actions on them (Buechley et al. 2019). In this symposium, we will build off of these two papers to provide a global overview of the status, threats, and research history for all raptors, while incorporating talks that highlight conservation and research priorities in greater detail for different species groups and regions, such as conservation priorities for Old World vultures (Botha et al. 2017; Santangeli et al. 2019a); conservation priorities for raptors in Asia (Concepcion et al. 2018); and research priorities for Neotropical Accipitriformes (Monsalvo et al. 2018). Further, we will incorporate talks that investigate the usefulness of using raptors as indicator and umbrella species to help promote the conservation of other species or ecosystems as a whole (i.e. Burgas, Byholm, & Parkkima, 2014; Regos, Tapia, Gil-Carrera, & Domínguez, 2017; Senzaki, Yamaura, & Nakamura, 2015) and talks that address the human components of raptor conservation (DeVault 2015; Santangeli et al. 2019b). Lastly, we will incorporate talks that highlight cutting-edge methodologies applicable to raptor conservation (Ferrer-Sánchez & Rodríguez-Estrella 2016; Watson 2018).

# Global Solutions for Raptor Fatalities on Power Lines

*Co-Chairs: Rick Harness & James Dwyer*

Raptors and other birds are killed by collision with or electrocution on power lines worldwide. In the U.S. alone, an estimated 12–64 million birds are killed by power lines annually, with 8-57 million birds killed by collision. It is also estimated that 2.5-25.6 million birds are killed per year at Canadian transmission lines. Contacts with electric lines can also lead to outages, damaged equipment, and in some cases, fires. In North America, animals cause approximately 8% of the duration of all outages. The cause of electrocution is due to engineering including phase design, pole type, pole equipment and materials used. This anthropogenic cause of mortality is preventable with appropriately engineered solutions. There has never been a more urgent need for solutions, as global investments in transmission and distribution will approach \$3.0 trillion in the decade prior to 2025. This symposium explores the cost-benefits of preventing electrocution and collision by raptors with power lines and the means for implementing solutions at a global scale. Presentations will be made from case studies from around the world that reveal the impact of electrocution or collision on raptor populations. Other presentations will focus on the social and economic concepts that influence decision-makers to either construct safe power lines in the first place or retrofit lines that are not safe. How to reach and influence key decision makers worldwide, whether they be engineers designing lines, utility workers installing lines, investors paying for lines, or governments authorizing lines, will be discussed as vitally important steps in promoting raptor-safe electrification worldwide.



*Paul Spurling*



*Eric Hudnall*



*Munir Virani*

# The Human/Raptor Interface in Archaeological Research & Its Multidisciplinary Potential

*Co-Chairs: Jonathan Dombrosky & Katelyn J. Bishop*

The archaeological record is an unparalleled source of information regarding the nature of human/raptor relationships through time and the environmental context in which these relationships occur across the globe. Presenters in this symposium highlight how the material traces of past humans and raptors relate to more anthropological topics such as the social organization, belief structure, behavior, and technology of past human groups. However, when possible, presenters also emphasize how their research can help with raptor conservation or how it reveals information about past raptor behavior, their ecological niches, or larger landscape histories. While archaeology is of interest to both public and academic audiences, this symposium explicitly seeks to showcase and engage biologists with archaeological perspectives to help facilitate multidisciplinary research on raptors in general. There is strong potential for archaeological research to situate present socio-environmental problems and guide decision-making, and this is especially the case when such problems relate to raptors considering the long coevolutionary history they have with humans.

# The Full Annual Cycle of the American Kestrel: Knowledge Gaps and Conservation Needs

*Chair: Jim Bednarz, Kelsey Biles, Jean-François Therrien & Anjolene Hunt*

The American Kestrel (*Falco sparverius*) is a relatively common and popular raptor, used as the model species for a variety of scientific studies (Bird and Bowman 1987). Despite their ubiquity, long-term data from the Breeding Bird Survey (BBS), raptor migration counts, and occupancy of nest boxes all suggest that American Kestrel populations are undergoing widespread declines across North America (Farmer and Smith 2009, Smallwood et al. 2009). The most severe declines seem to be occurring in populations along the Atlantic coast and the Appalachian Mountains (Farmer and Smith 2009), whereas trends are less conclusive in other regions of the U.S. (Farmer and Smith 2009, Smallwood et al. 2009). Regional declines in kestrel populations have been reported beginning as early as 1971 (Bednarz et al. 1990), and although many potential drivers of decline have been investigated, no clear conclusions have been reached. Recent analyses have indicated that low breeding success alone cannot explain this apparent decline, suggesting that more information on survival, and a better understanding of the full annual cycle is needed to uncover likely factors (McClure et al. 2017). Specifically, more information on non-breeding populations, adult survival, carry-over effects, and migratory connectivity are important to determine population-specific trends and potential conservation actions (McClure et al. 2017). This need has been recognized, and because of the plethora of researchers working with this well-studied species, a number of symposiums have been organized to summarize and share data on kestrel population trends and their biology. Also, recent broader-scale science initiatives, such as eBird and nestwatch, offer new opportunities for learning about kestrels across large-scales. Here, we propose that the time is right for this American Kestrel symposium to review new results and ongoing research, and have researchers and raptor enthusiasts collectively discuss and share ideas to again deliberate the status, potential drivers of declines, areas for collaboration, and possible conservation actions needed to address the kestrel population decline.

# SYMPOSIA contd.

## Prairie Falcons: What We Know and What We Don't

*Co-Chairs: Karen Steenhof*

Prairie Falcons (*Falco mexicanus*) are endemic to western North America, where the landscape has been altered significantly by wildfires, energy development, invasive plants, and climate change in recent decades. Unfortunately, little is known about the species' current population status or how it may have changed in response to these habitat alterations. Prairie Falcons were the reason that the Morley Nelson Snake River Birds of Prey National Conservation Area was established. Prairie Falcons nest in particularly high densities in southwestern Idaho, where they were studied intensively from 1970 to 2003. However, populations were not monitored in the Snake River Canyon from 2004 to 2018, and there is limited information on the size of nesting populations in other states and provinces. The purpose of the symposium will be to share information on the status of the Prairie Falcon throughout its range, to identify critical information needs, and to discuss opportunities and protocols for future research and population monitoring. The symposium will include presentations about recent research based on banding and genetic analyses as well as updates on recent sampling of nesting populations in the Snake River Canyon. Representatives will report on what is known about current population levels and trends as well as the status of current population monitoring in each state and province where the Prairie Falcon occurs. A discussion after the presentations will focus on prioritizing information needs and developing a framework for range-wide population monitoring.

## Raptor Propagation for Conservation: Past, Present & Future

*Co-Chairs: Beau Parks*

In 1966, the founders of the Raptor Research Foundation considered one of their most important functions to be "a cooperative effort to develop methods of breeding birds of prey in captivity" (Raptor Research News 1:1). Since then, and perhaps largely due to that effort, captive propagation has played an integral part in some of the most high-profile raptor conservation success stories and the growth of one of the most influential raptor conservation organizations in the world, The Peregrine Fund. Although both the RRF and TPF have diversified their research and conservation efforts far beyond the breeding chamber, captive propagation remains a valuable tool for the conservation of birds of prey. In addition to breeding for conservation, commercial breeding of raptors, primarily for sport falconry is now widespread. There is considerable knowledge in the private sector and opportunities exist for collaboration that can benefit conservation breeding programs. We continue the founders' cooperative effort with a symposium exploring the historical successes and challenges of breeding raptors for conservation, the current state of the art of raptor propagation and its potential applications for raptor conservation moving forward.



Rob Palmer



Steve Alsup

# VIEW CONFERENCE SCHEDULE

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VIEW  
SCIENTIFIC ABSTRACTS

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# CONFERENCE CODE OF CONDUCT

The Raptor Research Foundation (RRF) 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 on a virtual or online platform. 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, physical ability, physical appearance, age, sexual orientation, gender, or gender 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, online, or personal communication involving any activity of the RRF. This policy applies to speakers, staff, volunteers, exhibitors, and attendees. RRF members or conference delegates 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 RRF member or conference participant 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 any individual's behavior at any RRF-sponsored event should contact any member of the Code of Conduct Committee or RRF Board. The reporting person 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 possible thereafter. Confidentiality will be honored to the extent permitted as long as the rights of others are not compromised. Note the aforementioned course of action will be independent of any law enforcement investigation. If the alleged violation is deemed potentially criminal in nature, law enforcement authorities will be called.

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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 RRF. 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 of all 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. 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.

## Code of Conduct Committee

- **Cindy Kemper, Chair** | [chickadee2906@gmail.com](mailto:chickadee2906@gmail.com) | (587) 785-6072
- **JD Dwyer** | [jdwyer@edmlink.com](mailto:jdwyer@edmlink.com)
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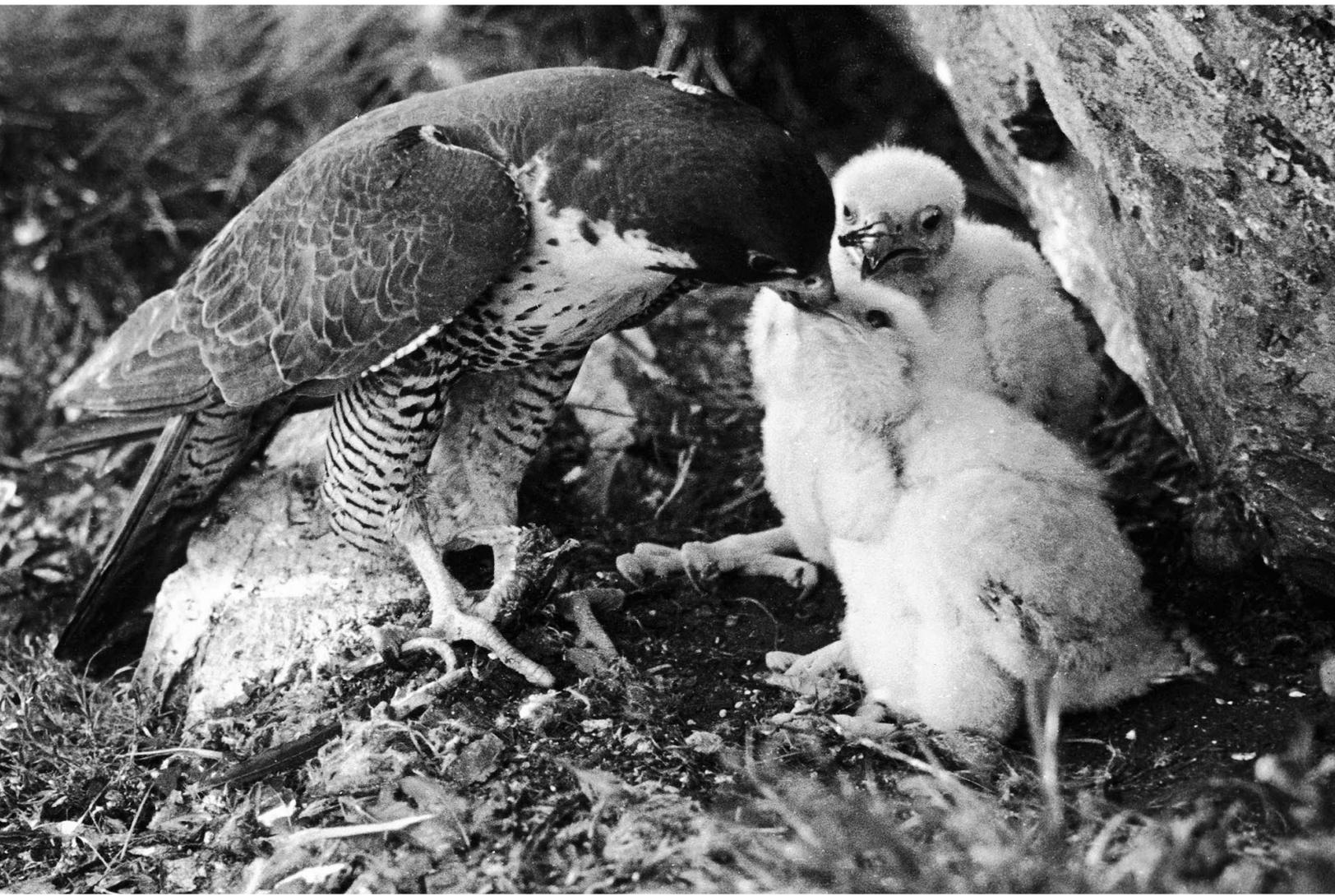
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## Acceptance type: General Session Oral

53

### Osprey Nest Success: Impact of High Fish Deliveries with Low Variation

MICHAEL H ACADEMIA, HARMONY J DALGLEISH  
William and Mary, Williamsburg, USA

#### Abstract

Ospreys (*Pandion haliaetus*) are obligate piscivores and nest success depend on sufficient amounts of fish delivered to the nests during the breeding season. Nests are considered successful when pairs raise a minimum of one young to fledging or near-fledging age. Through web cameras and online broadcasts of Osprey nests, citizen scientists quantified daily fish deliveries, days of observed nest survival, and nest success on a large scale. We received and analyzed data (one to seven seasons, 2014 - 2020) from citizen scientist groups representing 19 Osprey web cameras from four countries in North America and Europe. We compared the average and the coefficient of variation in number of fish delivered per day, days of observed nest survival, and nest success between the failed and successful nests within the early breeding season using Generalized Linear Mixed Models (GLMMs). Successful and failed nests had similar average number of fish delivered per day but failed nests had a higher variation in the number of fish deliveries. In addition, the variation and average number of fish delivered per day had strong associations with nest success. The global effort and manner in which this data was collected are novel and can provide innovations and insights to further our understanding about this charismatic species. The combination of citizen science and technology are powerful modern tools that can provide insights and have the potential to advance raptor research on a global level.

## **Generating Predictive Risk Models for Managing Poultry Predation by Raptors in Andean Temperate Forest Socio-Ecosystems.**

ROCIO ALMUNA<sup>1</sup>, JOSE T IBARRA<sup>1</sup>, HERNAN VARGA<sup>2</sup>

<sup>1</sup>Pontificia Universidad Católica de Chile, Villarrica, Chile. <sup>2</sup>The Peregrine Fund, Boise, USA

### **Abstract**

Human persecution is a worldwide threat to raptors, contributing to the decline of many species. Perceived or real predation of domestic animals is the main driver of persecution. Raptors have the potential to predate on small domestic animals, which is why farmers associate them with poultry loss. The Andean temperate region of Southern Chile is a Global Biodiversity Hotspot where diurnal raptors co-inhabit with humans in rural areas. Here, complaints from farmers on raptor attacks on poultry have steadily increased; however, there is no empirical information about the conflict. This study aims to build a predictive risk model to identify husbandry practices and landscape variables associated with poultry predation by diurnal raptors in Southern Chile. We applied questionnaires to farmers about their poultry husbandry practices and raptor predation dynamic. We used data from questionnaires, and landscape features of the areas surrounding the farmers' properties to generate risk models of poultry predation. We show that farmers maintaining an exclusion structure for the chickens, a guard dog and a high proportion of forest in their land can reduce the risk of raptor predation on their poultry. We revisited the local community to share our results by providing an educational illustrated brochure and establishing a conversation to share knowledge on poultry care against predation. These findings can be used to prevent raptor attacks on poultry by encouraging other farmers to implement these management measures in southern Chile. Our methodological approach, with local adaptations, may be replicated at larger scales or be used as a reference for reducing human-raptor conflicts elsewhere.

## Successful Reintroduction of Barbary Falcons in the Kingdom of Saudi Arabia

ALBARA M ALOTHMAN<sup>1</sup>, SUSAN M HAIG<sup>2</sup>, GIOVANNI LEONARDI<sup>3</sup>, MATYAS PROMMER<sup>4</sup>, VICTORIA JOSEPH<sup>5</sup>, BUSHRA I ALABDULHAFITH<sup>1</sup>, ABDULAZIZ M ALWAHIBY<sup>1</sup>

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### Abstract

Successful reintroductions are notoriously difficult and often take years before positive results are realized. However, through careful use of a network of local falconers and new laws protecting falcons, we were able to achieve remarkable success in our first year. In 2021, survey results suggested that only 7.05% (n = 53) of 752 historic Barbary Falcon (*Falco peregrinus pelegrinoides*) nests were active and 6.52% (n = 49) of non-active nests were occupied by an unpaired male. As a result, the Saudi Falcon Club, launched the Hadad Program to recover Barbary Falcons in the Kingdom. As falconry is the top sport among Saudis, encouraged by the efforts, falconers willingly donated captive Barbary falcons to the cause of conservation and preserving the tradition. Next, a network of local falconers volunteered to release the falcons and monitor their safety and success. From January through March 2021, the Hadad Project released 33 female Barbary Falcons to territories with unpaired wild male Barbary Falcons. Out of 33 released female Barbary Falcons, (87.9%), 29 have survived and reproduced. The pairings have produced more than 47 offspring in the 2021 breeding season. This increased the active nest count to 10.90% (n = 82) of the previously accounted 752 historic Barbary Falcon active nests. Key to the success of the project were new effective laws recently developed that make it illegal to take young falcons from nests or trap adults. Our results indicate that reintroduced Barbary Falcons can succeed when proper protocols are followed. This initiative is the start of similar conservation efforts supported by the Kingdom of Saudi Arabia.

## Using Stable Isotopes to Estimate Diet Composition in Gyps Vultures Over Space and Time in Tanzania.

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### Abstract

Dietary studies in birds of prey involve direct observation and examination of food remains at resting and nesting sites. Although these methods accurately identify diet taxonomy, they are time consuming, resource intensive and associated with raptor feeding ecology bias. Our study set out to estimate diet composition in *Gyps* vultures (*Gyps africanus* and *G. rueppelli*) informed by stable isotopes, providing a good representation of assimilated diet. We hypothesized that diet composition in *Gyps* vultures derived from stable carbon ( $d^{13}C$ ) and nitrogen ( $d^{15}N$ ) isotope ratios varies between Selous Game Reserve and Serengeti National Park and over time in Tanzania, and that location of prey items (prey source) derived from stable sulfur ( $d^{34}S$ ) isotope ratios does not vary across sites. Diet derived from  $d^{13}C$  in *Gyps* vultures consisted of grazing herbivores across study areas, with vultures in Serengeti National Park consuming higher proportions of grazing herbivores (> 87%). Proportional differences across sites were due to varying baseline isotope values in prey items.  $d^{13}C$  differences in vulture feather subsets per site did not significantly represent vulture diet change, and in combination with blood  $d^{13}C$ , vultures consistently fed on grazers for ~159 days before they were sampled. Similarly,  $d^{15}N$  values implied that *Gyps* vultures fed mainly on herbivores across space and time.  $d^{34}S$  ratios separated prey source for vultures in the two sites.  $d^{34}S$  variation in vultures across sites resulted from differences in baseline (plant)  $d^{34}S$  values, although it is difficult to match  $d^{34}S$  to specific locations. Our findings highlight the relevance of repeated sampling that considers tissues with varying isotopic turnover for *Gyps* vulture dietary analysis with stable isotopes. They also suggest movement isolation of vultures in Northern and Southern Tanzania. However, more sampling in combination with robust movement data is required to fully comprehend this observation and its implications to *Gyps* vulture ecology and conservation.

## Resistance to Rattlesnake Venom in a Great Plains Raptor Assemblage

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### Abstract

In an ecological context, snake venoms have the potential to exert powerful selective pressures upon other organisms within an ecosystem. While resistance to snake venoms in prey species has been demonstrated on various occasions, comparatively little research has explored the resistance capabilities of snake predators to venom. As opportunistic predators, raptors prey upon an array of available taxa, with predation on venomous snakes being widespread among birds of prey. Although raptors often successfully prey upon venomous snakes, numerous published records of mortality associated with snake envenomation exist. The Great Plains Region of North America is inhabited by a suite of raptorial birds that interact with the co-occurring prairie rattlesnake (*Crotalus viridis*). In the process of securing and subduing rattlesnakes, raptorial birds are at risk of being envenomated. Here, we explore proteolytic venom resistance in the Red-tailed Hawk (*Buteo jamaicensis*), Swainson's Hawk (*Buteo swainsoni*), Great Horned Owl (*Bubo virginianus*), Bald Eagle (*Haliaeetus leucocephalus*), and Golden Eagle (*Aquila chrysaetos*) using fluorescence-based enzymatic assays. Preliminary results indicate inhibition of snake-venom metalloproteinase activity conferred by Red-tailed Hawk serum. Further analysis is needed to understand serum inhibitory effect on other rattlesnake venom components (e.g. snake-venom serine proteases), and inhibitory potential of serum of other raptor species. This study, to our knowledge, is the first analysis of endogenous venom resistance mechanisms in raptorial birds. Characterizing venom resistance in raptors (or lack thereof) allows us to contextualize better the trophic ecology of raptors in their ecosystems, and better understand the selective pressures and risks associated with predation on venomous organisms.

## **New Nests for New Recruits: Trees Provide Comparable Nesting Substrate for two Primarily Cliff Nesting Eagle Species in Spain**

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### **Abstract**

In recent decades Bonelli's Eagle (*Aquila fasciata*) and Golden Eagle (*Aquila chrysaetos*) populations have grown on the Iberian Peninsula. Both species are known to primarily nest on cliff faces, but as their populations have grown, they have increasingly nested in trees. Using two long-term data sets on the number of young produced by Bonelli's Eagles (1980-2020) and Golden Eagles (1998-2020) across Andalusia in southern Spain, we assessed the reproductive value of nesting in trees and whether new recruits to each population are relegated to breeding in sub-optimal habitat or they are exploiting previously unused aspects of the landscape. Comparing alternative hypotheses with multiple models in an Information Theoretic approach, we found that the number of young fledged by Golden Eagles did not differ between nests in cliffs and trees and that Bonelli's Eagles fledged slightly more young when they nested in trees. Most variation in the number of young fledged was accounted for by the age of the parents. We suspect that historic persecution of these eagle species across Spain may have prevented nesting in trees since these are easier to access by humans than cliff nests. As attitudes have shifted and persecution has diminished, both species may now be able to establish territories in areas lacking cliffs available for nesting. Much of the previous research on the habitat requirements of these eagles emphasized the importance of cliffs for nesting, and while we still see an apparent preference for nesting in cliffs by these species in our data, knowing that nesting in trees provides comparable reproductive value could provide increased flexibility in conservation planning for the future.

## **Integrated Modeling and Habitat Prioritization for Golden Eagles: The Importance of Incorporating All Life-History Phases**

BRYAN BEDROSIAN<sup>1</sup>, BRIAN WOODBRIDGE<sup>2</sup>, JEFFREY R DUNK<sup>2</sup>, ZACH WALLACE<sup>3</sup>, DAVE LAPLANTE<sup>4</sup>

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### **Abstract**

Conservation of important habitats requires spatial prioritization of the landscape as a key first step. Wyoming has some of the largest golden eagle populations and most valuable areas for conservation of the species in the western US, but our ability to identify and prioritize important areas is limited. Conservation actions aimed at avoiding, minimizing, or mitigating threats to eagles, as well as habitat conservation (e.g., land-use planning, easements, restoration) are more effective and efficient when guided by knowledge of the importance of proposed project areas to eagle populations. To date, most efforts to prioritize landscapes for golden eagles have been focused on breeding birds and nesting habitat. To address this information gap, we are creating a comprehensive, integrated model of relative habitat importance that encompasses all major golden eagle life-history classes (i.e., breeding, wintering, and migration seasons, age, and migratory status). Through many collaborations, we compiled >9.5 million data points, which we classified by behavior type (e.g., roost, fast-flight, slow-flight, etc.) and age class. Using these data and a previously collected database of 2,642 nest locations, we have completed fine-scale (120-m) relative habitat suitability models for breeding, winter, fall migration and spring migration seasons across 15 ecoregions within and adjacent to Wyoming. Thus far, we have found some interesting differences in winter habitat use among different age and migration classes. Furthermore, although we found some overlap in high value breeding, wintering, and migration areas, there were many important areas only highlighted by one model. This highlights the importance of evaluating all eagle life-history phases in habitat prioritization. Using these models, we will spatially prioritize our study area for golden eagles, in addition to multi-species values and economic drivers. This final product will be available as an online decision support tool for agencies, developers, land trusts, NGOs, and others interested in golden eagle conservation.

## Recent Advances in the Application of Drones for Raptor Research, Management and Conservation

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### Abstract

Drones are gaining more and more acceptance as a bonafide technological tool for wildlife biologists and managers all over the world. Compared to using crewed light airplanes or helicopters, flying drones can be cheaper, greener, less obtrusive, and much safer (the number one source of mortality for wildlife biologists is dying in a plane or helicopter crash!). During the last 13 years or so, the use of drones by raptor biologists is proving to be a safe method for censusing raptor nests for productivity and for checking ages of nestlings for banding. For example, a total of 140 successful drone flights have been made over Bald Eagle (*Haliaeetus leucocephalus*) nests at Besnard Lake, Saskatchewan, Canada without incident. Since 2015, a total of 200 successful drone flights have been made over White-Tailed Eagle (*H. albicilla*) nests in the Quark Archipelago in Western Finland and a total of 250 drone flights were carried out successfully over Osprey (*Pandion haliaetus*) nests in Eastern Finland, Northern Savonia. Similar successful nest checks have been made over 116 nests of African Crowned Eagles (*Stephanoaetus coronatus*) in South Africa. Preliminary efforts by McGill University researchers include modifying an off-the-shelf drone to peer into the nesting holes of American Kestrels (*Falco sparverius*). The Finnish team has recently used drones to locate the ground nests of Western Marsh Harriers (*Circus aeruginosus*). In other applications, raptor-like drones are also proving to be quite effective at dispersing nuisance birds from airports and landfill sites. This presentation provides insights into the very latest raptor research and management using drones, including successes and failures.

## Patterns of Water Use by Raptors in the Southern Great Plains

CLINT W BOAL

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### Abstract

There is a paucity of data evaluating water use by raptors. Although raptors are generally believed to satisfy their water requirements through metabolic processes, they are known to experience reduced reproductive success during periods of drought, and there is evidence of water being important for site occupancy in arid landscapes. Several raptor species have a seasonal or year-round presence in west Texas, a drought-prone, semi-arid region of the southern Great Plains. I used cameras at man-made water sources to examine raptor species-specific temporal patterns of free water use in this region, and to explore environmental conditions associated with the behavior over a 48-month period. Preliminary analysis of 57% of 1206 detections revealed 11 species of raptors used man-made water sources; the raptor was drinking or appearing to drink water in 387 detections and bathing in 153 detections. Barn Owls (*Tyto alba*; 46.3%), Swainson's Hawks (*Buteo swainsoni*; 30.4%), and Northern Harriers (*Circus hudsonius*; 18.4%) were the predominate species detected. Barn Owls were detected year-round, Northern Harriers were detected from 20 August to 14 April, and Swainson's Hawks were detected from 24 March to 5 October. Mean time of visit by Barn Owls was 0102 (240 SD) and visits appeared independent of temperature. In contrast, the mean time of visit by Northern Harriers ( $1440 \pm 320$  SD) and Swainson's Hawks ( $1338 \pm 277$  SD) coincided with the hottest times of the day for the respective periods of occupancy. Analyses of seasonal and environmental variable influences are pending but will be completed for the full data set for presentation. Preliminarily, however, raptors will readily use free water when available, but how this influences survival and reproduction remains unknown. This may become a pressing question, as current models predict the study area will experience increases in heat and decreases in precipitation.

## How Habitat Fragmentation Modifies Productivity of Great Horned Owls in Desert Scrub of Baja California Peninsula

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### Abstract

Habitat loss and landscape fragmentation can produce a decrease in prey availability and structures for breeding that can modify the abundance and distribution of raptors. We evaluate the effects of landscape fragmentation on the productivity and body condition of the Great Horned Owl (*Bubo virginianus*) in the Baja California peninsula arid desert. A total of 256 nesting attempts were recorded during 2014, 2015 and 2017. From total nests a low percentage was active by the owls: 5-8% (n = 121) in natural area (NA) and 9-13% (n = 140) in fragmented area (FA). The density of occupied nests (n = 79) was 0.01 pair /km<sup>2</sup> in NA and 0.04 pair /km<sup>2</sup> in FA, being three times more in FA. In FA, breeding pairs started their reproduction earlier and were more successful than late breeders. Clutch size and productivity were higher in FA than in NA. The productivity in FA is highest reported for the species in desert ecosystems. We propose that small fragments inserted in the matrix of agricultural area are important for conservation and maintaining owl populations.

## Foraging Ecology of Sharp-shinned Hawks and Merlins Migrating Along the Pacific Coast of North America

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### Abstract

Bird-eating falcons and accipiters are thought to rely on flocks of migrant songbirds as a critical resource to fuel the energetic demands during long-distance fall migration. However, the foraging ecology of migrating raptors has been difficult to investigate due to the logistical challenges of documenting prey selection of highly mobile and inconspicuous predators during a difficult-to-study life history stage. To address these knowledge gaps, our objective was to develop a novel beak and talon swab method to collect prey DNA to describe dietary trends of bird-eating raptors during fall migration. In fall of 2015 and 2016, we swabbed visible and trace prey remains from the exterior surfaces of beaks and talons of migrating Merlins ( $n=72$ ; *Falco columbarius*) and Sharp-shinned Hawks ( $n=565$ ; *Accipiter striatus*) that were banded by volunteer citizen/community scientists at a long-term raptor migration monitoring station on the Pacific Coast of California, USA. With a DNA metabarcoding approach designed to target avian prey, we detected prey DNA on 80% of the raptors sampled with an average of 3 prey items per individual raptor. We documented prey DNA from 1,645 prey items comprised of 81 prey species. For both raptor species, migration diet was comprised of mainly migratory songbirds, and males selected smaller prey species on average compared to females. To investigate temporal trends in prey selection, we modeled prey detections with date and eBird data to show that migratory songbirds are selected more often during peak songbird migration (mid-September – mid-October) compared to resident prey species. By revealing what fuels raptor migration, we can begin to highlight critical resources for migratory raptors that hunt continuously en route and investigate complex predator-prey and coevolutionary relationships within migration corridors using dietary data that is now attainable.

## Climate Change, Pteropods, and Bald Eagles

DOUGLAS A BOYCE

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### Abstract

The world's climate is changing as industrial era green house gases continue to accumulate in our atmosphere at unprecedented rates. Resulting effects include higher atmospheric temperatures, rising sea levels, and acidic changes in ocean pH levels. Changes in climate are affecting trophic organization, but have remained unstudied for most raptors. Raptors occupy the apex of many food web pyramids and will be susceptible to quick changes to their food pyramid structure, including lowered abundance, or elimination, of prey they depend on for survival. Bald Eagles (*Haliaeetus leucocephalus*) in Southeast Alaska rely on capturing salmon (*Salmonidae*), returning to their spawning grounds after years of growth in the ocean, to feed their young. Many populations of salmon feed on pteropods (Phylum *Mollusca*, Order *Pteropoda*) while living in the ocean. Since pteropods are an important food source for salmon, and salmon are important to Bald Eagles, understanding the effects of pH changes to pteropods is critical in understanding crucial consequences to Bald Eagles. I describe a scenario of climate change effects to southeast Alaska Bald Eagles to encourage other raptor experts to develop similar scenarios for the world's raptors and their prey. These evaluations should allow us to watch for early indicators of stress within food pyramids and to create timely strategies to counter, to the extent possible, species losses.

## Northern Goshawks and Fire

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### Abstract

Wildfire, disease, and insects are among the disturbance agents influencing forest structure, species composition, forest growth, and spatial vegetative patterns. Northern Goshawks (*Accipiter gentilis atricapillus*) and many other wildlife species rely on mature to old forest conditions for their continued survival. Fire has reduced the amount of late succession forest west-wide in recent decades prompting land managers to seek solutions to slow the rate of forest loss by identifying and restoring low intensity ground fire to avert destructive canopy fires that continue to destroy habitat. We evaluated wildfire threats to existing Northern Goshawk habitat on a 1728 km<sup>2</sup> study area in Northern Arizona, USA where we located 124 Northern Goshawk territories. Using existing fuel conditions, we simulated wildfires and their effect within territories across the study area. Flame lengths of eight and 12 feet resulted in similar habitat loss patterns. The fuel loading conditions on the Kaibab Plateau are not unusual for the western United States; leading us to conclude that contemporary fire is an important threat to Northern Goshawk habitat stability and negatively affects population size.

## **The Context in which Vulture Supplementary Feeding Stations Operate in South Africa and the Potential Hidden Costs to Vultures.**

CHRISTIAAN WILLEM BRINK<sup>1,2</sup>, ARJUN AMAR<sup>1</sup>, ANDREA SANTANGELI<sup>3</sup>, KERRI WOLTER<sup>4</sup>, SONJA KRUGER<sup>5</sup>, GARETH TATE<sup>6</sup>, ANDREW TUCKER<sup>7</sup>, ROBERT LESLIE THOMSON<sup>1</sup>

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### **Abstract**

Under the current African vulture crisis, supplementary feeding stations (SFS) have become a popular conservation tool to address vulture declines. In South Africa, this practice is currently unregulated and its prevalence, the context in which it is performed and managers' adherence to best practices is unknown. In this study, we address this knowledge gap through a survey with SFS managers. We identify 143 currently active SFS, most commonly associated with livestock farming, providing an estimated 3301 tonnes of food to scavengers annually, the equivalent of 83% of the energetic needs of all vultures in the region. We show a positive correlation between the number of vultures seen at SFS and the amount of food provided. Overall, managers mostly (84%) perceived running a SFS as beneficial, largely attributed to the cleaning services provided by vultures, with the majority also perceiving no disadvantages. Managers, however, had somewhat limited knowledge of threats to vultures. For instance, 68% and 28% of SFS managers were unaware of the potentially harmful effects of lead and veterinary drugs, respectively, which highlights potential poisoning risks associated with SFS. Also, only 30% of managers considered threats to vultures when they decided on a location for their SFS. Overall, this study demonstrates the potential importance of SFS but also unveils that many SFS may not conform to best management practices of providing food under safe conditions to vultures. To minimise unintended negative consequences from SFS it will be essential to increase the interaction between SFS managers and conservation practitioners, to increase the flow of information on best management practices and enforce stringent and clear guidelines that minimise any risks to vultures.

## Cloacal Swabbing as a Tool to Study Diet in Migrating Raptors Using DNA Metabarcoding

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### Abstract

While much research has gone into understanding the timing and patterns of migration, little has been done to understand the diet of raptors during migration. Most raptor dietary studies focus on the breeding season or winter, but migratory diet may be quite different due to differences in habitat type and prey availability along migration flyways. Traditional methods for studying raptor diets are difficult or impossible to apply to the migratory season and thus new methods are needed to address this knowledge gap. In this study, I tested the efficacy of DNA metabarcoding to detect prey DNA on cloacal swabs. In 2019, we collected cloacal swabs from raptors during spring and fall migration in Duluth, MN. We analyzed 287 cloacal swabs from 11 species of raptors. Prey DNA was detected on 18.46% of cloacal swabs. Using a generalized linear model, we found that neither species, size of the raptor, nor migratory flight strategy (passive/soaring flight vs. active flight) were better than the null model at explaining differences in detection of dietary DNA. To our knowledge, this is the first study to use cloacal swabbing and DNA metabarcoding to detect dietary DNA and our results indicate that this method has potential for further use.

## **An Observation of a Female-Female Pair and Copulation Behavior in the American Kestrel**

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### **Abstract**

Same-sex copulations by raptors, and birds in general, have been rarely reported. To our knowledge, in American Kestrels (*Falco sparverius*), a female copulating with a female has not been previously reported. Here, we summarize our observations of a pair of female kestrels that bonded and were documented to copulate repeatedly with each other over a 5-wk period in north Texas. Two unbanded females were first observed together on 13 March 2020, when they copulated 23 times. That same day, we trapped and marked both females with coded anodized color bands. Between 13 March and 20 April 2020, we observed the pair copulate an average of 9.2 times/hr (7 days of observation,  $n = 7.9$  hr). The kestrels alternated which bird was in the top position during copulations, with female E/17 on top during 55.8% of copulations ( $n = 24$ ) and female E/20 on top during 44.2% ( $n = 19$ ). One or both kestrels vocalized during 75.6% of copulations. Both kestrels were present during 74.9% of our observations and perched side-by-side 62.0% of that time. We recorded other behaviors typical of breeding kestrels, including nest-site inspection, territorial defense, and an apparent aerial courtship display. Contrary to suggestions in published notes on same-sex pairs in birds, our observations do not support the hypothesis that the females typically adopt separate gender-specific behavioral roles. We discuss our observations in the context of typical sexual behavior and copulation frequency in American Kestrels and suggest potential benefits of a female-female pairing strategy. The most probable benefits include sharing of incubation and provisioning duties resulting in a greater number of young fledged and the ability to more easily defend and hold territory with two females, which typically hold higher-quality territories than males in American Kestrels.

## Roads as Potential Novel Predators of Wildlife: Are Barn Owls Nonresponders?

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### Abstract

Recent proliferation of roads across the globe and concomitant increases in traffic speeds and intensity have led to massive mortality of wildlife through wildlife-vehicle collisions. Local extirpations of species have even resulted in some cases. In one way, roads can be viewed much like the introduction of a novel “predator” into the environment, to which few species may be preadapted to escape. The extent to which species are affected by roads, however, may depend on their behavioral responses as well as their propensity to adapt. Animals may be pausers, speeders, avoiders, or nonresponders to roads (Jacobson et al 2016: Ecosphere). Among birds, vehicular collisions are particularly common with Barn Owls (*Tyto alba*), which “fall prey to roads” in large numbers throughout their global distribution. Thus, Barn Owls are hypothesized to be nonresponsive, or possibly even attracted, to roads. We instrumented adult Barn Owls in southern Idaho with GPS data loggers and tracked their movements during 2019-2021 to understand dynamics of flight near roads and whether owls used roads more than expected based on availability. We examined the likelihood of road crossing by comparison to otherwise innocuous linear features in their home ranges and investigated if and how they adjusted flight speeds or altitude when crossing roads. Using simulated correlated random walk analyses, we also examined the extent to which owls used roads more than expected based on their occurrence to address the possibility that owls are attracted to roaded areas for foraging or other potential purposes. Our paper will summarize these results to help elucidate whether Barn Owls behave like pausers, speeders, avoiders or nonresponders near roads, and if roads have the potential to lure Barn Owls as “prey.”

## **Barn Owl (*Tyto furcata*) Nest Box Selection in Napa Valley, California: Is It Adaptive?**

JAIME E CARLINO, MATTHEW D JOHNSON  
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### **Abstract**

As human populations continue to grow and per capita consumption continues to rise, there are greater pressures placed on agricultural landscapes to increase yield by way of expansion and/or intensification. Despite widespread negative impacts of agricultural expansion and intensification on biodiversity, some species, including Barn Owls, are able to thrive in working landscapes. In Napa Valley, California, farmers growing winegrapes in a heterogenous network of vineyards and native habitats have installed nest boxes to encourage occupancy by Barn Owls, a natural enemy hypothesized to provide vertebrate pest control services. It is understood that spatial and temporal variations in the resources and conditions making up a habitat influence the fitness of animals occupying that habitat, resulting in intense selective pressures on animals' choice of habitats. The hypothesis of adaptive breeding-habitat selection suggests that the habitat preferences of animals should be adaptive, with increased fitness often expressed by increased reproductive success in preferred habitats. Barn Owls in this system selected for wooden nest boxes placed at least 3 m high, facing North or East, and with high proportions of native habitats, especially grasslands, within 2.8 km of the nest box. I examined whether these attributes selected by Barn Owls also confer increased reproductive success, or if there is a mismatch between nest box selection and habitat quality. To test my prediction that nest box selection is adaptive, I measured the annual reproductive success of Barn Owls occupying nest boxes throughout Napa Valley. Using GLMs, annual reproductive success served as the response variable predicted by the preferred nest box and landscape attributes previously identified.  $AIC_C$  were used to rank and select candidate models, and models within 2  $AIC_C$  of the top model were considered competitive. Results of these analyses, their implications, and practical applications by farmers are further discussed.

## **Stable Isotope Analysis of Red Kite (*Milvus milvus*) Feathers to Understand Anthropogenic Dietary Contributions**

JULIETTE L T CAVERLY<sup>1</sup>, STUART BLACK<sup>1</sup>, MARK FELLOWES<sup>1</sup>, NAOMI SYKES<sup>2</sup>

<sup>1</sup>University of Reading, Reading, United Kingdom. <sup>2</sup>University of Exeter, Exeter, United Kingdom

### **Abstract**

The diets of reintroduced Red Kites from locations across the United Kingdom were analysed using stable isotopes to determine the proportion of human-provided food in diets. Analyses of kite feathers showed TEF-corrected  $d^{13}C$  values ranging from -27.97 to -22.71 and  $d^{15}N$  from 1.60 to 9.87, giving insights into bulk dietary components and allowing birds to be positioned within isotopic food-webs. Longitudinal analyses of feathers also showed changes throughout the period of feather formation. Ranges for natural kite diets were established using potential wild and human-provided prey sources for kites present in reintroduction areas, and known to be fed, using survey data on feeding. To explore the contribution of human-origin food sources, un-mixing models using FRUITS was undertaken in order to quantify the proportion of food provision. These food sources from kite feathers were also mapped to identify where human feeding signals are present and provide a framework of analysis for the exploitation of human foodstuffs. This study is part of the Wellcome-Trust funded project 'From Feed the Birds' to 'Do Not Feed the Animals', and will enable the antiquity of kite feeding to be traced using archaeological kite tissue, and the history of the close relationship between humans and kites to be better understood. The reintroduction of red kites to southern England has led to close interactions with humans, and kites occupy urban spaces and are fed from gardens at an unforeseen scale. Historical sources and the presence of kite bones at urban medieval and post-medieval sites suggests that this was common before their later extinction and identification of an isotopic feeding signal will enable further analyses of archaeological kite skeletons. This will contribute to a greater understanding of the dietary and ecological niche occupied by kites in populated and human-managed landscapes prior to their extinction and subsequent reintroduction.

## Bay-winged Hawk vs. Harris's Hawk: One Species or Two?

WILLIAM S CLARK<sup>1</sup>, SERGIO SEIPKE<sup>2</sup>

<sup>1</sup>N/A, Harlingen, TX, USA. <sup>2</sup>N/A, Eldorado, Argentina

### Abstract

The two main populations of *Parabuteo unicinctus* have long been treated as subspecies of the same species: Harris's Hawk (*P. u. harrisi*) of North and Central America, and Bay-winged Hawk (*P. u. unicinctus*) of South America. Contrary to some references, we found no valid records of Harris's Hawk in South America. Most of the major world bird checklists treat them as conspecific. However, these taxa differ considerably in plumages and behavior. Adult Harris's Hawks have plain dark remiges, plain rufous thighs, and a plain, dark throat; adult Bay-winged Hawks have pale, darkly barred flight feathers and rufous barred thighs, and a streaked throat. Differences are even more marked in the juvenile plumage, in which only the pattern of remiges is similar in both species, everything else being different both in pattern and coloration. Harris's Hawk has two plumages (adult and juvenile), but Bay-winged Hawks also have a well-differentiated Basic II plumage, not found in Harris's Hawk and not described in major raptor books nor in any South American bird field guide. Harris's Hawks breed and hunt cooperatively; Bay-winged Hawks are known to breed only in pairs, and hunt individually. We believe that these differences, especially in plumages, merit their treatment as separate species.

## **Unusual Raptor Plumages: Albinism, Melanism, Hybrids, Amelanism, and Others**

WILLIAM S CLARK

none, Harlingen, Texas, USA

### **Abstract**

Raptors do not always look like the illustrations of them in field guides. This talk is a presentation of a vast array of photos of unusual plumages of North American diurnal raptors, including albino, partial albino, and amelanism (dilute plumage, leucism) raptors and on the usage and misuse of these terms. Melanistic, hybrids, and other oddly plumaged raptors will also be shown and discussed, as are long-billed syndrome, methane burner casualties, and others. This presentation is used in raptor identification sessions and is updated regularly.

## Cases of Skipped Primary Feathers in the Molt of Harris's Hawks in South Texas

WILLIAM S CLARK

N/A, Harlingen, TX, USA

### Abstract

I will show cases of unusual molt in the primaries of Harris's Hawk (*Parabuteo unicinctus harrisi*). Molt of the primaries in Accipitrid raptors proceeds sequentially from the inner primary, P1, one feather at a time to the outer primary, P10. I captured 545 Harris's Hawks in south Texas, both as adults and in Second Pre-basic Molt, from 2003 until the present. I report herein on 10 instances in which one or more primaries were skipped or replaced out-of-order during the annual molt in Harris's Hawk: seven in the second pre-basic molt, and three in adults. I have looked at primary molt in more than 3000 individuals of 20 other species of diurnal raptors from 1982 until the present and found no other cases of skipped primaries. One published case of skipped feathers was found in Griffon Vultures. Possible causes of this oddity will be discussed.

## Ageing American Kestrels in Hand Using Tail Tip Shape

WILLIAM S CLARK<sup>1</sup>, JOANNE MASON<sup>1</sup>, JEFFREY J. KOLODZINSKI<sup>2</sup>, LANCE MORROW<sup>3</sup>, JILL MORROW<sup>1</sup>  
<sup>1</sup>N/A, Harlingen, TX, USA. <sup>2</sup>The Port Authority of NY & NJ, New York, NY, USA. <sup>3</sup>N/A, New York, NY, USA

### Abstract

Previously, we thought that we could age female American Kestrels (*Falco sparverius*; hereafter kestrels) by the width of the dark subterminal band: wide for adults and narrow for juveniles. But several sources report that juvenile female kestrels can have narrow or wide subterminal bands. Other investigators have shown a difference in tail tip shape between juvenile and adult female kestrels: wide and blunt on adults, and narrow and pointed or rounded on juveniles. We will show, using photographs of 169 known-age females' upper tails, that shape works to determine age, but with some caveats. Tail tip shape in photographs of 79 known-age males also worked as an aging criteria. Kestrels aged by molt, recapture, plumage, and fault bars are known-age and can be used to verify the accuracy of tail tip shape in ageing. We did find some cases in which, for various reasons, it did not work. We will discuss these herein.

## **Pedigree Analysis, Population Structure, and Patterns of Kinship in a Population of Western Burrowing Owls (*Athene cunicularia hypugaea*)**

BRENT CLARK<sup>1,2</sup>, JIM BELTHOFF<sup>1,2</sup>

<sup>1</sup>Boise State University, Boise, USA. <sup>2</sup>Raptor Research Center, Boise, USA

### **Abstract**

Natural populations of terrestrial wildlife are often influenced and regulated by their unique population characteristics and demographics. These regulate changes in age structure, size, and density through effects on fecundity, survival, mortality, and migration. We used data spanning a 25-yr period and a suite of pedigree analyses to explore patterns in, and implications of, kinship in a population of Western Burrowing Owls inhabiting the Morley Nelson Snake River Birds of Prey National Conservation Area in southwestern Idaho, USA. We reasoned that higher average relatedness among individuals, especially those nesting in proximity, could lead to kin-selected cooperation or deleterious consequences through intraspecific competition or inbreeding. We calculated coefficients of kinship and inbreeding for approximately 4900 individually marked Burrowing Owls recorded from 1997 to 2021 and examined variability in average annual relatedness. Our paper reports results of pedigree analyses to identify founder contributions, patterns of kinship and inbreeding, and estimates of productivity and apparent reproductive success as a function of kinship and inbreeding.

## Northern Pygmy-Owl (*Glaucidium gnoma*) Nesting Ecology in Northwestern Oregon

JOHN DESHLER

None, Portland, Oregon, USA

### Abstract

I report on the nesting ecology of the Northern Pygmy-Owl (*Glaucidium gnoma*) in northwestern Oregon based on 71 breeding attempts, including observations at 66 nest cavities during 12 years of study (2007–2013, 2016–2020). I focus on the annual shift in the start of laying and in productivity (clutch size) in relation to prey composition. For all years combined, the start of laying spanned 2 months (27 Mar–30 May). The mean annual start of laying varied across consecutive years by nearly 3 weeks ( $19.0 \pm 6.5$  d); mean productivity at nests varied annually by 23% ( $1.2 \pm 0.5$  eggs). Observed clutch size was most frequently 5 or 6 eggs ( $5.6 \pm 0.9$ , range 4–8 eggs,  $n=47$ ), but most clutches in early-nesting years were 6 or 7 eggs, and 4 or 5 eggs in late-nesting years. The mean incubation and nestling periods were  $29.4 \pm 1.1$  d and  $26.4 \pm 1.2$  d, respectively. Pygmy-Owls fledged a mean of  $5.1 \pm 1.1$  young at 58 successful nests and  $4.2 \pm 2.2$  for all breeding attempts. Vertebrate prey composition varied annually and seasonally. Pygmy-Owls took mammalian prey more often early in the breeding season (66% of vertebrate prey) and in early-nesting years (65%); avian prey were more frequently taken late in the breeding season (66%) and in late-nesting years (66%). Pygmy-Owls nested disproportionately in coniferous trees ( $\chi^2=67.48$ ,  $P<0.001$ ,  $df=1$ ,  $n=66$ ); nests in western redcedars (*Thuja plicata*) fledged 1.5 more owlets and failed less often (5% failed) than nests in other tree species (22% failed). Observations at this largest ever collection of Northern Pygmy-Owl nests reveal a commitment by these small owls (1) to produce young annually, even when they had to overcome obstacles such as mate procurement, mate loss, and nest depredation, and (2) to use mammalian prey to increase productivity in some years.

## **Community and Conservation: A Holistic Approach to Protecting the Critically Endangered Ridgway's Hawk (*Buteo ridgwayi*) on Hispaniola.**

GABRIELA DIAZ, RUSSELL THORSTROM, THOMAS HAYES, MARTA CURTI  
The Peregrine Fund, Boise, USA

### **Abstract**

The Ridgway's Hawk is a diurnal bird of prey endemic to the island of Hispaniola. When we began our work in 2000 the population of this Critically Endangered raptor was estimated at only 200-300 individuals and limited to one national park in Dominican Republic. Major threats to this species include human persecution, infestation by parasitic nest flies (which, if left untreated, can cause as much as 90% mortality in infested nestlings), and habitat destruction. To conserve this species we have designed a holistic project that includes: assisted dispersal (reintroduction), nest management, environmental education, and community engagement in the form of full time employment, training programs, and the temporary hiring of additional individuals within the community for specific services (i.e. transportation). The participation of local communities in this conservation project has proven to be a key component for its success, and has contributed positively to people's livelihoods in and around protected areas, even freeing some individuals from subsistence farming in at least one national park. At the same time, the communities have shown increased support for the conservation of the Ridgway's Hawk and we have seen a marked decline in the poaching of this species. Our project currently employs 22 Dominican staff members who are responsible for banding young, treating nestlings to prevent nest fly infestations, and assisted dispersal, among other tasks. In 2020, during the height of the Covid-19 pandemic, the Dominican staff managed to run the project without additional in-country assistance from project directors. As a result of our efforts, the Ridgway's Hawk population has nearly doubled and there are now three burgeoning populations of hawks on the island.

## Socio-ecological Dynamics of a Migrating Raptor Using the East-Asian Oceanic Flyway

PATRICIA KAYE T DUMANDAN<sup>1</sup>, CAMILLE B CONCEPCION<sup>2</sup>, VANESSA HULL<sup>1</sup>

<sup>1</sup>University of Florida, Gainesville, USA. <sup>2</sup>Mindanao State University, Gen.Santos, Philippines

### Abstract

Assessing the impacts of intensified human activities is a central goal of conservation ecology in the Anthropocene. It is especially relevant for long-distance migrants because of their increased potential exposure to more types of threats. However, for several East Asian raptor species, this relationship is largely unexplored. To fill this gap, we evaluated the socio-ecological dynamics of Grey-faced buzzards (*Butastur indicus*) migrating through an important, yet understudied flyway, the East Asian Oceanic Flyway. We used the telecoupling framework to identify biophysical, institutional, economic, and social factors that may influence buzzards in different socio-ecological systems (i.e., sending, spillover, and receiving systems). Then, we applied the concept of resistance surfaces to explicitly account for the probabilistic nature of various types of threats over space and time. Applying both concepts suggest that economic resistance may be an important factor in the sending system during breeding season because shifts in economic activities (i.e., industrialization) has led to changes in the land-use patterns in the region. This has contributed to the loss of the species' foraging and nesting habitats. Biophysical resistance may be affecting buzzards that move across the landscape during migration period as over-ocean crossings make them vulnerable to natural deaths. Social and institutional resistance may also be important during migration since they cross several political boundaries (i.e., in spillover and receiving systems). Acknowledging the complexity and uncertainty of the effects of these resistance factors in driving buzzard populations provide opportunities for determining research priority areas to better conserve the species in increasingly human-dominated landscapes.

## **Influence of Habitat and Weather on Reproduction of Red-shouldered Hawks (*Buteo lineatus*)**

CHERYL R DYKSTRA<sup>1</sup>, JEFFREY L HAYS<sup>2</sup>, MELINDA M SIMON<sup>2</sup>, ANN R WEGMAN<sup>3</sup>, LAURA R DYKSTRA<sup>4</sup>, KELLY A WILLIAMS<sup>5</sup>

<sup>1</sup>Raptor Environmental, West Chester, USA. <sup>2</sup>RAPTOR, Inc., Milford, USA. <sup>3</sup>Cincinnati Museum Center, Cincinnati, USA. <sup>4</sup>Calvin University, Grand Rapids, USA. <sup>5</sup>Ohio University, Athens, USA

### **Abstract**

Both habitat and weather can influence reproductive rates of raptors. Using reproductive data from our 20-year study of suburban and rural Red-shouldered Hawks, we tested how weather conditions and habitat near nest sites (500-m radius plots) were related to two measures of reproductive rate. We found that hawks in suburban and rural areas reproduced at similar rates, and fluctuations among years were synchronous in the two study areas. Suburban Red-shouldered Hawks raised 2736 young in 1773 nesting attempts (i.e., nest with eggs) at 302 territories (1.54 young per nesting attempt), while rural-nesting hawks raised 996 young in 640 nesting attempts at 108 territories (1.56 young per nesting attempt). Similarly, annual nesting success did not differ between study areas, averaging  $58.9 \pm 1.1\%$  for suburban birds and  $58.9 \pm 2.1\%$  for rural birds. Several factors influenced Red-shouldered Hawks' reproductive rates, measured as either the number of young per nesting attempt or the percentage of nesting attempts that were successful. Higher reproductive rates were associated with warmer air temperatures during May (the nestling period) and increasing amounts of coniferous forest, while increasing April air temperatures and increasing amount of grassland cover were associated with lower productivity. However, land cover variables associated with suburban landscapes, such as the amount of residential development, did not influence reproductive rates, which suggests that this species is well-adapted to human-dominated landscapes in southern Ohio. Our study also illustrates the value of long-term datasets for improving our understanding of factors that affect raptors' demographic parameters.

## **Does Degree of Reddishness Matter? Polymorphism in Barn Owls (*Tyto furcata*), Diet Patterns, and Habitat Choice in Napa Valley, California**

LAURA M ECHÁVEZ, MATTHEW D JOHNSON  
Humboldt State University, Arcata, USA

### **Abstract**

Many raptor species exhibit plumage polymorphism. Polymorphism allows individuals to exploit alternative spatial or temporal environments and food resources most successfully through the expression of a particular phenotype. Both the American and the European Barn Owl display variation in melanin-based pigments, with their plumage ranging from reddish to whitish and with many black spots to no spots at all. The phenomenon of habitat matching choice has been observed at a local scale in heterogeneous landscapes in both Switzerland and Israel, where reddish owls inhabit territories with proportionally more arable fields and consume proportionally more voles, whereas the whiter owls occupy more wooded areas and consume proportionately more mice. The first objective of this study was to quantify the degree of polymorphism in the American Barn Owl throughout Napa Valley, CA. Secondly, we sought to examine the relationships among prey composition, landscape composition, and degree of reddishness in the owls. Pellet analysis was used to determine the proportion of mice (*Peromyscus*, *Reithrodontomys*, and *Mus*), voles (*Microtus*), and gophers (*Thomomys*) in the owls' diet, and GIS layers were used to quantify the composition of land cover types within 2.8 km radius around each nest box. Analysis of these data with GLMs show the relationship among the variables. The results provide some of the first field data on the existence of polymorphism in the heterogeneous landscapes within and surrounding vineyards. Additionally, they allow ecologists to infer something about prey foraging techniques the owls may employ and potentially provide vineyard producers with information about pest removal services.

## Assessing Reintroduction Outcome: Comparison of the Juvenile Post-Fledging Dependence Period Between Wild and Reintroduced Bonelli's Eagles in Two Mediterranean Islands.

OLGA EGEA-CASAS<sup>1</sup>, ERNESTO ALVAREZ<sup>2</sup>, GIUSEPPE CORTONE<sup>3</sup>, MASSIMILIANO DI VITTORIO<sup>3</sup>, MANUEL GALAN<sup>2</sup>, JUAN JOSE IGLESIAS-LEBRIJA<sup>4</sup>, MARIO LO VALVO<sup>5</sup>, JUAN MARTINEZ<sup>2</sup>, STEFANIA MERLINO<sup>3</sup>, CARLOTA VIADA<sup>6</sup>, PASCUAL LOPEZ-LOPEZ<sup>1</sup>

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### Abstract

Bonelli's eagle (*Aquila fasciata*) is a threatened species throughout Europe, especially in Italy and Spain. In Italy its natural presence is limited to Sicily, where conservation actions are being performed. In Spain the species shows a wider distribution, although most of its territories have been lost, particularly in Balearic Islands where the species went extinct in the 20<sup>th</sup> century. Within the early stages of raptors, the post-fledging dependency period (PFDP) is the one in which individuals must face dangers without having completely developed their skills. Thereby, comparing PFDP patterns concerning reintroduced and wild individuals is of major interest as it would help to plan and improve future conservation actions. We analyzed the behavior of 38 juvenile Bonelli's eagles tracked through GPS telemetry, tagged as nestlings in two insular environments. The study period encompassed a total of nine-year movement data from reintroduced chicks in Mallorca (Spain) and wild nestlings from Sicily (Italy). Movement parameters (i.e., age of first flight, age of dispersal, length of the PFDP, revisits to the natal or release area, and residence time in them) were analyzed together with their behavior during the PFDP for reintroduced and wild individuals. Similar movement patterns were obtained for both origins, although wild individuals visited more times the natal site and dispersed earlier. Behavior was also similar, it varied throughout the PFDP, observing a more abrupt progress in wild individuals and an earlier development of traveling and hunting behaviors. The differences we found are probably due to parental pressure exerted on juveniles to expel them from their territories. Our results show that focused reintroduction projects aimed at encouraging the natural behavior of reintroduced individuals favor reintroduction success. Parental presence only anticipates the onset of dispersal and the development of skills but does not affect at any other behavioral level.

## Anticoagulant Rodenticides: Spatial and Temporal Trends in Terrestrial Birds of Prey from Western Canada

JOHN E ELLIOTT<sup>1</sup>, SOFI R HINDMARCH<sup>1</sup>, VERONICA SILVERTHORN<sup>1</sup>, SANDI LEE<sup>1</sup>, VICTORIA BOWES<sup>2</sup>, TONY REDFORD<sup>2</sup>, FRANCE M AISONNEUVE<sup>3</sup>

<sup>1</sup>Science & Technology Branch, Environment and Climate Change Canada, Delta, Canada. <sup>2</sup>Animal Health Centre, BC Ministry of Agriculture, Abbotsford, Canada. <sup>3</sup>Science & Technology Branch, Environment and Climate Change Canada, Ottawa, Canada

### Abstract

As the dominant means for control of pest rodent populations globally, anticoagulant rodenticides, particularly the second generation compounds (SGARs), have widely contaminated non-target organisms. Here we present data on hepatic residues of anticoagulants in 746 raptorial birds found dead or brought into rehabilitation centers in BC, Canada over a 30 yr period from 1988 to 2018. The incidence and extent of exposure varied by species, geographic area, and over time, with at least one SGAR residue detected in 74% of all raptor livers sampled. Hepatic SGAR concentrations varied from < 0.005 to 1.83 mg/g wet wt. Highest rates of exposure were in larger owl species with diverse diets, that include rats, and inhabit suburban and intensive agricultural habitats, such as Barred (*Strix varia*) and Great Horned (*Bubo virginianus*) Owls. Overall exposure to at least one AR in those two species on the south coast was 97% and 89% respectively. Barn Owls (*Tyto alba*), mainly a vole (*microtus*) eater, had a lower incidence of exposure of 66%. Concentrations of SGARs were very variable, for example Barred Owls had a geometric mean=0.14, with a range < 0.005 to 1.81 mg/g wet wt ( $n=195$ ). Putatively bird-eating raptors also had relatively high incidence of exposure, which include Cooper's Hawks (*Accipiter cooperii*) at 75%, Sharp Shinned Hawks (*Accipiter striatus*) at 60%, and Peregrine Falcons (*Falco peregrinus*) at 75%. Trends in the incidence of exposure to summed SGARs or to any individual compound did not change significantly over the time period in either all raptors collectively or individual owls with adequate sample sizes. However, mean concentrations of bromadiolone increased while brodifacoum and difethialone decreased coincident with implementation of regulatory restrictions on their usage commencing in 2012, which followed a trend among commercial applicators to move from brodifacoum to bromadiolone in 2008.

## Love Is In the Air? Aerial Displays in Crowned Solitary Eagle (*Buteogallus coronatus*) Reproductive Behavior

MANUEL ENCABO

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### Abstract

Reproductive biology is a well-studied aspect in raptor biology. However, behavioral aspects associated with reproduction are not so addressed for Neotropical species. Mating behavior is mainly related to effective fertilization, but different authors suggest other purposes and interpretations such as territorial signaling implications, or increase the chances of fertilizing all the eggs, to strengthen or maintain the pair bond, etc. This work presents a novel case of copulation display in the endangered Crowned Solitary Eagle (*Buteogallus coronatus*). This large buteonine inhabits forests and savannas of central and southern South America, has low population densities and is categorized "Endangered" by the IUCN. Recent studies focused on describing its breeding biology, with scarce references to mating behavior. During 4 consecutive breeding seasons 2013 - 2017, a nest of this species was monitored adding more than 763 hours of direct observation. Different aspects of couple reproductive behavior were recorded, including copulation events. These were classified as "effective mating" (EM) and "mating display" (MD). A total of 21 copulation events was recorded, including 66.6% of EM and 33.3% MD. EM were concentrated in the nest area and its surroundings, while the MD were carried out in random places up to 1,500 m from the nest, including for the first time aerial mating displays. The author had already registered MD as a possible territorial signaling for this species on previous occasions, in this and others territories, but performed only in presence of extra-pair conspecifics. For this couple, three aerial MD were performed entirely in the air and without documents conspecifics presence in the nearby. This behavior could support the hypothesis that copulation events are not only related to fertilization, but that they would be a key element in defending the territory by lowering the rate of direct confrontations.

## Impact of Barbed Wire Injuries on Birds of Prey in New Mexico, 2016-2021

CHRISTINE V FIORELLO

Hawks Aloft, Inc., Albuquerque, USA

### Abstract

Barbed wire fences are ubiquitous in western landscapes, causing habitat fragmentation, disruption of migration and dispersal, and direct injuries to wildlife. Barbed wire-associated mortalities in wildlife are almost certainly underreported, due to the extent and location of the fencing and the fact that carcasses are exposed to the elements and scavengers. New Mexico has a sparse human population, an open landscape crisscrossed with countless barbed wire fences, and a large diversity of raptors. Although there is a single report of a Burrowing Owl (*Athene cunicularia*) entangled in barbed wire, a systematic survey of raptors injured by barbed wire in New Mexico has not been published. Hawks Aloft, a nonprofit avian conservation and research organization based in Albuquerque, runs a state-wide raptor rescue hotline with the aim of rehabilitating and releasing wild birds of prey. From 2016 to mid-2021, Hawks Aloft saw 25 cases of birds injured by barbed wire fences, representing between 2 and 4.4% of the caseload each year. An additional 20 cases were seen by other New Mexico centers. The majority of birds affected were Strigiformes (37 of 45), with most (31) being Great-horned Owls (*Bubo virginianus*). The remaining birds were buteos and a falcon. The prognosis for birds injured by barbed wire was poor: six died, 28 were euthanized, six were released, and two were placed in permanent captivity (disposition of the remaining birds is pending). Only 13% of these birds were released, much lower than the >57% overall release rate for Hawks Aloft. Given the continental-wide avifauna decline, this threat must be taken seriously. There are ways to mitigate barbed wire impacts to wildlife, and these are likely to apply to birds of prey. More research is needed on methods and efficacy of mitigation, rehabilitation techniques, and prognosis of this anthropogenic threat to wild birds.

## Upper Midwest Bald Eagle Nesting Habitat Expansion: Implications to Diet and Productivity

JORDAN HARRISON<sup>1</sup>, ERIC HALLINGSTAD<sup>2</sup>, CECILY FOO<sup>3</sup>, DANIEL RISER-ESPINOZA<sup>4</sup>, TODD MATTSON<sup>3</sup>  
<sup>1</sup>WEST, Bozeman, MT, USA. <sup>2</sup>WEST, Boise, ID, USA. <sup>3</sup>WEST, Golden Valley, MN, USA. <sup>4</sup>WEST, Fort Collins, CO, USA

### Abstract

Since bald eagles (*Haliaeetus leucocephalus*) were delisted in 2007, the species' nest density has increased and range has expanded throughout the upper Midwest. Changes have also been observed in nesting site selection. Known to primarily nest in undisturbed, mature forests close to fish-bearing waters, bald eagles increasingly nest in upland agricultural areas located more than 1.6 kilometers (1.0 miles) from fish-bearing waters, or "suboptimal" nesting habitat. For wind energy and other developers, suitable bald eagle nesting habitat has become increasingly hard to avoid. Using nests located in "optimal" (<1.6 kilometers from medium- to large-fish-bearing waters) and "suboptimal" habitats, we compared diet, success, and productivity of bald eagle nests throughout Iowa from 2019-2021 (n=15 breeding attempts at 12 nests through the 2020 breeding season). We hypothesized that eagles nesting in suboptimal habitats would have a more diverse diet with fewer fish, less frequent prey deliveries, and lower productivity than nests located in optimal habitats. Preliminary results indicate that mammals and birds compose the majority of the diets (47% and 28%, respectively) of bald eagles that nest in suboptimal habitats, whereas fish composed over 85% of prey items recorded at nests in optimal habitats. The frequency of prey deliveries at suboptimal and optimal nests was similar leading up to hatching of the first egg, then frequency dropped at suboptimal nests relative to optimal nests. Nest success during the first year of study was 40% lower in suboptimal habitats compared to optimal habitats; nest productivity in suboptimal habitats (1.5 birds per nest) was also slightly lower than in optimal habitats (1.8). Additional understanding of how nesting eagles forage and use the landscape near wind energy facilities could inform future turbine siting consideration and mitigation. Data from the 2021 nesting season will include an analysis of suboptimal nests and livestock operations.

## Does Size Matter? Investigation of the Effect of Turbine Size on Raptor Fatality Rates

JULIE GARVIN<sup>1</sup>, JUNIPER SIMONIS<sup>2</sup>, JENNY TAYLOR<sup>1</sup>

<sup>1</sup>Tetra Tech, Inc., Portland, USA. <sup>2</sup>Dapper Stats, Portland, USA

### Abstract

Increases in turbine blade length and hub height have numerous, potentially confounding effects on raptor collision risk and on collision (i.e., fatality) rate estimation. For example, an increase in turbine blade length causes an increase in collision risk space, whereas an increase in hub height does not. However, increases to either aspect of turbine size expand the theoretical fall area of carcasses. This is noteworthy, because observation-based methods estimate fatality rates from the number of carcasses recovered during standard surveys, corrected for (among other things) the fall area assumed to not have been sampled. Understanding the many influences of turbine size is necessary to effectively quantify how raptor mortality may vary with changes to specific aspects of turbine size. Our research project investigating this question analyzes 86 unique post-construction mortality monitoring studies from the American Wind and Wildlife Information Center database, the Wind Energy Bird and Bat Monitoring Database, and client-authorized data collected by Tetra Tech. We have developed a unifying conceptual and theoretical framework that joins collisions with falls in a novel fashion using scattering theory and structured population models. To implement this framework, we developed code in R, incorporating components of the Gen-Est software program to calculate turbine-size-specific fatality estimates for raptors as a group, and raptor species commonly detected as fatalities. The resulting fatality estimates were incorporated into a meta-analysis using a generalized hierarchical (Bayesian) model. We discuss the high-level concepts of our analytical model, what assumptions were required due to gaps in existing research, and identify areas of future research to enable more accurate predictions of fatality rates at new or repowered wind energy facilities.

## Abundance, Distribution, and Breeding Ecology of Critically Endangered Vultures in Mole National Park, Ghana

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### Abstract

Vultures are among the most threatened taxa in Africa today, and many species are in imminent danger of extinction. Knowledge of their abundance, distribution, and breeding ecology is crucial for the development of conservation measures, but we lack many of these data in West Africa. We conducted surveys for three IUCN-listed Critically Endangered species, including Hooded Vultures (*Necrosyrtes monachus*), White-headed Vultures (*Trigonoceps occipitalis*) and African White-backed Vultures (*Gyps africanus*) in Mole National Park, Ghana, in 2019 and 2020. We observed a total of 74 African White-backed Vultures, 77 Hooded Vultures, and seven White-headed Vultures, as well as a single Palm-nut Vulture (*Gypohierax angolensis*) and 17 more unidentified vultures. In addition, we found 12 active nests of Hooded and White-backed Vultures (four and eight, respectively). All nests for both species were located in riparian woodland in a single species of palm tree (*Borassus akeassii*). *Borassus* palm is a riverine species, indicating the importance of watersheds and riverine habitats within Guinean savanna regions for the conservation of these two vulture species. However, Hooded Vulture nests were located significantly closer to roads than African White-backed Vulture nests, indicating the latter higher sensitivity to human disturbance. Finally, nests for each species appeared to be clustered, especially for African White-backed Vultures, with distances of less than 40 m between nests. To our knowledge, this is the first systematic assessment of the population abundance and breeding habitat of vultures in Ghana and the first confirmed breeding locations for Hooded Vultures and African White-backed Vultures in the region, indicating that Mole National Park serves as important habitat for these critically endangered vulture species. Further knowledge of vulture breeding ecology, suitable nesting habitats, and population size and distributions will be crucial for developing, implementing, and monitoring vulture conservation strategies in Ghana and elsewhere in West Africa.

## Habitat Selection of Dispersing Juveniles of the Main Avian Top Predator of the Andean Montane Forests: Conservation Implications

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### Abstract

Large raptors are the most mobile top predators and in consequence, they are essential components of ecosystem in fragmented landscapes. However, large raptors (e.g., eagles) are also one of the most threatened groups of raptors in the world and are frequently affected by habitat fragmentation. The Black-and-chestnut Eagle (*Spizaetus isidori*), with a long period of natal dispersal, is a top forest predator of the Andean montane forests. Andean montane forests in the altitudinal band between ~500 and 3,500 meters (i.e., the altitudinal distribution of the Black-and-chestnut Eagle), has probably lost more than half of its original vegetation cover. Our hypothesis is that habitat selection of dispersing juveniles of the Black-and-Chestnut Eagle will vary according to the remaining native forest, altitude, and slope. We captured six juveniles in four nests of the species within fragmented landscapes of South America (three nests in Colombia and one in Argentina). We tagged them with ~30 gr Global Position System (GPS) with data downloading via Global System for Mobile communication (GSM) (i.e., GPS/GSM loggers). Habitat selection was determined using a resource selection function (RSF). During the first year of natal dispersal, juveniles occupied large home ranges (mean = 996.3 km<sup>2</sup>; SD± 606; range = 294-2130 km<sup>2</sup>). While juveniles moved in their process of natal dispersal through fragmented landscapes, they selected areas with higher remaining forest cover, medium altitudes, and higher slopes than the mean available. Our study showed that juvenile Black-and-chestnut Eagles can tolerate a certain level of fragmentation during their period of natal dispersal although they clearly select forested areas. Thanks to the high dispersal capacity of juveniles through fragmented landscapes, Black-and-Chestnut Eagle can still keep essential ecological functions in the fragmented Andean montane forests of South America.

## Using Unmanned Aerial Systems to Create 3D Maps and Habitat Suitability Models of Golden Eagle Nesting Habitat

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### Abstract

Golden Eagle (*Aquila chrysaetos*) nesting sites in the Morley Nelson Snake River Birds of Prey National Conservation Area (NCA) are located on steep cliffsides that can be difficult to accurately represent on traditional, two-dimensional maps. The uncertainty in mapping nest locations makes long term monitoring of historical and current sites challenging. Biologists may map sites erroneously in areas with overhanging cliffs or in other complex terrain not easily identifiable on a 2D map. Even Google Earth does not clearly represent imagery or slope on these steep cliffsides as these tiled images are captured with a nadir looking sensor. To address these limitations, in May 2020 we used unmanned aerial systems (UAS) equipped with RGB cameras, thermal, and multispectral sensors to create highly accurate, full color, three-dimensional maps. We positioned cameras at oblique angles and created UAS flight plans to utilize a facade scanning approach to capture steep, complex, and overhanging cliffsides. We monitored Golden Eagle behavior during flight missions and recorded no changes indicative of disturbance. Further, we evaluated the topographic, thermal, and vegetative characteristics of known and historical Golden Eagle nest sites to build a predictive suitability model and ranking of nest site preference. The preferred nest site characteristics used in creating the suitability model include steep and rugged cliffsides, protection from solar radiation, little build up of dried tumble mustard (*Sisymbrium altissimum*), and areas away from the base of the cliffs. These data products, along with suitability maps of nest site preferences for Golden Eagles, are accessible through user-friendly online platforms, ArcGIS, and Google Earth Pro for convenient 3D viewing and use by researchers and land managers to guide future nest searching, UAS mapping efforts in the NCA, and for long term monitoring and management.

## Environmental Drivers of Reproduction by Golden Eagles in the Northern Range of Yellowstone National Park

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### Abstract

Golden Eagles (*Aquila chrysaetos*) are a North American species of conservation concern throughout their range. Within the northern range of Yellowstone National Park (YNP), territories of golden eagles occur at fairly high densities. However, average reproductive rates over the past ten years (2011-2020) have been low (productivity = 0.34, nest success = 28%), stimulating questions as to what environmental factors limit reproductive success. Hypotheses include extreme weather, variation in prey availability, and the recovery of large carnivores within YNP. We evaluated spatial and temporal components of golden eagle habitat that could explain reproductive output of eagles in YNP's northern range. Preliminary results indicate that increasing periods of prolonged precipitation during winter was negatively associated with apparent nest initiation. Nest success was negatively associated both with increased snow levels and with increasing periods of severe weather during early spring when eagles initiate nesting. Additionally, we found evidence to suggest that territories with more rugged terrain and in closer proximity to neighboring territories tended to have greater nest success than flatter, less densely packed territories. Our findings highlight potential drivers for the contrasting trends in territory density and nest success of YNP eagles and could be used to inform management of this population.

## Migration Ecology and Wintering Habitats of Adult Red-shouldered Hawks (*Buteo lineatus*) Breeding in Central and Northeastern Wisconsin

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### Abstract

Red-shouldered Hawks (*Buteo lineatus*) are forest-dwelling raptors that are threatened in Wisconsin and are of conservation concern throughout much of the Great Lakes region. While many studies have focused on their breeding ecology, little is known about their migration ecology and winter habitats. From 2018-2021 we used Global Positioning System (GPS) transmitters to track migration and identify wintering habitats for five adult Red-shouldered Hawks that bred in Wisconsin. Red-shouldered Hawks wintered in Wisconsin, Illinois, Kentucky, Alabama, and Louisiana and spent an average 91.4 d on their wintering territories. On average, Red-shouldered Hawks migrated 919.7 km over 29.8 d at a rate of 30.9 km/d to their wintering territories. In spring, Red-shouldered Hawks migrated on average 920.2 km over 11.4 d at a rate of 77.4 km/d to return to their breeding territories. During migration stopovers, Red-shouldered Hawks were primarily observed in deciduous (55%) and mixed forests (13%), and woody wetlands (12%). On average, during winter, Red-shouldered Hawks were primarily observed in deciduous (29%) and mixed forests (20%), and woody wetlands (26%). Filling in these knowledge gaps is critical to our understanding of the species life-history as well as its management and conservation.

## Collateral Damage: Anticoagulant Rodenticides Pose Threats to California Condor Recovery Efforts

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### Abstract

Recovery of an endangered species is contingent on managing factors that influence its population. In the case of the California Condor (*Gymnogyps californianus*), a federally endangered species in the United States, exposure to lead is the primary factor currently negatively influencing populations; however, condors are exposed to other contaminants that may act as additional stressors. Anticoagulant rodenticides (ARs) are widespread environmental contaminants that pose a risk to scavenging birds because they routinely occur within their prey base, resulting in secondary exposure. We examined California Condor tissues for ARs, and preliminary findings indicate wide ranging AR exposure (concentration differences >117-fold) with all condor flocks (Pinnacles/Ventana, Southern California, Arizona) being exposed to ARs. Nearly 50% of condors (n = 65) and 100% of surrogate Turkey Vultures (*Cathartes aura*) (n = 71) contained ARs in their livers. Although, concentrations generally were low (< 10 ng/g ww), 48% and 60% of California Condors and Turkey Vultures that were exposed to ARs, respectively, exceeded the 5% probability of toxicosis (>20 ng/g ww; Thomas et al. 2011), and 10% and 13% exceeded the 20% probability of toxicosis (>80 ng/g ww). As such, we saw some evidence of prolonged blood clotting in 16% of the free-ranging condors. Notably, we also documented a relationship between ARs and the probability of condors dying of lead poisoning and AR exposure in condors being associated with fluctuations in landscape rodent populations. Exposure to ARs may exacerbate efforts to recover California Condor populations within their current range and in the soon to be established northern California experimental population. Continued monitoring of AR exposure using plasma samples and blood clotting assays would allow for an improved understanding of recent exposure, and if paired with recent movement data, could help elucidate where on the landscape condors are being exposed to ARs.

## Conservation Needs of Burrowing Owls in Prairie Canada

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### Abstract

In Canada, the Burrowing Owl (*Athene cunicularia*) is listed as endangered under the Species at Risk Act. The number of breeding pairs declined 90% during the 1990's despite voluntary protection of over 37,000 hectares of the species habitat on private grasslands. Low recruitment exacerbates the Burrowing Owl's decline in response to habitat loss; typically only 3-4 young fledge from the average clutch size of 9 eggs. Food supplementation experiments indicated that the wild food supply was inadequate for this species to reach its reproductive potential in some years. Migration and dispersal are important ecological processes and understanding them is a requirement for species conservation efforts. Studies of movements of Burrowing Owls using banding, VHF telemetry, stable isotopes, geolocators, and satellite transmitters demonstrate that annual dispersal is a second factor driving the owl's decline in Canada. This talk summarizes 25 years of research into the breeding biology, migration and dispersal of this species in Canada, Texas and Mexico and recommends supplemental feeding of nests to be incorporated in recovery action plans and further research, alongside with protection of critical habitat. Greater international cooperation and direct conservation action are needed if this species is to remain on the northern Great Plains.

## Parental Roles of Nesting Prairie Falcons in Relation to Reversed Sexual Dimorphism

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### Abstract

Reversed Sexual Dimorphism (RSD) is common in birds of prey. In Prairie Falcons (*Falco mexicanus*) the weight of an average male is about two-thirds of the weight of an average female. Such a pronounced form of RSD is commonly associated with a differentiation in parental roles of the male and female of a nesting pair. I assessed the contributions of the male and female of a pair in terms of the amount of time each invests in essential tasks such as incubation and brooding, nest site attendance and nest defense, and providing food for the young. From 1984 through 1987, behavioral observations were made on 52 nesting Prairie Falcon pairs in southwestern Idaho for 613 observation days (9,068 h). Predicted parental roles were largely confirmed, but parental behavior was not as rigid as suggested by RSD. Time spent on incubation by successful pairs was remarkably constant, covering almost 100% of daylight hours. However, the division of labor between male and female varied considerably among pairs. Brooding was mainly a task of the female, whereas the male provided most of the food to the nest site. Both male and female equally engaged in nest defense with potential predators. Female generally showed a much higher nest attendance than males, which may have acted as an additional deterrent. Plasticity in parental roles is likely an important adaptive response to changes in environmental conditions and other factors that impact prey abundance

## Using Detection Dogs to Reveal and Decrease Illegal Pesticide Poisoning of Raptors in Hungary

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### Abstract

In Hungary, during the 2000s, pesticide poisoning became the most important threat for raptors, especially for the globally threatened Eastern Imperial Eagle (*Aquila heliaca*). In September 2013, with focus on carbofuran and phorate, the first poison and carcass detection dog (PCDD) unit was formed in Hungary by a specifically trained detection dog and its handler. Two more dogs were trained and joined the unit in 2017 and 2020 respectively. Between its inception to August 2020, the PCDD unit conducted 1,083 searches in five countries, which revealed 329 poisoned animals of 15 bird and nine mammal species, 120 poisoned baits and five pesticide products. Globally threatened species, including eight Eastern Imperial Eagles and four Saker Falcons (*Falco cherrug*) were also among the detected victims. Present at 66.45% of wildlife poisoning events, the unit revealed 37.87% of the victims and 79.70% of the poisoned baits known in Hungary during the period 2013-2020. Compared to human surveyors, the PCDD unit demonstrated a significantly higher find rate for poisoned baits. At 22 poisoning events (14.38% of all cases) only the PCDD unit revealed victims or poisoned baits, therefore these cases would be probably unnoticed without the PCCD unit. Of the two focal pesticides, carbofuran was more frequently detected, in 88.56% of the positive samples. Beside the field surveys, the PCDD unit was also successfully involved in 15 search warrants in association with eight different police investigations in four countries. The unit played a significant role in detecting and decreasing wildlife poisoning incidents by deterring potential offenders and facilitating police investigations through recovery of evidence otherwise hard to recover. The reduction of poisoning incidents resulted that the national population of Eastern Imperial Eagles started to increase again after a few years of stagnation.

## Mapping Habitat and the Consequence of Climate Crisis on Critically Endangered Vultures in Indian Floristic Regions

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### Abstract

A decline in once abundant vulture species in India resulted in critically endangered status and focus on their conservation efforts increased manifold. These vultures, resident in India and endemic to the Indian subcontinent are *Gyps indicus* (INVU), *Gyps bengalensis* (WRVU), *Gyps tenuirostris* (SBVU) and *Sarcogyps calvus* (RHVU). India is a huge country (3.29 million km<sup>2</sup>) with varying edapho-climatic conditions and vegetation, influencing vulture habitat. Therefore, to assess the importance of broadly categorized habitat, it was divided into eight floristic regions based on the unique vegetation communities which is an important shelter/habitat determinant in vultures. Species Distribution Models, a widely accepted tool in predicting the habitats of different species was used for mapping the habitat. In this study, 56 models were developed using MaxEnt 3.4.1 with the AUC ranging from 0.78 to 0.981 and falling in good and very good categories. For better habitat assessment, ensemble models of three Global Circulation Models (CCSM4, HadGEM2AO and MIROC5) were used selecting two RCPs (4.5 and 8.5) across short and long -term future scenarios. Variables, like, land use landcover, Bio15 (precipitation seasonality) and Bio01(annual mean temperature) played dominant role in habitat determination. Current area prediction indicated availability of suitable area in decreasing order: WRVU>INVU>RHVU>SBVU. Future change in this area was marginal without any definite trend of increase or decrease in different scenarios. However, future loss and gain in area suitability was found important due to its sizable expanse and varying locality. As per species richness, Western Himalaya was most species rich (all four) while Assam was least species rich (only SBVU and WRVU). Suitable area availability for vultures in general was maximum in Central India. This study will prove useful in filling the knowledge gap, highlighting the vulnerable habitat locations and aid the managers in making meaningful conservation plans.

## How Generalizable are Nest Box Selection Models for Barn Owls (*Tyto furcata*) in California Agriculture?

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### Abstract

Nest boxes are often installed in agricultural landscapes to attract Barn Owls and the ecosystem services they provide by removing rodent pests. For this practice to be effective, farmers need actionable guidelines on nest box design and placement to optimize nest box occupancy. Previous research has revealed nest box selection patterns in Napa Valley, California, but it remains unclear whether these patterns are generalizable to other years and regions with other crops. We addressed two primary objectives: 1) develop a model that predicts the proportion of years a nest box is occupied in Napa Valley, and 2) evaluate this model's predictive performance in other regions. We hypothesized the predictive model would perform better in regions with similar crops and landcover than in areas more ecologically dissimilar. Using nest box occupancy data from six years of monitoring Barn Owls in Napa Valley ( $n = 268$  boxes), we found that the proportion of years a nest box is occupied was best predicted by nest box attributes (e.g., pole height, box height, and entrance orientation), as well as local habitat (e.g., grassland within 75 m) and landscape scale metrics (e.g., grassland within 2.81 km). This model's predictions were strongly correlated with observed nest box occupancy in Napa ( $r = 0.76$ ,  $df = 266$ ,  $p = < 0.001$ ), but the model performed poorly when used to predict nest box occupancy in ecologically similar Sonoma ( $n = 134$ ,  $AUC = 0.53$ ,  $SD = 0.07$ ) and dissimilar Fresno Counties ( $n = 174$ ,  $AUC = .56$ ,  $SD = 0.05$ ). These results suggest models predicting Barn Owl nest box occupancy from a single region may not be generalizable to others, prompting a need to develop models unique to a given location to better understand Barn Owl habitat ecology and the ecosystem services they provide to farmers.

## Isotopic Niche Partitioning and Individual Specialization in an Arctic Raptor Guild

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### Abstract

Intra- and inter-specific resource partitioning within predator communities is a fundamental component of trophic ecology, and one proposed mechanism for how populations partition resources is through individual niche variation. The Niche Variation Hypothesis (NVH) predicts that inter-individual trait variation leads to functional trade-offs in foraging efficiency, resulting in populations comprised of individual dietary specialists. A modified version of the NVH [mNVH] predicts niche specialization is plastic and responsive to fluctuating resource availability. We quantified niche overlap and tested the mNVH within an Arctic raptor guild, focusing on three species that employ different foraging strategies: Golden Eagles (*Aquila chrysaetos*; generalists); Gyrfalcons (*Falco rusticolus*; facultative specialists); and Rough-legged Hawks (*Buteo lagopus*; specialists). Tundra ecosystems exhibit cyclic populations of arvicoline rodents (lemmings and voles), providing a unique system under which to examine interannual fluctuations in predator resource availability. Using blood  $\delta^{13}\text{C}$  &  $\delta^{15}\text{N}$  stable isotope ratios from 189 raptor nestlings on Alaska's Seward Peninsula (2014–2019), we calculated isotopic niche width and used Bayesian stable isotope mixing models to quantify diet, characterize individual specialization, and test the mNVH. We observed a high degree of isotopic niche overlap between the three raptor species and variable trophic responses to different stages of the arvicoline rodent cycle. Elevated arvicoline rodent abundance corresponded to reduced niche overlap among species and increased individual specialization in Golden Eagles and Gyrfalcons. Further, Gyrfalcons displayed a positive relationship between individual specialization and population niche width on an interannual basis consistent with the mNVH. As a wider variety of prey resources became available, individual Gyrfalcon pairs capitalized upon different components of the food web. Our findings suggest plasticity in niche specialization may reduce intra- and inter-specific resource competition and promote population stability under dynamic ecological conditions.

## Drivers and Dynamics of Mexican Spotted Owl Habitat from 1986-2020 in the Southwestern United States

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### Abstract

Understanding changes to species habitat is essential for effective conservation as landscapes rapidly change. We developed an automated habitat monitoring system on the Google Earth Engine platform and applied this framework to produce a dynamic model of Mexican Spotted Owl (*Strix occidentalis lucida*) habitat across the southwestern United States (Arizona and New Mexico) from 1986-2020. We evaluated environmental correlates of Mexican Spotted Owl habitat, assessed potential non-stationarity in habitat selection across modeling sub-regions, estimated long-term trends in Mexican Spotted Owl habitat by quantifying changes in habitat amount and quality between 1986 and 2020, and attributed the extent to which habitat changes over the past 35 years have been driven by recent wildfire. Topography and climate were consistently more important than reflectance-based (vegetation) metrics in describing Mexican Spotted Owl habitat. Habitat selection was strongly non-stationary across the southwestern US, suggesting a need for region-specific conservation, modeling, assessment, and monitoring. We estimated that total habitat area for Mexican Spotted Owl declined by ~21% since 1986 (0.6% annually), but trends varied strongly (and even reversed) across modeling sub-regions and over the past decade. Wildfire was responsible for between 8-35% of the habitat loss over the study period, depending on the sub-region considered. For Mexican Spotted Owl, an automated habitat monitoring system allowed both trend estimation and accurate assessment of current habitat status; maps are highly accurate, spatially detailed, and up to date. The ability to produce accurate current maps for large land areas and to keep these maps updated continuously for a threatened species such as the Mexican Spotted Owl enables appropriate and science-based land management on public lands in the southwestern US.

## Home Sweet Home? Parasite Loads of Ferruginous Hawk (*Buteo regalis*) Nestlings

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### Abstract

This study assesses how nest type and usage patterns influence parasite loads of Ferruginous Hawk nestlings across Utah, Idaho, Wyoming and Nevada. Ferruginous Hawks are listed as a Species of Greatest Conservation Need in all four states, and are threatened by habitat loss and fragmentation from urbanization, rural development, oil and natural gas extraction, habitat treatment projects, and wildfires. Artificial nesting platforms have been built to mitigate anthropogenic disturbances in several areas of the birds' breeding range. Platforms serve as a vertical buffer, enabling birds to escape disturbances without having to relocate their breeding territories. However, nest structures can serve as microrefugia and overwinter habitat for arthropods, including avian ectoparasites, thus nest reuse may contribute to higher parasite loads in areas with fewer alternate nest options. We present here a preliminary assessment of ectoparasite loads and hemoparasite prevalence on Ferruginous Hawk nestlings in 2020 and 2021 in an attempt to help us understand threats faced at early life stages, as well as the effects of artificial nesting platforms on overall brood success. This study provides an illustrative example of how human mitigation strategies may have unintended consequences by comparing parasite loads of hawks at artificial versus natural nesting substrate.

## Predicting Seasonal Variation in Future Distribution of California Condors in Oregon and California

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### Abstract

California Condors (*Gymnogyps californianus*) were extirpated from the wild in 1987, captive bred, and reintroduced in the 1990s. As their populations have grown, their range expansion has exposed them to a greater number of anthropogenic stressors. To proactively address these threats, managers wish to predict the future distribution of the species. We tested the hypothesis that availability of atmospheric updraft was a driver of the current distribution of this endangered species, and we used our models to predict its range expansion. Preliminary results suggest that during summer, condors' use of both thermal and orographic updraft was in direct proportion to the availability of these air movements. However, in winter, condors preferentially selected areas with orographic updraft and, in some months, against areas with thermal updraft. Responses to land cover and topography were weaker and less consistent across the calendar year. Species distribution models built to describe these responses across the states of Oregon and California predicted dramatic seasonal variation in ranging behavior of condors, patterns consistent with those observed for the species in its current range. Updraft parameters were an important driver of movements and distributions of condors, and their incorporation into models resulted in understanding that challenges conventional natural history knowledge about altitudinal movements of condors.

## **Assessing and Addressing the Decline of the Bearded Vulture (*Gypaetus barbatus*) in Southern Africa**

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### **Abstract**

This paper synthesizes 20 years of research on the Critically Endangered Bearded Vulture population in southern Africa to quantify the species' decline, investigate the potential drivers of this decline, and explore the most appropriate management actions necessary to recover this population. Extensive surveys of breeding territories between 2000-2012 revealed a decline of at least 30% during the past five decades. The population is currently estimated to be 306 to 382 individuals. Three hypotheses were examined to explain territorial abandonment: 1) human impacts, 2) climate change, or 3) food shortages. Strongest support was found for the human impact hypothesis, with abandonment more likely in territories with higher densities of power lines and human settlements. This finding was in accordance with the main causes of mortality, namely poisoning (including Pb poisoning) and collisions with power lines. Surveys also revealed that the productivity of the population was low ( $0.42 \pm 0.65$  young/pair/year), which may be an additional factor contributing to the declines. Tracking data from 21 individuals across different age classes allowed us to explore differences in ranging behaviors by age and was also used to build models and identify intensively used areas to inform spatial development planning. Adults used areas in close proximity to their nest sites, whereas non-adults moved over the entire species' range and were more likely to be exposed to risk factors. A population viability analysis predicted a negative growth rate for the population over the next 50 years ( $\lambda=0.99$ ) with a high probability (0.89) of extinction. A captive breeding program has been established and potential release sites and strategies for a reintroduction project have been investigated. The information obtained in our study is vital for a more holistic approach to the conservation of the species in southern Africa.

## Habitat Preferences of the Tawny Owl (*Strix aluco*) in a Special Conservancy Area of Eastern Spain

ANDRES LOPEZ-PEINADO, PASCUAL LOPEZ-LOPEZ

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### Abstract

The Tawny Owl (*Strix aluco*) is the most abundant nocturnal raptor in Europe. It has been thoroughly studied in various regions, but its habitat preferences in Mediterranean environments remain poorly understood. With the aim to present novel information about this aspect of the ecology of the Tawny Owl, we established 115 survey stations in the Special Conservancy Area “Sierras de Talayuelas y Aliaguilla” (Castilla-La Mancha region, eastern Spain) and carried out nocturnal surveys by recording spontaneous calls and vocal responses to call playbacks. We then assessed environmental characteristics (vegetation types, soil type, altitude, potential competitors, and anthropic disturbance) in areas where owls were detected or not detected during the breeding season. Overall, we detected 60 responding owls at 49 survey stations during breeding season in the study area (i.e., density 1.22 owls/km<sup>2</sup>). We found that Tawny Owls preferred lower elevations and patchy heterogeneous areas. Owls seemed to avoid natural grasslands and areas characterized by limestone soils and associated vegetation, and preferred areas characterized by clay soils and associated vegetation. Interestingly, we did not detect owls close to wind farms, which seem to create a buffer effect on owl occurrence. The noise generated by the turbines might be a limiting factor that could account for this avoidance. Our multivariate results showed that Tawny Owls preferred heterogeneous patchy habitat but avoided non-irrigated arable land. Tawny Owls inhabit Mediterranean landscapes where conditions are favorable, but human activities such as wind farms may limit their distribution. Additional research is needed to determine the drivers of this avoidance and whether Tawny Owls also avoid wind farms in other regions of their range.

## Cliff-nesting Raptors' Laying Date Depends on Nest Features and Breeders' Experience: A Long-term Study (2004-2020) with Bonelli's Eagle in Spain

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### Abstract

Adjustment of reproductive timing within the annual cycle is a crucial issue for both offspring and parents' survival, and breeding success. Early laying date is closely related to successful breeding outcome and obtaining long datasets on threatened long-lived species can contribute to their conservation. Nonetheless, to date few papers have analyzed laying date in long-lived raptors. Using field observations and telemetry information, we analyze how laying date of an endangered long-lived raptor varies with nest characteristics, individual factors and climatic variables during a 17-yrs study period in eastern Spain. We built Generalized Linear Mixed Models (GLMMs) to estimate how environmental and individual variables affect laying date and we also analyze repeatability to check if laying date was more repeatable within the territory, among years or within each pair. Laying date is positively correlated to previous success, previous brood size and previous laying date. It is also influenced by nest orientation and nest type. The presence of subadults as breeders delay laying date. Territory showed high repeatability between consecutive years, but not at the individual level. Our results highlight the importance of territory as the environmental frame in which birds need to adjust timing of reproduction to maximize biological fitness. Therefore, protection of nesting areas is of the outmost importance to improve the conservation status of declining long-lived species such as the Bonelli's Eagle (*Aquila fasciata*). Furthermore, in agreement with previous studies, we confirm that an increasing proportion of subadults as breeders in long-lived raptor's populations is an early warning signal because of their implications in breeding performance. High adult mortality allows subadults to settle as breeders and jeopardizes species' persistence. Finally, our results showed that previous experience is an important factor affecting breeding performance and an adequate predictor of laying date.

## Trapping in the City

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### Abstract

As raptors continue to adapt to urban habitats, researchers focus on understanding urban population dynamics and the role of these birds in urban ecosystems. In addition, urban raptors face unique hazards and potential conflicts with humans. Agencies and wildlife rehabilitators around the country commonly receive calls about raptors in buildings and batting cages or nesting in city parks and on commercial structures. Whether for research or rescue, there is often a need to capture birds in an urban environment. In this session, Brian and Kristin will discuss the inherent benefits and challenges to working in the urban “field”, from identifying safe and accessible trapping locations to dealing with the public. They will share lessons learned over 11 years of urban trapping and offer recommendations for successful, and relatively painless, trapping in the city.

## Essential Balance: Managing Telecommunications Needs with Nesting Birds' Needs

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### Abstract

The rising trend of nesting birds on cellular communications towers is concurrent with the wireless industry's push to upgrade sites with 5G capable equipment and networks. Because telecom services are essential to our modern lifestyles, an inherent conflict has emerged between the industry's need for timely work access and the needs of tower-nesting birds. Aggregated data provided by the telecom industry indicate that of 100,000+ US structures, tower-nesting has increased from less than 2% in 2012 to over 10% in 2020. Increasing populations among the more common tower-nesting bird species along with generational habituation, or imprinting, to tower structures for raising young, are likely just a few of the reasons for the expansion rate. We asked, what is required to achieve a win for tower-nesting birds and a win for the 5G wireless goals? We make three suggestions. First, a deeper understanding of the effects, if any, of work at sites hosting tower-nesting birds (e.g., type of work, vertical distance buffers, and stage-of-nesting) is an important step for better recommendations that avoid negative impacts to nesting birds yet provide common sense solutions for work access challenges. Second, sustainable best management practices for working at sites hosting nests that are ecologically sound, economically feasible, and logistically attainable, including adopting nesting exclusion devices and perch deterrents when and where possible. Third, updated regulatory expectations and guidelines with consideration for current population trends among tower-nesting species that provide more latitude in their specific management. In addition, more interface and collaboration between the industry and state and federal wildlife managers for developing pro-active management approaches, including better tracking of tower-nesting trends. Defining both industry and wildlife issues, eliminating unnecessary barriers based on outdated population estimates, and implementing more efficient processes to encourage compliance is essential in balancing industry needs with the needs of nesting birds.

## Influence of Natural and Anthropogenic Disturbance on Raptor Assemblages of the Tropical Dry Forest

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### Abstract

Both natural and anthropogenic disturbances modify habitat and resource availability for individuals, populations, and communities. Avian communities show differing responses to disturbance, but the response of tropical raptors to natural or anthropogenic disturbance is poorly understood. We evaluated the influence of natural disturbance by a major hurricane, and anthropogenic disturbance of forest loss and fragmentation in the diurnal raptor assemblage of tropical dry forest in Mexico. We conducted raptor surveys five times over 2016-2018 (dry/wet seasons) at 29 sites distributed among four habitats (semideciduous and deciduous forest, wetland, agricultural fields) located within and outside the area of impact by the hurricane. We compared density, species richness, assemblage structure, and composition of raptors in the four habitats and two hurricane conditions. We also applied multi-scale analysis to assess the influence of landscape structure on the abundance, richness, and temporal diversity of forest- and non-forest raptors. Raptors showed significantly lower density in hurricane-damaged forests, whereas wetlands affected by hurricane contained the most distinct raptor assemblage, with higher species richness and greater evenness, suggesting that raptors used wetlands as a refuge following disturbance. Similarity of raptor assemblages was higher within the area affected by hurricane, where forest-raptors were present in all habitats within this area. Regarding landscape structure, forest cover was the strongest predictor of raptor community responses, positively influencing abundance and richness of forest-raptors and decreasing their temporal diversity, whereas forest cover negatively affected abundance and richness of non-forest raptors but increased their temporal diversity. Forest fragmentation positively influenced abundance and species richness of all raptors, but it negatively influenced temporal diversity of forest-raptors, but positively influenced temporal diversity for non-forest raptors. Our results demonstrate that natural disturbances may modify habitat use patterns of raptors. Anthropogenic disturbance in the landscape affects the stability of raptor assemblages as greater forest cover decreases temporal diversity of forest-raptors, whereas both forest cover and fragmentation promote temporal diversity of non-forest raptors.

## Sublethal anticoagulant rodenticide exposure rates in Barn Owls and Red-tailed Hawks in Northern California agroecosystems

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### Abstract

California's agricultural landscapes support a diverse and abundant community of resident and migratory raptors. Because of the beneficial ecosystem services (natural pest control) they provide, raptors are often attracted to breed and hunt in agroecosystems through management practices. However, anticoagulant rodenticides (ARs) targeting rodent pests are often used concurrently, leaving raptors at an elevated risk of non-target AR exposure in these systems. Most of our knowledge of raptor AR exposure comes from liver samples of carcasses or birds in rehabilitation due to the difficulty of sampling free-roaming raptors and the short-lived nature of ARs in the bloodstream. Our goal was to document sub-lethal AR exposure rates in free-roaming raptors that utilize California's agricultural landscapes and to understand if exposure differs by region, species, or season. We tested the blood of adult and nestling American Barn Owls (*Tyto furcata*) on California farms in Napa ( $n=40$ ), Sonoma ( $n=38$ ), and Yolo counties ( $n=126$ ) over 3 years. Additionally, in winter months we sampled Barn Owls ( $n=54$ ) and Red-tailed Hawks (*Buteo jamaicensis*;  $n=34$ ) roosting and hunting on farms in Yolo County from 2018-2021. We found that breeding and wintering owls had limited circulating AR exposure, whereas over-wintering juvenile Red-tailed Hawks had the highest rate of exposure. Trace residues ( $<5$  ppb) of one or multiple second-generation AR compounds were detected in 21.7% (5/23) of the juvenile hawks sampled. The detected compounds are commonly applied for commensal rodents around buildings, rather than at the field-scale, so it is possible that mice and rats are the pathway for exposure in these individuals. Understanding sub-lethal AR exposure in raptors utilizing agroecosystems is important because exposure can negatively impact a raptor's health, fitness, behavior, and increase an individual's risk of mortality. Future research is needed to address unknown carry-over effects or consequences at the population level.

## Mapping and Prioritizing the Insulation of Pylons Endangering Eagles in Israel by a GIS Model Based on Hi-Res GPS loggers

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### Abstract

The Bonelli's Eagle (*Aquila fasciata*) experienced a dramatic decline in Israel during the last 40 years: from 30 to 15 and became considered as regionally critically endangered. Long term monitoring reveals that the survival of juvenile eagles and their recruitment rates are dramatically affected by mortality on medium voltage distribution pylons. Since 2011, 29 (74%) out of 39 cases of eagle mortality and injury were caused by electrocution. Electrocution is responsible for the mortality of juveniles that fledge in Israel, as well as of overwintering individuals, probably originating from northern populations.

A population viability analysis demonstrates that the species is expected to become extinct in Israel over the next few decades, yet it shows that annual addition of two to three juveniles to the population would have a dramatic contribution to its stabilization and even gradual growth.

Since electrocution is the main threat, it is imperative to minimise its annual toll, by insulating dangerous pylons. On the other hand, the insulating process is slow and expensive (since 1996, the Israeli Electric Corporation insulated some 4,000 pylons out of 330,000 in the entire distribution network), hence there is a strong demand for directing the retrofitting towards the most dangerous pylons in the most frequently used areas by the eagles.

In order to prepare an informed plan for insulating the most dangerous pylons, the data collected by high resolution GPS-loggers fitted on 32 BE (both from the wild and captive-bred) was used in a GIS model that mapped the most sensitive areas where eagles disperse and where they tend to perch. The model also incorporates data of physical properties of the landscape and land use, influencing eagle's tendency to perch on pylons. The ultimate mitigation priority is set also according to pylon's specific design and its relative insulating cost.

## Understanding Golden Eagle Persecution Through the Experiences of Raptor Rehabilitators

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### Abstract

Many direct and indirect anthropogenic factors affect Golden Eagle (*Aquila chrysaetos*) conservation. Data from USFWS suggests that firearms ( $n = \sim 700$ ) lead all significant known causes of Golden Eagle mortality in the Western United States. The lessons learned from nearly a century of wildlife management in the American West establish that a cornerstone of Golden Eagle conservation must be its human dimensions. Persecution by direct human action, i.e., firearm mortality, is a persistent and complex conservation challenge with broad consequences that range from ecological (e.g., trophic cascades via intraguild predation) to cultural (e.g., the perpetuation of shooting eagles as social acceptability). Raptor rehabilitators often experience the consequences of raptor persecution firsthand, as well as directly interact with the public and communities regarding issues of raptor conservation. Raptor rehabilitators offer useful perceptions of the sociocultural factors that contribute to Golden Eagle persecution and mortality in the American West. This study utilizes qualitative data analysis techniques to discover core concepts and themes that motivate negative interactions and persecution, with the aim to give essential contextual insight that can inform federal and state remediation efforts and conservation planning.

## The Whereabouts of the First GPS Transmitter-Tagged Andean Condors in Bolivia

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### Abstract

On 8 March 2019, Palca, an adult female Andean Condor that had been rescued and rehabilitated, was released at the foot of the Mururata, a picturesque scenario for an historical moment of raptor research in Bolivia: Palca was the first condor that was going to be studied through satellite telemetry in this country. The study of Palca is part of an ambitious project that aims to tag more Andean Condors with GPS transmitters and by using this approach, to obtain information on their habitat preferences in largely unstudied areas of their distribution. After just over two years of tracking Palca her transmitter is still ticking, and seven other condors have joined the flock of condors that have been tagged in Bolivia. All together, they have flown over an area of roughly 80,000 km<sup>2</sup> in the eastern Andes, and so far we have obtained c. 11,000 fixes, including 69 roosting sites. Several research milestones have been reached thanks to these condors, and it is worth mentioning that we now know important, or likely important, sites for Andean Condor conservation in Bolivia in every department of this country where the species occurs; likewise, we have documented, for the first time, international movements of condors between Peru and Bolivia, highlighting once again that Andean Condor research should be planned regardless of political borders. Hence our goal is to keep tagging and tracking the largest possible number of condors not only in Bolivia but throughout the Andes, since there is no doubt that large scale approaches are indispensable to effectively conserve this species. We will focus in using the telemetry data to characterize the important areas for condor conservation (e.g. roosts, foraging grounds and nests), propose protection measurements for these areas and we will extrapolate this approach to other highly mobile species.

## Distribution of Golden Eagles (*Aquila chrysaetos*) in eastern North America

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### Abstract

Identifying where a species resides and the resources it selects is critical for conservation and management, especially when wildlife are rare or cryptic. Golden eagles (*Aquila chrysaetos*) once bred in the northeastern US and are regular winter visitors in the eastern US. Furthermore, although they are readily seen during migration, they are more rarely seen during winter. Recent camera trap and telemetry studies suggest that Golden Eagles may be more widely distributed in the East than was previously thought. Therefore, to understand the distribution of this enigmatic species, we compiled observational data from a variety of sources including banding, telemetry, camera traps, eagle surveys, literature review, eBird, Global Biodiversity Information Facility, and ornithological society records. We described the distribution on a county basis and determined the empirical distribution for each month. Observations spanned from 1868 - 2021, with Golden Eagles being recorded in every state and most counties east of the 100<sup>th</sup> meridian. Preliminary analysis suggests that eagles have been recorded in the East every month of the year, but they were most commonly observed in October and November. Summer observations occurred rarely but were in areas where Golden Eagles previously bred or where introduced birds were released. Overall, the highest number of observations occurred in the Appalachian Mountains and the Driftless Area of the Midwest, but Golden Eagles were regularly observed along the Atlantic Coast and in interior areas, especially where waterfowl concentrate. By compiling data from multiple sources, we show that Golden Eagles are more widely distributed than previously recognized.

## Two-sex Integrated Population Model Reveals Differences in Life History Strategies for Female and Male Cooper's Hawks

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### Abstract

Integrated population models (IPM) combine population counts with demographic data to improve precision of estimates of population size and demographic rates. IPMs can also provide information on demographic parameters for which data are lacking (e.g., immigration), if sufficient information is available. IPMs are structured around a matrix population model that reflects the life cycle of the species. IPMs often use demographic data from one sex, usually females, implicitly assuming the chosen sex adequately represents the species' life history; for highly size-dimorphic raptors, that assumption may not hold true. We developed a two-sex IPM for a New Mexico population of the highly size-dimorphic Cooper's Hawk (*Accipiter cooperii*) from 2011–2020 and compared estimates of life history characteristics between sexes. Because we had data to directly estimate sex- and age-specific probabilities of breeding, fecundity, survival, brood sex ratios, and emigration rates, we could indirectly estimate age-specific immigration rates for both sexes. Our two-sex IPM revealed that population growth was most strongly associated with increased immigration and decreased first-year (FY) emigration in females but with after-first-year (AFY) survival in males. Most males that recruited as new breeders on our study area were AFY residents, whereas most female recruits were AFY immigrants. All females fledged on our study area that survived bred in their first year, whereas only 3% of FY males bred. We found evidence of density dependence in survival of AFY males ( $r = -0.11$ , 95% credible interval (CRI) =  $-0.36 - -0.03$ ), but only marginal evidence of density dependence in AFY female immigration ( $r = -0.02$ , 95% CRI =  $-0.10 - 0.01$ ). Our findings reveal that male and female Cooper's Hawks differ in their response to population density, and in how they contribute to population growth. Thus, sexual differences in vital rates can be an important consideration in raptor population models.

## Long-term Concentration of Tropical Forest Nutrient Hotspots is Generated by a Central-Place Apex Predator

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### Abstract

Apex predators typically affect the distribution of key nutrients for soil and vegetation through the heterogeneous deposition of prey carcasses and excreta. These effects can be in the form of nutrient concentration in a hotspot or nutrient spread against a natural gradient. Examples of nutrient transport have been restricted to mammalian apex predators in temperate ecosystems. The exact role of central place foragers such as tropical raptors in nutrient deposition and cycling is not yet known. We investigated whether Harpy Eagles (*Harpia harpyja*) in Amazonian Forests—a typically low soil fertility ecosystem where phosphorus is a limiting nutrient—affect soil nutrient profiles and phytochemistry around their nest-trees through cumulative deposition of prey carcasses and excreta. Nest-trees occurred in densities of 1.5 - 5.0/100 km<sup>2</sup>, and each nest received ~102.3 kg of undressed carcasses each year. Effects of nests were surprisingly negative over local soil nutrient profiles, with soil underneath nest-trees showing reductions of nutrients compared with controls. These effects were presumably negative because the canopy surrounding nest-trees intercepts nutrients through foliar uptake, in the form of excreta, allowing increased removal of nutrients from soil because those limiting nutrients are abundantly available. Leaves from the canopy around nests showed significant 99%, 154% and 50% increases in nitrogen, phosphorus and potassium, respectively. Effects on understory vegetation underneath nest-trees were positive for potassium only, with increases of 16%. Since harpy eagles have experienced a 41% decline in their distribution range, and many raptor species are becoming locally extirpated, this is a general example of disruption in biogeochemical cycles and nutrient heterogeneity caused by apex predator population declines. This further poses the question of how far the downstream effects triggered by a central-place predator can spread over animal and plant communities in tropical forest ecosystems.

## **Habitat Preferences of Endangered Egyptian Vulture, *Neophron percnopterus* (Linnaeus, 1758) in Uttar Pradesh, India**

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### **Abstract**

Habitat use patterns represent the actual distribution of individuals across habitat types. Information about habitat preference is important and necessary for effective management and conservation plans of any species. The present study focuses on the habitat preferences and population comparison of the Egyptian Vulture in different landscapes of Uttar Pradesh, India. There are 18 administrative divisions in Uttar Pradesh, of which 12 divisions (Agra, Aligarh, Bareilly, Chitrakoot, Dehri, Faizabad, Jhansi, Kanpur, Lucknow, Meerut, Moradabad, Allahabad) were surveyed from January 2014 to December 2018. A total count of the Egyptian Vulture population was conducted in three seasons (Summer, Winter, and Monsoon). Habitat preference was tested on the basis of population size of the Egyptian Vulture in the study area. Habitat type, season, water availability, human interference, and food availability were included as a predictor of population size in an ANOVA model to identify the most important factor. Seasonal fluctuation was observed with more population aggregation during winter. Results indicated that urban habitat (near human settlement) had more individuals in comparison to other habitat. Distance from rubbish dump, a source of food, was found to be a significant predictor of population size. Unexpectedly, forest habitat had a comparatively lower adult population. In conclusion our analysis suggests that population size is dependent on food availability. However, further research is needed to identify the factors affecting food availability in different habitats.

## Importance of Power Pole Selection when Retrofitting for Eagle Compensatory Mitigation in the United States

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### Abstract

In the United States, Bald Eagle (*Haliaeetus leucocephalus*) and Golden Eagle (*Aquila chrysaetos*) populations are federally managed to ensure stable or increasing populations while allowing for incidental take from anthropogenic sources. Compensatory mitigation, through retrofitting high-risk power poles to reduce eagle electrocutions, can be used to offset unavoidable take, enabling the US Fish and Wildlife Service (USFWS) to achieve their population management objectives. Regulators, permit holders, electric utilities, and consultants need an objective and repeatable method for discriminating between high-risk and low-risk power poles to ensure authorized take is fully offset by conservation actions. To illustrate the importance of accurately identifying and retrofitting high-risk poles, we compare conservation benefits among three retrofitting project scenarios: a) high-risk poles only, b) a circuit of both low- and high-risk poles, and c) low-risk poles only. We assert that, in the absence of a common definition of high-risk power poles that is applied uniformly across the landscape, mitigation approved by USFWS will fall short of its intended value and eagle population management objectives will not be met. We define high-risk poles in the context of eagle compensatory mitigation as poles in high-quality eagle habitat with a relative risk index  $> 0.40$  based on number of phases, number of jumper wires, and presence of pole grounding. We estimate that the conservation benefit of retrofitting a high-risk pole is at least 5.25 times greater than the benefit of retrofitting a low-risk pole. In the long-term, if compensatory mitigation intended to offset take and achieve population management objectives falls short of its assumed conservation value, the USFWS could be forced to limit future take authorizations until populations recover from incorrectly calculated conservation benefits. To avoid that negative outcome, we recommend the USFWS set consistent and transparent standards for identifying poles to count as compensatory mitigation credit.

## Harpy Eagle (*Harpia harpyja*) in Mexico: Recent Efforts to Find and Conserve the Northernmost Population

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### Abstract

The Harpy Eagle (*Harpia harpyja*) has a broad distribution from southern Mexico to northern Argentina yet has been extirpated across much of its former range, particularly Mexico and Central America mainly due to human persecution, poaching, habitat loss and fragmentation. Its global conservation status is Near Threatened, given its recognized decline, while its national conservation status in many countries, including Mexico, is Endangered. Mexican Laws recognize it as a priority species for conservation, however a notion persists that it has been extirpated from the country. Due to its ecological and cultural importance, we started in 2016 an initiative to search, conserve and monitor the Harpy Eagle and four other raptor species (King Vulture, Ornate, Black, Black and White Hawk-Eagles) in southeastern Mexico. Study area includes Montes Azules, Yaxchilan, Chan-kin, Lacanjá, El Triunfo y El Ocote Biosphere Reserves in Chiapas, Mexico. Efforts have resulted in four recent records of Harpy Eagles in the Lacandon Forests and a dozen of previously unknown historic records. Monitoring has been done with the help of trained local indigenous people inside well-preserved areas. No nest has been found to date; our present search efforts target nests and nesting areas using species distribution models (SDM) fed with nests data provided by The Peregrine Fund. We have also assessed and identified areas in good habitat suitability and healthy prey populations as possible reintroduction sites for Harpy Eagles in the future. Conservation efforts include the training of local guides and promotion of bird watching and nature tourism, payment for environmental services, etc. Our research concludes that there are still Harpy Eagles in Mexico, and suggests it should be considered critically endangered at the national level. Moreover, conservation efforts and funds should be allocated immediately to target this top predator and its habitat before it is truly extirpated.

## Supplementary Feeding and Extraction of Nestlings for Reintroduction Projects: Management Differences for Facultative and Obligate Siblicide Raptor Species

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### Abstract

The effect of supplementary feeding on the increase of productivity and its potential to over-produce nestlings for reintroduction projects has been previously tested. However, differences in the ability to respond to this management differs between facultative and obligate siblicide species. We compared the effect of supplementary feeding and the species management results of two reintroduction projects from Spain, the Spanish Imperial Eagle (*Aquila adalberti*) and the Bearded Vulture (*Gypaetus barbatus*). In both projects the source of nestlings used for the reintroduction came from donor populations where supplementary feeding was used to increase the productivity of the donor breeding pairs. Additionally, knowing populations density, fledging survival, juvenile survival, age of first breeding and productivity of both reintroduced and donor populations, the potential breeding value of a chick left in the nest was compared with the potential breeding value of a chick extracted and released in the reintroduced population with the hacking technique. Simulating the effect of supplementary feeding and different extraction scenarios on both species, we concluded that management techniques should differ between facultative and obligate siblicide raptor's species in order to optimize the effect of the supplementary feeding on the over-production of nestlings to use for reintroduction projects.

**Snowy Owl (*Bubo scandiacus*) Nesting Distribution Near Utqiaġvik, Alaska**DENVER W HOLT<sup>1</sup>, HENRY F MROS<sup>2</sup><sup>1</sup>Owl Research Institute, Charlo, USA. <sup>2</sup>Fitchburg State University, Fitchburg, USA**Abstract**

The Snowy Owl is one of the largest owl species in the world, and breeds within the circumpolar tundra habitat of the northern hemisphere. From 1992 to 2020, we mapped and recorded the coordinates of 277 Snowy Owl nests on the Coastal Plain of the North Slope of Alaska, USA near the village of Utqiaġvik (formally Barrow). In our 214 km<sup>2</sup> study area, topographic relief is low (sea level to 22m) and the landscape is dominated by ice-wedge created polygonal ground, shallow lakes, and underlying permafrost. On its tundra breeding habitat, Snowy Owls nest primarily on the ground among mounds, promontories, ridges, and rocks. With the exception of this study from Utqiaġvik and another from Vrangal Island, Russia, most breeding season studies last only a few seasons. In our 29-year study, nest numbers per season ranged from none to 54 nests and Snowy Owls bred during 17 of the observed years. The spatial distribution of nesting locations for 15 of the breeding years either exhibited a pattern of dispersion ( $p < 0.05$ ) or a pattern that was not significantly different from random. However, when all nesting locations were analyzed collectively, the observed pattern was significantly clustered ( $p < 0.001$ ) which may be indicative of choice nesting areas within the region of study.

## Experiences and lessons on the recovering efforts of an insular raptor: the Puerto Rican Sharp-shinned Hawk (*Accipiter striatus venator*) after Hurricane Maria

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### Abstract

The Puerto Rican Sharp-shinned Hawk (SSHA, hereafter) is an endangered endemic restricted to mature montane forest of Puerto Rico. Historically, the SSHA was found nesting >400 m in the major mountain systems of the island, but the species experienced a sharp decline (~40%) between 1983-1991. The reasons of this decline are unknown, but might be the result of habitat change (e.g., deforestation and human sprawl), high rates of *Philornis spp.* parasitism, and nest predation. In 1998, category 3 hurricane Georges severely affected the main breeding areas of the SSHA, its population status post-hurricane was unknown, and no survey or conservation actions were taken. On 20 September 2017, the small population was further depressed to 19 observed individuals (from a conservative high of 75) following the category 5 Hurricane Maria. Maria caused a widespread forest destruction in the Cordillera Central Mountain range which was the last SSHA's stronghold. In 2018, we initiated a conservation effort to increase productivity by collecting clutches from wild pairs to promote second clutches, assisted propagation, and nest management. Here, we are presenting the highlights learned lessons of our conservation efforts before (2015-2017) and after Hurricane Maria (2018-2021). In 2019, we treated nests with an insecticide to prevent infestation of *Philornis*, which contributed to an increase in productivity to 2.2 young/per nesting attempt whereas untreated wild nests yielded 0.4 young/per nesting attempt. Nest treatments will be implemented in future years as part of the species' recovery effort. Our experiences offer an insight of pre-and-post hurricane to help our understanding on the effects of major disturbances on small and declining populations and to assist conservation actions to help prevent extinction. This insular raptor is extremely vulnerable to stochastic events, and the reason for the current conservation measures taking place to save this unique Accipiter.

## Vultures Response to Extreme Weather Events in Southeastern United States of America.

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### Abstract

Extreme weather events such as cyclones and tornados have been found to change the spatial and temporal abundance of raptors by decreasing survival and forcing the emigration of residents individuals, or by increasing habitat heterogeneity and facilitating recolonization of disturbed areas. Nonetheless, little is know how extreme weather events could affect raptors movements and their patterns of space use in areas disturbed at large scales post-weather events. We studied how extreme weather affected the movements of Black and Turkey Vultures (*Coragyps atratus* and *Cathartes aura*, respectively) in Mississippi, USA, facing tropical cyclone Zeta in November 2020 and tornados MS-43 and MS-44 in May 2021. We GPS-tracked fifteen vultures in the paths of the storms. We compared daily displacements before, during and after of the storms using linear mixed-effect models. Since storm avoidance behavior has been observed in other birds, we expected that vultures shifted their movements out of the predicted path of the storms before storm days. Therefore we would not expect differences in daily displacements, before, during and after the storms. Contrary to our expectations, all vultures stayed in the same area before, during and after the storms. Although we did not find statistically significant differences in daily displacement, vultures greatly reduced their movements during cyclone days. Vultures traveled in average 26.5 (95% CI: 16.4-42.9), 12.6 (95% CI: 7.8-20.5) and 20.3 (95% CI: 12.5-13.8) km before, during and after the cyclone. Daily displacement was similar before, during and after tornados. Our results suggest either Black and Turkey Vultures lack the ability to sense extreme weather events in advance and/or there is no benefit to additional energy investment in finding suitable areas outside of the storms path. Ongoing work is exploring how these birds respond to weather patterns including intense storm events likely become more frequent over this century.

## Movements patterns of captive-reared and wild-rehabilitated Harpy Eagles released in Central American landscapes

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### Abstract

Understanding the spatial context of animal movements is fundamental for establishment and management of protected areas (PA). However, these data are not readily available for large raptors, particularly for tropical species. We telemetry-tracked 36 captive-reared and wild-rehabilitated *Harpia harpyja* and estimated dispersal and space use after release in Mesoamerica. We evaluated the effectiveness of PA in the protection of home ranges and examined how individual traits (sex/age), human intervention (captive management/release method) and landscape composition and configuration influenced dispersal and home range using mixed-effects models. Mean annual dispersal was 29.4 km (95% CI: 22.5-38.5), annual home ranges averaged 2034.1 km<sup>2</sup> (95% CI: 978-4472). The home ranges of nine individuals were distributed across three countries. Movement patterns were influenced by release method, patch richness, patch and edge density, and contagion. PA in Mesoamerica may not be effective conservation units for this species. Harpy Eagle average home range greatly exceeded the average size of 1115 terrestrial PA (52.7±6.1 km<sup>2</sup>) in Mesoamerica. Given its spatial requirements, restoration of the Harpy Eagle in Mesoamerica may provide an opportunity to inform the design and management of dynamic conservation concepts, such as biological corridors. Due to their wide use of space, including transboundary, Harpy Eagles conservation efforts may fail if they are not carefully coordinated between the countries involved. Future restoration efforts of umbrella forest-dwelling raptors should select release sites with highly aggregated and poorly interspersed forest. Release sites should have a buffer of approximately 30 km and should be located completely within PA. Sites meeting these requirements are likely scarce across the Neotropic and located in remote areas where soft-releases would be difficult to carry out. Therefore, use of a hard-release approach may be warranted.

## **It's Not the Tag, it's the Bird: Wing-tags do not Impair Movements of Black Vultures (*Coragyps atratus*) in Southeastern United States of America**

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### **Abstract**

Wing-tags have been used for decades in marking and studying birds of prey. Recently, evidence has been put forth that wing-tags can negatively affect movements of Old World vultures. We assessed the impact of wing-tags on flight performance of Black Vultures (*Coragyps atratus*, hereafter vultures) tagged in Mississippi, U.S.A. We equipped 13 birds (body mass  $\bar{x} = 2,102 \text{ gr} \pm \text{SE } 52$ ) with GPS tags (CTT ES-400, 35 gr), seven wing-tagged with cattle ear tags only (16 gr: one tag per wing). The other six vultures were not wing-tagged but were outfitted with GPS tags. We compared flight altitude and speed of wing-tagged vs non-wing-tagged vultures using generalized additive models while accounting for variation in air temperature, relative humidity, orographic uplift and wind-speed. Data analyzed were collected in Summer 2020. We hypothesized that since cattle ear tags have been found to lift off the wings in flight, we expected that these tags could impose resistance, or impulse, by creating drag against headwinds or tailwinds, respectively. Although we did not find significant differences among metrics examined between groups, we did find variation in flight altitude and speed within groups (wing-tagged vs. not wing-tagged: CV > 50%). No evidence was found that wing-tags influenced the flying altitude of vultures, but weather conditions did affect movements of these birds, independent of tagged status. Vultures flew low altitude in areas with high orographic uplift and during hot and humid days. As expected, vultures increased and reduced flight speed with tailwinds and headwinds, respectively with no differences evident between tagged and non-tagged individuals. Although our sample size is small our preliminary analysis indicates there is no net effect of wing-tagging on Black Vultures. Rather, we see high intra-individual variability in flying performance among these birds based, in part, on weather conditions.

## Prey Deliveries and Estimated Biomass Consumed by Barn Owl Nests in the Sacramento Valley, California

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### Abstract

Rodents are one of the most detrimental pests to agriculture and decreasing pest rodent populations in these landscapes is expensive. Many farmers are implementing integrated pest management systems that allow chemical (i.e., toxic) and natural (i.e., non-toxic) pest controls to be used together. American Barn Owls (*Tyto furcata*) commonly consume major rodent pests; however, it is difficult to determine and quantify how well Barn Owls are controlling rodent populations. We gathered diet information of Barn Owls nesting on a large-scale vineyard in Yolo County, California. We used a novel camera design set up at the nest box entrance to identify prey items brought back by adults and to identify adult provisioning rates. In addition, we dissected fresh pellets that were collected weekly from inside nest boxes and measured rodent jaw bones for estimated biomass. We recorded over 500 prey deliveries on video from nine nest boxes and dissected over 1600 pellets from over 40 nest boxes to identify prey type proportions and estimate biomass consumed at each nest box. The diet consisted of over 97% of rodent pest species (gophers, voles, mice, and rats). Prey delivery rates and average biomass delivered to chicks per night were both significantly different between adults with males delivering prey more often and providing more total biomass. Initial findings show an average of four prey deliveries per chick each night. Findings further demonstrate that Barn Owls are targeting pest species in agriculture landscapes and highlights a potential energy tradeoff between female incubation and male prey delivery rates, which helps further our understanding of the Barn Owls' life history in California agroecosystems.

## **Andean Condors (*Vultur gryphus*) in Peru: Current Conservation Status and Some Knowledge Gaps.**

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### **Abstract**

Despite being a species deeply rooted in the Peruvian culture, Andean Condor ecological requirements and population size are not well known. These knowledge gaps hamper conservation efforts that are urgently needed to preserve the species in Peru which is suspected to be diminishing. Here, I present the results of my studies on Andean Condor ecology and threats derived from satellite telemetry, citizen science and literature review. Population size of the species has not been properly measured, yet estimates derived from citizen science and from data obtained in key areas account for 360 individuals that mainly occur in 18 priority areas located in the southern Peruvian Andes. Information on habitat use by the species, based on satellite data obtained from two rehabilitated adult males show that foraging areas used by these birds were located higher than roosting areas (3934 m vs 3356 m), and that foraging areas were dominated by low-laying native vegetation such as grasses and bushes that are being reduced by agriculture and urban development. Andean Condors face many threats in Peru, with poisoning being the main cause of mortality. Additionally, traditional celebrations such as the Yawar Fiesta, which is mainly conducted in the Apurimac region in the south, is associated to the mortality of individuals and should be stopped. Andean Condors in Peru might be key to maintain connectivity between larger populations in Chile and Argentina with smaller populations in Ecuador and Colombia. Andean Condors breeding in the Illescas protected area in north west Peru might be key to maintain this genetic connectivity, and due to its low reproduction rate, its conservation should be prioritized.

## Interpreting Long-distance Movements of Non-migratory Golden Eagles: Prospecting and Nomadism?

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### Abstract

Movements by animals can serve different functions and occur over a variety of spatial and temporal scales. Routine movement types, such as residency (localized movements) and migration, have been well studied. However, non-routine movement types, such as dispersal, prospecting, and nomadism, are less well understood. Documenting these rarely detected events requires tracking large numbers of individuals across all age classes. Of >500 Golden Eagles (*Aquila chrysaetos*) we tracked by telemetry over 10 yrs in western North America, 160 engaged in non-routine, long-distance (>300 km) movements. We identified spatial and temporal correlates of those movements at both small and large scales, and we quantified movement timing and direction. We further tested which age and sex classes of eagles were more likely to move long distances. Preliminary analysis of 88,144 daily tracks suggested that distances traveled by eagles responded to the updraft potential of the spatial and temporal landscape they encountered. Daily tracks covered longer distances at locations and times of higher updraft potential, and older birds traveled farther than younger birds. By contrast, after decomposing daily tracks into 563 multi-day movements, only duration of travel was responsive to environmental conditions and to characteristics of individual eagles. Longer trips were made by young birds, in winter, and when initiated in open and warm landscapes. Finally, long-distance movements were more frequently made outside of winter, in north-south directions, and by young birds. Our study is the first to describe these movement types by Golden Eagles, and we documented clear correlates of non-routine, long-distance movements at small, local scales but found little evidence of such correlates at larger, regional scales. Most long-distance movements we documented fit patterns associated with traditional definitions of prospecting and nomadism but not of migration.

## Dynamic Coexistence and Growing Risk of Conflict between Peregrine (*Falco peregrinus*) and Saker Falcon (*Falco cherrug*) in Hungary

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### Abstract

Although Peregrine and Saker Falcons occupy different niches, their food sources and nest site requirements increasingly overlap potentially leading to conservation conflicts. Historically, Peregrines occupied cliffs in hills and mountains, while Sakers habited grasslands hosting colonies of European Ground Squirrel (EGS) (*Spermophilus citellus*). As pastures encroached to hills and mountains in some areas, falcons shared cliffs or used them alternately in those regions. By 1949 species' populations declined to 17 (Peregrine) and 27 pairs, then Peregrine became extinct in 1955 due to DDT. Saker population was also depleted, and it started to recover only in the 1980's as a result of conservation programs. In the 1990's grazing was abandoned in many sites, which along with the impacts of climate change caused EGS colonies collapse and by the mid-1990s Sakers gradually withdrew to the lowland, where their diet shifted from EGS to Feral Pigeons (*Columba livia f. domestica*) and Common Vole (*Microtus arvalis*). Saker population continued to grow until about 2010 and fluctuating since then (164 pairs in 2020). Peregrine returned to breed in Hungary only in 1997 and the population has been growing exponentially since then (91 pairs in 2020). Demographic parameters suggest that Peregrines perform better ( $\lambda = 1.173678$  and  $r = 0.1541331$ ) than Sakers ( $\lambda = 1.079315$  and  $r = 0.0683$ ). Equilibrium population size, however, is higher for Sakers ( $K=156$ ), than for Peregrines ( $K=113$ ), if not considering potential urban habitats for the latter. Sakers' breeding success are more sensitive to cold and rainy weather. Peregrine population started to expand recently occupying nest boxes in the foothills installed on power lines for Sakers. Considering breeding performances and growing competitions for nest sites and food, as well as flying capability and more aggressive behavior of Peregrines, Saker Falcons may disappear from some areas in Hungary, as a result.

## One-time Treatment of Nest Material is Enough to Prevent Parasitism by *Philornis pici* in the Endemic and Critically Endangered Ridgway's Hawk (*Buteo ridgwayi*)

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### Abstract

Parasitic flies of the genus *Philornis* cause fitness costs to their avian hosts, especially in geographically-restricted and endangered bird species. This group of Neotropical ectoparasites affects a wide array of avian hosts, including raptors. Ridgway's Hawk (*Buteo ridgwayi*) is a Critically Endangered species endemic to Hispaniola. A high percentage of Ridgway's Hawk nestlings die due to parasitism by subcutaneous-feeding larvae of *Philornis* spp. (primarily *P. pici*). The Peregrine Fund began experimental treatments of Ridgway's Hawk nests in 2012, by 2013 we had developed a highly effective treatment to prevent *Philornis*-related death in nestling hawks. However, this treatment was not ideal since it was costly and time-consuming, directly exposed nestlings to insecticide (applied topically), and weekly applications increased the likelihood of stress and injury to nestling and adult hawks. Between 2016 and 2020 we developed and tested a new treatment protocol. By applying a single dose of controlled-release permethrin (Permacap 1%) to the perimeter of the hawk nest, we successfully prevented parasitism by *Philornis* spp. This new treatment was as effective as the old one at preventing *Philornis* infestations, while reducing human labor, exposure of nestlings to insecticide, and disturbance at nests. As of 2020, this method has also been used to prevent *Philornis* infestation of nestling Puerto Rican Sharp-Shinned Hawk (*Accipiter venator venator*). *Philornis* with subcutaneous larvae, such as infect Ridgway's Hawk and Puerto Rican Sharp-shinned Hawk, represent >80% of known *Philornis* spp. This new treatment may be suitable for preventing infestations of subcutaneous-feeding *Philornis* spp. in other susceptible birds of conservation concern.

## Ferruginous Hawk Average Home Range During The Breeding Season In Western Wyoming

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### Abstract

The Ferruginous Hawk (*Buteo regalis*) is considered an understudied species that some suggest is sensitive to habitat loss and fragmentation from energy development and other anthropogenic activities. The impacts of development on Ferruginous Hawks are poorly understood because no studies have been able to assess habitat use and selection both before and after development occurs within a singular study area. A large, natural gas development project has been approved in Sublette County, Wyoming in a landscape with breeding Ferruginous Hawks. The objective of our study was to identify Ferruginous Hawk home range sizes and the biotic and abiotic factors associated with habitat use prior to a large-scale energy development, with the goal of informing mitigation measures. In 2019 and 2020, we outfitted breeding adult hawks with transmitters ( $n = 9$ ) set to gather GPS locations at either 30-min or 1-hour intervals during daylight hours (0600 - 2100). Home range sizes were calculated using 50% and 95% minimum convex polygons (MCP). Home range for males averaged 24.23 km<sup>2</sup> (SE=2.64) and 2.92 km<sup>2</sup> (SE=0.82) for core area. Female home ranges averaged 5.94 km<sup>2</sup> (SE=2.86) and 0.71 km<sup>2</sup> (SE=0.07) for core area. Breeding males home ranges averaged 4.07 times larger compared to breeding females. Future work will include resource selection analyses, incorporating both remotely sensed and habitat data collected in the field, and using a use-available design within 95% KDE home range. This study provides a unique opportunity to study Ferruginous hawk home range and habitat selection *prior* to a large-scale energy development. An understanding of important habitat requirements is imperative to reducing potential impacts from energy extraction activities to Ferruginous Hawks and other raptors of conservation concern.

## **For the Emerging Generation of Raptor Conservation Biologists, No 'Words of Wisdom' From a Member of the Older Generation, But Instead, a Proposal**

ROBERT W RISEBROUGH

The Bodega Bay Institute, Berkeley CA, USA

### **Abstract**

For the Emerging Generation of Raptor Conservation Biologists, No 'Words of Wisdom' From a Member of the Older Generation, But Instead, a Proposal

ROBERT W. RISEBROUGH, The Bodega Bay Institute, 2711 Piedmont Avenue, Berkeley, CA 94705 USA

What can we do to help a young Raptor Conservation Biologist, or any Conservation Biologist intent on ending or reducing harmful environmental effects of human activities be the most effective in accomplishing her/his mission? And how can we modify the education process to put much more emphasis on thinking, much less emphasis on memorizing established dogma, thereby requiring students to make their own conclusions? My suggestions: 1) for any harmful or potentially harmful effect on a raptor population, make available those facts and observations 'that nobody can deny'; 2) provide the full range of available interpretations and proposals, without supporting or denying any; 3) establish a network of websites, each devoted to a specific topic, that would provide the information suggested above, and that would publish, at least temporarily, correspondence; 4) encourage local censuses or studies of local populations of whatever species by publishing the results on the website. A powerful motivation for ambitious young people. Much to discuss.

## The Red-tailed Hawk Project: Developing a Model System for Studies of Raptor Ecology and Evolution

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### Abstract

The Red-tailed Hawk (*Buteo jamaicensis*) is a common and widespread raptor with the potential to serve as a model for broad patterns and processes in the ecology and evolution of raptors. This species serves as an apt model largely because of its abundance, and the great variation in population-level plumage characteristics, geographic variation in presence of plumage polymorphism, and variation in migratory tendencies among populations. This potential is limited, however, by many gaps in our knowledge of the evolution, geographic variation, migratory connectivity, and landscape genomic patterns of the species. The Red-tailed Hawk Project is a research collaboration focused on filling these gaps, with the primary goal of empowering its use as a system for increasing our understanding of patterns and processes in the ecology and evolution of raptors at large. We are focused on increasing our understanding of the species' movement ecology, population genomic and phylogenomic patterns, as well as the genomic mechanisms that control plumage polymorphism. Our hope is that through studying and understanding these aspects as they relate to the Red-tailed Hawk, we will develop a framework for similar research on other species. Over the past 1.5 yrs, collaboration with researchers from six organizations has resulted in the capture and sampling of more than 117 individual Red-tailed Hawks from 7 of the 14 described subspecies. We have deployed 30 GPS-GSM tracking units on individuals to 1) gather full annual-cycle movement data and, 2) connect standardized photographs and genomic data to remote breeding locations. Moving forward, we will focus on completing both the comprehensive distribution-wide genomic and phenotypic sampling of breeding individuals, and increasing the diversity of full annual-cycle movement data.

## Restoration of the red kite *Milvus milvus* to Ireland

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### Abstract

The reintroduction of the red kite *Milvus milvus* has occurred in Ireland since 2007 and here we analyse the implementation, progression, status, outcomes of the reintroduction programme and reviews the detected threats and pressures on this species in Ireland and identifies opportunities for future conservation management.

Red kite juveniles were translocated from Wales to various release localities within Ireland (Dublin, Wicklow) and Northern Ireland (Down) and reintroduced into the wild whereupon a detailed monitoring programme was undertaken to examine survival, dispersal, breeding localities and identify causes of mortality. Monitoring includes radio-tracking, satellite tracking, patagial wing-tags monitoring and field-based observer monitoring and finding of nests following best practice survey methodologies.

Re-sightings of wing-tagged birds have been collated from across Ireland, and further afield, and several thousand re-sightings documented. Breeding and wintering observations have allowed monitoring of breeding pairs, productivity, prey items and unusual nesting materials and monitoring at communal roost sites which allows an assessment of survival and dispersal via tag re-sightings.

In 2021 a minimum of 50 – 80 chicks are now fledging annually across Ireland and breeding kites are now recorded in a minimum of six counties in Ireland with around 100 – 120 pairs estimated. Studies of prey items identified, in Ireland, they are mostly scavengers, feeding on small carcasses, including road-kill, but also a variety of live prey including nestlings (notably corvids), rodents, rabbits, frogs and invertebrates.

Records of mortality includes shooting, electrocution, power-line and turbine collisions, train / road collisions (presumably whilst scavenging), and particularly via chemical toxins (primarily alphachloralose and carbofuran) and many carcasses have been found to contain second generation anti-coagulant rodenticides. These deaths have highlighted the on-going negative effects of toxins on wildlife. It therefore remains important to monitor the causes of mortality in red kites in Ireland to ensure continued population viability.

## Bayesian State Space Modeling Framework for Understanding and Predicting Golden Eagle Movements Using Telemetry Data

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### Abstract

Predicting raptor movements through a wind power plant under given atmospheric and topographical conditions is a crucial first step in the overall goal of quantifying the risk of turbine-related collisions and mortalities. Extracting behavioral traits of golden eagles (*Aquila chrysaetos*) from telemetry data requires the fusion of noisy and sparse movement data (location, heading, velocity) with a stochastic mathematical representation of the eagles' decision-making processes. In this study, we framed this problem in a Bayesian state-space framework where both observations and decision-making are assumed to be stochastic processes connected through hidden states (mode of flight, intent), and the unknown model parameters are assumed to be random variables that are calibrated using the available telemetry data. This framework allowed for rigorous consideration of underlying uncertainties while allowing for both data and prior biological knowledge to contribute to a probabilistic and predictive agent-based movement model. We implemented and applied the Bayesian framework to understand movement behavior of 23 GPS-tagged golden eagles travelling in the western US for years 2019 and 2020. Our preliminary findings show that the Bayesian state-space framework provides a robust inverse modeling apparatus to decode eagle behavioral characteristics from telemetry data. This study was primarily aimed at verifying and validating the framework with selected golden eagle tracks (both long- and short-ranged), with future research aimed at extending the framework to include multi-mode flight, consideration of atmospheric data and uplift mechanisms, eagle-to-eagle interaction, and eagle-to-turbine interaction.

## Individual Variation in Movement Strategies and Space Use of Bald Eagles (*Haliaeetus leucocephalus*)

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### Abstract

Understanding of population level migratory behavior requires investigating individual movement patterns and space use. Between 2018 and 2021, we used GPS transmitters to track movements of 15 Bald eagles (*Haliaeetus leucocephalus*) tagged on the south coast of the British Columbia coast. This fine-scale telemetry data was used to evaluate movement strategies and spatial habitat usage within age and sex classes, as well as rehabilitated individuals. We found that individuals exhibited markedly different migration strategies; for example, one bird traveled as far at the northern coast of Northwest Territories, while others flew no further than a 200km radius. Males overall traveled farther than females throughout the year. Individuals that had been rehabilitated each offered a unique migration strategy, and there were no distinct spatial use patterns. All individuals made stops at landfills along their migration routes, highlighting landfills as important resource areas for Bald eagles. Overall, we found variation in home ranges and areas of high intensity use throughout the annual cycle among individual Bald eagles. Quantifying how individuals adjust their movement behavior to resource hotspots can provide valuable information for the management of these critical habitat features and wider conservation goals for Bald eagles.

## **Falconers and Restoration of Tree Nesting Populations of European Peregrine (*Falco peregrinus peregrinus*) in Poland.**

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### **Abstract**

Tree-nesting Peregrine Falcon (*Falco peregrinus*) populations formerly inhabited the lowlands of Central and Eastern Europe. The last tree nest in Poland was found in 1964, and the ecotype subsequently went extinct in Poland, Germany, and neighboring countries. Falconers started to breed Peregrines in Germany in the 1940's. With the ban on DDT in most countries, Peregrine Falcon populations that survived the crisis began to rebuild. Reintroduction significantly accelerated the restoration process, with some populations restored from zero, but tree-nesting population failed to regenerate. Polish falconers started their first attempts to breed Peregrine Falcons in the late 1970s, and reintroductions in Poland started in 1990, conducted mainly in forested areas, mountains, and cities. In Poland 245 nestlings were released from 1990-2009 (average 12 per year). The first breeding attempt occurred in 1998, and the first breeding in a city occurred in 1999. A total of 124 Peregrine Falcons hatched during the period 1998-2009. In 2010 the program was revised and conducted by the Society for Wild Falcons. From 2010-2020, 879 young Peregrine Falcons were released (average 80 per year). The first nestlings from a tree nest were ringed in Poland in 2012, and since 2020 ca. 20 pairs have been observed nesting in trees, producing 145 nestlings. In 2020 121 nestlings were produced, including 41 in tree nests, 17 in mountains, and 63 in cities. After German reunification, tree nesting was co-managed by the conservation organization "Arbeitskreis Wanderfalkenschutz", hunting organization "Landesjagdverband Mecklenburg-Vorpommern" and falconer association "Deutscher Falkenorden" with ca. 50 pairs now breeding in trees. Webcam transmissions at Peregrine nests began in 2003, and now total 20 cameras, with two in nests.

## Comparison of Genetic Variation in A Captive Breeding Population of Peregrine Falcons (*Falco peregrinus peregrinus*)

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### Abstract

Falcon breeders are a main source of reintroduction material to restore peregrine populations. Research indicates that peregrine population genetic variability prior to bottleneck effect was low compared to the genetic variability observed in other bird species. Low genetic variability of contemporary peregrine populations is confirmed by many researchers. It can have both behavioral and environmental causes. The possibility of creating population from scratch gives a unique opportunity to monitor genetic status of released birds. According to research in Scandinavia, there were genetic differences between wild and captive populations. However, studies of analogous populations in Poland and Czechia showed no significant differences between them. As some authors suggested, decades of breeding may have affected falcon genome through the selection regime. Moreover, some data suggest that captive falcons have sometimes been hybridized to obtain certain traits. Therefore, it is crucial to know the genetic structure of breeding population. In our studies peregrine blood samples from 47 breeders in 5 countries were used to isolate genomic DNA. All individuals were genotyped using 10 microsatellite markers previously described in literature. Quality of fragments was assessed using GenAlex 6.5 and length of fragments, heterozygosity across populations and markers, and effective number of alleles was calculated. One marker was excluded due to null heterozygosity. Genetic variability for all investigated birds were obtained. The distance between "nests" from different breeders was calculated, and phylogenetic trees were constructed using the UPGMA method using MegaX software. Individual offspring from the same breeder but different years were compared to detect changes in parental pairs. Additional clustering analyses was performed in SPSS and STRUCTURE software.

## How do Commercial and Military Drones Compare to Ground-based Scope Observation for Golden Eagle Nest Monitoring?

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### Abstract

The U.S. Army Dugway Proving Ground (DPG) in western Utah was the host installation for an Environmental Security Technology Certification Program (ESTCP) project to evaluate the use of “drones” for Golden Eagle (*Aquila chrysaetos*) nest monitoring. DPG is home to high levels of military testing and training, as well as 11 Golden Eagle territories, and “in-use” eagle nests have the potential to stop military activities in their tracks. Therefore, it is critical for DPG and similar installations to efficiently monitor eagle nests on their property. We evaluated whether “Small Unoccupied Aircraft Systems” (sUAS), and military “Unoccupied Aircraft Systems” (UAS) could obtain eagle nest locations and status updates more efficiently (i.e., quickly) than an experienced ground observer, while still conforming to eagle survey recommendations (e.g., 800-m horizontal buffers) during a two-year blind study. During our first season (2019), the sUAS observation team proved most efficient at locating in-use and previously unknown nests. The UAS team was the most efficient observer of nest status, completing visits in <10 minutes on average. Results differed significantly in 2020, due to changes in both the sUAS and UAS platforms and camera payloads. In 2020, the sUAS team struggled to locate nests or identify nest status due to a downgrade in camera resolution. In contrast, the UAS team saw an increase in its effectiveness with a new HD camera. Both sUAS and UAS platforms show promise as tools for monitoring Golden Eagle nests, provided the platforms meet certain minimum standards. A final technical report and guidebook were produced to share lessons learned and a framework for future use of drones on military installations. This project won the ESTCP 2020 Project of the Year Award.

## **Raptor Research During the COVID-19 Pandemic Provides Invaluable Opportunities for Conservation Biology**

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### **Abstract**

Research is underway to examine how a wide range of animal species have responded to reduced levels of human activity during the COVID-19 pandemic. In this talk we will outline why raptors are particularly well-suited for investigating potential 'anthropause' effects: they are sensitive to environmental perturbation, affected by various human activities, and include many locally and globally threatened species. Lockdowns likely alter extrinsic factors that normally limit raptor populations. These environmental changes are in turn expected to influence – mediated by behavioral and physiological responses – the intrinsic (demographic) factors that ultimately determine raptor population levels and distributions. Using this population-limitation framework, we present a range of research opportunities and conservation challenges that have arisen during the pandemic, related to changes in human disturbance, light and noise pollution, collision risk, road-kill availability, supplementary feeding, and persecution levels. Importantly, raptors attract intense research interest. Many professional and amateur researchers run long-term monitoring programs, often incorporating community-science components, advanced tracking technology and field-methodological approaches that allow flexible timing, enabling continued data collection before, during, and after COVID-19 lockdowns. This will allow the international raptor research community to tackle ambitious analyses across geographic regions, ecosystems, species, and gradients of lockdown perturbation. Under the most tragic of circumstances, the COVID-19 anthropause has afforded an invaluable opportunity to significantly boost global raptor conservation.

## Range-wide Habitat Use and Key Biodiversity Area Coverage for a Lowland Tropical Forest Raptor Across an Increasingly Deforested Landscape

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### Abstract

Quantifying habitat use is important for understanding how animals meet their requirements for survival and provides useful information for conservation planning. Currently, assessments of range-wide habitat use that delimit species distributions are incomplete for many taxa. The Harpy Eagle (*Harpia harpyja*) is a raptor of conservation concern, widely distributed across Neotropical lowland forests, that currently faces threats from increasing habitat loss and fragmentation. We used a logistic regression modelling framework to identify habitat resource selection and predict habitat suitability based on a new method developed from the International Union for the Conservation of Nature Area of Habitat range metric. From the habitat use model, we performed a gap analysis to identify areas of high habitat suitability in regions with limited coverage in the Key Biodiversity Area (KBA) network. Range-wide habitat use indicated that Harpy Eagles prefer areas of 70-75% evergreen forest cover, low elevation, and high vegetation heterogeneity. Conversely, Harpy Eagles avoid areas of >10% cultivated landcover and mosaic forest, and topographically complex areas. Our habitat use model identified a large continuous area across the pan-Amazonia region, and a habitat corridor from the Chocó-Darién ecoregion of Colombia running north along the Caribbean coast of Central America. Little habitat was predicted across the Atlantic Forest biome, which is now severely degraded. The current KBA network covered ~18% of medium to high suitability Harpy Eagle habitat exceeding the target representation (10%). Four major areas of high suitability habitat lacking coverage in the KBA network were identified in the Chocó-Darién ecoregion of Colombia, western Guyana, and north-west Brazil. We recommend these multiple gaps of habitat as new KBAs for strengthening the current KBA network. Modelled area of habitat estimates as described here are a useful tool for large-scale conservation planning and can be readily applied to many taxa.

## **Twenty Years of Monitoring Nocturnal Owls in Alberta: What Are We Learning?**

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### **Abstract**

In 2021, the Alberta Nocturnal Owl Survey has collected 20 years of owl monitoring data from volunteers that surveyed an average of 95 routes per year. Volunteers are sent random routes, survey manuals, and call playback recordings to conduct surveys. There were 193 volunteers surveying for owls in 2021 across mostly forested regions in Alberta, and nine species of owls were detected. Throughout the past 20 years, Barred, Great Gray, Boreal, Northern Saw-whet, Long-eared, and Great Horned Owls are commonly detected, while Northern Hawk, Northern Pygmy, and Short-eared Owls have been observed in low numbers. Great Horned and Northern Saw-whet Owls showed cyclic populations changes, while other species populations remained stable. Citizen science has been crucial in helping determine owl population changes in non-remote areas. As part of a network of agencies from across Canada conducting nocturnal owl surveys in a standardized way, the program collects important long-term information on owl distribution, abundance, and population trends regionally, provincially, and nationally. The volunteer data has also been provided to various agencies to help inform survey designs in remote areas and help with management considerations. Birds Canada is finalizing the data import of citizen science monitoring data from across Canada with the goal of completing a national analysis of nocturnal owl populations.

## Assessment of Updraft Modeling Bias Using Computational Fluid Dynamics

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### Abstract

Golden Eagle (*Aquila chrysaetos*) habitats may overlap with wind energy development in some regions of the US. Eagles, and similar soaring bird species, are therefore at risk of collision with wind turbines when flying through wind farms. Recently developed behavioral modeling approaches can predict the presence of eagles near turbines within the rotor-swept layer but require reliable prediction of atmospheric flowfield conditions. In particular, the vertical component of the wind speed dictates a soaring bird's ability to maintain or gain altitude, since they rely on updrafts to subsidize their flight. In this work, we investigate the atmospheric conditions around a wind farm in complex terrain and compare methods for atmospheric characterization. We use computational fluid dynamics (specifically, large-eddy simulations, or LES) to simulate the atmospheric boundary layer over a region encompassing multiple wind farms with high temporal and spatial resolution (seconds and 10's of meters, respectively). We compare traditional non-simulation-based methods of determining the orographic updraft potential based on wind direction, terrain slope and aspect, with the flowfields from LES that include both orographic updrafts alone and combined thermal and orographic updrafts. Preliminary analysis suggests that although the model captures the horizontal pattern of vertical updrafts, their magnitude can be improved with information about the surface heat flux, which is usually correlated with time of the day. Within our study region, we found that the low-fidelity model may over- or underestimate updraft potential by up to 400% at 80 m AGL, depending on local orographic features. This can result in an inaccurate representation of eagle presence and, consequently, risk. Another important finding is that flowfield time-averaging can hide important details about the flight environment, including how thermally generated flow structures within the atmospheric boundary layer (e.g., convective rolls and/or cells) may be important drivers of eagle flight.

## Hospital Admissions of Australian Coastal Raptors Show Fishing Equipment Entanglement is an Important Threat

VICTORIA K THOMSON

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### Abstract

Coastal raptors in urban landscapes face multiple threats. Australia's coastal raptors (Osprey [*Pandion haliaetus cristatus*], White-bellied Sea-Eagle [*Haliaeetus leucogaster*], Brahminy Kite [*Haliastur indus*], and Whistling Kite [*Haliastur sphenurus*]) are all found in the urban region of South-East Queensland/northern New South Wales, and have varying sensitivities to urbanization. To assess some of the effects of urbanization on these species on Australia's mid-east coast, we reviewed Currumbin Wildlife Hospital Foundation (CWHF) admissions data from July 1998 to February 2020. Overall, more birds were admitted because of anthropogenic causes than natural causes, although the hospital had high treatment success, with most patients surviving their injuries to be released to the wild. The most significant identifiable impact was fishing equipment entanglement, accounting for 21% of raptors for which we could determine the cause of admission, followed by bird attack, and vehicle strike. To our knowledge, this is the first assessment to show fishing activities to be a significant cause of injury. Understanding the causes of injury and mortality to these birds, including especially anthropogenic causes, is critically important for species management and conservation. As recreational fishing is a popular practice in this region, it is important to continue to provide education and disposal bins for fishing tackle in popular fishing areas to reduce the number of coastal raptors affected.

## Sex Allocation and Sex-specific Offspring Performance under Variable Food Conditions in the Color Polymorphic Tawny Owl (*Strix aluco*)

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### Abstract

The plumage coloration of Tawny Owls is determined by heritable variation in pheomelanin expression, producing brown and grey morphs in varying frequencies across their Eurasian geographic range. These plumage differences have been associated with variation in immune response, aggression, and conversion of food to body mass. Previous studies within the genus *Strix* also suggest differences in life-history strategies between color morphs, including parental investment in offspring based on food availability. In this study, we investigate how color morph and food availability may affect both parental adjustment of offspring sex ratios in broods prior to egg-laying, and sex-specific condition of hatched offspring. Data on tawny owl physiology and reproductive behavior were collected annually during 2009-2019 in southern Finland, along with seasonal estimates of food availability. We found that, while there was no significant annual deviation from equal sex ratios at the population level, brood sex ratios varied significantly with timing of breeding. Late breeding is associated with poor food conditions, which suggests tawny owl parents adjust their brood sex ratios based on food availability. Additionally, this effect differed between parent color morphs, particularly among females: late broods of brown mothers were more male-biased, while the late broods of gray mothers were more female-biased. As females of this species are larger than males, they require more resources and are costlier for parents to raise. Brown offspring have been shown to be larger than gray offspring, and early-laid offspring were also heavier than late-laid offspring. Overall, we show that sex ratio adjustment occurs in the tawny owl and is dependent on female color morph and food availability. We suggest that morph-specific sex ratio adjustment may be adaptive, because it allows individuals of each morph to allocate reproductive resources to optimize the condition and survival of their offspring, which ultimately increases individual reproductive success.

## First Official Golden Eagle (*Aquila chrysaetos*) Aerial Survey for the Baja California Peninsula, Mexico

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### Abstract

The breeding population of Golden Eagles (*Aquila chrysaetos*) from Baja California was poorly known before the previous decade. In recent years, known nesting sites have been monitored to the extent possible, and a few new sites were identified through ground surveys during the 2019 - 2020 breeding season. Detailed ecology and reproductive data are available for multiple seasons from these surveys. Supported by GPS tracking of eagles, network analysis, and reproductive niche modelling, a protocol was developed for an aerial survey, resulting in a significant increase in the population data for the Baja California Peninsula. Including historic and new nest records from ground surveys, preliminary results indicate the aerial survey resulted in a 4.2-fold increase in nesting records; new records account for 76% of nests known in the north and center portions of Baja California Peninsula. Irregularities in habitat quality are of concern across most of the survey track including grazing and water supply. Seventy-three percent of nests had evidence of recent activity, 22% of nests were structurally sound but had no evidence of recent activity, and 5% of nests were degraded. The survey was conducted with ease, suggesting future aerial surveys are a practical method for surveying Golden Eagles in the Baja California Peninsula. Priority areas for future aerial surveys have been identified through findings, omissions, and habitat quality analysis.

## Peregrine Falcon Survival Rates Derived From a Long-term Study at a Migratory and Overwintering Area in Coastal Washington, USA

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<sup>4</sup>Coastal Raptors, Battle Ground, USA. <sup>5</sup>Touro University, Henderson, USA

### Abstract

After a well-documented recovery following substantial population declines throughout most of North America, the Peregrine Falcon (*Falco peregrinus*) was delisted under provisions of the Endangered Species Act in 1999. Post-delisting monitoring for the Peregrine Falcon involved surveys of breeding locations and did not specifically emphasize other metrics of population performances such as estimates of survival. We used banding data from Peregrine Falcons captured on the Washington coast during 1,212 vehicle surveys between 1995 and 2018 to assess apparent survival and resighting frequencies. Our mark-recapture data set included 226 Peregrine Falcons, 148 females and 78 males. A total of 14 Peregrine Falcons were recovered dead and another eight were found injured or uninjured and unable to fly due to illness or substantially soiled feathers. We had 744 resightings, 67.1% ( $n = 499$ ) by our research group during surveys (Group A) and 32.9% ( $n = 245$ ) by others (Group B). We found a dramatic increase in Group B contributions beginning in 2008 due to the emergence of digital camera use in wildlife photography and increased public awareness of our project. Between 1995 and 2018 we collected data that supported the estimation of apparent survival for three age classes: 0.4238 (SE = 0.0568) for hatch-year (< 1 yr old); 0.6634 (SE = 0.0663) for second-year (1 yr old), and 0.7382 (SE = 0.0295) for after-second-year (> 2 yr old). These longer-term data represented a more complete understanding of apparent survival in this population in comparison to data we previously reported from the period 1995 to 2003: an annual apparent survival estimate of 0.597 (SE = 0.054), which included no difference by age class. Our long-term mark-resighting analyses of overwintering and migratory Peregrine Falcons along the Washington coast provide evidence of a reasonably high level of apparent survival that suggests good population performance.

## Survival and Behaviors of Juvenile and Subadult Swainson's Hawks

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### Abstract

Swainson's Hawks (*Buteo swainsoni*) are migratory raptors that breed in western North America and winter in the Pampas of Argentina. Most research on this species has focused on reproduction, habitats, foraging, and populations, with relatively little research on migration or wintering ecology, and, importantly, there is a lack of information about the juvenile and subadult period, which lasts three to five years. We equipped 17 fledgling hawks with satellite transmitters to describe ecology and survival during their first years of life. We observed a post-fledging-dependence period of 19 to 79 days. After gaining independence, hawks spent time wandering the breeding range until migration. Young hawks migrated south at the same time as adults, and first migration attempts showed high variability in routes; most hawks that deviated from the primary route presumably perished before reaching the wintering grounds. Some first-wintering periods were spent at a location northwest of the primary wintering grounds of adult hawks. Hawks that survived the first winter used expected pathways and had lower mortality during future migrations. Young hawks left for the northward migration later and arrived on the summering grounds later than adults, possibly because they were not intending on breeding upon return. On summering grounds, hawks wandered and explored; one hawk appeared to establish a home range in third and fourth summers. Survival was lowest immediately following fledging, and first migrations were another common period for mortality. We never observed a breeding attempt among this sample, and therefore could not establish natal philopatry or dispersal.

## Risk of Swainson's Hawks Encountering Wind Turbines Across Their Global Range

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### Abstract

Wind energy is a known hazard for many avian species, with raptors being especially vulnerable due to flight characteristics, low fecundity, and small population sizes. Swainson's Hawks (*Buteo swainsoni*) are migratory raptors that inhabit regions of North and South America that may be prime areas for building wind energy facilities. However, little information exists regarding vulnerability of this species to wind turbine mortality, displacement, or other impacts. We equipped 41 adult and juvenile Swainson's Hawks with satellite transmitters and tracked them across multiple years; we compared transmitter data to locations of wind energy facilities to assess risk. We could not find reliable wind facility locations internationally, so we used satellite imagery to identify suspected and confirmable wind turbines throughout the migration route and wintering range. To further assess risk, we used transmitter and wind turbine locations to model resource selection and resource selection probability functions throughout the global range relevant to our sampled hawks. We found 26,258 wind turbines that might present a hazard to tracked hawks, with most turbine facilities being located on the breeding range. However, most hawk locations (90%) did not occur in collision-risk buffers, and those that did were also mostly (98%) on the breeding range; models agreed with the result that the breeding range presents the most significant risk from this industry. Swainson's Hawks have rarely been found dead at turbine facilities though, perhaps because of their hunting style (i.e., flights low to the ground, perching on the ground, and diving from perches) and adaptability to changing landscape conditions.

## Can Volcanic Ashes Affect Andean Condor (*Vultur gryphus*) Health Status?

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### Abstract

Volcanic eruptions can produce different health alterations in animals affected for both the emitted gases and deposited ashes. We evaluated whether the ashes generated by the eruption of Puyehue-Cordón Caulle in 2011 produced alterations in the health of the Andean condors that live in the geographical area most affected by the eruption. We studied different clinical and biochemical parameters of the Andean Condors before and after the volcanic eruption. The most common clinical alteration in the condors trapped after the volcanic eruption, was the presence of irritating pharyngitis, undetected in individuals captured before this event. In condors trapped after the eruption, blood levels of albumin, calcium, carotenes (xanthophylls and beta carotenes) and total proteins decreased. Andean Condors health resulted affected by the volcanic eruption and, therefore, the permanence in the affected area is associated with some specific costs that should be further evaluated. However, differently from that reported for wild and domestic mammals in which health alterations resulted serious and even lethal, condors suffered only minor alterations, possibly associated with a shortage of food sources.

## **Raptor Trauma Scoring System: A Decision Framework for Triageing Raptors in the Field**

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### **Abstract**

Wildlife professionals regularly interact with raptors in field settings, including live-trapping and handling birds for purposes of scientific collection, banding and marking, depredation mitigation, and other practices. Occasionally raptors are found with indication of a disease or injury, or they become injured during these procedures - leaving investigators or wildlife technicians unsure about how to effectively handle the situation. Is the injury such that the bird should be released (with or without minor treatment), transported for veterinary care and rehabilitation, or euthanized? Besides regulatory issues and permit restrictions, what is in the bird's best interest (i.e., what is most humane)? Trauma scores are commonly used in human and veterinary medicine to predict patient outcomes. Similarly, species-specific health scorecards can help livestock managers and pet owners determine if or when to seek veterinary care for their animals. We developed a Raptor Trauma Scoring System, which uses both pictures and text to describe the most common traumatic injuries with discriminating criteria for grading the extent of injuries and prognoses. This guide can help personnel triage raptors in the field and allow them to determine whether to release, transport, or euthanize a bird. Coupled with training in the recognition of common injuries and illness, basic wound care and bandaging, and best practices for transportation or euthanasia, wildlife professionals can be better prepared for unforeseen situations, have confidence in their decision making and overall improve the welfare of raptors.

## Acceptance type: Symposium

### American Kestrels

184

#### **Proposed Collaborative, Continental-wide Study Framework to Elucidate the Population Demography and Ecology of the American Kestrel Full Annual Cycle**

JAMES C BEDNARZ, KELSEY S BILES

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#### **Abstract**

Most studies on raptor migratory and wintering ecology are initiated when a biologist, who has an interest in these subjects, identifies a local research opportunity. For example, a local biologist interested in raptors discovers a nearby “leading line” or landscape configuration that concentrates migrating hawks may initiate a hawk count and implement other studies to address migration questions. Although sometimes productive, in a sense, this approach to identifying study areas and research questions may not be the most efficient process to addressing continental-wide research challenges. One contemporary challenge that faces raptor biologists is the understanding of the population dynamics of the full annual cycle of the American Kestrel (*Falco sparverius*). U.S. survey-wide Breeding Bird Surveys have demonstrated a relatively steady decline in kestrel populations of 52% from 1966 to 2019. Although the kestrel is still a common species, this long-term, near-continental-wide decline is seriously concerning. Rather than the helter-skelter approach used in the past employed to attempt to answer continental-wide ecological questions and infer avian annual cycles, we propose a designed research framework targeted at potential study locations where wintering American Kestrels are concentrated. To develop this proposed collaborative study framework, we used eBird data to identify winter locations where abundant populations of kestrels occur. Because regional differences occur in geomorphology and ecophysiological selective factors, we propose that latitudinal studies of wintering kestrel populations be implemented in each of the four flyways. Within each recognized North American flyway, we then identified three latitudinally-separated locations that supported abundant wintering kestrels by comparing maps of breeding and non-breeding abundance. We propose that interested collaborators based near these target winter concentration areas consider initiating wintering and migratory kestrel studies to help answer a suite of demographic and ecological questions that would enable us to elucidate key factors that drive continental-wide population dynamics.

## Apparent Survival of Wintering American Kestrels in North Texas

KELSEY S BILES<sup>1,2</sup>, JEFF A JOHNSON<sup>3</sup>, SARAH E SCHULWITZ<sup>2</sup>, JAMES C BEDNARZ<sup>1</sup>

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### Abstract

Despite the American Kestrel (*Falco sparverius*) being one of the most extensively monitored raptor species in North America, the cause of their observed decline remains unknown. One possible explanation for the kestrel decline that has received limited attention concerns increased mortality during the nonbreeding season. In our study, we estimated apparent survival of American Kestrels in North Texas during the nonbreeding season using mark-resight methods. We marked kestrels across the winter from December 2016 to December 2020 ( $n = 205$ ) with anodized color bands that had unique 2- or 3-character codes, which enabled individual identification across multiple years. We searched for banded kestrels during re-sighting surveys from November 2017 to March 2021. Encounter histories were analyzed using Cormack-Jolly-Seber models in Program MARK. We estimated monthly apparent survival during the winter to average 95.0% from 2018 to 2021, and annual apparent survivorship at 80.2% across 4 years. However, our monthly apparent survival rate may be negatively influenced by the presence of transient birds who do not hold a winter territory. For two winters, 2018-2019 and 2019-2020, we estimated average monthly apparent survival to be 96.4% and annual survival for the following years to average 77.8%. This discrepancy suggests that kestrels may be suffering a higher annual mortality rate during the migratory and breeding periods. Additionally, an analysis of morphometric data collected from these kestrels during banding showed annual return rates were significantly negatively related to the presence of fault bars on their tail feathers at the time of capture. These fault bars, which are caused by stress factors when the feathers are growing, only accrue during the summer when the birds are growing rectrices and do not reflect winter stresses. Our data suggest that annual survival of American Kestrels in North Texas may be most depressed outside of the winter season.

## The American Kestrel: From Common to Scarce

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### Abstract

Peruse any popular book or booklet on North American birds of prey written twenty years ago and you are apt to read the words “widespread and numerous” or “most common” as descriptors for the American Kestrel (*Falco sparverius*). In his 1982 book, *The Falcons of the World*, Tom Cade estimated there to be more than 1.2 million pairs of kestrels breeding in North America. Now, 36 years later, it would be interesting to know whether such an estimate would still be accurate. Over the last three decades, many managers of long-term nest-box programs for kestrels in North America have noticed disturbing declines, not in the productivity, but in the numbers of nest boxes occupied by kestrel pairs. However, not all kestrel populations seemed similarly afflicted, e.g., those in Idaho, Oregon, and New York City. There is no shortage of interesting hypotheses for the cause of the decline, which are by no means mutually exclusive. Some of the more prominent ones include predation pressure from larger raptors, e.g. Cooper’s Hawks (*Accipiter cooperii*); diseases such as West Nile virus; competition with introduced cavity-nesters like European Starlings (*Sturnus vulgaris*); impacts of poisonous chemicals such as brominated flame-retardants, selenium, and rodenticides; strikes by aircraft at airports; and more subtle, widespread changes in habitats and/or invertebrate prey availability due to climate change. This presentation will provide the latest figures on population trends, assess the various hypotheses, and conclude with a discussion of what can be done and what is being done to stem the decline. One thing is for certain—American Kestrels can be easily bred in captivity for release programs. Let us hope that it does not come to that.

## The Role of Food Quantity and Quality in Nestling Development of American Kestrels (*Falco sparverius*)

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<sup>1</sup>Penn State Altoona, Altoona, USA. <sup>2</sup>Cedar Crest College, Allentown, USA. <sup>3</sup>Hawk Mountain Sanctuary, Orwigsburg, USA

### Abstract

Nest-box programs with long-term monitoring data have reported steady declines in occupancy of adult American Kestrels (*Falco sparverius*). However, fledging success of nest-box-breeding pairs remains relatively high. This suggests that quality of successfully fledged chicks may be lower than necessary to replace adults. Ecological conditions that lead to optimal nestling development, especially physiological development, remain understudied. Because a possible cause of decline in the American Kestrel is linked with a reduction in food supply (prey availability) via a reduction in habitat and the potential application of pesticides, we investigated how diet during the nestling period might determine nestling maturity just prior to fledging. Here we assess how components of nest environment (breeding phenology, brood size, nestling sex ratio) and diet metrics (diet diversity, percentage of prey types, rate of prey biomass delivery per chick) interact and relate to nestling maturity (mass, tarsus length, wing length, hematocrit, hemoglobin concentration). We hypothesized that: 1) components of nest environment such as breeding phenology would influence inter-nest diet variation; and 2) quantity of food would be more important than quality in determining nestling maturity. Chicks were measured for morphological and physiological development in combination with recorded food delivery and diet. Results show higher insect biomass in the diet for later season nests, although we found no consequence on nestling quality. Nests with more specialized diets had higher quality chicks, however, no specific prey type was predictive of nestling maturity. Instead, total prey biomass per chick was more predictive of maturity than prey type. Additionally, we attempted to test this relationship by increasing food quantity by providing feeder mice in a food-supplementation experiment. Our findings indicate the importance of evaluating individual variation and sexual differences in diet specialization in an ecological and evolutionary context.

## Results of a Nest Box Monitoring Project for American Kestrels (*Falco sparverius*) at the Top of the World: 2002-2020

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### Abstract

Research suggests that American Kestrel populations have declined in recent decades in parts of North America. Understanding the biology of peripheral populations of raptors can be important when establishing long-term conservation practices for a species. Little is known about American Kestrels at the northern extreme of their range, we placed boxes in northern Alaska and monitored their use by kestrels from 2002-2021. We placed the boxes on trees along the Dalton Highway, north of the Arctic Circle and within the Brooks Mountain Range. The number of nest boxes we monitored varied from 14 in 2002, to  $\pm 26$  in subsequent years. The variation was due to the destruction of some boxes by wildfire, animal predators, and/or human disturbance. Nonetheless, we monitored nest boxes a total of 474 box-years during the study. Kestrels competed for available nest boxes with Boreal Owls (*Aegolius funereus*), which nest earlier, red squirrels (*Tamiasciurus hudsonicus*) and rarely, Hymenoptera or Anatidae. Percent annual occupancy of available boxes by kestrels (2002-2021) ranged from 17.4 - 82.4% (mean =  $46.0 \pm 4.0\%$  SE). Clutch size ranged from 1-7 (mode = 5). We observed kestrels in the study area as early as 28 March but have no information on average arrival dates. Egg-laying generally occurred in the latter part of May-early June, hatching in late June, and fledging about mid-late July but we observed variability in nesting phenology among years. We use TreeNet, a stochastic gradient boosting algorithm to describe the potential influence of weather and other environmental factors on nesting parameters of American Kestrels in the Arctic environment.

## Winter Ecology of American Kestrels in South Texas

CARTER G CROUCH<sup>1,2</sup>, ROBERT H BENSON<sup>3</sup>, LEONARD A BRENNAN<sup>1</sup>, ERIC D GRAHMANN<sup>1</sup>

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### Abstract

American Kestrels (*Falco sparverius*) are North America's most abundant falcon, but they are declining throughout much of their range. Understanding kestrel demographics and ecology throughout their annual cycle is important to understanding this decline. For this study, we estimated apparent survival, site-fidelity, and territory size of wintering kestrels and documented roost site use of these non-breeding birds. We trapped and color-marked 65 kestrels, and we re-sighted birds once a week from September-March over three winter seasons (2014-2017). We documented roosts and behavior around roosts through observations of color-marked and unmarked birds. We used Cormack-Jolly-Seber (CJS) to estimate winter survival (20-week) as  $67.1 \pm 7.1\%$  for kestrels in the winter they were marked and  $84.4 \pm 6.3\%$  for kestrels in returning winters. The 2-yr average apparent winter site fidelity was 27.8% for males and 50.2% for females, and the 2-yr average adjusted winter site fidelity was 41.7% for males and 65.7% for females. The linear average territory size was  $\leq 738 \pm 74$  m across the three winter seasons. Our estimates of site fidelity are 12-15% greater than previously reported, and our linear winter territory sizes (pooled over 3 yr) were less than half the size of those previously reported for wintering kestrels. We identified 50 roost sites in shrubs, trees, buildings, petroleum and farm equipment, and electrical structures. Roost sites varied greatly in the level of concealment and exposure. Small territories and high winter site fidelity suggest that South Texas agricultural areas are likely an important region for wintering kestrels. However, because we observed aggression around roost sites, communal roosting, and roosting in sites exposed to weather and predators, we speculate that roosting sites suitable for kestrels may be limited or poorly dispersed in this agricultural landscape.

## Ten Years of Participation Trends in the American Kestrel Partnership

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### Abstract

Operated by The Peregrine Fund and launched in 2012, the American Kestrel Partnership (AKP; [kestrel.peregrinefund.org](http://kestrel.peregrinefund.org)) is a program with a mission to uncover the causes of decline of American Kestrels (*Falco sparverius*). The program enlists members of the public (“community scientists”) as well as professional scientists to contribute data that may help the research community to better understand causes of decline. Program staff invest considerably in recruiting partners, fostering an understanding of kestrel biology and conservation, and communicating nest installation and monitoring protocols. The goal of such investment in communications is to develop partners committed to monitoring the same nest boxes in a consistent manner across multiple breeding seasons and to contributing high quality data that may be used by the research community to answer various questions related to kestrel conservation. Thus far, AKP partners have contributed to multiple studies that are helping to uncover the picture of kestrel decline. For example, partner data has contributed to findings of important patterns in lay date and nest success by regions across the continent. However, one challenge we have found in managing such a program is retention of partners contributing high quality data over multiple years. We analyzed 10 years of data (2012-2021) contributed by partners to quantify patterns in retention and protocol adherence, specifically looking at box installation (initial input) and monitoring over time (longer commitment). We found that partners set up boxes generally in line with protocol. However, partners generally cease monitoring at similar rates after enlisting. Partners with greater initial investment (i.e., more registered boxes) monitored their boxes longer. In applying these findings, we suggest to other program managers to avoid asking for long-term commitment in community science projects, when possible. Alternatively, if long-term commitment is needed, managers may consider approaching sustaining groups (e.g., Audubon chapters) rather than individuals.

## Creating a Genetically Explicit Individual-based Model to Understand Climate-driven Laydate Shifts in American Kestrels (*Falco sparverius*)

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### Abstract

To conserve biological diversity in a changing world, managers must understand which species are vulnerable to the effects of climate change and whether there is sufficient capacity for these species to adapt. This is especially applicable to birds, who may experience changes in phenology (e.g., the timing of migration and/or breeding) in response to shifts in annual growing seasons and resource availability. Individual-based models (IBMs) provide a method to forecast phenological shifts using empirical data that is representative of risk exposure (e.g., climate projections), species sensitivity (e.g., long-term demographic data sets), and adaptive capacity (e.g., genetic data). Here, we integrate an IBM with long-term demographic data sets, climate models, environmental spatial layers, and genetic markers (single nucleotide polymorphisms, or SNPs) affecting circannual rhythms to explore shifts in laydate in American Kestrels (*Falco sparverius*). Through this research, we have identified important considerations for integrating SNPs into IBMs, including the assessment of trait heritability, linkage, and additive genetic variation. Results indicate that putatively functional SNPs have a small effect on laydate over time, but select markers experience large shifts in allele frequencies in response to climate change. This work provides methodological approaches for integrating genetic and ecological information into models that simulate both evolutionary and ecological processes, which is an important advancement for understanding and predicting population responses to environmental change.

## Insights and Challenges in Tracking the Migration of North America's Smallest Falcon, the American Kestrel

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### Abstract

Variation in migratory strategy and population trends across the American Kestrel (*Falco sparverius*) range creates a unique opportunity for comparative research. However, as a widespread and highly mobile species, it is logistically difficult to track individuals across the full annual cycle. Despite recent miniaturization of tracking devices, there is little available published data on their efficacy for, and impacts on, this species. We tagged American Kestrels with light-level geolocators or satellite transmitters, and used data from both device types to estimate migration timing and connectivity. We assessed reliability of recovering geolocators or receiving locations from transmitters. Lastly, we monitored tagged individuals during the breeding season to assess impacts on behavior, nesting success, body condition, and tag condition. We successfully tracked three tagged (one geocator and two transmitter) individuals that nested in three distinct areas: Idaho, Alberta, and presumably the Great Lakes region, and wintered in New Mexico, Nicaragua, and Texas, respectively. We recovered geolocators from six of 49 (12%) individuals, five of which did not migrate. Location information had a high amount of error, likely because of cavity use for roosting. We obtained migratory tracks from two of 22 (9%) individuals with transmitters, while the remaining transmitters failed prior to migration. In-person monitoring and nest-box images revealed that transmitters failed on live birds despite adequate battery levels and no visible damage. Individuals tagged with either device type had similar nest success to non-tagged individuals, and there was no evidence of tags causing harm to birds. Although geolocators provide a low-cost alternative to transmitters, low recovery rates and shading effects caused by cavity use make this method of tracking imprecise for this species. Transmitters can potentially provide informative migration tracks, however, because of high rates of failure of unknown cause, further testing is imperative before more of these tags are deployed.

## Why the American Kestrel (*Falco sparverius*) has a low success in natural nests? A study case in Argentina.

FERNANDO G LÓPEZ<sup>1</sup>, PAULA M OROZCO-VALOR<sup>2</sup>, IGOR BERKUNSKY<sup>3</sup>, JUAN M GRANDE<sup>1</sup>

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### Abstract

Reproduction is the most important process in the life of any given species as it allows the persistence of its populations. The availability and quality of nesting sites, predation rates, inter/intraspecific competition and climatic factors among others are key factors to understand how species breeding success is shaped. The American kestrel (*Falco sparverius*) is a secondary-cavity-nester. They can adopt cavities on trees or artificial nest-boxes, but sometimes use nests of Monk Parakeets (*Myiopsitta monachus*) or Brown Cachalotes (*Pseudoseisura lophotes*). Since 2016, we followed 68 American kestrel natural nests (between 20/25 per year; 13 on cavities, 2 on Brown Cachalote nests, and 53 on Monk Parakeet nests) and 21 nest boxes (per year) in semiarid forests of central Argentina. The probability of breeding successfully was lower in natural nests (27%) compared with nest boxes (54%). Among natural nests, only breeding attempts in monk parakeet nests were successful (2016/17=20%, 2017/18=33%, and 2018/19=30%). Pairs breeding in natural nests had smaller clutch sizes than pairs breeding in nest boxes ( $2,4 \pm 0,1$  vs.  $4 \pm 0,1$ ) and a smaller number of fledglings ( $1,6 \pm 0,1$  vs.  $3,4 \pm 0,2$ ). Our results suggest that the presence of parakeet nests is critical for the breeding success of Kestrels using natural nests in our study area. Nest-boxes can help to reinforce the kestrel population in our study area, however, the effects of such reinforcement in other species should be carefully analyzed. Further research would be needed to disentangle this different apparent selection of nesting sites.

## **Rapid Urbanization Alters Winter Abundance and Sex Ratio in the American Kestrel (*Falco sparverius*)**

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### **Abstract**

Urbanization has become increasingly prevalent, leading to the continual conversion of natural habitats into human-dominated landscapes. Habitat conversion typically results in altered prey diversity and abundance, modified land cover, and increased human disturbance, all leading to habitat degradation for several species. Areas witnessing rapid urbanization allow us to investigate the direct effects of urbanization on species at the individual and population level within feasible time frames. We quantified overwintering abundance and sex ratios of the American Kestrel (*Falco sparverius*) throughout the past three decades in a rapidly-developing region of its wintering grounds in southeast Florida to elucidate spatial and temporal population trends. We discovered directional shifts in abundance leading to fewer individuals inhabiting the most developed areas. Sex ratios also significantly shifted from predominantly female to equally male:female over time, suggesting decreasing habitat quality in this sexually dimorphic species. These results suggest that urbanization has negatively impacted American Kestrels overwintering in Florida and could be a factor at play in the overall declining population trends.

## Diet and Breeding Success of American Kestrels in Natural and Agricultural Lands in Central Argentina

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### Abstract

Agricultural expansion and intensification can alter food provisions for birds and have negative consequences on their diet and breeding performance. The American Kestrel (*Falco sparverius*) is one of the commonest birds of prey across its breeding range. Recent evidence indicates that they are declining in areas of North America, and the effects of agricultural intensification are one of the studied candidate factors. In Argentina, where intense agricultural intensification has taken place over the last decades, the species occurs throughout the country primarily in areas of agroecosystems. We analyzed the diet of American Kestrel nestlings and species breeding performance across native forest, traditional farmland, and intensive farmland. We found no differences in diet diversity but did find differences in composition. Diet was dominated by arthropods in all three areas, with Orthoptera and vertebrates found more frequently in native forest. Diet was complemented by other groups of arthropods in both agricultural areas, suggesting that changes in land use generate a functional response in the American Kestrel's diet. The extension of pastures surrounding nest boxes had positive effects on the probability of breeding success, while climatic variables had strong effects on the species breeding timing, productivity and probability of breeding success. Our results highlight the relevance of pastures and grasslands for American Kestrel reproduction. These environments are the most affected by land-use change to intensive agriculture in Argentina indicating a potential large-scale effect on the species breeding output. Long-term analysis of diet variation in relation with land-uses and its effects on breeding performance may shed light on the way through which agricultural intensification shapes American Kestrels' reproduction.

## Drivers and Patterns of Individual Migration Strategies in a Partially Migratory Population of American Kestrels (*Falco sparverius*)

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### Abstract

Migration, or the seasonal movement of organisms from one location to another, is a significant and often recurring event in an animal's annual cycle. Partially migratory systems provide an excellent opportunity to study the evolutionary ecology of seasonal movement and the trade-offs of different migration strategies because they allow comparison between residents and migrants living in similar breeding environments. For many species, we do not know why some individuals migrate and others remain resident during the winter. Additionally, it is often unclear whether these strategies shift on an annual basis. We used stable hydrogen isotope ratios extracted from claw samples to assign individual migration strategies to American Kestrels breeding in the Treasure Valley, ID from 2013-2021 to address these gaps in our understanding. We examined whether sex, mass, or winter weather conditions interact to influence whether an individual migrates or overwinters on their breeding grounds. Additionally, we examined whether individuals can switch migration strategies on an annual basis, and whether the proportion of residents has increased in the Treasure Valley. Results from this study will advance our understanding of partial migration and how it operates in American Kestrels. More broadly, results will improve our knowledge of how ecological conditions are interacting to influence the migration patterns and phenology of migratory birds.

## A Potential Role for Intraguild Predation in the Observed Decline in Kestrels?

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### Abstract

Among the various hypotheses brought forward to explain the ongoing population declines in American Kestrels (*Falco sparverius*) across North America over the last decades, intraguild predation by larger raptors has been suggested as a possible mechanism. For generalist predators such as accipiter hawks, whose population size is influenced by the total sum of prey and not by a shortage of any one particular species, intraguild predation could have considerable population impacts on less common species that are preyed on, such as the American Kestrel. Indeed, diet studies of Cooper's Hawks (*Accipiter cooperii*) indicate that the American Kestrel falls within the range of prey taken by this species. Although intraguild predation has been shown to have significant importance for population dynamics of some avian predators, the phenomenon has received little consideration to explain observed population declines in raptor species, especially on a continental level. We used a long-term citizen database (Christmas Bird Counts) across all contiguous 48 United States and 10 Canadian provinces over the 1970-2015 period to correlate population trends of American Kestrels and Cooper's Hawks. In addition, we used telemetry tracking on kestrels around Hawk Mountain Sanctuary (Pennsylvania) to assess survival rate and cause(s) of mortality during the non-breeding season. The measured winter survival rate was low (0.61) and avian predation was the main cause of mortality for American Kestrels. Cooper's Hawks were the raptor most frequently observed interacting with kestrels, and they were seen in the wintering areas of 68% of our tracked birds. We also found a negative relationship between Cooper's Hawk population trends and American Kestrel population trends during winter across North America. These results suggest that Cooper's Hawks may be competing with and directly predating American Kestrels, reducing their survival rate and negatively impacting their population dynamics.

## The Influence of Habitat Heterogeneity on Breeding Success of the American Kestrel (*Falco sparverius*)

RICHARD W VAN BUSKIRK

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### Abstract

Trends in American Kestrel (*Falco sparverius*; hereafter kestrel) populations in North America show significant geographic variation that complicates the determination of causal factors. For example, in some regions habitat loss appears to be a significant factor, while in other areas interactions between climate change and migration timing may play a crucial role in explaining downward trends. The northern Willamette Valley of Oregon presents opportunities to explore habitat use by kestrels in a region where the impacts of climate change have thus far been relatively modest. The agricultural landscape surrounding the metropolitan urban growth boundaries remains heterogeneous, with a mixture of annual and perennial crops. In addition, remnant native bottomland riparian forests are interspersed throughout the cultivated regions. Kestrels make ready use of this varied landscape, employing nest boxes, human structures and natural cavities for breeding. Through nest box monitoring, VID banding and radio telemetry, our team has begun to investigate relationships between territory composition and nesting success. We plan to implement a fine-scale Motus automated telemetry array to triangulate the flight paths of foraging parents along with prey delivery monitoring using motion-activated cameras in order to explore the relationship between territory use, habitat quality and reproductive success.

# Archaeological Research

225

## The Human-Raptor Relationship in Prehistoric Chaco Canyon, NM

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### Abstract

The archaeological record of the US Southwest contains tantalizing clues to how people of the past valued and interacted with raptors. Both the archaeological record as well as ethnographic studies of present-day and historic Pueblo groups in NM and AZ suggest that for a long time, raptors have been important in ceremony and ritual, and that their feathers were used in the manufacture of many ceremonial objects. In this paper, I discuss the human-raptor relationship among Ancestral Pueblo peoples living in Chaco Canyon, NM, which between 800 to 1200 CE developed into the center of a major regional cultural system that included the construction of many large masonry pueblos. By examining the skeletal remains of raptors from multiple archaeological sites and the contexts of their deposition, I suggest that the inhabitants of Chaco Canyon valued multiple local raptor species as some of the most ceremonially significant of all birds. Hawks, eagles, kestrels, owls, and vultures are well represented in the avifaunal assemblage, which includes many interments of complete individuals or special parts—including wings, legs, feet, and heads. Special deposits of large quantities of wings and legs were placed in pits or sealed in rooms, reflecting an interest in these parts as ceremonial paraphernalia or for use in ceremonial costuming. Relative to other types of birds (e.g. ravens, quail, bluebirds, jays, and others) represented in the Chaco avifaunal assemblage, raptors would have been some of the most challenging to physically locate and procure. Today, raptors have important symbolic associations among modern Pueblo groups, relating to the sky, the sun, and hunting. The avifaunal assemblage of raptor bones from Chaco Canyon suggests that its inhabitants pursued the capture of birds who, either as complete birds, parts, or feathers, were considered worth the effort of acquisition.

## Falconry on Anglo-Saxon England—Evidence from Middle Saxon Brandon

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### Abstract

Brandon is a high status Middle Anglo-Saxon (ca. 650-850 CE) site located in the on the edges of the Fenland in the northwestern corner of the County of Suffolk (UK). Large scale excavations were carried out at the site between 1980 and 1988, and the excavations yielded a large quantity of bird and mammal bones. Most of the avian assemblage consisted of the remains of domestic chickens and geese, along with smaller numbers of water birds and waders. The avian assemblage also included the nearly complete skeleton of a female peregrine falcon (*Falco peregrinus*). This paper will address the implications of this find for our understanding of early medieval falconry. The paper will also briefly address the conservation status of peregrine falcons in eastern England today.

## Individuals from Isotopes: Can Stable Isotopes Distinguish the Skeletal Remains of Individual Cooper's Hawks (*Accipiter cooperii*)?

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### Abstract

The history of archaeology is filled with attempts to identify how individual animals were used by past humans. However, traditional zooarchaeological techniques designed to trace individual animals with skeletal remains have faced serious methodological difficulties. The analysis of stable isotopes could offer one cost-effective way to track individual animals in the past. Stable isotopes help reveal the feeding ecology of animals and can quantify an individual's niche. Defining isotopic niche variation within and between individual animals could help differentiate them in the past. Here, we measure  $\delta^{13}\text{C}$ ,  $\delta^{15}\text{N}$ , and  $\delta^2\text{H}$  of bone collagen from multiple skeletal elements and the soft tissues of 20 modern Cooper's Hawks (*Accipiter cooperii*). We highlight the causes of skeletal isotope variation, show how reliably individual Cooper's Hawks separate in isotope space, and detail how this information is useful for archaeology and the historical ecology of raptors around the world.

## **Human-raptor Engagements in Deep-time: From European Neanderthals to Early Agriculturalists in the Dutch Lowlands**

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### **Abstract**

Raptors are iconic diurnal birds of prey who often play pertinent roles in human cultural practices and as apex predators of the sky supply critical ecosystem functions and services. Falconiformes and hominins share a long evolutionary history and diurnal birds of prey have co-inhabited the landscape with humans for many thousands of years. Even though the significance of birds, including raptors, in early human evolution has recently been re-appraised, archaeological studies of human-raptor relationships often retain problematic nature-culture polarities and foreground the role of raptors as a food and feather extraction resource or as a projection of human symbolism. This paper presents an alternative approach to past human-raptor interfaces focusing on multifaceted constellations of raptor-related material and cultural productions, and the ethology and ecosystem-behaviour of large diurnal birds of prey. Drawing on symbolic ecology and recent developments in multispecies studies as well as post-humanist theory, human-raptor intersections are examined and compared across three paradigmatic case studies: (i) the entanglement of raptors and hyper-carnivorous Neanderthals in Pleistocene Europe, (ii) the role of diurnal birds of prey in complex forager societies from the Epipalaeolithic Mediterranean Levant, and (iii) the engagement of raptors and late Mesolithic and early agricultural societies in the Dutch Lowlands. These examples not only illustrate the situated nature of the human-raptor nexus and the many benefits of exploring human-raptor relations from a deep-historical perspective, they also showcase that human-raptor interfaces are always co-moulded by ecological factors and human sociocultural practices. Raptors and humans are part of dynamic multispecies assemblages and their relationships depend on the possibilities created by the needs, agential qualities and ecosystem roles of both actors. Archaeological research offers the opportunity to map these relationships and the logic underpinning them through space and time, hence furnishing important resources for rethinking human-raptor relations today and in the future.

## **Becoming Birds in the Near Eastern Neolithic: Humans and Vultures at Çatalhöyük, Turkey**

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### **Abstract**

Human interactions with raptors stretch back into deep prehistory, with Neanderthals seeking out scavenging raptors, including vultures, for their feathers. In the Near Eastern Neolithic, at the time of the first farming in the early Holocene, vulture depictions and to some extent vulture remains link these birds to death and the afterlife. I use the bird remains and artistic corpus from Çatalhöyük in central Anatolia, a large settlement occupied for ca. 1000 years during the Neolithic, to examine human-vulture relations, set in the broader context of bird remains and art from other Near Eastern Neolithic sites.

Sites with well-studied bird assemblages show targeted selection of vulture body parts: mostly wings and/or feet, often found in special deposits rather than ordinary trash. At Çatalhöyük, the focus is on vulture feet, including a collection of four articulated feet in a storage room and a talon placed on the chest of a human body in a grave. This pattern argues not only for symbolic meaning attributed to vultures but use of their body parts as costumes or paraphernalia in ceremonies. I suggest that the mimesis experienced in embodying vultures in dance formed part of an identification of humans with vultures seen also in the art, where humans and vultures blend, intertwine, and interact. The role of actual vultures in human funerary practices at Çatalhöyük remains unresolved, but imagery of vultures with headless humans at Çatalhöyük and elsewhere link them to a widespread belief in a power or soul that resided in human and animal heads (including a vulture head at Çatalhöyük) even after death.

## The Antiquity of Raptor Migrations over Eilat (Israel): Evidence from the 8th Millennium BC Site of Nahal Roded 110

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### Abstract

Israel lies on one of the major spring/autumn migration routes for Palearctic raptors. Over thirty-five raptor species pass over the southern city of Eilat today. This research describes the raptor assemblage excavated from a historic site where raptors were hunted. Nahal Roded 110 was dated to 7100-7300 cal BC, and part of a larger cluster of mostly unexcavated mountain cult sites. While 5-10% of bird remains on most Neolithic sites represent raptors, at Nahal Roded 110 raptors comprise 100% of the avifauna, with few bones of other animals present. At this site, a total of 581 raptor bones were identified to species and body part, and represent a minimum of thirty-three individual birds. Both diurnal (96.5%) and nocturnal raptors are present. The dominant raptor taxa are 64% Black Kite (*Milvus migrans*) and 19% Honey Buzzard (*Pernis ptilorhynchus*). Other raptors each representing <4.5% of the assemblage are: Long-legged Buzzard (*Buteo rufinus*), Pallid Harrier (*Circus macrourus*), Eagle Owl (*Bubo bubo*), Sparrowhawk (*Accipiter nisus*), Lesser Spotted Eagle (*Aquila pomarina*), Golden Eagle (*Aquila chrysaetos*), Buzzard (*Buteo buteo*), Hobby (*Falco tinnunculus*), and Long-eared Owl (*Asio otus*). Considerable attention was placed on raptor capture and processing with cutmarks on Honey Buzzard and Black Kite bones. The placement of cutmarks are related to meat procurement as well as feather and talon removal (for personal adornment); however, the majority of cutmarks are transverse slices through the shaft of the bones, which may represent one of the steps in bead manufacture. We will discuss: (i) the frequencies of the site's raptor taxa relative to their representation in current migrations, (ii) available data relating to the season of site use, and (iii) the role of raptors in Neolithic culture.

## **Animal Management and Sacrificial Power: Using Ancient Genomics to Study Golden Eagle (*Aquila chrysaetos*) Sacrifice in Teotihuacán**

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### **Abstract**

Excavations of the Moon and Sun Pyramids (1998-2004) at Teotihuacán (1-500 AD) have yielded both human and animal sacrifices, interred as part of state rituals. These rituals demonstrated the power of the state, and the species chosen reflected that power, being primarily large predators. Isotopic and zooarchaeological analyses of the sacrificed animals show that some of them were held for extended periods of time before their deaths—they have skeletal lesions associated with restraints and evidence of maize based diets—while others were sacrificed fairly quickly. We conducted genomic analysis on Golden Eagle (*Aquila chrysaetos*) remains that were sacrificed and interred in Teotihuacán to determine the relationships among sacrificed individuals and to compare them with extant populations. We also tested different library preparation techniques in order to maximize DNA yields from degraded samples. Despite low DNA yields, single stranded library preparation methods improved molecule recovery for most samples. These data provide insight into how the eagles were procured and managed before sacrifice as well as into ancient Mesoamerican Golden Eagle populations. By investigating the resource cost for obtaining and keeping these animals for sacrifice, we can improve our understanding of how ancient Mesamericans interacted with them. Additionally, this ancient population data can improve our understanding of past and present genomic diversity, and can be used to assess ongoing conservation efforts for Golden Eagle populations. These techniques developed for ancient DNA can also be applied to degraded or low yield modern samples, such as feathers, reducing the need to capture wild eagles for population assessments.

## **'The Hawk in Hand': The Art and Archaeology of Falconry in Early Medieval England.**

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### **Abstract**

This paper examines the evidence for human relations with raptors in early medieval England, focussing on falconry and its role in social and religious change. It begins by discussing the preponderance of raptors in Style II art, especially the 'crouching bird of prey' motif which, among other images of top predators, indicates that early Anglo-Saxon warrior-leaders aligned themselves with these creatures in an ideology of predation. It then considers the faunal remains of birds of prey and finds of small copper-alloy bells which, alongside hawk-with-preys motif in visual culture, suggest that falconry emerged as a high-status hunting pursuit in the late sixth century. The juxtaposition of 'pagan' and 'Christian' elements on the 'northwest Essex Anglo-Saxon ring', which may show a falconer with a Style II raptor upon the fist and another in flight wearing falconry equipment, presents supporting contemporary evidence which suggests that falconry and falconry birds may have played important roles in the dynamics of pagan-Christian 'discursive space'. The possible image of a falconer on the Bewcastle Cross offers an important if contested analogy from the middle Anglo-Saxon period. Archaeological finds of high-status 'falconry graves' in Scandinavia and Central Europe provide wider contextual support for the importance of raptors and the practice of falconry in early medieval England. These diverse strands of evidence indicate that human engagements with raptors were a significant element of human-animal relations in early medieval England, with falconry in particular being highly revealing about how people related to one another and their wider-than-human world.

## The Fossil Remains of Raptor Meals and Their Implications for Past Environments: An Example from Paleolithic Germany

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<sup>3</sup>Institute for Early Prehistory and Quaternary Ecology, University of Tuebingen, Tuebingen, Germany

### Abstract

Today, and in the past, humans and raptors use the same locations to eat, seek shelter, sleep, and raise their young. This is particularly true for caves and rock shelters, where the remains of both raptor and human activities of the past have been preserved in the fossil record. We present a study using data from a rock shelter site in the Lone Valley of southwestern Germany, called Langmahdhalde, which dates to the Last Glacial Maximum (~18,000-11,600 yrs ago; during the Paleolithic). This talk shares how the remains of raptor meals, e.g., the bones and teeth of rodents and insectivores, from the site can be used to reconstruct the environmental conditions throughout the past occupation of the rock shelter. Further, we discuss characteristics of the remains that can indicate the type of raptor(s) that deposited the assemblage. In our example, we find that environments were more heterogeneous than previously expected and likely included patches of trees. We also find that the remains were deposited predominately by several species of owl, including the Eurasian Eagle-owl (*Bubo bubo*), Tawny Owl (*Strix aluco*), and Great Grey Owl (*Strix nebulosa*). Based on the hunting ranges of these species, maximum 70 km<sup>2</sup>, we characterize this environmental reconstruction as local to the Lone Valley. We suggest that the environmental diversity of the valley made it more attractive to humans who were returning to Central Europe after the height of the Last Glacial Maximum and that this diversity has implications for how raptors used the landscape. We conclude by suggesting ways that this research can inform biology and by highlighting what knowledge these types of archaeological studies require from biologists.

# Barred Owls

62

## Diet Composition of Barred Owls (*Strix varia*) across the Range of the Northern Spotted Owl (*Strix occidentalis caurina*)

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University, Corvallis, USA. <sup>3</sup>Ornithology and Mammalogy, California Academy of Sciences, San Francisco, USA. <sup>4</sup>Wildlife Department, Hoopa Tribal Forestry, Hoopa, USA. <sup>5</sup>U.S. Geological Survey, Forest and Rangeland Ecosystem Science Center, Corvallis, USA. <sup>6</sup>US Fish and Wildlife Service (retired), Lacey, USA

### Abstract

The recent range expansion and invasion of Barred Owls into the Pacific Northwest necessitates understanding their diet to inform competition mechanisms with Northern Spotted Owls and identify species that may be at risk through direct predation or indirect interactions through the food web. Here we present preliminary results of stomach content analysis from 1559 Barred Owls collected at five localities across the Northern Spotted Owl range in Washington, Oregon, and California. Collections occurred between 2006-2019 to assess lethal removal of Barred Owls as a management action for Northern Spotted Owl Conservation. We also summarize the past research on Barred Owl and Northern Spotted Owl diets. Prey items were visually identified and counted, with some select items identified through genetic barcoding. We identified 6051 individual prey items across a diverse range of taxa. Barred Owl diets differed substantially from those of Northern Spotted Owls as they included a much wider range of taxa. While Northern Spotted Owls specialize on mammalian prey such as Humboldt's Flying Squirrels (*Glaucomys oregonensis*), tree voles (*Arborimus* spp.), and woodrats (*Neotoma* spp.), Barred Owls exhibit a generalist diet preying on arthropods and amphibians along with a broader array of mammals - including those preferred by Spotted Owls - such as shrews (*Sorex* spp.) and Shrew Moles (*Neurotrichus gibbsii*). The dominant prey taken by Barred Owls also differed markedly between the five collection areas. The Barred Owl's flexibility in their foraging strategy has probably allowed it to invade the western United States and contributed to its competitive advantage over Northern Spotted Owls. Additionally, this broad diet coupled with the Barred Owl's higher population densities, larger size, and bigger broods likely results in more prey biomass consumed per unit area and may place a variety of prey species under threat that were not previously subjected to predation by Northern Spotted Owls.

## **Barred Owl (*Strix varia*) Basics: Natural History in Eastern North America and the Westward Range Expansion**

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### **Abstract**

This presentation will introduce one of the two owl species in ecological conflict in North America west of the Rocky Mountains. Barred Owls are forest-dwelling, generalist raptors, preying on a wide variety of animals from small insects to medium-sized birds and mammals. They are typically cavity nesters but will use abandoned stick nests. They prefer moist forests, typically hardwood predominated. They are typically monogamous, relatively sedentary, and non-migratory. Most (73%) band recoveries for hatch-year banded Barred Owls were less than 24 km from the banding site, but 20% were between 24 and 96 km from their banding location. In recent decades, Barred Owls, particularly in the southeastern US, have established populations in densely populated suburban habitats. Historically restricted to forests east of the Great Plains, they evidently were able to move westward through the prairies due to increased forest cover effected by fire suppression and tree planting by European settlers. Barred Owls started moving up riparian corridors into Montana by the late 1800s. By the 1950s, '60s and '70s, they had moved into Saskatchewan, Alberta, British Columbia, southeast Alaska, Northwest Territories, Idaho, Washington, Oregon, and California. They now are in direct conflict with their slightly smaller, more specialized, and less aggressive congener, the Spotted Owl (*Strix occidentalis*).

## Moving from Experiment to Management of Western Barred Owls

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### Abstract

The Northern Spotted Owl Recovery Plan identified competition from the non-native Barred Owl (*Strix varia*) as one of the two primary threats to the survival and recovery of the Northern Spotted Owl (*Strix occidentalis caurina*). Recently, Barred Owls have invaded the range of the California Spotted Owl (*Strix occidentalis occidentalis*) in the Sierra Nevada. The recovery plan recommends the US Fish and Wildlife Service (USFWS) “manage to reduce the negative effects of Barred Owls on Spotted Owls” (Recovery Action 30). To fulfill this recovery action, USFWS is developing a Barred Owl Management Strategy (Strategy), in coordination with Federal, State, and Tribal agencies. The Strategy covers the range of both Spotted Owl subspecies and will provide an umbrella for management actions by Federal, State, and private entities. Differences in the history and density of Barred Owls, land ownership patterns, and physical characteristics dictate application of different approaches in different areas. Depending on the conditions in each region, the Strategy may include defined management areas, rules for selecting management areas, or dispersed approaches. The USFWS is considering all management techniques, including lethal removal, and continues to search out new options. While recent studies have greatly increased our understanding of Barred Owls in the western US, we lack some important information. To this end, the Strategy will include robust monitoring and adaptive management components.

## Exploring Ethical Concerns in the Study and Management of Invasive Barred Owls in the West

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### Abstract

The US Endangered Species Act mandates that Federal agencies use their authorities for the conservation of listed species. Northern Spotted Owls (*Strix occidentalis caurina*) were listed as threatened in 1990, due primarily to the historic and ongoing loss of habitat and the resulting declining populations. Competition from the non-native Barred Owls (*Strix varia*) in the western US, mentioned as a potential threat in the listing, rose to a primary threat by a 2004 review. The 2008 Northern Spotted Owl Recovery Plan described the Barred Owl threat as co-equal with habitat loss and defined 10 associated recovery actions. Evidence from a study on Green Diamond Resources Company lands in California and British Columbia's Barred Owl removal program indicated that removal might be a viable tool to manage Barred Owl populations. Recovery Action 29 directed the USFWS to conduct a large-scale experiment to test the efficacy of Barred Owl removal as a tool for conserving Spotted Owls on a broader landscape. The largest barrier to implementing Recovery Action 29 was not the technical aspects, but rather, public concerns over the ethics of removal. We received significant resistance within and outside the biological community over the lethal removal of a charismatic raptor species. To address this, we engaged a broad-based stakeholder focus group. Following discussions of the issues, biological interactions, and Spotted Owl population dynamics, we used this group to ensure we captured the ethical concerns over the experiment, as well as potential future management strategies. While engaging the focus group was time and resource intensive, the increased understanding led to wider support for the experiment. Using information on the root of the ethical concerns, we crafted ongoing public outreach and education. Information from the experiment, including the focus group, is being used to develop a Barred Owl management strategy.

## Genomic Variation and Recent Population Histories of Spotted (*Strix occidentalis*) and Barred (*Strix varia*) Owls

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### Abstract

Spotted Owls (*Strix occidentalis*; SOs) are a flagship species inhabiting old-growth forests in western North America. In recent decades, their populations have declined due to ongoing reductions in suitable habitat caused by logging, wildfires, and competition with the congeneric Barred Owl (*Strix varia*; BO). The Northern Spotted Owl (*S. o. caurina*; NSO) has been listed as “threatened” under the Endangered Species Act since 1990. Here, we use an updated SO genome assembly along with over 50 high-coverage whole-genome sequences of SO, BO, and putative hybrids to examine population structure and recent changes in population size in SO and BO as well as hybridization between BO and SO. We found that potential hybrids identified from intermediate plumage morphology were a mixture of pure BO, F1 hybrids, and F1 x BO backcrosses. Genetic data suggests that SO experienced a population bottleneck around the Pleistocene–Holocene transition, but their population sizes rebounded and show no evidence of any recent historical (i.e., 100–10,000 yrs ago) population decline. This suggests that the current decrease in SO abundance is due to events in the past century. Finally, we estimate that western and eastern BOs have been genetically separated for hundreds or thousands of yrs, instead of the previously assumed recent (i.e., <150 yrs) divergence. Although this result is surprising, it is unclear where the ancestors of western BO lived after the separation. In particular, although BO may have colonized western North America much earlier than the first recorded observations, it is also possible that the estimated divergence time reflects unsampled BO population structure within central or eastern North America.

## Barred Owl Contributions to Range-wide Declines of Northern Spotted Owl Populations: A Meta-analysis

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### Abstract

The Northern Spotted Owl (*Strix occidentalis caurina*) inhabits older coniferous forests in the Pacific Northwest and has been at the center of forest management issues in this region. The immediate threats to this federally listed species include habitat loss and competition with Barred Owls (*Strix varia*), which invaded from eastern North America. We conducted a prospective meta-analysis to assess population trends and factors affecting those trends in Northern Spotted Owls using 26 years of survey and capture-recapture data from 11 study areas across the owls' geographic range to analyze demographic traits, rates of population change, and occupancy parameters for Spotted Owl territories. We found that Northern Spotted Owl populations experienced significant declines of 6–9% annually on six study areas and 2–5% annually on five other study areas. Annual declines translated to  $\leq 35\%$  of the populations remaining on seven study areas since 1995. Barred Owl presence on Spotted Owl territories was the primary factor negatively affecting apparent survival, recruitment, and ultimately, rates of population change. Analysis of Spotted and Barred Owl detections in an occupancy framework corroborated the capture-recapture analyses with Barred Owl presence increasing territorial extinction and decreasing territorial colonization of Spotted Owls. While landscape habitat components reduced the effect of Barred Owls on these rates of decline, they did not reverse the negative trend. Our analyses indicated that Northern Spotted Owl populations potentially face extirpation if the negative effects of Barred Owls are not ameliorated while maintaining Northern Spotted Owl habitat across their range.

## Translocation Response of Barred Owls (*Strix varia*) Removed from Forests Managed for Northern Spotted Owl (*Strix occidentalis caurina*) Recovery in British Columbia, Canada

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### Abstract

Barred Owls (*Strix varia*) are a major threat to Northern Spotted Owl (*Strix occidentalis caurina*) recovery in British Columbia, Canada. A control program implemented in 2007 included Barred Owl translocation away from forests managed for Northern Spotted Owl. Of 108 Barred Owls translocated over a 10-yr period, three were recaptured by 2016 within 0.3–14.6 km of their removal sites, while the fate of the rest is unknown. Therefore in 2017, we initiated a study using new GPS satellite technology to determine success of the translocation method. We tagged and monitored nine Barred Owls (5 females, 4 males) translocated during the breeding season (April–July) and compared their seasonal movements to eight Barred Owls resident outside of Northern Spotted Owl managed areas (5 males, 3 females). GPS relocations per individual varied (translocated owls: 50–154; resident 34–166). Male and female movement responses did not differ for translocated or for resident owls. Estimated kernel density breeding (April–August) home range size for seven resident owls averaged 222.3 ha (SD = 93.0, range 100–352 ha); one additional outlier female had a large 890 ha home-range. Maximum distances traversed from capture/release locations of the eight resident owls during the breeding season were 0.9–4.9 km. In contrast translocated owls did not settle at or near release locations by the end of the breeding period (August 31) and maximum traversed distances were 6.0–59.0 km away from their release locations. Four translocated Barred Owls (2 males, 2 females) were tracked for one year through to spring 2018 of which three moved away from and then back towards their release locations. Our findings indicated that translocated Barred Owls made large movements, including back towards their capture areas, and were unable to establish home ranges within the first year of release.

## Scientific Collections and Experiments on Barred Owls' Effects to Spotted Owls under Section 10 of the Endangered Species Act

KEITH A HAMM<sup>1</sup>, BRIAN P DOTTERS<sup>2</sup>

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### Abstract

The approval and implementation of Habitat Conservation Plans (HCP) under Section 10 of the Endangered Species Act includes conservation measures addressing effects of land management activities on covered species. Two recently approved HCPs for private forest lands in northern California encompassing nearly 8,000 km<sup>2</sup> include the Northern Spotted Owl (*Strix occidentalis caurina*) and the California Spotted Owl (*S. o. o.*), species that are well studied throughout their range due to associations with older forests, sensitivities to timber harvest, large scale high severity wildfires, and competitive interactions with invasive Barred Owls (*S. varia*). Green Diamond Resource Company (GDRC) operated under an HCP for Northern Spotted Owls from 1992-2019 and is presently under an approved 50-year HCP that includes experiments to quantify effects of Barred Owls on Northern Spotted Owl survival, fecundity, and site occupancy. GDRC's experiment removing Barred Owls is ongoing across approximately 1,450 km<sup>2</sup> with 240 removals in north coastal California since 2019. Sierra Pacific Industries is operating under a recently approved 50-year HCP for Northern and California Spotted Owls that includes studies to assess genetics and diets of Barred Owls with 158 collections and continued efforts on approximately 13,360 km<sup>2</sup> in the Northern Sierra Nevada and Klamath/Cascade Regions of California. These HCPs establish long term commitments from large private landowners that complement and address recovery actions and form conservation partnerships with federal and state regulatory agencies, land management agencies, and research institutions.

## Arresting the Spread of Barred Owls in the Sierra Nevada and Rapid Recolonization by California Spotted Owls

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### Abstract

The range expansion of Barred Owls (*Strix varia*) represents a threat to faunal biodiversity in western North American forests and poses an existential threat to Northern Spotted Owls (*S. occidentalis caurina*) in the Pacific Northwest. Barred Owls have more recently invaded the range of the California Spotted Owl (*S. o. occidentalis*) in the Sierra Nevada, California, but still occur at relatively low densities. Therefore, we conducted an experimental removal study to assess the feasibility of Barred Owl management and its potential benefits to California Spotted Owls during the early stages of the Barred Owl range expansion, focusing on the leading edge of the invasion in the northern Sierra Nevada. From 2018 to 2020 we removed 64 Barred Owls and 12 Barred Owl x Spotted Owl hybrids, many from sites previously occupied by Spotted Owls. Large-scale passive acoustic monitoring surveys in the Sierra Nevada showed that Barred Owl site occupancy declined six-fold from 0.19 in 2018 to 0.03 in 2020, and site extinction (0.92) exceeded colonization (0.02). California Spotted Owls recolonized 56% of formerly occupied territories within one year, contrasting starkly with removals conducted after Barred Owls achieved high densities in the Pacific Northwest. Thus, our results suggest that removals conducted while Barred Owl densities are low are both effective and logistically feasible, and moreover can prevent the likely extirpation of Spotted Owls by Barred Owl competition.

## Barred Owl Collections as a Unique Sampling Opportunity for Exposure to Rodenticides

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### Abstract

Exposure of non-target wildlife to anticoagulant rodenticide (AR) is a global conservation concern that has historically occurred around urban or agricultural areas, though exposure to AR has emerged as an important threat to wildlife in forested settings in western North America. However, understanding the extent to which ARs pose a threat to non-target wildlife is hindered by 1) the rarity of obtaining a large sample size of specimens, and 2) challenges of testing species of conservation concern directly. One solution is through the use of indicator species. Through several studies, we demonstrate that barred owls (*Strix varia*), a top generalist predator collected through experimental removal in western North America, act as reasonable indicator species for ecosystem contamination and for the exposure of closely related and iconic spotted owls (*S. occidentalis*). We screened a total of 239 barred owls and 12 barred x spotted owl hybrids collected from six study areas in California, Oregon, and Washington and detected ARs in 132 (53%) individuals. Exposure rates were highest in California's Sierra Nevada (62%) and Washington's Cle Elum (64%) study areas, and lowest in western Oregon (38%). We further screened 10 spotted owls – opportunistically found dead – and found 70% were exposed to AR. Although we found no associations between AR exposure and biological or environmental factors in Oregon and Washington, we found that barred owls collected closer to the wildland-urban interface in California's Sierra Nevada and Klamath Mountains were more likely to be exposed to AR, and that female owls were more likely than males to be exposed. Together, our results provide evidence of high rates of AR exposure in top forest predators, indicating that AR has contaminated western forest food-webs and that exposure to AR may function as a synergistic threat to other threats that forest fauna are facing.

## Diet of Barred Owls in California Elucidated with High-Throughput-Sequencing

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### Abstract

Barred Owls (*Strix varia*) continue to expand through the Pacific Northwest and into the Sierra Nevada, California, threatening both Northern and California Spotted Owls (*S. occidentalis caurina* and *S. o. occidentalis*). As generalist and apex predators that can occur at high densities, Barred Owls may also have strong direct and indirect effects on other sensitive species and biological communities in colonized ecosystems. In this study, we conducted genetic-based dietary analyses using intestinal samples from Barred Owls collected at the front end of their invasive expansion - the southern Klamath Mountains and northern Sierra Nevada. Using a diverse panel of DNA amplifying primers and high-throughput-sequencing, we successfully screened the intestinal contents of Barred Owls ( $n=124$ ) for potential vertebrate and invertebrate prey species. A small number of Barred x Spotted Hybrid Owls ( $n=6$ ) were also screened and analyzed. We use the resulting data to describe Barred Owl dietary habits, examine trends along environmental gradients, and compare distinct groups of individuals by features such as sex, region, age, and hybridization. In addition, this methodology provides a list of known prey species, at high taxonomic resolution, that may be directly threatened by novel predation as the Barred Owl expands its range in California. The resulting list highlights the consumption of key Spotted Owl prey species, as well as a broad spectrum of additional native species.

## Characterizing Barred Owl Dispersal at the Leading Edge of their Range Expansion: Preliminary Results From Two Ongoing Studies

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### Abstract

The range expansion of the Barred Owl (*Strix varia*) into western North America over the last century has emerged as a major threat to the Spotted Owl (*S. occidentalis*) and to the health of western forest ecosystems. A better understanding of Barred Owl dispersal is critical to the implementation of effective management. Here we present on two ongoing studies examining this issue. In the first, our research team attached satellite-GPS tags to juvenile Barred Owls in the Coastal Redwood Region of northern California in order to characterize their movement and habitat use as they disperse from natal territories, one of the primary driving mechanisms of range expansion. These tags allow for fully remote tracking of owls and have the potential to provide locations of owls up to 1.5 yrs past the date of deployment, making this study the first of its kind. Preliminary data from juvenile Barred Owls captured and tagged just prior to their dispersal in the summers of 2020 and 2021 have revealed their capacity to travel up to 146 km from their natal territory. Survival rates and habitat use (including avoidance of severely burned forest) during dispersal will be discussed. In the second study, we examine Barred Owl dispersal in the Southern Klamath and Sierra Nevada regions of northern California. Utilizing lethally collected barred owls and genetic methods informed by a large panel of single nucleotide polymorphism (SNP) loci, we identify parent-offspring (PO) dyads and calculate distances between territory locations. These data provide information on not only dispersal distance between established territories, but additionally examines Barred Owl movement between Northern (*S. o. caurinus*) and California (*S. o. occidentalis*) Spotted Owl populations.

## Barred Owl Removal Halts Long-term Population Declines of the Northern Spotted Owl

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### Abstract

Programs to control invasive species are common but gauging the effectiveness of such programs using carefully designed, large-scale field experiments is rare, especially at higher trophic levels. We used a large-scale before-after-control-impact removal experiment to investigate the effects of an invasive competitor, the Barred Owl (*Strix varia*), on the population dynamics of a threatened, iconic old-forest native species, the Northern Spotted Owl (*S. occidentalis caurina*). Removal of Barred Owls had a strong, positive effect on survival of sympatric Spotted Owls, which arrested long-term population declines of Spotted Owls. After removals, the estimated mean annual rate of population change for Spotted Owls stabilized in areas with removals (0.2% decline per year), but continued to decline sharply in areas without removals (12.1% decline per year). Our results demonstrated that the most substantial changes in population dynamics of Northern Spotted Owls in these study areas over the past two decades were associated with the invasion, population expansion, and subsequent removal of Barred Owls. Fast-moving development and implementation of management actions for Barred Owls based on experimental results, coupled with long-term management of suitable forest conditions, will be essential to the persistence of Northern Spotted Owls throughout their geographic range.

## Density Dependence Influences Competition and Hybridization at an Invasion Front

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### Abstract

Landscape and climatic change are promoting range shifts, potentially leading to competition and hybridization between formerly isolated species. However, density-dependent interactions can impede the timely identification of associated conservation problems. The expansion of Barred Owl (*Strix varia*) expansion into the Spotted Owl (*S. occidentalis*) range provides a natural experiment to test for density dependence in niche overlap and hybridization in the early versus late stages of a biological invasion, thus illuminating an important biogeographical process. In the northern Sierra Nevada, where Barred Owl density was low, we quantified niche overlap between Barred Owls and Spotted Owls along three axes (landscape-scale habitat selection based on passive acoustic survey data, foraging habitat selection measured with GPS tag data, and diet measured with stable isotopes) and assessed hybridization with phenotypic data. We then compared our findings to studies of these species from the Pacific Northwest, USA, where Barred Owl density is high. In the Sierra Nevada, overlap in landscape-scale habitat selection was low (Spotted Owl sites also occupied by Barred Owls: 21%), overlap in foraging habitat selection and diet was high (Pianka's niche overlap: 0.802; stable isotope ellipse overlap: 0.52), and hybridization was common (hybrid:barred owl ratio: 0.364). In the Pacific Northwest, niche overlap was high (Barred Owl occupancy of Spotted Owl territories: 40 - 95%, Pianka's niche overlap of foraging habitat selection and diet: 0.809 and 0.429) and hybridization was rare (hybrid:barred ratio: 0.061). Foraging habitat selection and diet were density-independent and therefore predictive of the competitive exclusion of Spotted Owls in the Pacific Northwest that has resulted from the Barred Owl invasion. Landscape-scale monitoring programs capable of yielding systematic data for multiple species can offer an early warning of invasions; however, individual-level traits such as foraging habitat selection may influence the population processes that can determine invasion outcomes.

## The Roles of Competition with Barred Owls and Habitat in the Range-Wide Territorial Occupancy Dynamics of Northern Spotted Owls

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### Abstract

Since the early 1990s, the Northwest Forest Plan has reduced the rate at which old forests are lost due to timber harvest on federal lands. These older forests are a critical component of Northern Spotted Owl (*Strix occidentalis caurina*) habitat, especially for nesting and roosting. Despite old forest protections, Northern Spotted Owl populations have continued to decline, primarily because of competition with growing Barred Owl (*Strix varia*) populations. Here, we focus on quantifying the impacts of competition with Barred Owls and habitat on Northern Spotted Owl territorial occupancy dynamics across 11 study areas spanning their geographic range while also forecasting responses to potential management actions. Results of two-species occupancy models indicate that Northern Spotted Owls have declined range-wide over the last twenty years, primarily due to competition with invading Barred Owls. Competition with Barred Owls has increased Northern Spotted Owl territory extinction probabilities across all study areas and driven recent declines in Northern Spotted Owl populations. Both owl species have overlapping habitat preferences and Northern Spotted Owl occupancy declines have been greatest in the highest quality old forest. Without management intervention, the Northern Spotted Owl subspecies will soon be extirpated from large parts of its current range. In the short term, Barred Owl removal can be effective but over longer time spans, maintaining or improving old-forest conditions can help promote the persistence of Northern Spotted Owl populations.

# Global Priorities in Raptor Conservation

166

## Toward Scoping Reviews of Individual Raptor Species

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### Abstract

Scoping reviews—where the literature on a given topic is systematically collated and summarized—aid literature searches and highlight knowledge gaps on a given topic, thus hastening scientific progress and informing conservation efforts. Because much research and conservation is targeted at the species level, ornithology and bird conservation would benefit from scoping reviews of individual raptor species. We present and apply a framework for scoping reviews for three disparate raptor species: California Condor (*Gymnogyps californianus*), Harpy Eagle (*Harpia harpyja*), and Gyrfalcon (*Falco rusticolus*). We consulted expert panels to develop appropriate search strings and lists of essential literature, i.e. 'benchmark articles'. We searched Web of Science, Scopus, and Google Scholar. Searches for California Condor, Harpy Eagle, and Gyrfalcon returned 268, 138, and 343 articles, respectively, that discuss, review, or collect empirical data for the focal species. Our searches returned all benchmark articles identified by species experts, indicating that the searches captured the most important work on each species. We coded each study according to the topic addressed, country, and month in which data were collected. We also coded threats, stresses, and conservation actions addressed by studies, following definitions used by the International Union for the Conservation of Nature (IUCN) during Red List assessments. Literature summaries for each species include the number of studies addressing certain topics, monthly timing of research, and global maps of research focus. Our coding scheme preliminarily revealed important knowledge gaps for each species. Effects of conservation actions on wild individuals were relatively little-studied for California Condors. Harpy Eagles were relatively little studied outside of Brazil and Panama, and Gyrfalcons were little studied outside of their breeding season. Scoping reviews of the world's raptor species would help to identify critical knowledge gaps, thereby aiding the global effort to assuage the sixth mass extinction.

## **A Novel Approach to Modelling Animal Tracking Data: Defining Behavioral States to Understand Space Use for Conservation**

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### **Abstract**

Though critically endangered, we know little of African White-backed Vultures' (*Gyps africanus*) spatial ecology. Understanding the external variables that affect vultures' decisions regarding space use, specifically during foraging and feeding when they encounter high risk threats, can assist in effectiveness of conservation measures. We tracked 26 African White-backed Vultures between 2015 and 2019 in Southern Tanzania and used Hidden Markov Models' to identify behavior from raw GPS points and Point Process Models' to test resource selection decisions in vultures during foraging and feeding. Our distribution model indicated rivers and habitat openness are key features for foraging behavior, with protected area status of lower relative importance. Similar to other studies, we show that vultures switch to foraging in areas of high thermal availability and early in the day. Our feeding analysis highlighted the lack of feeding in areas with high livestock density, suggesting that vultures avoid cattle as a primary food source and that such areas have low alternative food availability. We found that foraging behavior was relatively more frequent in Game Reserves and WMAs than expected from overall use, and our feeding models showed that detected carcass locations are more widespread than foraging preferences might have indicated: birds apparently found carcasses in areas where they spent relatively little time foraging. This adds to the growing evidence that although protected areas are important, the management of unprotected areas must be included in conservation efforts. Results differed between seasons and populations, highlighting the need for detailed understanding of behavioral decision making. These results provide insight into how animals use their habitat explicitly rather than describing where they spend most of their time and are of conservation benefit.

## Identifying Priority High-Risk Areas for Anti-poison Work for the Conservation of Endangered Vultures

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### Abstract

Vultures are declining worldwide and poisoning is the greatest threat in Africa. Tanzania remains one of the last strongholds for vulture populations in Africa and information on poisoning risks is limited but vitally important to conservation actions. We estimated the exposure, threat, and risk of poisoning to vultures in Southern Tanzania. Exposure to poisoning was defined as the areas that vultures use and where carcasses are likely to be found by a given individual, and was calculated using GPS tracking data from 33 vultures and capture-recapture modelling. Threat of poisoning was a proxy of human footprint and thus areas where poisoning was possible. Risk of poisoning was determined by areas with an overlap of exposure and threat. Similar to other studies, our results support that vultures are highly efficient at finding carcasses where they spend time foraging. We found that locations with the greatest risk of poisoning were at the periphery of protected areas and where human-wildlife conflict is often highest. We found that risk areas identified using our risk assessment framework covered a smaller geographic area than simple spatial buffers. Finally, we identified priority areas of anti-poisoning interventions in southern Tanzania. We infer from these findings where to prioritize anti-poisoning interventions to reduce the risk of vultures encountering poisoned carcasses.

## A New Critical Partner for Raptor Conservation: The Mohamed Bin Zayed Raptor Conservation Fund

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### Abstract

The Mohamed Bin Zayed Raptor Conservation Fund was founded by H.H. Sheikh Mohamed Bin Zayed Al Nahyan, Crown Prince of Abu Dhabi and Deputy Supreme Commander of the UAE's Armed Forces, in April 2018. The Fund's vision is to ensure that raptors and their habitats are restored whilst its mission is to act and facilitate global programs that support raptor conservation, including restoration of their habitats. As a new critical actor in the field of raptor conservation, the approach of the fund will be to support the conservation of endangered raptors species that are not yet benefiting from conservation actions as well as of those raptor species not yet considered endangered but facing rapid population declines that justify pre-emptive conservation actions. Since 2018, the Fund has made significant progress in developing partnerships in a number of raptor projects that include, amongst others: i) reducing raptor electrocutions of c. 30,000 power poles in the Mongolian steppes by remedial action; ii) restoring Saker Falcon (*Falco cherrug*) breeding populations in the Southern Balkan region; and iii) building on a long-term voluntary release program of rehabilitated wild caught falcons in the Central Asian states. By collaborating and building partnerships with governments, UN and development agencies, donors, NGOs, university and research entities, the private and energy sector, and global media outlets, the Fund aims to deliver an international coordinated response to conserve raptors and their habitats across the globe. Through these collaborations and global partnerships, the Fund aims to ensure that all raptors continue to thrive in their natural habitats. Over the next five years, the Fund will continue to build partnerships in developing a global raptor conservation strategy that will ensure the survival of the world's most highly threatened raptors and their habitats as well as strengthening capacity for global raptor conservation.

## Lead in Wildlife

107

### **North American Non-lead Partnership - expanding the coalition of hunters, anglers, and other conservationists dedicated to improving ecosystem and wildlife health**

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#### **Abstract**

Hunters and anglers have been at the forefront of natural resource conservation throughout North America for over a century, and hunters continue to meet increasingly complex conservation challenges each year. Historically, many successful conservation efforts have focused on individual species recovery, and habitat conservation and improvement. In the last 20 years, significant research has identified lead exposure in scavengers across North America, and the world, with continental evidence of impacts. However, discussion of solutions has been mired in political controversy, limiting engagement from necessary stakeholders. The North American Non-Lead Partnership seeks to expand the coalition of hunters, anglers and other conservationists dedicated to improving ecosystem and wildlife health by choosing non-lead options. Using a fact based, collaborative approach, focused on incentives and voluntary participation, the Partnership has had success engaging stakeholders. This Partnership helps to create specifically tailored processes for partners like state agencies and traditional hunting conservation groups to engage with their own stakeholders on the specific details of the issue, ammunition choices, and ways to protect both our tradition of wildlife conservation and hunting heritage that are critical to both the North American Model and the future of hunting.

## **Stronger Laws and Stronger Partnerships: Successful Efforts to Protect New Hampshire's Common Loons from Lead Poisoning by Ingested Lead Fishing Tackle**

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### **Abstract**

New Hampshire efforts to address lead poisoning of Common Loons from ingestion of lead (Pb) fishing tackle can inform efforts to address poisoning of wildlife through exposure to spent lead hunting ammunition. In 2018, Loon Preservation Committee (LPC) launched a Lead Tackle Buyback campaign with NH Fish and Game (NHF&G) and local tackle shops (originally two, now eight) that has already collected 25,345 pieces of lead tackle weighing 162 pounds. The LTB campaign follows successful advocacy efforts by LPC in 2013 that led to passage of stronger NH laws (effective in 2016) that now ban the sale and freshwater use of lead fishing sinkers and jigs weighing one ounce or less—the most protective laws in the nation. The interplay between LPC's legislative efforts and lead tackle buyback campaign have provided a unique opportunity to demonstrate: (1) the importance of value exchange in voluntary lead reduction initiatives; and, (2) the critical role played by partners in the sporting community in moving advocacy efforts from adversarial to collaborative. LPC's 2013 legislative effort saw strong opposition from a major industry group representing manufacturers and several local bass fishing clubs presenting national talking points. With the launch of the buyback campaign, one of the most influential opponents became a participating retailer in the buyback pilot and has now become a full-time manufacturer of non-lead tackle. Meanwhile, by funding ten-dollar vouchers for the trade-in of one ounce or more of banned lead tackle, LPC has "put its money where its mouth is"—a move that has been well-received by anglers and participating retailers. Understanding how LPC has turned opponents into allies can inform efforts to do the same with regard to opponents of efforts to reduce wildlife exposure to spent lead hunting ammunition.

## The Lead Lining of Agriculture-Related Subsidies: Enhanced Golden Eagle Growth Rates Tempered by Lead Exposure

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### Abstract

Supplementary food resources (e.g., subsidies) associated with agriculture can benefit wildlife, increasing food predictability and availability. Avian scavengers, including raptors, take advantage of subsidies associated with recreational hunting and pest shooting on agricultural lands. However, these subsidies can contain lead (Pb) fragments if they are shot with Pb-based ammunition. Nesting Golden Eagles (*Aquila chrysaetos*) commonly forage in agricultural lands during the breeding season, and both adults and nestlings are susceptible to Pb exposure from scavenging shot wildlife. We assessed Pb exposure in 258 Golden Eagle nestlings (401 total blood samples), along with physiological and growth responses, in agricultural lands across four western states in the United States. We also evaluated nestling Pb stable isotope signatures to inform exposure sources. Twenty-six percent of nestlings contained Pb concentrations associated with subclinical poisoning for sensitive species (0.03–0.2 µg/g wet weight), 4% exceeded subclinical poisoning benchmarks (0.2–0.5 µg/g), and <1% exceeded concentrations associated with clinical poisoning (0.5–1.0 µg/g) or those considered to cause severe clinical poisoning (>1.0 µg/g). Lead was highest in nestlings in proximity to fields that potentially provided subsidies and declined exponentially as distance to subsidies increased. However, proximity to agriculture, and presumably subsidies, positively influenced nestling growth rates. Across the range of Pb exposure, nestlings had a 67% reduction in delta-aminolevulinic acid dehydratase activity, indicating the potential for anemia or cellular damage. Isotopic ratios of <sup>206</sup>Pb/<sup>207</sup>Pb increased non-linearly with increasing blood Pb in nestlings, and 45% had blood Pb isotope ratios consistent with those of ammunition. However, for nestlings with blood Pb levels above 0.10 µg/g, the proportion associated with ammunition increased to 89%. An improved understanding of the growth and physiology effects associated with proximity to subsidies would be beneficial to managers when evaluating measures to reduce Pb exposure across the landscape.

## Comparison of Heavy Metal Exposure in Resident and Migratory Raptors in Mexico

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### Abstract

Increased habitat loss and contamination in the tropics cause ornithologists to suspect that migratory birds encounter elevated contaminant exposure during migration, and overwintering periods. Our research question is: When are migratory raptors exposed to higher metal concentrations during their annual cycle? We hypothesized that sampling heavy metals in blood and feathers would help us identify the boreal or austral exposure. During the fall of 2016 and 2017, we sampled juvenile (hatch year) Sharp-shinned Hawk (*Accipiter striatus*), Cooper's Hawk (*A. cooperii*), Aplomado Falcon (*Falco femoralis*), Roadside Hawk (*Rupornis magnirostris*), and Short-tailed Hawk (*Buteo brachyurus*) in Veracruz, Mexico (a primary migratory corridor for raptors in the fall). We analyzed 194 blood and corresponding feather samples through voltammetry for zinc (Zn), cadmium (Cd), lead (Pb), mercury (Hg), and copper (Cu). We compared mean values of metal concentrations and found that feather concentrations were one to two orders of magnitude higher than blood, and mean values of migratory and resident species had comparable metal levels. The only significant difference between resident and migratory species (wet weight, ppm) was, Pb in blood (migratory > resident,  $P < 0.01$ ). This study provides information about the temporality of heavy metal exposure pathways in raptors outside of their breeding areas in North America. Higher Pb levels in the blood of migratory species indicate elevated exposure during the migration period, before the Pb deposits into the tissues of the organism. The four other metals analyzed did not result in significant differences between resident and migratory species in respective tissues, indicating insignificant exposure of Zn, Cd, Cu, or Hg during the migratory and nesting periods. Feather concentrations containing one to two orders of magnitude higher than blood confirms feathers as a pathway to deposit metal body burdens through the molt cycle.

## Non-lead Ammunition Distribution Programs to Offset Golden Eagle Mortalities in Wyoming

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### Abstract

Wind power has expanded greatly over the past two decades and collision with wind turbines sometimes kills Golden Eagles (*Aquila chrysaetos*) at wind facilities. As a result, the United States Fish and Wildlife Service developed requirements for specific conservation actions designed to mitigate eagle deaths resulting from energy development. To test the use of non-lead ammunition as a viable mitigation tool, we implemented a non-lead ammunition distribution program in southeast Wyoming, an area with high risk of lead toxicity and high Golden Eagle use. During the 2020 hunting season, we purchased non-lead ammunition for 434 big game hunters with limited-quota tags in the study area. Following the 2020 hunting season, we surveyed all program participants to assess use of the distributed non-lead ammunition and whether hunters were successful in harvesting game. Preliminary analysis suggests that of the 434 program participants, 80% used the ammunition to hunt and these efforts resulted in >215 lead-free gut piles. The relative reduction in eagle deaths based on the use of non-lead ammunition was quantified using a multi-faceted compensatory mitigation model. Preliminary results suggest that the use of non-lead ammunition provided to hunters through a formal distribution program is an effective method to offset golden eagle mortalities from wind development.

## **A Research Update on Efforts to Measure and Reduce Lead Exposure in Raptors from Mainland Australia**

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### **Abstract**

Despite the worldwide nature of lead exposure in raptors, little research has been performed on this threatening process in Australia. This presentation describes progress made in improving understanding of this issue on a continent where use of lead-based ammunition is currently widespread. No research had been conducted prior to 2020, when studies commenced on Tasmanian Wedge-Tailed Eagles (*Aquila audax fleayi*). On the other side of the continent, mainland Wedge-Tailed Eagles (*A. a. audax*) from the south-west of Australia showed evidence of elevated lead exposure from a small number (11) of bone samples. South-eastern mainland Australia, where the majority of the human population resides, has been the subject of little research in this field. A 2020 study utilized camera traps over 78 shot carcasses to identify the raptor species most vulnerable to lead ingestion, namely Wedge-Tailed Eagles and Little Eagles (*Hieraaetus morphnoides*). A passive surveillance research project then began to measure lead levels in liver and bone from archived specimens of the above species as well as Whistling Kites (*Haliastur sphenurus*), Black Kites (*Milvus migrans*), Black-Breasted Buzzards (*Hamirostra melanosternon*) and Brown Goshawks (*Accipiter fasciatus*). A 2021 project examined the utility of portable x-ray fluorescence (XRF) for measuring lead levels in 92 archived bone samples from Wedge-Tailed Eagles and found elevated levels (>10 mg/kg) in >50% of birds. Concurrently, studies are underway aimed at reducing lead exposure in Australian raptors. Recent trials have investigated the efficacy of lead-free bullets for ground-based shooting of European rabbits (*Oryctolagus cuniculus*) and helicopter-based shooting of wild hogs (*Sus scrofa*). It is hoped that the culmination of these research efforts will enable Australia to make a more substantial contribution to the international conversation surrounding lead poisoning in wildlife.

## The Impact of Lead on Bald Eagle Dynamics in the Northeast United States

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### Abstract

Poisoning from lead (Pb) ammunition fragments causes death to birds of prey worldwide. While ingestion of Pb from spent ammunition kills individual Bald Eagles (*Haliaeetus leucocephalus*) throughout the United States, it is unclear the impact that these mortalities have on population dynamics at the ecological scale. In fact, the species has even been deemed a wildlife recovery success story after populations rebounded from near extirpation despite continued mortalities from lead toxicosis. We pooled necropsy and demographic data from seven states in the northeastern region of the US to determine whether deaths from Pb toxicosis altered the dynamics of the eagle population over the past three decades. We adapted a combinatorial optimization algorithm (COA) and used it in conjunction with a mathematically symbolic life history to compare population dynamics of eagles under current (Pb) and hypothetical (Pb-free or Pb-reduced) scenarios. The data suggest that Pb depressed the long-term growth rate of eagles in the northeast and altered the shared movement of individuals through their life cycle. The methods used may be expanded to assess the population scale impacts of lead toxicosis to eagles outside of the northeast.

## **Status Update: A Reintroduced Population of California Condors in Northern Arizona and Southern Utah, Lead Monitoring and the Path to a Self-sustaining Population**

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### **Abstract**

California condors (*Gymnogyps californianus*) are long-lived obligate scavengers with low reproductive rates making them more vulnerable to increased mortality and morbidity from novel threats like lead poisoning. Through twenty-five years of effort, the reintroduced condor population has shown numerous signs of success: range expansion throughout northern AZ and southern UT, free foraging on a variety of non-proffered carcasses, and hatching 46 young in the wild, including an F2 generation. The population contains a stratified age structure with 55% at or beyond the minimum breeding age of five years or older, and more than 20 breeding pairs. Despite these successes, lead poisoning remains the primary impediment to a self-sustaining population. Voluntary lead reduction programs for big-game, mostly deer-hunting in AZ and UT, have decreased the amount of available lead on the landscape, yet blood-lead levels continue to spike following peaks in hunting seasons. Without continued replacement of lost individuals with captive-reared and wild-hatched young, and continued lead reduction, recovery will remain a challenge. More is needed to reduce available lead on the landscape for the benefit of condors and for overall ecosystem health. Never have these efforts been more important, as captive-breeding facilities work to increase production for release to the wild. We will continue annual releases of captive-reared condors while monitoring lead levels of trapped individuals. Lead poisoned birds will be treated when warranted, and we will continue to work with partnering agencies and members of the public to decrease the threat of lead.

## Small Mammal Shooting as a Conduit for Lead Exposure in Avian Scavengers

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### Abstract

Lead (Pb) exposure is a widespread wildlife conservation threat. Although commonly associated with Pb-based ammunition from big game hunting, small mammals (e.g. ground squirrels) shot for recreational or pest management purposes represent a potentially important Pb vector in agricultural regions. We measured the responses of avian scavengers to pest shooting events and examined their Pb exposure through consumption of shot mammals. There were 3.4-fold more avian scavengers at shooting fields relative to fields with no recent shooting and avian scavengers spent 1.8-fold more time feeding after recent shooting events. We isotopically labeled shot ground squirrels in the field with an enriched <sup>15</sup>N isotope tracer; 6% of avian scavengers sampled within a 39 km radius reflected this tracer in their blood. However, 33% of the avian scavengers within the average foraging dispersal distance of nests (0.6 – 3.7 km) were labeled, demonstrating the importance of these shooting fields as a source of food for bird nesting in close proximity. Additionally, Pb concentrations in 48% of avian scavengers exceeded subclinical poisoning benchmarks for sensitive species (0.03 – 0.20 µg/g ww), and those birds exhibited reduced delta-aminolevulinic acid dehydratase activity, indicating a biochemical effect to Pb. The use of shooting to manage small mammal pests is a common practice globally. Efforts that can reduce the use of Pb-based ammunition may lessen the negative physiological effects of Pb-exposure on avian scavengers.

**Lead (Pb) in Scandinavian Brown Bears (*Ursus arctos*)**

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**Abstract**

The Scandinavian brown bear is an omnivore that consumes a variety of food items including berries, plants, ants, moose (*Alces alces*) and ungulate hunting slaughter remains. We found a mean blood Pb concentration of 87.1 µg/l (SD: 36.5 µg/l; range: 22.6-220.5 µg/l;  $n=239$ ) which is more than seven times higher than the European Food Safety Authority's threshold for developmental neurotoxicity (12 µg/l blood). Significant correlations were found between blood Pb concentrations of suckling cubs and their mothers, and between blood and milk Pb concentrations of lactating females, indicating that dependent cubs are exposed to Pb throughout their suckling period. No significant correlations were found between Pb blood concentration and any standard haematological or biochemical parameters. However, Pb concentration in young bears ( $n=16$ ) was significantly higher during hibernation compared to the active period. We also sampled organs from 34 hunted bears, and found Pb in the liver (mean: 1569.9 µg/kg dry weight; SD: 736.9 µg/kg dry weight; range: 455.2-3791.5 µg/kg dry weight), kidney medulla (mean: 392.5 µg/kg dry weight; SD: 156.4 µg/kg dry weight; range: 130.9-944.4 µg/kg dry weight) and kidney cortex (mean: 3430.5 µg/kg dry weight; SD: 1125.1 µg/kg dry weight; range: 1642.9-7017.3 µg/kg dry weight), although no Pb-associated pathology was identified in these organs based on routine histopathology. Therefore, it is clear that the Scandinavian brown bear population is exposed to high concentrations of Pb. Although the exact source of Pb and potential adverse health effects in the species remain unclear, likely sources include Pb-based hunting ammunition and contaminated soil. As Pb exposure continues to be a global One Health issue, further research into Pb sources and potential health effects in wild mammals is needed in order to highlight the importance of reducing Pb in the environment.

## **Efficacy of Non-lead Ammunition and the Implications for Adjustment of Striking Impact Requirements Relating to a National Transition**

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### **Abstract**

Denmark banned the use, possession, and marketing of lead gunshot in 1996, and today, the Danish transition to non-lead gunshot is regarded as being complete. Over the last decade, there has been increasing concern about the adverse impacts of the continued use of lead rifle ammunition on wildlife and human consumers. As a result, more than one fifth of all Danish hunters have already shifted to non-lead alternatives in the absence of any legal regulations to require such a transition. Some state owned hunting districts and private hunting estates have also introduced their own transition programs. One state owned district provided the venue for a research program to compare the efficiency of non-lead rifle bullets with traditional lead ammunition used in the culling of 531 Fallow (*Dama dama*), Red (*Cervus elaphus*), and Sika Deer (*C. nippon*). Under special dispensation from existing legislation, most of the deer were culled with ammunition not currently legal for the normal hunting of large deer species in Denmark. In this presentation, we present the results from this research project, which demonstrated that the killing efficiency of rifle bullets related more to the entry point in the target animal than to other variables, including caliber, shooting distance and bullet composition material. Although some non-lead bullet types showed shorter (and some longer) flight distances than equivalent lead types, all measured flight distances fell generally well within accepted limits for the normal killing efficiency of rifle ammunition. We discuss the results in relation to future amendments to national legislation relating to caliber, bullet weight, and kinetic energy in hunting rifle ammunition in relation to completing the announced national transition from lead to non-lead rifle ammunition in Denmark.

## Lead Poisoning in the California Condor Population, 1992-2020

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### Abstract

While lead poisoning was documented as a cause of death in several of the last California condors (*Gymnogyps californianus*) in the remnant wild population, the magnitude of lead's effect on the population was unknown. Through the process of releasing and monitoring condors from 1992 - 2020, we found that condors were exposed to lead often and repeatedly. Analysis of blood, feathers, tissues, and metallic fragments found in sick and dead condors illustrated the extent of lead exposure. Lead poisoning was the cause of death in 107 free-flying condors; 50% of the deaths where cause of death could be determined. Annual mortality in the wild population exceeded the number of wild-fledged chicks entering the population. A population viability analysis (PVA) of the CA population indicated that a reduction in mortality of approximately 2-3% is necessary for positive population growth without the release of captive-bred juveniles to the wild. Therefore, continued growth of the population in the wild remains dependent on releases of captive-bred birds. Current research is underway to assess the effect of lead treatment on overall survivorship in the CA population and expanding PVA models to include AZ and Baja, Mexico populations. The expanded PVA model will be used to assess the effects of management and survivorship in each population and at the species level. Finally, lead isotopic analysis demonstrated the principle source of lead in condors is the inadvertent ingestion of spent ammunition in carrion fed upon by condors. Therefore, a significant effort is underway to reduce the amount of spent lead ammunition available to condors.

## Sporting Lead-Free: An Example of a Grass-roots Lead-Free Education Initiative in Wyoming

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### Abstract

The use of lead ammunition and tackle in the field has led to the unintentional poisoning of wildlife and the presence of lead in packaged game meat. Sporting Lead-Free is a new Wyoming-based educational initiative, working with hunters and anglers in local communities to raise awareness of the issue and to increase access to lead-free ammunition and tackle. Our collaborative approach is built on the foundation that hunters and anglers are the backbone of wildlife conservation and their voices will be the most effective in reaching the outdoor sporting community about lead-free alternatives. Efforts to regulate the use of lead in hunting and fishing have faced fierce opposition and resistance in Wyoming and legal or regulatory action will almost certainly result in low compliance. As such, we have developed an educational, voluntary approach to our lead-free initiative. We have developed a three-pronged approach to our initiative: raising *awareness* through education and outreach opportunities, building a *community* of hunters and anglers, and addressing *availability* through local retailers across the state. Sporting Lead-Free is an example of developing a place-based, local, grass-roots educational initiative. We will provide information on how Sporting Lead-Free was formed, hurdles, opportunities, and financial responsibility necessary to begin this state-wide initiative. While one of several on-the-ground non-lead educational campaigns in the US and Canada, we will provide perspectives on the organizational framework, collaborative processes, messaging, branding, and collateral needed to successfully launch this multi-year campaign. By sharing this information, we endeavor to help inform other organizations, regions and states on how to launch their own lead-free initiative for greater education across North America.

## Lead Seasonality in Humans, Animals, and the Natural Environment

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### Abstract

Lead is toxic to humans, animals, and the natural environment. Lead seasonality, i.e., higher lead burdens in warm weather, is evident in humans, domesticated and wild animals; land and water species; urban and rural, developed and pristine environments. The consistency of the evidence suggests that lead seasonality is multifactorial within the natural world, including humans. Seasonally higher temperatures, solar radiation, humidity and anthropogenic pollution result in lower pH (acidification) in air, water and soil. Lead seasonality in the biosphere is also influenced by higher growth rates, slightly increased exposures, and more Vitamin D metabolism. The acidification of the natural environment increases lead's bioavailability and mobility thus intensifying human, animal and plant exposures. Hence, global warming will increase lead bioavailability and mobility. Using a One Health perspective, we arrayed the data from EPA's Integrated Science Assessments of Lead on the published literature, which we supplemented with subsequent and related publications to assess data on the seasonality of lead exposure across species and through the earth's systems. Our integrated assessment suggests that:

- 1) 'Seasonality' is a multifactorial, terrestrial phenomenon affecting the natural world; human activities have exacerbated natural cyclicities that impact lead exposures across species. In particular, 'hunting season' is a wholly anthropogenic phenomenon that raises lead exposures across multiple species.
- 2) Human lead remediation strategies can only be sustainable in the context of the total environment.
- 3) Climate change, especially global warming, is anticipated to increase lead exposures and toxicity to all species throughout the natural environment.

## Widespread Lead Exposure in Golden Eagles Captured in Montana

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### Abstract

Lead poisoning threatens many species of raptors, including Golden Eagles (*Aquila chrysaetos*). Much of this lead likely comes from bullet fragments that remain in the carcasses of animals killed by hunters. The likelihood of lead exposure may peak during fall hunting seasons and early winter until leftover carcasses from hunting become scarce. From 2011 to 2018 in western Montana, we captured 91 Golden Eagles in the winter, tested their blood lead levels (BLL), and outfitted a subset of birds (n = 29) with GPS transmitters to determine their migratory nature. Nearly all Golden Eagles (94.5%) had elevated BLL ( $\geq 10 \mu\text{g dL}^{-1}$ ), and eight of them had BLL above clinical exposure levels ( $> 60 \mu\text{g dL}^{-1}$ ), where they may lose coordination and experience a host of other neurologic and physiologic disorders. Juvenile and immature birds tended to have lower BLL later in the winter, but that trend did not apply to adults. At least two-thirds of the Golden Eagles equipped with GPS transmitters migrated northward, spending the summer throughout Alaska and northwestern Canada. Blood lead levels did not differ between migratory and non-migratory Golden Eagles. Overall, we show that elevated BLL are widespread among Golden Eagles throughout winter in western Montana, regardless of sex, age, and whether the birds migrate.

## Health Perspectives on the Cost of Lead to Birds and Humans

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### Abstract

Lead (Pb) is extremely toxic and known to cause long-term, adverse outcomes across species. This presentation describes a lead dust study of Northern Mockingbirds (*Mimus polyglottos*) in New Orleans and presents the health effects of shooting guns on citizens at firing ranges, range personnel, and their families. In New Orleans, the disparity of the distribution of soil lead dust has been detailed and mapped over three decades. Mockingbirds living in high lead areas behave more aggressively than Mockingbirds living in low lead areas of the city. Comparing high lead areas of the city with low lead areas of the city, the response by Mockingbirds to lead dust mimics the exposures by humans. In the United States, gun ownership has increased exponentially along with recreational firearm use by men, women, and even children. An estimated 1 million law enforcement officers train at indoor firing ranges and 20 million citizens practice target shooting as a leisure activity at an estimated 16,000–18,000 firing ranges in the USA. Discharge of Pb dust and gases is a consequence of shooting firearms. There is no known safe level of lead exposure and children are at the highest risk. Out of 36 studies, 31 reported blood lead levels (BLLs) >10 µg/dL in some shooters, 18 reported BLLs >20 µg/dL, 17 studies reported >30 µg/dL, and 15 studies reported BLLs >40 µg/dL depending on the air Pb at firing ranges, the number of bullets discharged, and the caliber of weapon fired. Prevention includes changing clothing after shooting, curtailing smoking and eating at firing ranges, improved ventilation at indoor ranges, and installing airflow systems at outdoor ranges. Eliminating lead dust risk requires primary prevention and ultimately using lead-free primers and lead-free bullets.

## **Risks from ammunition-derived lead to wildlife and human health in Europe: science to policy and practice**

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### **Abstract**

Lead from ammunition poisons birds that eat spent shot directly (such as waterfowl and terrestrial gamebirds) and raptors and other birds that eat shot or bullet fragments in the flesh of game animals that they prey upon or scavenge. Lead from ammunition also puts at risk the health of people that frequently consume wild-shot game, particularly children and pregnant women. Recent reviews reveal lead poisoning in more wildlife species and places than previously recognised, and that large numbers of people are eating wild-shot game on a frequent basis and thus exposed to elevated levels of lead. The estimated annual economic costs to society of only a limited number of impacts associated with the continued use of lead ammunition ranged from €444 million and €1.3 billion in Europe, exceeding estimated costs of switching to non-lead ammunition. There is global scientific consensus on the risks posed to human and wildlife health by lead from ammunition, and a range of non-toxic alternative ammunition types have long been available. Changes in policy and practice to transition away from lead ammunition use have been slow, despite the clear scientific case and obvious public interest. However, there has been recent progress in Europe where the European Commission has requested the European Chemicals Agency to prepare a restriction proposal on the placing on the market and use of lead in ammunition (gunshot and bullets) and of lead in fishing tackle. In February 2020, nine UK shooting and rural organisations announced a voluntary phase out within 5 years of lead shotgun ammunition used for shooting live quarry. In this presentation, I will describe the science base and the steps taken to try to achieve change in practice and policy in the UK and EU, identifying some of the tipping points.

## **History of effective small scale programs aimed at decreasing the threat of lead poisoning to scavenging wildlife while shaping a path for landscape scale change**

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### **Abstract**

A growing body of scientific evidence examining the relationship between lead ammunition and scavenging wildlife has helped to shape our understanding of impacts. However, efforts to reduce or eliminate impacts have largely been small-scale and sometimes deemed marginally effective. Bridging the gap between contemporary science and creating lasting change in the field takes time, creativity, tenacity, and persistence. It is often the case that small-scale programs are overlooked for lack of overall impact, but initiating the conversation, sharing and translating corroborating science, are necessary steps to shape landscape-level change. By examining what seems to work at a small scale, larger programs can be designed and implemented.

## High Frequency of Lead Exposure in the Population of an Endangered Australian Top Predator, the Tasmanian Wedge-tailed Eagle

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### Abstract

Lead poisoning, mainly through incidental ingestion of lead ammunition in carcasses, is a threat to scavenging and predatory bird species worldwide. In Australia, shooting for animal control is widespread, and a range of native scavenging species are susceptible to lead exposure. However, the prevalence of lead exposure in Australia's scavenging and predatory birds is largely unknown. We evaluated the degree to which the Tasmanian Wedge-tailed Eagle (*Aquila audax fleayi*), an endangered Australian raptor and facultative scavenger, showed evidence of lead exposure. We detected lead in 100% of femur and liver tissues of 109 eagle carcasses opportunistically collected throughout Tasmania between 1996 and 2018. Concentrations were elevated in 10% of 106 liver (> 6 mg/kg dw) and 4% of 108 femur (> 10 mg/kg dw) samples. We also detected lead in 96% of blood samples taken from 24 live nestlings, with 8% at elevated concentrations (> 10 µg/dL). Of the liver samples with elevated lead, 73% had lead<sup>207/206</sup> isotope ratios within the published range of lead-based bullets available in Tasmania. These first comprehensive data on lead exposure of an Australian raptor are comparable to those for raptor studies elsewhere that identify lead-based ammunition exposure as a conservation threat. Our findings highlight the importance of further research and efforts to address lead contamination throughout the Tasmanian ecosystem and in other Australian regions.

## **Lead from Fishing Gear: Poisoning, Populations, and Policy.**

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### **Abstract**

Lead poisoning from ingested fishing gear has been documented in a wide variety of taxa including loons (*Gavia spp*) and swans (*Cygnus spp*). Population level effects have been demonstrated in some species. We will review these findings and discuss non-toxic alternatives. In addition, we will discuss the mixed record of educational and regulatory solutions to date.

## Lead Poisoning in Bald Eagles: Trends in Admissions and Outcomes at a Wildlife Rehabilitation Center

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### Abstract

Lead toxicity in Bald Eagles (*Haliaeetus leucocephalus*) has been reported in the scientific literature for decades with much of the available information coming from eagles admitted to wildlife rehabilitation facilities. Because there are inherent challenges to rigorously integrating data from multiple sources, there are advantages to analyzing trends in admission of lead-poisoned eagles to wildlife rehabilitation from a single database. The Raptor Center at the University of Minnesota (TRC) has tested all eagles admitted for blood lead levels and maintained a data collection protocol since 1991, with records for over 2500 bald eagles. Over that timeframe, bald eagle populations have increased over three-fold, and bald eagle admissions at TRC have reflected this. A retrospective study was done to look at patterns of admissions and outcomes of lead poisoned bald eagles. While numbers of annual admissions have increased, patterns of admission related to lead toxicity have changed minimally. Lead toxicity is more prevalent and severe in adult birds. These eagles have the poorest outcomes. Lead exposure in hatch year birds follows the same seasonal pattern as adults with a significant increase in prevalence (based on blood lead levels) occurring during months associated with deer-hunting and available deer carcasses on the landscape. Over 50% of hatch year eagles, however, have some amount of lead exposure before deer hunting season, increasing to 80% lead exposure in first year birds admitted after the start of deer season. While there has been a consistent grass roots effort for hunter education on the risks to wildlife from spent lead ammunition in the past decade as well as limited regulatory efforts to reduce/ban the use of lead ammunition on public lands, the data from wildlife rehabilitation demonstrates that minimal progress has been made to date on this problem.

## Lead Toxicity in Bald Eagles: The Science of Triage and Treatment

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### Abstract

Lead toxicity in Bald Eagles (*Haliaeetus leucocephalus*) has been reported in the scientific literature for decades with much of the available information coming from eagles admitted to wildlife rehabilitation facilities. Knowledge accumulated over the years is a combination of experience and anecdotal information. The limited raptor-specific research publications on lead toxicity have focused more on sources of exposure than treatments or outcomes. Treatment protocols for lead toxicosis, often developed through extrapolation from the mammalian literature, have been refined using evidence-based medicine. There is a lack of data on the use of these drugs in raptors. Despite efforts at improving treatment, lead toxicity continues to carry a very poor prognosis in bald eagles due to permanent neurological and cardiovascular damage. Eagles with low level lead toxicity (<60ug/dL blood lead levels) have a similar successful outcome rate as eagles admitted without detectable levels of lead in their blood. Very few eagles are admitted and/or treated with moderate blood lead levels (60-100ug/dL) while those admitted with levels above 120 ug/dL have extremely poor outcomes. Using evidence-based medicine, The Raptor Center at the University of Minnesota (TRC) has developed triage criteria for lead-poisoned eagles based on blood lead levels, clinical pathology and physical exam findings, promoting timely decision-making and reducing unnecessary suffering. Additionally, for those eagles in which treatment is initiated, TRC has an established treatment protocol to optimize outcomes. These results can be used to improve triage and timely decision-making for bald eagles in wildlife rehabilitation.

## Current Status of Lead Poisoning in Eagles, in Japan

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### Abstract

The Steller's Sea Eagle (*Haliaeetus pelagicus*) and the White-tailed Eagle (*Haliaeetus albicilla*) winter in large numbers on the island of Hokkaido, Japan. Lead poisoning of Steller's Sea Eagles in Japan was first confirmed in 1996. Since then, 148 Steller's and 65 White-tailed Eagles have been diagnosed as lead poisoning fatalities. Also, 37 lead poisoned Mountain Hawk Eagles (*Nisaetus nipalensis*) were found in Hokkaido from 2003 to 2019. The primary source of lead exposure is from feeding on lead contaminated deer carcasses abandoned in the field by hunters, which have become a major food for eagles. The Japanese government reacted to eagle lead poisoning by regulating the use of lead rifle ammunition for Sika Deer (*Cervus nippon*) hunting in Hokkaido since the winter of 2000. From the winter of 2001, deer hunters have been required to use non-toxic rifle bullets or shotgun slugs. The same regulation for hunting bears began in 2004. The possession of lead ammunition during the deer hunting season has been banned since 2014. Recently, the number of lead poisoning events in eagles has obviously decreased in Hokkaido, but has not been eradicated. Our joint research revealed that two Mountain Hawk Eagles and two Golden Eagles (*Aquila chrysaetos*) had been lead poisoned on Honshu island where lead ammunition is still used legally. We conducted a trapping survey of the Mountain Hawk Eagle there to understand the occurrence of lead poisoning. Two of the six individuals caught in 2019 and 2020 were lead poisoned. The reasons that non-toxic ammunition has not spread in Japan are: 1) the price of a copper bullet is higher than lead, 2) the difficulty of obtaining non-toxic ammunition outside Hokkaido, 3) poor knowledge and awareness of lead poisoning among the hunters living outside of Hokkaido.

## Communication Strategies for Reducing Lead Poisoning Risks in Wildlife and Humans

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<sup>1</sup>University of Missouri, Columbia, MO, USA. <sup>2</sup>USGS Missouri Cooperative Fish and Wildlife Research Unit, Columbia, MO, USA

### Abstract

Although lead poisoning in North American waterfowl has been reduced, it persists among other wildlife. Despite substantial information about lead poisoning in wildlife, an explicit and strategic plan for using existing information to develop an effective communication program is lacking. Local and regional efforts encouraging hunters and anglers to voluntarily use non-lead alternatives could benefit from a nationally coordinated and strategic focus. We propose that the diffusion of innovation theory provides a useful framework for developing and implementing voluntary non-lead hunting ammunition and fishing tackle programs. The theory consists of all activities and effects occurring from the problem, research and development of the innovation, marketing of the innovation, rates of adoption, and consequences of adoption (both intended and unintended). Decisions are characterized by five stages: 1) acquisition of knowledge; 2) persuasion; 3) decision to adopt or reject; 4) implementation of decision; and 5) confirmation or reinforcement. By recognizing these stages, communicators can craft different messages aimed at specific audiences. These groups can then be categorized as 1) innovators; 2) early adopters; 3) early majority; 4) late majority; and 5) laggards or traditionalists. Change agents play a crucial role by being a catalyst for change by developing the need for change, building rapport among stakeholders, and make meaningful connections with target audiences. This framework can help communicators refine messages, increase efficiencies in developing communication materials, and monitor adoption of non-lead alternatives. The initial step in this process, however, is to engage stakeholders about the importance of the issue and leverage that concern as a catalyst for positive change.

## **Assessment of a Voluntary Nonlead Ammunition Outreach Program on Midwestern National Wildlife Refuges**

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### **Abstract**

Data suggest eagles are at risk of lead poisoning related to deer hunting. During 2016–2018, U.S. Fish and Wildlife Service (USFWS), established a program encouraging the use nonlead ammunition on 54 National Wildlife Refuges (NWRs). To assess the program, we used structured observations of nonlead presentations, semi-structured staff interviews, and an online survey of NWR staff. Objectives were to (1) explore attitudes and experiences of NWR staff implementing the program, (2) examine staff attitudes about threats to eagles, lead poisoning in eagles, human health risks, use of nonlead ammunition, and socio-economic factors, (3) examine factors influencing staff support, and (4) assess nonlead presentations. First, staff interviews resulted in 12 themes organized around three categories: (1) challenges within the agency, (2) effects of contextual factors on program implementation, and (3) the effect of different elements observed to be present/absent in successful voluntary conservation programs. Second, differences were found in attitudes among refuge staff who hunters and nonhunters, lead or nonlead ammunition use by hunters, and likely or unlikely future nonlead use. Third, the survey demonstrated program support was greatest among refuge staff who strongly agreed with problems related to eagles and lead exposure, individuals who strongly agreed with the importance of informational program materials, and individuals with greater innovation characteristics. Fourth, nonlead presentations discussing the issue were less than four minutes with minimal hunter interest observed. Results suggest additional training to increase staff knowledge and message credibility, audience segmentation with targeted messaging, and inclusion of human health lead risks. This study also showed nonhunters as an important target audience, especially human health lead risks. Fostering an appreciation for dealing with this complex socio-political issue composed of competing values, ethics, and worldviews may be important to achieving desired outcomes.

## Demographic Implications of Lead Poisoning for Eagles Across North America

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### Abstract

Lead poisoning occurs worldwide in populations of predatory birds, but exposure rates and population impacts are known only from regional studies. We evaluated lead exposure of 1,185 Bald Eagles (*Haliaeetus leucocephalus*) and Golden Eagles (*Aquila chrysaetos*) from 44 US states across North America. Preliminary interpretation of results suggests we detected unexpectedly high frequencies of both chronic (bone: 46-47%, Bald Eagle and Golden Eagles) and acute (liver, blood, and feather: 23-27% Bald Eagles, 7-35% Golden Eagle) lead poisoning of eagles. Frequency of lead poisoning always was influenced by age and, for Bald Eagles, by region and season. Continent-wide demographic modelling suggests poisoning at this level suppresses population growth rates for Bald Eagles by 3.8% (95% CI: 2.5%, 5.4%) and Golden Eagles by 0.8% (0.7%, 0.9%). Lead poisoning is an under-appreciated but important constraint on populations of these iconic protected species.

## Portable X-Ray Fluorescence Bone Lead Measurements of Live California Condors in Field to Assess Cumulative Lead Exposure

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### Abstract

Lead poisoning remains the leading cause of diagnosed death for the critically endangered California Condors (*Gymnogyps californianus*), which are annually monitored via blood tests for lead exposure. Blood tests are only reflective of more acute lead exposure events. Since California Condors are victim to chronic lead exposure, measuring bone, which is reflective of years to decades worth of exposure, is a much more valuable biomarker. In this study, we measured bone Pb of the tibiotarsus of 32 California Condors using a portable x-ray fluorescence device. Average uncertainty for measurements was found to be  $3.5 \pm 1.5$  ug/g bone mineral. The average bone lead level was found to be  $29.1 \pm 23.5$  ug/g bone mineral. Bone lead correlated significantly with average lifetime blood lead level ( $R=0.65$  p-value $<0.01$ ). Bone lead also correlated significantly with a summation of normalized annual blood lead levels identified over the lifetime of the bird ( $R=0.82$  p-value $<0.01$ ). This normalized annual blood lead level was taken as an average blood lead level per year if multiple tests were administered. In summary, bone lead is a viable biomarker in live condors to assess chronic, cumulative exposure to lead, which in the future can help to inform treatment planning and address more of the chronic health implications from lead in the species.

## Targeting Non-lead Ammunition Outreach as the Lead Threat Continues for Condors in Central California in the Pandemic Era

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### Abstract

Since 2019, we have documented an increase in California Condor (*Gymnogyps californianus*) fatalities in central CA due to lead poisoning. This increase came despite state laws requiring the use of non-lead ammunition for shooting wildlife, and our distribution of free non-lead ammunition to hunters and ranchers in the condor range. The increase coincided with implementation of state regulations governing ammunition sales and continued through the onset of the COVID pandemic. High demand for firearms and ammunition in the wake of the pandemic resulted in an unparalleled shortage of ammunition available for purchase. For much of 2020 and 2021, non-lead ammunition for most major calibers was scarce, especially two popular rimfire calibers, .17 HMR and .22 LR, that are widely used for controlling small non-game mammals on private ranches. With a limited supply of non-lead ammunition available, we prioritized distribution to local ranches where condors were likely to scavenge. We used condor movement data collected remotely by satellite GPS transmitters to identify rural land parcels where condors, including lead-poisoned birds, had been present on the ground, and likely feeding. We considered these properties to be potential sources of lead exposure, and we prioritized distribution of our limited rimfire stock to those landowners. While this data-driven, targeted approach to outreach can help reduce lead exposure, long-term recovery of the species will depend on improved market availability of non-lead ammunition and compliance with the laws requiring its use.

## Misled on Lead: Science Denial and Lead Ammunition

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### Abstract

The use of lead ammunition in the USA and the EU is considered the greatest, largely unregulated source of lead deliberately discharged into the environment. Although there is a scientific consensus that lead exposure from spent lead ammunition poses a health risk to both humans and wildlife, the issue has been highly politicized. Yet the topic of lead ammunition is not widely recognized as an issue of science denial. We identified rhetorical techniques used by the lead industry and lobbyist organizations that are consistent with science denial and misinformation in other domains including climate change, tobacco use, and COVID19. We illustrate examples of strategies to counter lead ammunition science denialism, including making the scientific consensus known, disclosing strategies and motives of denialism, inoculation, and debunking.

## Modeling Risk of Lead from Big Game Hunting to Fall-migrating Golden Eagles to Support Spatial Prioritization of Conservation Action

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### Abstract

Ingestion of lead (Pb) ammunition fragments from carcasses and offal of hunter-harvested big game animals is a major source of poisoning for Golden Eagles (*Aquila chrysaetos*), a raptor species of global conservation concern. Impacts may be elevated due to the overlap of many big game hunting seasons with the fall migration period, when more Golden Eagles from a wider geographic area are potentially exposed. Incentives for use of non-lead ammunition and removal of gut piles have been implemented proactively in some areas, and suggested as possible forms of compensatory mitigation to offset Federally permitted take of Golden Eagles. To maximize the effectiveness of conservation measures by targeting them in areas of greatest risk, we developed a spatial model of exposure of Golden Eagles to Pb during the fall migration season in a 573,286-km<sup>2</sup> area centered on Wyoming, USA and including portions of four surrounding states. We mapped relative risk by overlapping a predictive model of fall migration habitat for Golden Eagles with spatial data on density of big game harvest. Our results suggested areas of very-high risk were relatively rare (3%), while risk in most areas was classified as high (8%), moderate (11%), low (13%), very low (15%), or lowest (50%). The greatest concentration of risk was in the intermontane valleys of western Montana where a Golden Eagle migration corridor coincided with high hunter harvest rates. Risk among land surface management categories was generally proportional to their size, with the greatest amount of risk on Federal lands; however, land managed by Non-Governmental Organizations (primarily through conservation easements on private land) had high risk disproportionate to their area. The risk maps and associated data products from our analysis will be publicly available to support broad-scale spatial prioritization of management actions to reduce impacts of Pb on Golden Eagle populations.

## Bacterial Diversity in Captive and Free-ranging Andean Condors (*Vultur gryphus*)

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### Abstract

Microbiota resident in the digestive tract of birds play an important role in the physiology of nutrition, growth, and protection against other pathogens. However, excessive proliferation of some microbes can become harmful to the host. Vultures have adapted to deal with the toxic bacteria they incorporate and effectively digest, but due to their feeding habits and displacement capacity, they can play a role as reservoirs and disseminators of bacteria. The objective of this study was to describe the biodiversity of cultivable aerobic bacteria present in the gastrointestinal tract of 70 free-living Andean Condors (*Vultur gryphus*), and compare results with findings from 56 condors admitted for rehabilitation. In the oropharynx of free ranging animals, most frequent findings included *Staphilococcus*, *Micrococcus*, and *Bacillus* genera. Most prevalent genera from the anus were *Escherichia*, *Klebsiella*, and *Corynebacterium*. Enterobacteriae represented 50% of the isolations from the anus, but only 25% in oropharynx. Most common findings from the oropharynx from the rehabilitation group were *Staphilococcus*, *Escherichia*, and *Corynebacterium*, while *Escherichia*, *Enterococcus* and *Staphilococcus* were more common in the anus. For this group, enterobacteriae represented 50% of the genera identified in both anus and oropharynx, possibly related to both the change of diet and the use of space while being confined to human care. In the rehabilitation group, a single case of *Salmonella sp.*, and one of methicillin-resistant *S. aureus* were obtained, among other relevant findings. These results serve as a reference to findings that could be expected when working with free ranging Andean Condors, addressing new questions related to changes in bacterial prevalence and their possible association with subclinical health conditions.

## **Powerline Solutions**

**50**

### **Wildland Fires Ignited by Avian Electrocution**

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#### **Abstract**

Uncontrolled wildfires are occurring with increasing frequency across western North America due to a combination of historic wildfire suppression, climate change, invasive beetles, and human population growth in fire-prone landscapes. A poorly studied mechanism of wildland fire ignitions occurs when a bird perched on an overhead powerline is electrocuted, its plumage ignites, and the burning bird falls into and ignites dry vegetation. These ignitions have been occasionally documented, but not spatially analyzed in the contiguous United States. We hypothesized that spatial analysis could demonstrate specific regions where ignitions from avian electrocutions may be more frequent. To test our hypothesis, we compared public reports of wildland fires ignited by bird electrocutions to Environmental Protection Agency ecoregions. We found reports of 46 wildland fires ignited by avian electrocutions in the contiguous US from January 2014–December 2018. The Mediterranean California ecoregion had the highest density of these wildland fires. Electric utilities in the Mediterranean California ecoregion in the US, and in fire-prone landscapes globally, should include in their fire mitigation plans, a focus on modifying power poles to reduce risk of avian electrocutions and resulting wildfires.

## **How Can My Voice Be Heard in Environmental and Social Impact Assessments?**

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### **Abstract**

The objective of this presentation is to inform raptor experts how they can contribute to the ESIA process and have influence. The presentation will address the following: What is ESIA? What does it have to do with Birds, Transmission and Distribution lines and Electrocutation? Why do it? Who requires it, when and where? How can one become aware of proposed projects? The presenter will discuss how those who care about raptors as experts, firms, or NGOs, can ensure that ESIA's consider: (i) alternatives for siting lines to avoid or reduce electrocution and collision; (ii) linking direct impacts to indirect and induced habitat (e.g., access roads and increased access); (iii) socio-economic effects; (iv) construction techniques and timing to reduce impacts on habitat and reproduction, (v) mitigative measures, e.g., building in adequate clearances for electrocution and deploying appropriate line-markers for collision and (vi) maintenance and monitoring.

## Mortality Rate of Raptors on Medium Voltage Power Lines in Slovakia: Conflicts and Solutions

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### Abstract

We conducted research focused on mortality rate of raptors caused by 22 kV power lines in 13 Special Protection Areas in Slovakia under LIFE Energy project. It was the most comprehensive and systematic study of its kind ever carried out in Slovakia. In the period between 12/2014 and 02/2016, 5,211 km of power lines were inspected twice during two periods (12/2014-03/2015 and 04/2015-02/2016) of field survey. As a result, 2,992 bird carcasses and bird remains representing 35 bird species and 10 bird orders were identified. Raptors were associated with 40% of all identified victims of electrocution representing 14 bird species and 3 orders. Two peaks of incidence were recorded, in March and in September predominantly featuring electrocution of raptors. The Common Buzzard (*Buteo buteo*) was the most common detected and associated with 85.39% (1,023 ind.) of all identified electrocution of raptors (n = 1,198). Metal branch pylons and corner pylons with exposed jumper wires passing over insulators above the cross-arms were the most dangerous configuration, accounting for 34.72% of total recorded electrocution fatalities (0.13 carcass/pole). Altogether 78.24% of bird carcasses were found under non retrofitted poles, 5.05% under poles with a damaged product and 3.07 % under poles where the product was installed incorrectly. Cases of electrocution were also recorded for two bird species of major conservation concern in Slovakia: Saker Falcon (*Falco cherrug*) with 14 identified carcasses and Eastern Imperial Eagle (*Aquila heliaca*) with 16 identified carcasses. Lowest risk was identified for protective products which allow birds to perch safely. The results and methods are replicated and adopted in ongoing LIFE Danube Free Sky project, representing an example of wide transnational cooperation of 15 beneficiaries from 7 countries along the most important migration corridor, Danube river. The project has received funding from the LIFE Programme of the European Union.

## **Raptors' Electrocution, a Spread Poorly Known Environmental Problem in Argentina**

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### **Abstract**

Despite improvements in the identification of dangerous designs and the retrofitting of many electrical pylons in developed countries, thousands of birds die electrocuted worldwide every year. The situation is much worse in the developing world, where this problem is rarely assessed. A small number of reports and studies exist for South America where the problem is still mostly out of the environmental agenda. Here we provide some data on electrocution events recorded opportunistically in different provinces of Argentina. We recorded birds' electrocution events in 10 provinces and five bird families with no previous records. So up to now electrocution events have been recorded in 13 of the 23 provinces implicating up to 11 bird families. Most birds were raptors (86.8%) that were found in 11 provinces, followed by parrots (11.4%) and herons (0.6%). The new records are in line with previous studies that showed that concrete pylons with jumpers above the crossarm or with vertical insulators are the most dangerous designs although three events occurred on pylons with transformers. In general, dangerous pylons are a small fraction of most power lines, although in some specific lines all the pylons were dangerous. Dangerous pylons were identified in areas where Black-chested Buzzard Eagle and Variable Hawk congregate, highlighting hotspots where power lines retrofitting could have a stronger improvement on raptors survival. However, retrofitting of dangerous pylons should be also prioritized in important areas for endangered species such as the Chaco Eagle. There is a general lack of knowledge about the problem by environmental authorities of regional governments, by the electricity companies and by environmental impact assessors imply that this threat is almost entirely overlooked in the country and thus specific awareness campaigns and training workshops on the problem are urgently needed.

## **Adaptive Management for Electrocution Mitigation in Bonelli's Eagle: Successes and Future Challenges**

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### **Abstract**

Mortality caused by power lines is a major threat to raptor species conservation. However, our understanding of how to optimize the implementation of mitigation actions is still partial, which limits our capacity to implement effective mitigation campaigns over extensive power line networks. Adaptive management (AM) is based on an iterative learning-based decision making, so it offers a suitable framework to improve the effectiveness of future mitigation actions. Therefore, it is critical that mitigation actions are well planned and that main conservation targets are monitored before and after the implementation of measures. Here, we focus on the Bonelli's Eagle (*Aquila fasciata*), a threatened species in Europe, to illustrate several examples of successes in the mitigation of electrocution on this species in Catalonia (NE Spain). To assess the effectiveness of actions we monitored whether: 1) retrofitted pylons were effective at reducing the number of casualties; and 2) demographic parameters of target populations were restored after mitigation actions were done. Our results illustrate that retrofitting was highly effective both to reduce raptor electrocution and to restore survival to levels that guarantee the long-term viability of our target population. Even so, we detected several weaknesses to suitably monitor and to implement mitigation actions at a broader spatial scale, which include: 1) the standardization of protocols of casualties monitoring; 2) the estimation of baseline levels of electrocution of target species; and 3) the recording and sharing of databases on electrocution casualties and the type of corrections implemented between conservation actors (e.g. managers, companies and researchers). Based on our experiences, we develop an AM framework for electrocution mitigation that accounts for the mentioned weaknesses and that we are currently implementing in our study area. Overall, we highlight that AM provides a powerful framework to improve our understanding to effectively mitigate this threat on raptor species.

## The Threat of Power Lines to Two African Vulture Species

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### Abstract

Animal behavior and distribution are constantly influenced and under pressure by anthropogenic disturbances (e.g., habitat loss, poaching, climate change, etc.). Vultures are known as the cleanup crew that limits the spread of diseases by removing carcasses and recycling nutrients back into the food web, but are considered as one of the most threatened taxa. Our study aims to classify a vulture power line crossing density map across South Africa to implement the necessary proactive mitigation strategies to make power lines more vulture safe. Our study provides further support that African White-backed (*Gyps africanus*) and Cape Vultures (*Gyps coprotheres*) spend approximately 33.1% and 6.7% of their time in protected areas, respectively. Furthermore, our analysis indicates that power line incidents are found in close proximity to colonies and vulture restaurants. As in the previous study, our analysis shows that vultures are more likely to be electrocuted by distribution lines and more likely to collide with transmission lines. Our study concludes that power lines pose a real threat to African Vultures. Our study suggests that proactive mitigations should, as a starting point, be concentrated around vulture restaurants and colonies. However, other hotspot regions within their ranges need to be determined to implement the necessary mitigations further.

## **Developing a National Guideline for Mitigating Avian Electrocutions and Collisions in Iran**

MAHMOOD KOLNEGARI<sup>1</sup>, JAMES F DWYER<sup>2</sup>

<sup>1</sup>Iran's Birds and Power Lines Committee, Arak, Iran, Islamic Republic of. <sup>2</sup>EDM International, Fort Collins, CO, USA

### **Abstract**

Electrocutions and collisions of birds on power lines is an emerging concern in Iran where approximately 82 million people rely on a power grid consisting of 127,581 km of transmission lines and 815,367 km of distribution lines. Iran's Birds and Power Lines Committee (IBPLC) has been formed to address concerns regarding wildlife interactions with power lines, including raptor electrocutions. Dr. Mahmood Kolnegari heads the IBPLC. Dr. Kolnegari's publications on wildlife's interactions with power lines include diverse topics, ranging from documentation of carnivorous mammal electrocutions resulting from animals climbing pylons to completing the first installation and documentation of effectiveness of line markers to reduce avian collisions. With regard to avian electrocution documentation and mitigation, Dr. Kolnegari has published original research in the Journal of Raptor Research describing how installing nest boxes on a power line increased Common Kestrel nesting, reduced electrocutions, and reduced electrical faults. Other research includes documenting avian electrocutions occurring on three-phase transformer arcing horns. Across publications, Dr. Kolnegari has documented electrocutions of 114 raptors of 20 species. These findings, among others, such as documentation of grass fires ignited by birds burned during electrocutions, have led the IBPLC to develop a National Guideline for Mitigating Avian Electrocutions and Collisions in Iran. The National Guideline is the first of its kind in the Middle East, reflecting Iran's leadership and commitment to biodiversity conservation, and helping to standardize how Iran's electric utilities anticipate, understand, and respond to incidents. One of the keys to success for the IBPLC and the National Guideline is that both rely on frequent two-way communication with members of Iran's many electric power utilities. In this presentation, we will summarize key findings of Dr. Kolnegari's research, and describe the IBPLC and the National Guideline.

**The Material Science Behind Raptor Covers and What to Look For (Revised)**

STEPHEN PARKER

TE Connectivity, Fuquay-Varina, NC, USA

**Abstract**

Distribution power line poles with limited clearances between energized and grounded components increase electrocution risk to animals, including perching and nesting birds. Animal-caused outages often result in damaged equipment and loss of service to customers. According to the Institute of Electrical and Electronics Engineers (IEEE 2011), equipment most often damaged are bushings and insulators. Besides direct damage to insulators, faults can cause stress in other equipment, such as transformers and breakers, reducing the longevity of equipment and sometimes resulting in complete equipment failure. Migratory bird electrocutions can also be prosecuted under the Migratory Bird Treaty Act (MBTA). Animal-caused faults are of unique concern because many are preventable and present an opportunity to improve system reliability. Fortunately, protective covers to address wildlife interactions with power lines are readily available for a broad array of applications. In 2019 the Electric Power Research Institute (EPRI) published a compendium of animal-caused outage prevention products, which provided a list of 347 commercially available products. Selecting the proper mitigating measures is critical for a long-term solution. Products must properly cover exposed hardware and be easy to install. They must be durable and have superior mechanical and electrical properties. This presentation focuses on the construction and material science of raptor covers that are commonly used on power poles to eliminate bird electrocutions. Discussion will include raptor-friendly pole framing, available industry resources, and product selection.

## Global Problems of Bird Electrocution - Case Study of Saker in Mongolia

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<sup>1</sup>International Association for Falconry and Conservation of Birds of Prey, Warsaw, Poland. <sup>2</sup>Mongolian Falconers' Association, Ulanbaatar, Mongolia

### Abstract

With Saker ranges across 80 states of Eurasia and Africa, electrocution is globally a top threat according to the CMS Saker Global Action Plan. A significant problem is that breeding adults are electrocuted and this leads to devastating population impacts. The IAF proposed a IUCN 2016 Resolution on preventing electrocution by appealing to the financing institution to include electrocution mitigation protocols with new or renovated power lines. The Mongolian Falconers Association started 2017 project to retrofit dangerous poles of one most dangerous line near Ulanbataar, Argalant sum (30km of medium-voltage lines - 156 concrete poles). Plastic tubes around metal cross-arms were used and second pin insulators on top of the poles added. This would serve as a pilot for large MBZRCF project which would cover all dangerous Mongolia lines. Survey before retrofitting conducted of six field trips / May 2017 – July 2018/. Ten species electrocution were recorded with 268 dead specimen (128 Sakers), average 44,7 birds/ 21,3 Sakers per trip. Survey after retrofitting conducted of seven field trips / September 2018- September 2020/. Electrocution of six species recorded, total 40 dead specimen /four Sakers/, average of 5.7 birds/ 0.7 Sakers per trip. Five species recorded also in first survey, one new corvid species (chough). Dead birds were found almost exclusively under special poles. The rate of electrocution for all species declined by 86.9%, while for just the Saker the decline was 97,3%. The lowest decline observed for carrion crow and common raven, an increase was observed for black kite (with very low figures). Retrofitting method used proved to be very effective for raptors (90.7%), less effective for corvids (70.9%), but with significant average electrocution decline for all species. This is evidence of inexpensive technology to get extremely effective results which will last until the insulation finally degrades.

## Global Problems of Bird Electrocution, and the Role of Financial Institutions to Reverse it

JANUSZ SIELICKI

International Association for Falconry and Conservation of Birds of Prey, Warsaw, Poland

### Abstract

Numbers of electrocuted birds globally are difficult to estimate, but electrocution of a large number of breeding adults has devastating impacts on populations. Falconers in the 1970s were among the first to notice the problem of electrocution when falconry birds were electrocuted. To address the problem of electrocution, The International Association of Falconers (IAF) and ICBP (International Council for Bird Preservation) co-sponsored the 1st World Conference on Birds of Prey in Vienna in 1975. Papers by Nelson & Nelson on bird electrocution were presented, and it was especially interesting that trained birds were used to test mock-ups of power lines to detect dangerous construction types. In 2016 IAF proposed a resolution on preventing electrocution, adopted at World Conservation Congress. The main idea was to appeal to institutions that finance the development of electrical infrastructure when considering new construction or renovation of electrical distribution lines. IAF prepared the special brochure in 16 languages and published it on-line (<http://birdelectrocution.org/>). The website presents information on different aspects of the electrocution problem and gives information on possible solutions. IAF works with EBRD, the International Finance Corporation, and the World Bank, on guidance for preventing electrocutions on distribution lines. Discussions with bank specialists proved that existing specialized guidance is too difficult to understand and there is need for simple and short guidance for non-specialists. The preliminary document is available online. The main aims are bird safety for new and re-constructed lines. IAF proposed to include bird electrocution into IFC guidelines and the process continues. The final guidance may be available by the time of this conference. Importantly, electrocution is the top threat to the Saker falcon (*Falco cherrug*) globally, as stated in the Saker Global Action Plan of the CMS.

## Electrocution and Collision on Power Lines: a Potential Threat to Raptors and Other Birds in Nepal

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### Abstract

Mortality of birds from electrocution or collision with the power lines has been recognized as a significant human-induced threat worldwide, especially for raptors. Inadequate power line designs could increase the electrocution or collision risk for birds resulting in injuries and deaths. In this study, we present the first report on mortality of raptors and other birds due to electrocution and collision on power lines in Nepal. We conducted power pole surveys in lowlands, as well as middle and high mountain ranges. We also incorporated mortality data from satellite-tracked raptors and opportunistic observations. We conducted a survey of 440 power poles and found 44 electrocuted birds (0.1 bird/pole) including 6 raptors (0.01 raptor/pole). The greatest mortality rate of raptors was 0.07 raptor/pole around Pokhara and followed by Lumbini (0.01 raptor/pole). Among non-raptors, the highest mortality (0.6 bird/pole) was in Tribhuvan University Kathmandu. We reported seven raptor species that died due to electrocution; Himalayan Vulture (*Gyps himalayensis*) with highest cases ( $n = 6$ ), White-rumped Vulture (*Gyps bengalensis*), Himalayan Buzzard (*Buteo refectus*), Steppe Eagle (*Aquila nipalensis*), Mountain Hawk-Eagle (*Nisaetus nipalensis*), Black-winged Kite (*Elanus caeruleus*), Barn Owl (*Tyto alba*); and another six non-raptor species; 3 species of corvids (with highest cases,  $n = 33$ ), Common Pigeon (*Columba livia*), Indian Pond Heron (*Ardeola grayii*), and Common Myna (*Acridotheres tristis*). Similarly, one Bearded Vulture (*Gypaetus barbatus*) and three Sarus Cranes (*Grus antigone*) died due to collision. Detection and scavenger rates were not quantified meaning these were minimal estimates and the real number killed per month is unknown. Our result suggests that the existing and growing network of power lines in Nepal could be a significantly important threat to birds. Electrocution seems to be a more critical concern than collision. We encourage the implementation of mitigation measures and national regulations to conserve endangered species of raptors and other birds.

# Prairie Falcons

199

## Prairie Falcon (*Falco mexicanus*) Abundance in the Morley Nelson Snake River Birds of Prey National Conservation Area is Greater Now than During 1974-2003

STEVEN ALSUP<sup>1</sup>, JIM BELTHOFF<sup>2</sup>, TODD KATZNER<sup>3</sup>, KAREN STEENHOF<sup>4</sup>, MICHAEL KOCHERT<sup>3</sup>

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### Abstract

The river canyon in the Morley Nelson Snake River Birds of Prey National Conservation Area (NCA) supports one of the world's highest densities of nesting Prairie Falcons and an estimated ~5% of the species' global population. Prairie Falcon abundance and reproduction were studied in the NCA from 1974-2003. However, populations were not monitored for the subsequent 15 years. In 2019 and 2020, we used a stratified random subsampling approach to assess Prairie Falcon territory occupancy and nesting success along 10 5-km river segments that constituted ~30% of the Snake River Canyon. Results based on this sample extrapolated to ~300 occupied Prairie Falcon territories in the entire NCA, and this compared to the estimated 200-220 between 1974-2003. To confirm the apparent increased abundance in 2019 and 2020 compared to the 1974-2004 timeframe, and to evaluate an alternative hypothesis of shifts in distribution leading to the higher 2019-2020 estimates, we completed a full-canyon (160-km) survey of Prairie Falcon nesting territories in 2021. Preliminary analysis of 2021 counts indicate a number close to the estimates in 2019 and 2020. Nesting success based on observations at 50 occupied territories per year was 54%, 72%, and 60% in 2019, 2020, and 2021, respectively, which are rates generally as high or greater than when last measured in in 2002 (58%) and 2003 (42%) and are within the confidence interval of the long-term average of 63% ( $\pm 14$ ) previously reported for 1974-1997. These results indicate that the number of occupied Prairie Falcon nesting territories in the NCA did not decline between 2003 when last surveyed and in 2019-2021. Instead, it appears that increases in abundance have occurred while nesting success remained within long-term average rates.

## A Prairie Falcon Update in Nevada, USA

JOSEPH G BARNES

Nevada Department of Wildlife, Reno, USA

### Abstract

The Prairie Falcon (*Falco mexicanus*) is a widely distributed species across Nevada in areas with suitable nest cliffs and nearby foraging habitat in the Mojave and Great Basin deserts, and is a Species of Conservation Priority in Nevada's 2012 State Wildlife Action Plan (SWAP). Recognized conservation challenges include impacts from industrial scale renewable energy projects, conversion of arid landscapes to exotic grasslands, and contamination from poisoning and shooting ground squirrels. The Nevada Department of Wildlife (NDOW) is tasked with ensuring healthy populations of all of the state's wildlife, and our statewide raptor nest database is the primary repository of confirmed or suspected Prairie Falcon nest locations. The NDOW raptor nest database includes records of confirmed ( $n = 712$ ) or suspected ( $n = 465$ ) Prairie Falcon nests since 1969, although the data has largely been collected incidentally, and there has not been a comprehensive statewide survey effort to date. Prairie Falcon nesting records largely reflect the agency's emphasis of raptor surveys in general, with 215 records documented in the 1970s, and 267 confirmed records since 2010. While occurring across Nevada in a range of habitat types, a statewide population estimate should be considered loosely, with any population trend data generated outside of species-specific survey efforts (e.g., avian point count surveys). A recent comparative study of Mojave Desert birds in Nevada and California (Iknayan & Beissinger 2018) yielded a site persistence probability decline of 93% from the early 1900s to early 2000s. Territorial interactions have been equivocal between the two species, but I have documented an increase from 20 to 88 known Peregrine Falcon (*Falco peregrinus*) breeding territories in Nevada from 2006–2021. I recommend a statewide breeding population survey initiative, ideally as part of a region-wide effort across the species' breeding range.

## Preliminary Results on the Phylogenetics and Population Structure of the Prairie Falcon (*Falco mexicanus*) with Management Implications

DOUGLAS A BELL<sup>1</sup>, JACQUELINE M DOYLE<sup>2</sup>, JOSEPH E DiDONATO<sup>3</sup>, LARRY LaPRE<sup>4</sup>, GAVIN EMMONS<sup>5</sup>, PETER H BLOOM<sup>6</sup>, AMY L FESNOCK<sup>7</sup>, TODD E KATZNER<sup>8</sup>, KOLBE LEONARD<sup>2</sup>, PHILLIP SAN MIGUEL<sup>9</sup>, RICK WESTERMAN<sup>9</sup>, J. ANDREW DeWOODY<sup>9</sup>

<sup>1</sup>East Bay Regional Park District, Oakland, USA. <sup>2</sup>Towson University, Baltimore, USA. <sup>3</sup>Wildlife Consulting and Photography, Ferndale, USA. <sup>4</sup>Bureau of Land Management, Moreno Valley, USA. <sup>5</sup>Pinnacles National Park, Paicines, USA. <sup>6</sup>Bloom Research, Inc., Los Angeles, USA. <sup>7</sup>Bureau of Land Management, Sacramento, USA. <sup>8</sup>United State Geological Survey, Boise, USA. <sup>9</sup>Purdue University, West Lafayette, USA

### Abstract

We undertook genetic analyses of the Prairie Falcon to elucidate its phylogenetic relationship to other *Falco* species and its population structure. We sequenced the genome of a female Prairie Falcon to generate a 1.17 GB draft genome assembly. Phylogenetic analysis of nuclear protein-coding genes and complete mitochondrial genomes indicate that the Prairie Falcon is an outgroup to the clade that includes the Peregrine Falcon (*Falco peregrinus*) and taxa in the subgenus Hierofalco. Using the draft genome assembly, we annotated >16,000 presumptive genes and nearly 600,000 single nucleotide polymorphisms (SNPs). We then developed an SNP assay featuring >140 gene-associated markers and a molecular-sexing marker. We used the SNP assay to genotype over 100 individuals from three regions in California (the San Francisco East Bay Area, Pinnacles National Park, Mojave Desert) and Idaho (Snake River Birds of Prey National Conservation Area). Results from a test for genetic structure reveal a single, randomly mating population of Prairie Falcons across our sample locations. This implies that the Prairie Falcon is panmictic, a finding that aligns with incidental band recoveries. Overall, our data provide key insights into Prairie Falcon biology and natural history that may be important for the conservation and management of the species. For example, Prairie Falcons sampled in the three sub-regions of California could potentially be managed as one population. Thus, at the local level, actions such as cessation of applications of rodenticides could influence Prairie Falcons state-wide. Similarly, impacts from mortality caused by renewable energy projects could have negative effects far beyond the local population.

**Status of the Prairie Falcon (*Falco mexicanus*) in California: The Great Unknown!**

DOUGLAS A BELL<sup>1</sup>, GAVIN EMMONS<sup>2</sup>, LARRY LaPRE<sup>3</sup>, JOSEPH E DiDONATO<sup>4</sup>, CARRIE BATTISTONE<sup>5</sup>, AMY L FESNOCK<sup>6</sup>

<sup>1</sup>East Bay Regional Park District, Oakland, USA. <sup>2</sup>Pinnacles National Park, Pinnacles, USA. <sup>3</sup>Bureau of Land Management, Moreno Valley, USA. <sup>4</sup>Wildlife Consulting and Photography, Ferndale, USA. <sup>5</sup>California Department of Fish & Wildlife, Sacramento, USA. <sup>6</sup>Bureau of Land Management, Sacramento, USA

**Abstract**

To our knowledge, no systematic, state-wide survey of prairie falcons in California has been undertaken since the 1970s. That survey resulted in a state-wide estimate of approximately 520 territorial pairs. In 2004, Partners in Flight published a California population estimate of 2,900 prairie falcons. Some regions of the state have been surveyed or monitored to varying degrees of coverage. We report here on the following regions and surveys. At Pinnacles National Park, up to 25 historical nesting territories, with a range of 7-14 occupied nesting territories, have been intensively monitored annually since 1987. In the San Francisco East Bay Area, up to 32 historical and newly discovered nesting territories, with a range of 6-12 occupied nesting territories, have been monitored annually since 2004. In the Mojave Desert, up to 21 nesting territories have been surveyed sporadically since 2007.

## Insights Into Prairie Falcon Ecology From Continental-Scale Banding Data

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<sup>1</sup>Sparrowhawk Data Science, Reno, USA. <sup>2</sup>Owyhee Desert Studies, Murphy, USA

### Abstract

Despite being widespread and locally common within western North America, we know relatively little about the overall population status, population trends, characteristic demographic vital rates, and range-wide space use of the Prairie Falcon (*Falco mexicanus*). To better understand Prairie Falcon ecology at a continental scale, we examined the North American banding records available from the USGS Bird Banding Laboratory. The earliest banding record dates to 1928, but we focused on records from 1960 to the present. Preliminary mark-recapture analysis of this extensive (20,289 birds banded) yet sometimes sparse data set (612 individuals recaptured or recovered dead at least one calendar year after banding) suggested that annual apparent survival rates could vary greatly between years, especially for first-year birds. The maximum distance between initial banding location and eventual reporting location was over 2,900 km, but the mean distance was 249 km (95% CI, 0 - 1238 km). Birds initially banded as nestlings or first year age class were reported at longer distances from their initial banding location (mean of 314 km [0 - 1304] versus 122 km [0 - 1020]). Similarly, birds that were reported as dead when found were farther from their initial banding location than those who were reported as still alive (mean of 384 km [0 - 1500] versus 117 km [0 - 744]). Prairie Falcons in the eastern portion of their range tended to be recovered farther from their initial banding location. We intend for our findings to provide context for future targeted studies of this species' demography and population trends, as well as to suggest potential research questions.

## The Status of Prairie Falcons Nesting in Colorado

APRIL ESTEP<sup>1</sup>, WILLIAM KEELEY<sup>2</sup>

<sup>1</sup>Colorado Parks and Wildlife, Colorado Springs, CO, USA. <sup>2</sup>City of Boulder Open Space and Mountain Parks, Boulder, CO, USA

### Abstract

Colorado Parks and Wildlife (CPW) has been monitoring Prairie Falcons (*Falco mexicanus*) for many years as part of a multi-species monitoring plan for the state. The Prairie Falcon is a Tier 2 species in the State Wildlife Action Plan, warranting concern for the species, but it is not one of the state's main priorities. CPW monitors 138 nesting sites throughout Colorado, documenting activity at nest sites. City of Boulder has been monitoring a handful of Prairie Falcon nesting sites since 1990. In Boulder, at a local scale with a limited sample size, Prairie Falcon nesting attempts and reproductive output are decreasing whereas Peregrine Falcon (*Falco peregrinus*) nesting attempts and productivity are increasing.

## Status Of Prairie Falcon Populations in New Mexico

GAIL L GARBER, TREVOR W FETZ

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### Abstract

The status of Prairie Falcon (*Falco mexicanus*) in New Mexico has been poorly documented. We reached out to all raptor researchers and requested information from the New Mexico Avian Conservation Partners, but this yielded no studies of the species or anecdotal information about population trends. For over 20 years, Hawks Aloft, Inc. (HAI) has conducted two raptor monitoring projects that document the status of Prairie Falcon in portions of New Mexico. HAI monitored populations of nesting raptors, including Prairie Falcon, during 14 years between 2000-2020 for the Bureau of Land Management in Taos County, New Mexico. Inconsistent funding precluded surveys and resulted in reduced survey effort in some years. Annual documented active nests and territories ranged from 2 - 8 between 2000-2020, with a decrease since 2013. Prairie Falcon presence was consistent between 2017-2020 (n = 4 nests and active territories/ year), but lower than earlier years. HAI also conducted point count transects for raptors in the Middle Rio Grande and Estancia valleys of NM since 1995. In the Estancia Valley since 1996, annual summer Prairie Falcon densities varied per 100 miles from 0 - 5 birds, while annual winter densities varied from 1 - 11 birds per 100 miles. The summer density trend was relatively stable, while the winter density trend showed a decrease. In the Middle Rio Grande Valley, surveys began on the Armendaris Ranch route in 2007. Annual summer density varied from 0 - 12 birds per 100 miles, while winter density varied from 0 - 15 birds per 100 miles. Summer density has decreased over time, with no detections in 2017 - 2020. Winter density has shown a slight increase, with an average of 10 birds per 100 miles in 2019. Given the paucity of recent research on Prairie Falcon in New Mexico, we recommend an increase in monitoring throughout the state.

**Most Adult Alberta Prairie Falcons are Non-travelers.**

GEOFF HOLROYD<sup>1</sup>, DALE PATON<sup>2</sup>, HELEN TREFRY<sup>1</sup>

<sup>1</sup>Beaverhill Bird Observatory, Beaver County, Canada. <sup>2</sup>Anatum Ecological Consulting, Pincher Creek, Canada

**Abstract**

Previous studies of Prairie Falcons have shown migrations of falcons within the western US and Canada. Since juvenile falcons migrate from Alberta south into the western US and adult falcons from Idaho moved into prairie Canada post fledging, we explored the movements of breeding falcons within prairie Canada. We attached 18 PTT satellite transmitters to breeding falcons in southern Alberta. One falcon migrated to Clifton, Kansas. Only three of the falcons moved outside their breeding territories during the post breeding season and one moved over 100km for the winter. Given the harsh winter weather in prairie Canada, the lack of a migration to warmer climes indicates that some other factor is limiting their movements. We suggest that limited nest sites encourage falcons to stay on territory. Increases in over-wintering waterfowl at anthropogenic sites may facilitate over-wintering in southern Alberta.

## Status of Prairie Falcons in Alberta

JOHN CAMPBELL<sup>1</sup>, GEOFF HOLROYD<sup>2</sup>

<sup>1</sup>none, Pincher Creek, Canada. <sup>2</sup>Beaverhill Bird Observatory, Beaver County, Canada

### Abstract

The Prairie Falcon (*Falco mexicanus*) is listed as a Sensitive species in Alberta. The 2018 status report estimated the Alberta population to be 200 pairs. This is the bulk of the Canadian population with small numbers occurring in Saskatchewan and possibly British Columbia. Its dependence on a restricted number of river nesting sites and Richardson's Ground Squirrel (*Urocitellus richardsonii*) prey make it vulnerable to cumulative changes in an already endangered prairie landscape. Systematic surveys to determine population trends for the provinces are not currently done. However, surveys have been carried out on select portions of several Alberta Rivers over the past decades by volunteer banders. We present occupancy and productivity trends collected from 1970 to 2021 and discuss regional and historical changes and challenges. We also compare occupancy of artificial nest sites to natural sites.

## Foraging Strategies, Habitats and Conservation of Alberta Prairie Falcons

LAURIE HUNT<sup>1</sup>, GEOFF HOLROYD<sup>2</sup>

<sup>1</sup>Northern Alberta Institute of Technology, Edmonton, Canada. <sup>2</sup>Beaverhill Bird Observatory, Beaver County, Canada

### Abstract

Conservation of cliff nesting raptors requires an understanding of their key prey, their foraging habits and the available suitable prey habitats that are adjacent to limited suitable nest sites. We studied the diet of Prairie Falcons (*Falco mexicanus*) on the Bow River in southern Alberta through the collection of prey remains and direct observation of feeding of nestlings. The diet from prey remains was biased to birds. Based on direct observations 68% of the diet was Richardson Ground Squirrel (*Urocitellus richardsonii*) with sex based differences depending on the nestling stages. We used VHF radio telemetry to determine the foraging home ranges of each adult. The foraging distances varied by prey type and by adult sex; thus home ranges varied through the nesting season. Since Prairie Falcons nest on cliffs the suitable habitat must be maintained close to prairie rivers in Alberta. While foothill habitats appear secure with livestock grazing, lower elevation sites are adjacent to irrigated cropland jeopardizing the future of these falcons.

## Status of Prairie Falcons in British Columbia

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<sup>1</sup>Beaverhill Bird Observatory, Beaver County, Canada. <sup>2</sup>J Hobbs Ecological Consulting, Pender Island, Canada

### Abstract

The Prairie Falcon (*Falco mexicanus*) has been on the Red List in British Columbia (BC) as a candidate for Threatened or Endangered status assignment for over a decade, with no action taken. The 2004 status report estimated the BC population to be 20 pairs; however, a province wide survey in 2005 located only five pairs. Further, three nests were detected during a province-wide survey in 2010, only one nest was detected in a 2015 survey (same area) and, again, only one Prairie Falcon nest was located during the province-wide survey in 2021. Causal factors for this decline are unclear because no research has been conducted in BC and no funding has been allocated towards the investigation of this trend. We present occupancy data collected intermittently over the past century to demonstrate that this species is almost extirpated in BC.

## **Brief Review of the Limited Information on Prairie Falcons (*Falco mexicanus*) in Arizona**

KENNETH V JACOBSON

Arizona Game and Fish Department, Phoenix, USA

### **Abstract**

Prairie Falcons (*Falco mexicanus*) can be encountered throughout Arizona at any time of the year with a greater abundance during the fall migration and winter seasons when resident individuals and northern migrants co-inhabit the state. During this time of greater abundance, prairie falcons are primarily encountered in grassland and agricultural habitats. The most concerted effort to document prairie falcon nesting was from 1993 to 2000 through the Arizona Breeding Bird Atlas where evidence of breeding was detected in 101 (6%) of the 1834 priority survey blocks. Of these, breeding activity was confirmed in 20 blocks (20%), probable in 15 (15%), and possible in the remaining 66 (65%). The highest concentrations of breeding territories were in the Sonoran Deserts of Southwestern Arizona and on the Colorado Plateau in Northeastern Arizona. In the southwestern regions, nesting activity has been documented as early as January. In the rest of Arizona, pairs typically occupy territories in February to March with egg laying from March to April. Fledging of young typically occurs from May through June. More recently while conducting statewide aerial nest surveys for golden eagles (*Aquila chrysaetos*) from February to June each year from 2011 - 2021, the Arizona Game and Fish Department recorded 104 opportunistic sightings of Prairie Falcons including four detections of breeding behavior (incubation or nestlings) and 12 sightings of pairs of falcons (suggestive of breeding). A majority of the sightings (~62%) occurred in the Sonoran and Mojave deserts of southwestern to northwestern Arizona. Northeastern Arizona on the Colorado Plateau was not included in the survey. Additional information on Prairie Falcon nesting is opportunistically available through coordinated bird surveys in Important Bird Areas and voluntary public reports to eBird.

## **Nesting Prairie Falcon (*Falco mexicanus*) Movement Ecology: How Individual Predators Use Disturbed Landscapes in Southwest Idaho.**

EDEN S RAVECCA<sup>1</sup>, TODD E KATZNER<sup>2</sup>, TREVOR CAUGHLIN<sup>3</sup>, STEVEN ALSUP<sup>1</sup>, MATTHEW J STUBER<sup>4</sup>, KEVIN S WARNER<sup>5</sup>, JENNYFFER CRU<sup>1</sup>

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<sup>3</sup>Boise State University, Boise, USA. <sup>4</sup>U.S. Fish and Wildlife Service, Division of Migratory Birds, Medford, USA. <sup>5</sup>Idaho Army National Guard, Boise, USA

### **Abstract**

Habitat loss and modification remain key drivers of global species declines and extinction. In particular, habitat change as a result of anthropogenic disturbance is an amplifying concern, with its cascading effects posing complex challenges for conservation. Restoration aims to counteract impacts of disturbance by restoring degraded habitats, often assuming that if plant communities recover, prey and predators will naturally repatriate. The associated benefits of recovered plant communities for predators is seldom evaluated, yet is important in ensuring that restoration promotes entire ecosystem function. In 2021, we deployed GPS-GSM telemetry units on ten Prairie Falcons and tracked their movements late into the nesting season. Each falcon collected fixes at two-second intervals while in flight up to three times per week. Using natural recovery as a proxy for successful long-term restoration, we evaluate how the legacy of habitat change in the sagebrush steppe has influenced predator foraging decisions after decades of disturbance within the Morley Nelson Snake River Birds of Prey National Conservation Area. We address questions including: How do Prairie Falcons currently use the landscape within their home range? What factors drive foraging decisions? Are there significant differences among individuals in their foraging movements? To answer these questions, we estimated home range and foraging area of falcons, as well as the influence of current land cover types, prey abundance, and legacy of habitat change. We expect individuals will forage in similar habitats, preferring stable native conditions over recovering or declining habitats. We also expect wide differences in home range and foraging area extents among individuals. Preliminary analysis suggests individual falcons repeatedly travel up to 20 km from the nest site several times per day on foraging trips. Project findings should guide future conservation and restoration strategies that ensure benefits can scale up to higher trophic levels and promote overall ecosystem health.

## Prairie Falcons in Oregon

FRANK B ISAACS<sup>1</sup>, KAREN STEENHOF<sup>2</sup>

<sup>1</sup>Oregon Eagle Foundation, Philomath, USA. <sup>2</sup>Boise State University, Boise, USA

### Abstract

The Prairie Falcon (*Falco mexicanus*) was described as a “common permanent resident of eastern Oregon” in “Birds of Oregon” published in 1940, “widespread east of the Cascades” based on Breeding Bird Survey results for 1995–1999, and breeding “throughout the open country east of the Cascades” in “Birds of Oregon: A General Reference” published in 2003. Even though breeding has been very rare west of the Cascades, Prairie Falcons have been documented wintering both east and west of the Cascades during East Cascades Audubon Society Winter Raptor Surveys. There has not been a statewide survey of nesting, however historical nest records exist in agency files, and many nesting locations were documented during statewide Golden Eagle nest searches and monitoring from 2011 to 2020.

## Status of Prairie Falcon Populations and Monitoring in Wyoming, USA

ZACH P WALLACE<sup>1</sup>, ROBERT J OAKLEAF<sup>2</sup>, JOHN R SQUIRES<sup>3</sup>

<sup>1</sup>Wyoming Natural Diversity Database, University of Wyoming, Laramie, USA. <sup>2</sup>Wyoming Game and Fish Department, Lander, USA. <sup>3</sup>Forestry Science Lab, Rocky Mountain Research Station, Missoula, USA

### Abstract

Prairie Falcons (*Falco mexicanus*) occur year-round in Wyoming, USA, breeding and wintering in the extensive grassland and shrubland habitats of the state, and migrating over mountainous areas. Breeding has been documented in all 28 of Wyoming's latitude-longitude degree blocks, with most nests on cliffs and some in trees. The Wyoming Natural Diversity Database ranks Prairie Falcon as apparently secure in its breeding and wintering ranges, and the species does not have conservation status or designations in the state beyond protection under the Migratory Bird Treaty Act. Broad-scale monitoring programs suggest apparent stability or increases in Prairie Falcon abundance in Wyoming in recent decades, but data are too sparse to provide reliable information on population status. The North American Breeding Bird Survey estimated an annual increase of 0.7% from 1966–2019 (95% CI: -0.43 to 1.84, N: 93 routes), the Integrated Monitoring in Bird Conservation Regions program estimated a mean trend of 1.02 from 2009–2020 (95% CI: 0.85–1.20, N: 31 individuals), and HawkWatch International reported apparently stable trends for the species at their Commissary Ridge migration count site. Prairie Falcons were the subject of several studies by the University of Wyoming in the 1980s and 90s that provided regional information on habitat selection, home range size, food habits, and found no apparent negative effects of oil and gas development or experimental harvest of nestlings for falconry. Various agencies and entities monitor nest sites as part of land-use planning and compliance, but no coordinated monitoring occurs across the state. Stressors related to degradation and fragmentation of habitat may impact Prairie Falcons in Wyoming less than other areas due to the relatively high intactness of the state's landscape, while other known hazards like electrocution, illegal shooting, and collisions likely affect populations.

## **Prairie Falcon Monitoring History, Uncertain Status, and Survey Needs in Washington State, USA**

JAMES W WATSON, GERALD E HAYES

Wash. Dept. Fish and Wildlife, Olympia, WA, USA

### **Abstract**

The Prairie Falcon (*Falco mexicanus*) nests in the Upper Columbia Basin in Washington along canyon rims and on glacial till throughout the basin. In 1971, records compiled largely from the falconry community identified 162 nesting territories and occupancy was 86% at 99 territories. Washington Department of Fish and Wildlife (WDFW) conducted statewide surveys in 1986 and 1988 when territory occupancy was found to be 35% and 43%, respectively, and the species was classified as common. However, during the last 30 years anecdotal observations indicating an absence of falcons at historical scrapes, along with the concurrent recovery of Peregrine Falcons (*F. peregrinus*) and decline of two native ground squirrel species prompted us to initiate a prairie falcon occupancy survey in 2017. From 2017-2019 volunteers determined occupancy at 113 of 278 historical territories presently identified by WDFW, and only 14 territories were occupied (12%). We report results of 2021 occupancy surveys, discuss survey needs, and implications of the apparent decline of the species in Washington.

## **Prairie Falcon Monitoring Needs in Utah and Trends from HawkWatch International's Migration Network**

JESSE L WATSON

HawkWatch International, Salt Lake City, USA

### **Abstract**

The Prairie Falcon (*Falco mexicanus*) can be found year-round throughout Utah. Despite large portions of the state providing suitable nesting habitat, little is known about their abundance, distribution, and status. Historical data is scant, limited to incidental breeding records predating the mid-2000s. I report on incidental nesting records collected during HawkWatch International (HWI) Golden Eagle (*Aquila chrysaetos*) nest surveys and give a brief synopsis of Prairie Falcon observations collected by community scientists through Ebird. Prairie Falcons are infrequent migrants across the HWI migration network, so passage rates yield little insight into trends in western North America. To improve our understanding of the species' status in Utah, I recommend establishing a comprehensive database for tracking incidental reports of scrape locations and occupancy that would provide a future baseline for longer-term, standardized trend surveys.

## **Status of Prairie Falcons in Saskatchewan, Canada**

DAN ZAZELENCHUK

none, Kyle, Saskatchewan, Canada

### **Abstract**

In 2021 I banded nestling Prairie Falcons at seven territories along the South Saskatchewan River/Lake Diefenbaker system and one territory along the Battle Creek of the Milk River Watershed (two of the four areas where the species has nested historically in Saskatchewan). Banding data from 1992 to 2021 along the South Saskatchewan River system suggests stable to a slightly declining population along that system.

# **Raptor Propagation**

**73**

## **Captive Breeding As A Tool For Endangered Species Conservation**

DANIEL J CONE

World Bird Sanctuary, St. Louis, USA

### **Abstract**

For over forty years, World Bird Sanctuary has bred endangered raptor species from around the world. Our emphasis on conservation breeding is the driving force in our collection plan, and leads our resource allocation more directly toward saving species. Over the course of four decades, our organization successfully bred and released over one thousand American Barn Owls in the state of Missouri, resulting in their delisting from the state's endangered species list. As the species has improved, our resources are shifting to combatting the decline of endangered vulture species.

## Raptor Propagation at the World Center for Birds of Prey

CAROLINA GRANTHON

The Peregrine Fund, Boise, USA

### Abstract

The Peregrine Fund has been breeding raptors for conservation for over 50 yr. We have hatched, raised, and released numerous species of raptors such as the Aplomado Falcon (*Falco femoralis*), Harpy Eagle (*Harpia harpyja*), and Mauritius Kestrel (*Falco punctatus*), and pioneered many propagation techniques that are still in use today. Most noticeable are our propagation efforts in favor of the Peregrine Falcon (*Falco peregrinus*), producing over 4,000 birds for release, which played an important role in their removal from the US Endangered Species List. Currently, our propagation efforts at The World Center for Birds of Prey are two-fold: the recovery of the California Condor (*Gymnogyps californianus*), and propagation of the Taita Falcon (*Falco fasciinucha*). The California Condor is critically endangered and relies heavily on field management and captive propagation. We house the largest captive population of California Condors in the world at our headquarters in Boise, ID, and have produced over 300 young for release over the past 25 yr. We focus on hands-on management of all eggs produced and hands-off management of all birds, providing an undisturbed environment for our birds to breed and raise their young. Additionally, The Peregrine Fund recently pioneered the use of unpaired adult condors as foster parents. This approach enhances our ability to produce as many young condors as possible that can be raised by conspecifics, and have the highest chance of success after release. Our Taita Falcon population is small and experimental, allowing us to explore propagation techniques. Moving away from our historical focus on artificial insemination and hand rearing, we aim for our pairs to hatch and raise their own young successfully. This approach helps us develop additional tools for future propagation needs, as well as a self-sustaining falcon population that requires few resources and limited human intervention.

## White-tailed Sea Eagle Reintroduction to Ireland: Restoration of a Large Avian Apex Predator

ALLAN MEE<sup>1</sup>, TORGEIR NYGÅRD<sup>2</sup>, CLARE HEARDMAN<sup>3</sup>

<sup>1</sup>Golden Eagle Trust, Limerick, Ireland. <sup>2</sup>Norwegian Institute for Nature Research, Trondheim, Norway.

<sup>3</sup>National Parks & Wildlife Service, Cork, Ireland

### Abstract

White-tailed Sea Eagles (*Haliaeetus albicilla*) were extirpated on the island of Ireland in the early 20<sup>th</sup> century largely due to human persecution. Along with Golden Eagles (*Aquila chrysaetos*), the last known nest sites were in remote coastal and upland sites. Following research and consultation into the feasibility of reintroduction, 100 chicks were collected from nests in Norway and released in Killarney National Park in SW Ireland. Patagial tagging and VHF/GPS satellite tagging allowed us to monitor birds post-release, identify areas important for birds during the pre-breeding years, locate breeding pairs as well as identify mortality factors. Tagging at nests since 2013 has allowed us to track Irish bred birds with the first of these now reaching breeding age. Birds made large-scale movements within Ireland but also to northern Scotland and England. Timing of dispersal of release vs Irish bred Sea Eagles varied widely between individuals: Birds of Norwegian origin dispersed much earlier than Irish bred ones. Birds returned to breed predominantly south to south-west of the release area despite large-scale dispersal in 2<sup>nd</sup> to 4<sup>th</sup> calendar years. Most birds settled to breed <30km of the release area with a smaller cohort settling 120-160km from the release area. Thirty-five young have fledged to date (2013-2021) but productivity (mean 0.33 young/terr. pair) and fledged brood size (1.2 young/succ. nest) remains lower than the reintroduced Scottish population. Restoring a top avian predator/scavenger requires long-term commitment. Re-establishment is threatened mainly by anthropogenic factors (eg., poisoning) but new threats (e.g., avian influenza and wind-turbines) may arise to impact population recovery and viability.

## Captive Propagation of North American Accipiters and Prospective Reproductive Technologies for Raptor Breeding

JOHN E PARKS<sup>1</sup>, BEAU E PARKS<sup>2</sup>

<sup>1</sup>Raptor Insights, Inc., Chapel Hill, USA. <sup>2</sup>San Diego Wildlife Alliance, San Diego, USA

### Abstract

Captive propagation of raptors on a scale meaningful for species conservation was famously implemented during the recovery and ultimate delisting of the once-endangered Peregrine Falcon (*Falco peregrinus*). Techniques and procedures for raptor breeding have since been applied successfully by private and institutional breeding programs to a broad range of raptor species for their conservation, educational exhibition, and use in falconry. Typically, captive breeding is accomplished by (1) pairing compatible male and female adults in an aviary of appropriate design and space and applying requisite husbandry procedures or (2) collecting semen from cooperative male raptors imprinted on humans and artificially inseminating cooperative egg-laying female imprints housed separately. Captive breeding Accipitrine raptors presented special challenges related to their limited availability in the early 1990's and recalcitrant disposition in captivity. At Cornell University, a project was initiated to breed North American Accipiters (Sharp-shinned Hawk (*Accipiter striatus*, SSHA), Cooper's Hawk (*Accipiter Cooperii*, COHA), and North American Goshawk (*Accipiter gentilis*, NOGO)) using compatible pairs, mostly acquired as non-releasable, non-imprinted rehab cases, and paired in large aviaries designed for breeding raptors. Four pairs of COHA fledged 16 young between 1994-1999, eight SSHA pairs fledged 58 young between 1994-2002, and four goshawk pairs fledged 26 young from 1996-2005. Most young were released by hacking; some were retained as breeders. During the past 20 yrs, many raptor breeders have effectively produced Northern Goshawks (North American and other subspecies) primarily through artificial insemination with imprinted males and females. Evolving reproductive technologies such as semen cryopreservation, in vitro fertilization, and germ cell transplantation have potential as conservation tools to facilitate propagation of raptors and other avian species.

## **Propagation and Conservation of The Puerto Rican Sharp-shinned Hawk (*Accipiter striatus venator*): Utilizing Captive Raptor Propagation Techniques in a Field Environment**

HANA WEAVER, JULIO GALLARDO, MELISSA MURILLO, RUSSELL THORSTROM  
The Peregrine Fund, Boise, USA

### **Abstract**

Hurricanes are the most important natural disturbance and species in the Caribbean, such as the endangered and endemic Puerto Rican Sharp-shinned Hawk (SSHA, hereafter), have evolved to cope with the outcomes of such events. However, compounding effects of habitat change (e.g., deforestation and human sprawl), increase in nest infestation by *Philornis spp.*, and nest predation have hindered the ability of the SSHA to recover from natural disturbances. In 2017, the already small population was further depressed to 19 observed individuals (2017, n= 75) following Hurricane Maria. This category 5 storm crossed the last stronghold of the SSHA destroying large expanses of mature montane forest, habitat that the species depends on. The increase of canopy openings and changes in forest structure after the hurricane resulted in a significant reduction of suitable habitat and might trigger the observed increase of nest failure. It was feared that these circumstances might jeopardize the long-term viability of the SSHA's populations. In 2018, a conservation effort began with the goal of increasing SSHA productivity through propagation and management of wild nesting pairs. Known captive raptor propagation techniques such as double clutching, artificial incubation, hand-rearing and hacking were adapted to a field based recovery project. These techniques increased productivity of breeding pairs, reduced the risk of egg and nestling fatalities, and further increased fledging success of wild and hacked young. Hatchability of artificially incubated eggs has increased from 75% (n=8) in 2018 to 100% (n=11) in 2021 with no nestlings lost after hatch. The success of this recovery effort relies heavily on accurately interpreting breeding behavior of SSHA in the field, perceptive understanding of how Accipiters interact with their environment (particularly during the branching and fledging life-stages), and the ability to quickly adapt and adjust protocols based on moment-to-moment observations and surrounding environmental complications.

# Steppe Ecosystems

116

## Migration of Steppe Eagles (*Aquila nipalensis*) from Mongolia

NYAMBAYAR BATBAYAR

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### Abstract

The Steppe Eagle is one of the complete long distance migratory large eagles in Eurasia. They breed in southwestern Russia across Kazakhstan, Kirgizstan, into Mongolia and northeast China. Two races of Steppe Eagle are considered intergrading around the west of Russian Altai: western - (*A. n. orientalis*) and eastern - (*A. n. nipalensis*). Migrations of western Steppe Eagles that breed in southern Russia and Kazakhstan have been documented through satellite tracking studies. All tracked birds wintered in the Arabian Peninsula and Africa. However, very little was known about the migration of Steppe Eagles from the eastern breeding range. We captured and GPS marked 18 individual Steppe Eagles from the central

part of Mongolia between 2015 and 2018. Five individuals were 2<sup>nd</sup> calendar year birds, and the remaining 13 individuals were nearly or recently fledged young eagles. The average weight of the birds was 3000 g (with min 2005 g and max 4400 g). All eagles flew in a southwest direction across central Mongolia and continued flying west of Turfan Depression and Tarim Basin, and the eastern part of the Tibetan Plateau. Steppe Eagles crossed the Himalaya Mountains and wintered in Myanmar, Bangladesh, Assam, Uttar Pradesh, and Uttarakhand states of India, and Pakistan. None of the eagles we tracked wintered in Nepal, but they all passed through this country during both spring and autumn migrations. Because all birds were non breeding birds, they wandered widely during the breeding season. Their foraging range stayed within Mongolia exploiting areas infested with voles and gerbils.

## Migration of Black-eared Kites *Milvus migrans lineatus* in East Asia Revealed by GSM-GPS Telemetry

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<sup>1</sup>Wildlife Science and Conservation Center, Ulaanbaatar, Mongolia. <sup>2</sup>Max Planck Institute for Ornithology, Konstanz, Germany. <sup>3</sup>Korea Institute of Environmental Ecology, Daejeon, Korea, Republic of. <sup>4</sup>Research Center for Eco-Environmental Sciences, Chinese Academy of Sciences, Beijing, China

### Abstract

The Black-eared Kite *Milvus migrans lineatus* is a long-distance migratory raptor in Asia. Despite numerous observations of this species at their breeding and wintering grounds, the migration paths and timing of this species is not well known in East Asia. We used GPS telemetry to track migration of 33 Black-eared Kites (23 adults and 10 juveniles) captured in western, central and eastern Mongolia. Autumn migration lasted 26 days on average. It started in mid-September (range: 7 - 23 Sep) and birds arrived at their wintering ground in mid-October (range: 26 September - 4 November). Distances of autumn migration were ~3,500 km, from central Mongolia to Bangladesh and northeast India. Spring migration lasted 24 days on average. It started at the end of March (range: 26 March - 30 April) and ended with the bird's arrival in central or eastern Mongolia in mid-May (range: 28 April - 16 May). Migration paths were in general the same during both autumn and spring and in both years. The birds traveled through central Mongolia, the eastern Tibetan Plateau, and the southern and southeast end of the Himalayan Mountains. Juvenile kites wandered widely in the summer of their second year, some of them reaching eastern Mongolia and the Lake Baikal region. Adults did not wander, and their movements were restricted to nesting territory. Tracking migration of Black-eared Kites reveals that foraging behavior of urban kites are associated with cities at both wintering and summering areas. Comparing migration of kites that inhabit natural and urban areas might be of importance to understand the foraging strategy of this species.

## Change in Breeding Pattern and Numbers of Lesser Kestrel on the Steppe Plains of Kazakhstan after Collapse of Human Population

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<sup>1</sup>Naurzum State Reserve, Kostanay, Kazakhstan. <sup>2</sup>GAUK «Don heritage», Rostov-on-Don, Russian Federation

### Abstract

The range of Lesser Kestrel (*Falco naumanni*) covers virtually all the arid steppe of Kazakhstan. However, the species is distributed very sporadically and constrained by the distribution of suitable nesting sites. During 2003-2016, we surveyed the southern Kostani Region for kestrels. Historical records suggest that in the middle of the 20th century, in this region the density of the Lesser Kestrel was very low. Those historical nesting records were all of small groups or solitary pairs in cavities of isolated derelict mausoleums or houses, and occasionally in older settlements and or cliffs. Over time many of these structures were destroyed due natural causes, but new structures built recent time no longer had cavities suitable for kestrel nesting.

Nest availability changed in the 1990s, after economic collapse of the Soviet Union, and in conjunction with migration of people from villages to cities. Abandoned settlements and isolated houses rapidly became attractive for Lesser Kestrels, and we regularly found colonies, mainly under slate roofs, of from 2 to 40 pairs. On surveys in 2003 and 2007-2009, once rare Lesser Kestrels were the second most common raptor species representing 28.3% of 1656 individual raptors counted.

During the period 2013-2016, structures were degraded enough to no longer effectively support kestrel nesting. Nevertheless, colony locations have remained in the same places. During this later period, > 82% of nests were located on a ground, under sheets of slate or metal, inside tires, or in piles of broken slates and bricks. The largest of these colonies included ~46 pairs of kestrels. This situation shows the remarkable plasticity in nesting behavior of Lesser Kestrels, but it also highlights potential vulnerability of the species to economic change and, in the current situation, to threats from ground predators that can destroy nests.

## **The Initial Investigations for Breeding Lesser Kestrel (*Falco naumanni*) in Mongolia: Characteristics of Reproduction and Migration**

ONOLRAGCHAA GANBOLD

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### **Abstract**

I monitored a breeding population of Lesser Kestrels in Ikh Nart Nature Reserve (INNR), Mongolia beginning in 2007. Here, I report findings from the breeding seasons of 2012-2014, and partially published reproduction data in *Ornithological Science*. At the culmination of this three-year investigation, I found that Lesser Kestrels laid eggs between 24 May and 2 June each year, with mean clutch size of  $4.0 \pm 0.7$  SE eggs. The overall hatching success rate was 84.2% (214 of 254 eggs), whereas an overall fledgling success rate of 89.7% (192 of 214 nestlings), that resulted for a mean of 2.79 fledglings per breeding pair. There were 62 mortalities recorded of which 40 were unhatched eggs, and the remaining were 20 nestlings that died from 1 to 10 d of age. In addition, I gathered important information on species migration when I placed light sensitive data loggers on three adult Lesser Kestrels. The data loggers showed that this small falcon migrates to central Africa from our study site at Ikh Nart Nature Reserve, Dornigobi, Mongolia. The three kestrels each arrived to different wintering ranges in central Africa: Kestrel-A wintered in Sudan, Angola and the Democratic Republic of the Congo; Kestrel-B wintered in Chad, Congo, Cameroon, the Central African Republic, and the Democratic Republic of the Congo; Kestrel-C spent the winter season in Ethiopia, Kenya, and Tanzania. This research was the first to study the breeding biology and migratory movements of Lesser Kestrels in southeastern Mongolia. The information gathered in this study will improve the conservation of this small falcon locally and globally.

## Breeding Biology, Dispersal and Hybridization of Eastern Imperial Eagles and Steppe Eagles in Central Anatolia

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<sup>1</sup>MME BirdLife Hungary, Budapest, Hungary. <sup>2</sup>Hortobágy National Park Directorate, Debrecen, Hungary. <sup>3</sup>Ministry of Forestry and Water Affairs, Ankara, Turkey. <sup>4</sup>Hacettepe University, Ankara, Turkey. <sup>5</sup>BirdLife Austria, Wien, Austria. <sup>6</sup>Russian Raptor Research and Conservation Network, Novosibirsk, Russian Federation

### Abstract

The breeding distribution and population size of the globally 'Vulnerable' eastern imperial eagle (*Aquila heliaca*) was poorly known in Turkey. Besides, the status of the 'Endangered' steppe eagle (*Aquila nipalensis*) was even more unclear, as the regular breeding of the species was not proved in the last decades and the nearest known Russian breeding areas are 1500 km far to the west. BirdLife Hungary, with the support of volunteers and cooperating organizations executed 15 expeditions including 133 field days between 2007 and 2019 in order gather data on the status of the two species in Central Anatolia. The surveys resulted in location of 128 imperial eagle nests in 77 different territories within the provinces of Bolu, Ankara, Eskisehir, Cankiri and Corum. The surveys were extended to the provinces of Kirsehir, Aksaray and Konya from 2015, where 26 nests in 12 active steppe eagle territories have been found. The successful breeding of an imperial-steppe eagle hybrid male with an imperial eagle female was found in 2012, which was the first proved hybridization between the two species in the world. The dispersal and migration of 11 imperial eagles, 6 steppe eagles and 2 hybrid fledglings have been tracked with GPS transmitters. Imperial eagles showed regional dispersal within Anatolia, while the steppe eagles and the hybrids migrated to the Sahel for wintering. The surveys also highlighted significant threats to these eagle populations, like electrocution, shooting, massive habitat alteration and infrastructural developments. Therefore, intensive further studies, including active species and habitat conservation measures are inevitable for the maintenance of these globally significant Anatolian eagle populations.

## Steppe Eagle (*Aquila nipalensis*) in Russia: Population Status and Conservation Actions

IGOR KARYAKIN<sup>1</sup>, ELVIRA NIKOLENKO<sup>1</sup>, ELENA SHNAYDER<sup>1</sup>, ILYA SMELANSKY<sup>1</sup>, ANNA BARASHKOVA<sup>1</sup>,  
LUDMILA ZINEVICH<sup>2</sup>

<sup>1</sup>Siberian Environmental Center, Novosibirsk, Russian Federation. <sup>2</sup>Koltzov Institute of Developmental Biology of Russian Academy of Sciences, Moscow, Russian Federation

### Abstract

Steppe Eagles once inhabited the steppe zone of USSR from Ukraine to Dauria, Russia. However, populations have declined rapidly since the 1990s. In western Russia, the population has declined by ~ 90% over 30 years, from 15,000–20,000 pairs in the 1980s–1990s to about 1,200–1,900 pairs in 2014. The eastern Russia population is larger and the current population estimate for the entire country is about 2,600–3,900 breeding pairs. There are three small and declining breeding groups in eastern Russia, in the Republic of Kalmykia (405–720 pairs), and in the Volgograd and Orenburg Regions (300–500, and 200–350 pairs, respectively). These European populations appear to persist largely because of inflow of floaters from Western Kazakhstan. The largest remaining, and the only stable, breeding population is in eastern Russia, in the Altai-Sayan Ecoregion (1,335–1,680 pairs); there are also two small eastern populations in the Baikal Region and in Dauria. The collapse of the Steppe Eagle population in Russia is related to large-scale habitat loss caused by changes in agricultural and grazing practices, decline of the main prey species, Ground Squirrels (*Spermophilus* spp.), and electrocution on power lines. However, the population declines observed in Siberia, where anthropogenic pressure is low, suggest substantial pressures on Steppe Eagles during non-breeding seasons and life stages. One possibility is that diclofenac affected Steppe Eagles; once veterinary use of the drug was banned in India, the rate of decline of the eagle population slowed. Conservation actions for Steppe Eagles in Russia involve establishment of nature reserves, retrofitting of dangerous power lines, and providing breeding sites that protect nests from fires. Finally, recent telemetry studies revealed that juvenile Steppe Eagles that originate from Russia spend their first summer predominantly in Kazakhstan, giving this country a key role in the fate of the species.

## Saker Falcon in Russia in the 21st Century: Population Trend, Threats, and Conservation

ELVIRA NIKOLENKO, IGOR KARYAKIN, ELENA SHNAYDER  
Siberian Environmental Center, Novosibirsk, Russian Federation

### Abstract

The Saker Falcon (*Falco cherrug*) is given endangered status on the IUCN Red List, with an overall population decline of 47% from 1993–2012. Since the mid-20th century, the Saker population in Russia has declined by 80%, from 9,000 to 2,000 breeding pairs. The Russian part of the Altai-Sayan Ecoregion (ASER) holds the largest remaining breeding population of this species, making up >80% of the remaining population in Russia. We have conducted regular surveys of these birds to track population trends, identify threats, and take conservation measures. From 1999 to 2019 ASER population decreased by 45%, from 2056 (1962–2150) to 1130 (1076–1179) breeding pairs. The main threat facing this population is the illegal trapping of female Sakers for use in falconry in the Middle East. Because of this activity, males occupy breeding territories for, on average, 10 years, while turnover rate of females is high, with most birds not lasting >2 years on a territory. Because of the active conservation measures we have implemented, other threats generally accepted as key factors in the global population decline are currently of marginal importance in the ASER. For example, for 10 years we have worked with power grid companies to retrofit dangerous power lines, and since 2006, we have built artificial nests to encourage traditionally cliff-nesting Sakers to use nests in trees. Finally, we have worked extensively with customs police to increase anti-poaching activity.

## Supporting the Breeding Success of Rare Species of Raptors in the Steppe Habitats of the Tuva Republic, Russia, via Nest Boxes and Artificial Breeding Platforms

ELENA SHNAYDER, ELVIRA NIKOLENKO, IGOR KARYAKIN  
Siberian Environmental Center LLC, Berdsk, Russian Federation

### Abstract

After the collapse of the Soviet Union a major part of the agricultural and electrical infrastructure in the Tuva Republic has been degraded or destroyed. While pylons of powerlines, power grid transformer boxes, and trees in shelterbelts provide nesting sites for different species of raptor, the destruction of the infrastructure deprives birds of breeding substrates in steppe areas. Thus, despite suitable prey abundance and low levels of persecution, populations of raptors in the Tuva Republic have declined rapidly. Since 2006, the RRRCN has instituted a project to erect artificial breeding platforms in Tuva to provide raptors with a breeding substrate in two independent sample plots (630 km<sup>2</sup> and 700 km<sup>2</sup>). The platforms were positioned regularly to fill in gaps in raptor distributions that were identified with a GIS-model that incorporated the average distance between neighboring pairs in native populations and distribution of the remaining nests on cliffs. In the initial years of the study, between 2006 and 2009, 109 platforms were erected. Four years later, 86.6% of those platforms were used as nesting sites by raptors. Among the main users, there were two target species - Upland Buzzard (*Buteo hemilasius*) (72.5% of all known pairs in sample plots were found on our platforms) and Saker Falcon (*Falco cherrug*) (57.1%). Black-eared Kites (*Milvus migrans lineatus*) were also common users (45%). Implementation of this program resulted in increases in the number and breeding success of these species. Thus, the project was continued in 2011 with the addition of 100 new platforms. In 2014, 60% of all platforms were occupied by breeding raptors and the density of Saker Falcons reached 2.06 pairs per 100 km<sup>2</sup>, and Upland Buzzard density was 10.93 pairs/km<sup>2</sup>. The project was continued in 2018-2021 by addition of 25 platforms, 55 large, and 22 small nest boxes.

## Acceptance type: Poster

210

### Comparing Apples to Oranges: What is the Relative Nutritive Value of Avian and Rodent Prey to an Apex Arctic Predator?

SEBASTIAN ACEVEDO<sup>1,2</sup>, MICHAEL T HENDERSON<sup>3</sup>, DAVID L ANDERSON<sup>3,1</sup>

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#### Abstract

Effective conservation and management of raptors necessitates an understanding of their diet and feeding habits, especially in environments highly susceptible to anthropogenic change. The Gyrfalcon (*Falco rusticolus*) is an apex avian predator of the Arctic tundra ecosystem that specializes on Willow Ptarmigan (*Lagopus lagopus*), Rock Ptarmigan (*L. muta*), and Arctic ground squirrels (*Urocitellus parryii*). Gyrfalcon habitat and dietary specialization make them particularly susceptible to changing prey distributions and abundances resulting from climate induced landscape changes, yet the relative nutritive value of their primary prey types is poorly understood. We compare the nutritive value of Ptarmigan vs. Ground Squirrels collected from the Seward Peninsula, Alaska. We quantified the edible biomass of 15 Ptarmigan and eight Ground Squirrels through lab dissections, and obtained protein, fat, and energy values from tissue assays. With the edible biomass and nutritive profiles obtained, we will compare these nutritive variables via tests of significance. We will then use seven yrs of Gyrfalcon nesting data in conjunction with our results to determine if Gyrfalcons experience greater productivity when provisioning diets dominated by Ptarmigan or Squirrels. Our findings will elucidate how Gyrfalcons may be affected by altered prey abundances and distributions in a changing ecosystem, particularly if the prey type most susceptible to population changes is also the most nutritious primary food source.

## Predicting the Potential Distribution of the Lanner Falcon on the Arabian Peninsula: Implications for its Conservation Management

BUSHRA I ALABDULHAFITH<sup>1</sup>, GIOVANNI LEONARDI<sup>2</sup>, ALBARA M ALOTHMAN<sup>1</sup>, SUSAN M HAIG<sup>3</sup>, MATYAS PROMMER<sup>4</sup>

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### Abstract

The Lanner Falcon (*Falco biarmicus*) is a widespread species that occupies a vast geographical area including the entire African continent, part of Mediterranean Europe and the Middle East. The high environmental heterogeneity within this broad distribution exerted different selection pressures especially at the margin of a species' distribution where populations may have a lower fitness, being negatively affected by sub-optimal or harsh environmental conditions. Lanner Falcon nest sites ( $n = 25$ ) were sourced from the extensive field survey made in Saudi Arabia in 2015. An additional 17 nests were considered from archival data retrieved from comprehensive reviews. Thirty-five bioclimatic and topographic variables were obtained from the WorldClim (v2.1) and the ENVIREM datasets. After removing highly correlated variables, eight climatic variables only were included as predictors. SDM maps were fit using MAXENT, a robust algorithm with good prediction accuracy even at low sample sizes. The predictive map suggests a potential distribution of the Lanner Falcons that runs from north to south along the eastern coast of the Red Sea. The Hijaz and Sarawat mountains from the western Saudi Arabia to Yemen seems to be the most suitable areas for breeding. The terrain roughness index (TRI) contributed the most to the breeding range model predictions, indicating a high preference for lowland flat areas with very low terrain complexity. Other predictors include precipitation of coldest quarter (Bio19) and isothermality (Bio3). This falcon is recently considered a near-extinct species in the Arabian Peninsula and the breeding population show a fragmented structure due to sub-optimal conditions. The resilience of this species in the area depends also on conservation issues and public awareness in order to avoid loss of sub-adult floaters and nesting pairs.

## Managing Human/Golden Eagle Conflict: Best Practices for Relocating Golden Eagles

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<sup>1</sup>Colorado State University Pueblo, Pueblo, USA. <sup>2</sup>International Eagle Austringers Association, Montana, USA

### Abstract

Golden Eagle (*Aquila chrysaetos*) depredation on sheep is causing a significant human wildlife conflict that is negatively impacting ranchers and eagles. Identifying and introducing best conservation practices for eagle relocation can help reduce this conflict, and in turn improve the economic livelihood of the ranchers, while reducing potential eagle impacts. The objective of this research is to identify quality habitat areas that meet specific conditions to relocate eagles and then understand how habitat and distance from trap sites effect spatial patterns once released. We are sampling vegetation, prey abundance, human disturbance, and eagle nest densities at randomly selected, spatially balanced sample sites to identify appropriate habitat and to aid in release site selection. We are trapping 12 eagles per year and fitting them with cellular GPS transmitters that will provide insight into their movement patterns and habitat preference after relocation. Eagles will be relocated at distance intervals, ranging from 100-400 miles. We will then identify movement patterns over time, so we can determine if the eagles return to the depredation area or stay at the relocation site. Hoping to find resources that keep eagles on the relocation site, we will rank resource selection models using Akaike's Information Criterion to determine habitat preference. The management application for this project is to identify best practices for eagle relocation to reduce persecution as well as gain further insight into their spatial ecology. This project will help facilitate a long-term cooperative effort between falconers, biologists, and ranchers.

## **Annual Survival of Black Vulture and Turkey Vulture in Southeastern Pennsylvania**

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### **Abstract**

Populations of Black Vultures (*Coragyps atratus*) and Turkey Vultures (*Cathartes aura*) are increasing in many parts of their range, including Pennsylvania, however annual survival within these increasing populations remains unknown. Black and Turkey vultures were trapped at feeding or nesting sites from September 2008 through October 2020 and resightings were collected from September 2008 through June 2021. A total of 46 adult, 24 second-year and 19 hatch-year Turkey Vultures and 57 adult, 18 second-year, and 61 hatch-year Black Vultures were fitted with uniquely numbered patagial tags. Total resightings numbered 1263, 284 Turkey Vultures resightings and 979 Black Vultures resightings, representing 59% and 77% of tagged Turkey Vultures and Black Vultures respectively. We will use program MARK to estimate annual survival among age classes for both species.

## Do Barn Owls Flock To Idaho Only To Meet Their Demise? An Analysis Of The Geographic Origin Of Road-killed Owls Along An Interstate Highway.

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### Abstract

Barn Owls (*Tyto alba*) are frequent casualties of roadway mortality throughout their global range. One of the world's highest rates occurs along Interstate 84 (I-84) in southern Idaho, USA. We were interested in the extent to which dead Barn Owls were locally produced or if they arrived from wider geographic extents, which is important for quantifying the spatial influence of roads. Thus, using analysis of feather hydrogen isotopes, we assessed the geographic origins of dead Barn Owls (n = 150) found along I-84 between 2004 and 2021. We focused isotopic analysis on the first primary because in Barn Owls it may not be molted for four or more years from hatching; thus, even birds that dispersed to southern Idaho as juveniles would retain the isotopic signature of their natal area for years after arrival. Contour feathers from the breast or back of live nestlings (n = 50) captured from nests near the Interstate highway were used as a reference for comparison to dead birds. We reasoned that if dead birds were of local origin, both mean and variability of hydrogen isotope ratios would resemble those in locally produced nestlings. In contrast, if mean hydrogen isotope ratios differed, and/or if isotopic variability in road-killed owls was more extensive than in reference nestlings, we could infer that dead birds were from a broader geographic origin, and the variability would reflect the likely spatial extent. In this manner, the possibility that southern Idaho and the I-84 corridor attracts Barn Owls from wide geographic extents only for them to meet their demise along the interstate through vehicle collisions can be elucidated.

## Blood Lead Concentrations in Nocturnal Raptors Presented to a Wildlife Rehabilitation Center

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### Abstract

Facultative and obligate scavengers are well established to be at high risk for lead toxicosis due to their feeding ecology. Accordingly, rehabilitation centers commonly evaluate blood lead concentrations in these patients, regardless of clinical signs and presentation. Other raptors, such as owls, are less commonly tested as their feeding ecology is not thought to pose a significant risk. Wildlife Center of Virginia (WCV) has expanded species tested for lead, and found that many non-scavenging raptors have detectable blood lead concentrations, including several species of owl. Not all owls presented to the WCV during this period were tested for lead, however of those tested, 30% of Barred Owls (*Strix varia*; n=23), 30% of Eastern Screech Owls (*Megascops asio*; n=30), 19% of Great Horned Owls (*Bubo virginianus*; n=21), and 100% of Long-eared Owl (*Asio otus*; n=1) had detectable concentrations of blood lead when measured with a point of care lead analyzer (Lead Care II). Barred owls had an average blood lead of 0.06 ppm, Eastern Screech Owls 0.08 ppm, Great Horned Owls 1.3 ppm and the single Long Eared Owl's blood lead was 0.035 ppm. While most of these concentrations may be considered "subclinical lead", or "background levels", lead is a cumulative metabolic poison that severely affects numerous body systems; Human and avian literature supports that even low levels of lead can have significant long term health effects. The detecting of blood lead concentrations in these non-scavenging raptors is notable and suggests that owls should be included in routine screening for blood lead concentration, and treatment should be elected when lead is detected. Future work will aim to continue to expand the range of raptors tested for lead.

## **Assisted Reproduction of Golden Eagles (*Aquila chrysaetos canadensis*) As a Strategy for Its Conservation in México**

EDGAR A ALVIRDE, SALVADOR A FIGUEROA  
EL Sahuaro, Queretaro, Mexico

### **Abstract**

The property and facility that manages Wildlife (PIMVS) in El Sahuaro, is registered with the General Directorate of Wildlife in Mexico City, with the following folio DGVS-PIMVS-CR-IN-1107-QRO/09, as a center for reproduction of birds of prey in danger of extinction. El Sahuaro has reproduced in its facilities for four consecutive years four Golden Eagle young within its program of conservation of threatened and endangered birds of prey by artificial or assisted insemination. It is worth mentioning that this was a great success for the species and for Mexico. Other institutions have not yet succeeded due to their complexity or lack of training and experience in handling techniques and in knowing the biology of this species. This arduous work took more than eight consecutive years and with five years of training abroad for the reproduction by artificial or assisted insemination. The insemination results since 2017 to 2021 achieved hatching of a nestling each year confirming that Mexico is preventing this species from disappearing in the future, as it is currently in danger of extinction in the Official Mexican Standard (NOM-059- SEMARNAT-2010) because of destruction and fragmentation of their habitat, poaching, and stealing their young for species trafficking. The technique that is used today in El Sahuaro ensures that at least every year a Golden Eagle young is produced, but the thought of including artificial incubation makes El Sahuaro dream that it could obtain more than one young per year. This is the aim of increasing hatchlings and then to do releases in their natural habitat and to maintain the wild population, of the queen of the skies, the Golden Eagle. That is why this achievement is a great contribution to the conservation of this species, as there is still time.

## Drivers of Nonrandom Occupancy by Gyrfalcons (*Falco rusticolus*) on the Seward Peninsula, Alaska

MICHAELA L GUSTAFSON<sup>1</sup>, MICHAEL T HENDERSON<sup>2</sup>, TRAVIS L BOOMS<sup>3</sup>, LEAH DUNN<sup>2</sup>, DAVID L ANDERSON<sup>2</sup>

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### Abstract

Occupancy correlates strongly with measures of reproductive success and can be used as a measure of territory quality and resource importance. The Gyrfalcon, an Arctic habitat and diet specialist, is among the North American bird species most threatened by climate change. Gyrfalcons exhibit nonrandom occupancy on the Seward Peninsula, Alaska. Through the use of nest cameras, we know large prey items comprise the majority of the Gyrfalcons' diet during the brood-rearing period and protectiveness of the nesting site affects productivity and other breeding parameters. However, it is still unclear which specific attributes determine occupancy by Gyrfalcons. To address this knowledge gap, we will use comprehensive prey surveys, a multinomial N-mixture model, and remote-sensing data to characterize and predict prey habitat within Gyrfalcon territories. We will use Gyrfalcon occupancy surveys, prey habitat estimates, and measurements of nesting site characteristics to generate occupancy models and determine the relative importance of landscape and nesting site characteristics for Gyrfalcon occupancy. We predict high-occupancy territories will have a higher proportion of primary prey habitat and more protective nesting sites. By understanding what characteristics determine Gyrfalcon habitat suitability, we can better predict how this specialist predator will respond to a changing world and better inform the management and conservation of Arctic landscapes in the face of climate change.

## First Observations of Typical Polygyny and Cooperative Polygyny in Ridgway's Hawk (*Buteo ridgwayi*)

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<sup>1</sup>The Peregrine Fund, Boise, USA. <sup>2</sup>Department of Biological Sciences, Boise State University, Boise, USA

### Abstract

Although monogamy is the prevalent mating system in birds, some species regularly employ polygamy in the form of either polyandry or polygyny, while others will occasionally engage in non-monogamy opportunistically. Among raptors, multiple species within the genus *Buteo* have been documented using polyandrous or polygynous strategies. We describe the first known cases of polygyny in Ridgway's Hawk, which is generally considered to be monogamous. This small forest hawk is endemic to Hispaniola and its breeding behavior has been studied since the mid-1970s, intensively during the last 20 years. We consider the unusual polygynous breeding events we document here for the first time, to be opportunistic responses that display Ridgway's Hawk behavioral flexibility and may serve to benefit the conservation of this critically endangered raptor.

## Local Weather Explains Annual Variation in Northern Goshawk (*Accipiter gentilis*) Reproduction in the Northern Great Basin, USA

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### Abstract

Weather is thought to influence raptor reproduction through effects on prey availability, condition of adults, and survival of nests and young; however, there are few long-term studies of the effects of weather on raptor reproduction. We investigated the effects of weather on Northern Goshawk (henceforth goshawk) breeding rate, productivity, and fledging date in south-central Idaho and northern Utah, USA. Using data from 42 territories where we found evidence of breeding attempts in  $\geq 1$  yr from 2011–2019, we analyzed breeding rates using 315 territory–season combinations, analyzed productivity for 134 breeding attempts, and analyzed fledging date for 118 breeding attempts. We found April precipitation, previous year’s April–July precipitation, April–May mean temperature, and March–May mean temperature to be related to measures of goshawk reproduction. Greater April–July precipitation in the previous year and lower April precipitation in the current year were associated with higher breeding rates. Years with warmer average April–May temperatures were associated with increased goshawk productivity. Years with greater April–July precipitation during the previous year and lower mean March–May temperatures were associated with later fledging dates. Based on these relationships, we considered projected changes in weather in the northern Great Basin over the next 50 yr as a result of climate change (without directly accounting for habitat changes caused by climate change), and predicted that climate change will: (a) have no significant effect on goshawk breeding rate, (b) have a positive effect on goshawk productivity, and (c) cause a shift toward earlier goshawk breeding. We suggest that the relationship between raptor breeding and weather be further investigated to enable higher resolution predictions of how changes in the climate may influence their populations, particularly changes that may not have been captured by our study.

## Gyr Falcon Health in Alaska: A Temporal and Spatial Assessment of the Risk of Emergent Diseases for an Arctic Specialist During Rapid Climate Change

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### Abstract

Disease pathogens are an integral component of all ecosystems and can have profound effects on populations, particularly when species lack an appropriate immune or behavioral response. Ambient temperature and moisture are critical predictors for pathogen distribution and abundance, especially for diseases transmitted by insect vectors. Rapid Arctic climate change is facilitating the northward encroachment of parasites and pathogens, and exposing wildlife to novel threats. As an Arctic specialist and top predator, the Gyr Falcon (*Falco rusticolus*) serves as an effective indicator species for ecosystem health and their sensitivity towards novel diseases makes them a particularly effective sentinel for changes in disease ecology. Here we aim to delineate the northern encroachment of relevant Gyr Falcon diseases by comparing molecular and immunological disease prevalence data in archival Gyr Falcon nestling blood samples collected 2004 - 2021, from the Yukon-Kuskokwim Delta and Seward Peninsula, Alaska. Further, migratory prey may transmit more novel diseases, thus we are trapping free-flying Gyr Falcons (adults and juveniles) that are hunting primarily migratory waterfowl, which serve as reservoir hosts for important diseases. Our analyses focuses on hematozoas (e.g., Malaria), endoparasites, bacterial infections (e.g., Salmonella and Chlamydia), and viruses (e.g., West Nile Virus and Avian Influenza). Despite being in the early stages of this research, a preliminary trapping effort and subsequent analyses revealed that 6 out of 6 Gyr Falcons (two adults and three hatch-year birds) had been exposed to *Salmonella typhimurium*. Surveillance in other raptor species has demonstrated Salmonella organisms, and this may represent a common isolate in raptors feeding on a variety of birds and small mammals. Climate change is the greatest threat to Arctic wildlife and the northward progression of pathogens and infection of novel species will likely be of critical importance for conservation. Our research will provide important data on the changing disease ecology of North America's largest falcon.

## Potential Effects of Roads and Land Cover on Brood Sex Ratios in Barn Owls in Southwestern Idaho

JAYEWON D HILL, BRIAN BUSBY, MICHAEL GORDON, AUSTIN DAVIS, JIM BELTHOFF  
Boise State University, Boise, ID, USA

### Abstract

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*), and one of the world's highest roadway mortality rates for Barn Owls occurs along Interstate 84 (I-84) in southern Idaho, USA. Studies frequently find juvenile Barn Owls are killed through WVC in greater numbers than adults, possibly because juveniles outnumber adults and are simply killed in proportion to their abundance. Another common pattern is that WVC involve female Barn Owls more frequently than males. For instance, 1.4 times more females than males are killed along roads in Idaho and 2.8 times more frequently than males in California. A 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. Our objective was to examine relationships between roads and other land cover on brood sex ratios in Barn Owls to examine the hypothesis that nests experiencing the greatest road intensity would be most likely to be female biased. To do so we used DNA isolated from owl blood to sex 726 nestlings from 167 broods during 2019-2021. Using a series of generalized linear mixed models, we then examined the potential influence of roads and other land cover covariates on brood sex ratios and examined spatial variation in the likelihood of male- and female-biased broods.

**Anticoagulant Rodenticides: Focus on Spatial Patterns and Trends of Exposure in Terrestrial Birds of Prey in Relation to Registered Uses.**

SOFI R HINDMARCH, JOHN E ELLIOTT

Science & Technology Branch, Environment and Climate Change Canada, Delta, Canada

**Abstract**

This poster abstract complements one by Elliott et al on a related topic and with the latter intended as a platform presentation. Using the database on hepatic residues of anticoagulants in 746 raptorial birds found dead or brought into rehabilitation centers in British Columbia, Canada over a 30-year period from 1988 to 2018, we will focus here on spatial patterns in a detailed subset of 400 birds, and attempt to discriminate among suburban, commercial and agricultural uses and sources. The geographic focus will be the south coast Lower Mainland region of British Columbia, a complex urban, suburban, agricultural and conservation area landscape. It is also a landscape that supports a diversity of diurnal and nocturnal birds of prey, both breeding and wintering populations.

## **Anthropogenic Threats to Golden Eagles in Western Montana: A Rehabilitation Case Study**

BROOKE TANNER<sup>1</sup>, JESSE VARNADO<sup>1</sup>, ROBERT DOMENECH<sup>2</sup>, MAGGIE HIRSCHAUER<sup>1</sup>

<sup>1</sup>Wild Skies Raptor Center, Potomac, USA. <sup>2</sup>Raptor View Research Institute, Missoula, USA

### **Abstract**

Long distance migrants, including eagles, face many threats across their range. Wild Skies Raptor Center in western Montana admitted 20 Golden Eagles (*Aquila chrysaetos*) between 2016-2021. The majority (60%) of Golden Eagle admissions to the rehabilitation facility were anthropogenic and included vehicle collisions, lead toxicosis, trap injuries, and gunshot. Wild Skies admitted a female hatch-year Golden Eagle after being hit by a vehicle 21 October 2019. Five weeks later she was released with a 65-gram GeoTrak GPS transmitter. In April 2020 she migrated 3,700 km to northwest Alaska then returned to western Montana the following October. Her body was recovered 16 December 2020 less than 120 km from where she was originally recovered in 2019. A necropsy from the Southeastern Cooperative Wildlife Disease Study lab confirmed she succumbed to lead poisoning. This case study highlights the severity and pervasive nature of anthropogenic threats Golden Eagles encounter in western Montana and emphasizes the need for continued community education.

## Patterns of Occupancy, Productivity, Site Tenure, and Recruitment in a Population of Burrowing Owls in Idaho, USA

AARON B JOHNSON, JIM BELTHOFF, BRENT CLARK  
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### Abstract

Western Burrowing Owls (*Athene cunicularia hypugaea*) are ground-dwelling owls of western and central North America that breed in abandoned mammal burrows. The species is of conservation concern throughout portions of its range, so understanding population dynamics, fitness outcomes, and attributes of the most productive breeding sites are important for management, conservation, and the understanding of life history. Between 1997-2021, a mark-recapture approach was used to monitor a nesting population of Burrowing Owls making use of artificial burrows in the Morley Nelson Snake River Birds of Prey National Conservation Area, ID, USA. The study area is predominantly shrub steppe and disturbed grasslands but has a small percentage of irrigated agriculture, and Burrowing Owls breed in both settings. Using data from this 25-yr timespan, our objective was to assess attributes of the most productive and most frequently occupied artificial burrow sites. We also were interested in deciphering patterns of tenure and turnover of individuals among sites, as well as locations of sites that were sources of recruits to the breeding population. We analyzed data from approximately 4900 individually marked owls from approximately 950 nests, including 800 nesting adult females, 400 adult males, and almost 4000 nestlings. We identified sites with the greatest occupancy, productivity, and number of recruits, assessed land cover characteristics at each, and analyzed relationships with occupancy, productivity, tenure, and recruitment. Finally, we evaluated if patterns were similar between agricultural areas and grasslands/shrublands.

## Connectivity, Timing and Duration of Autumn Migration of Steppe Eagles Across Their Range

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### Abstract

Migration is for many species an ecologically critical time period, and its outcomes may affect demography and conservation. However, for many raptor species, detailed information on migration is sparse. We used GPS telemetry to evaluate timing and connectivity of migratory Steppe Eagles (*Aquila nipalensis*), a declining large raptor, studied across their summer range from Mongolia in the east, through Russia and Kazakhstan to Turkey in the west, and of birds that wintered in Oman. During autumn migration, total distance and timing varied within and among birds of different origins and ages. Wintering areas also varied greatly, with Eagles from Mongolia (the most eastern studied sub-population) wintering between India and Myanmar, distinguishing them from the other populations that wintered in a wide longitudinal range from Pakistan in the east to Chad in the West. In general, birds of more eastern natal origins usually wintered more to the east. Wintering site latitude ranged from south-west Russia in the north to southern Ethiopia in the south. Our results demonstrate the high flexibility in migration timing and destinations among and within populations of Steppe Eagles. Understanding these aspects of migratory ecology of these endangered Eagles can lead to important and conservation-relevant insights by linking migration routes with known and possible threats to the species.

## Population Genetics of Mississippi Kites (*Ictinia mississippiensis*) in the Southern Great Plains

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### Abstract

During the mid-1900's, Mississippi Kites (*Ictinia mississippiensis*) expanded their breeding range from the southeastern coastal plains and Mississippi Valley into the Great Plains. At the landscape scale, Mississippi Kites appear to breed abundantly throughout the southern Great Plains; however, at a finer scale, the breeding range is disjunct with kites breeding only in cities and exurban patches of trees with expanses of unsuitable landcover stretching between. As such, the breeding landscape for this species is essentially a series of islands, each with its own breeding population. Given that site-fidelity is high, founder populations are small, and evidence suggests short natal dispersal, Mississippi Kites may exhibit a localized genetic population structure across this landscape. We obtained genetic samples of Mississippi Kites (live captures, salvaged feathers, loans from natural history collections, and donations from wildlife rehabilitators) from across their Great Plains range. From these (n = 78) and samples to be collected in 2021, a set of single nucleotide polymorphisms (SNPs) will be used to determine the genetic connectivity of populations. Laboratory analyses are ongoing and preliminary results will be presented at the 2021 Raptor Research Conference.

## **Seriemas: A Literature Assessment and Recommendations for Future (Raptor) Research**

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<sup>1</sup>Aves Rapaces en Bolivia - Programa de Investigación, Sucre, Bolivia, Plurinational State of. <sup>2</sup>Museo Nacional de Historia Natural, La Paz, Bolivia, Plurinational State of. <sup>3</sup>The Peregrine Fund, Boise, USA. <sup>4</sup>University of Idaho, Moscow, USA

### **Abstract**

The Red-legged and Black-legged Seriemas are two exclusively South American birds that inhabit open and sparsely forested vegetation. Seriemas have been recently included among the group of raptors based on ecological and evolutionary arguments. This consideration of seriemas as raptors is non-traditional and might be controversial. Therefore, further information regarding the evolution, taxonomy, morphology, and ecology of these birds will inform the validity of their consideration as raptors. Here we present a review of the published information on seriemas and discuss future research for these new raptors. To conduct our review, we developed a systematic map and searched all databases available within Clarivate Analytics' Web of Science, performed a keyword search of Google Scholar, and included the corresponding bibliographies from the Birds of the World website. We reviewed 95 studies, and found that Red-legged Seriema was subject of more studies than Black-legged Seriema. Overall, Brazil and Argentina were the site of most studies. The majority of studies examined physiology (48), followed by behavior (36), threats (33), and demography (26), whereas the fewest studies examined conservation actions (10), and stresses (17). Patterns of study categorizations were similar across both species and the distribution of studies across months was fairly even for both species as well. This is the first study to systematically review and assess the published information on seriemas. Our results show where past studies have focused and highlight potentially fruitful avenues for future research. Although threats to seriemas have been identified, these have not been thoroughly assessed, thus their extent and impact on seriema populations was difficult to ascertain. Future research should focus in testing existing hypothesis on seriema feeding, vocal, social, and territorial behaviors, while documenting natural history. Researchers should also build upon past research while establishing programs to monitor the conservation status of seriemas across their ranges.

## **A Better View: Osprey Nest Survey Methods and Behavioral Response Across the Southeast**

NATASHA K MURPHY, DYLAN G BLANCHARD, SCOTT A RUSH  
Mississippi State University, Starkville, USA

### **Abstract**

Osprey (*Pandion halieatus*) have experienced 50–99% population increase across North America in the past half-century. Unfortunately, these abundances have led to greater human-Osprey conflict. For instance, nests on vital utility infrastructure may cause risk to utility distribution, residents, equipment, and birds. Persistence in building nests on these structures, despite removal or deterrents, exacerbates these conflicts. Evaluating nest occupancy and offspring status is an integral aspect of conflict mitigation when Osprey nests impede utility functions. While typically climbed or surveyed by manned aircraft, Osprey nests are frequently inaccessible, e.g., on powered infrastructure or over water. As such, unmanned aerial vehicles (UAVs) may present a novel survey method tailored towards the growing need to monitor nests on human infrastructure. Our study compared the effectiveness of UAV flights with traditional climbs in surveying Osprey nests on human infrastructure and in natural sites (trees). Behavioral surveys of adult Osprey assessed the impacts of both methods on nest defense behavior. Preliminary findings suggest that call and flush frequency of nesting adult Osprey varied significantly by survey method and by the sex of adult attending the nest. Adults of both sexes spent more time away from the nest, called more often, and engaged in more defensive behaviors when approached by a climber. Female Osprey were more likely to remain on the nest or, if flushed, return to the nest during UAV surveys. Images of nest contents from UAV surveys were, however, often obscured by incubating females. Our results suggest that utilizing UAVs to determine nest occupancy may be less invasive than conventional methods but may not provide adequate information on nesting stage and nest contents. We encourage other researchers to test UAV-based monitoring strategies in a wide variety of contexts and for other raptor species.

## Lead Concentrations in Black Vultures at Two Solid Waste Management Facilities in Mississippi

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### Abstract

Birds of prey, including New World vultures, are highly susceptible to issues associated with assimilation of lead (Pb). This study focuses on Pb levels in *Coragyps atratus* (Black Vultures; hereafter vultures) captured and sampled at two landfills, located 120 km apart in Lowndes and Lauderdale Counties, Mississippi, USA during February 2020 – March 2021. Blood samples were collected from trapped vultures, and the age and sex of birds was determined for each trapping event. Among the 140 vultures sampled in 16 capture events ( $\bar{x} = 9$ , std. dev. = 6 birds per trapping event), we found mean blood-lead concentration of 11.6  $\mu\text{g/dL}$  (std. dev. = 10.2). Lead concentrations did not differ between sampling sites ( $t = 0.71$ ,  $df = 85.34$ ,  $p = 0.48$ ) nor between the sexes of birds sampled ( $t = 0.65$ ,  $df = 137.59$ ,  $p = 0.51$ ). Pb concentrations increased with the age of birds at both locations with young (hatch year and second year) birds showing an average of 10.3  $\mu\text{g/dL}$  (std. dev. = 6.4) and adult birds (after second years) showing an average of 13.1  $\mu\text{g/dL}$  (std. dev. = 13.4). Age ratios between young and adult vultures were 1:0.8 (77:63 individuals) across all sampling events, making juvenile vultures the more prevalent age group. Females birds were more common than males at one site 1:0.5 (18:9 individuals) while sex ratio were similar at the other site 1:0.9 (59:54 individuals). The ratio of male to female birds captured changed across seasons with an equal ratio of females to males during the spring and summer (1:1 spring, 1:1.1 summer) but more females than males in fall (1:0.4) and winter (1:0.5).

## Urban Nest Site Selection by Merlins (*Falco columbarius*) in the Northeastern Great Plains

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### Abstract

Merlins are known to breed in urban areas throughout the northern Great Plains. Hypotheses to explain this behavior include prey availability, for example due to bird feeding, and nest site availability in a landscape historically dominated by grassland. To better understand the factors influencing Merlin nest site selection in urban settings, we initiated a pilot study to find and monitor nests in Moorhead, MN, USA. In spring 2021 we conducted playback surveys at 246 points spaced 200 meters apart within 12 0.64 km<sup>2</sup> survey areas in Moorhead, MN, USA. We revisited possible nest sites and monitored nests from the ground using binoculars and spotting scopes. We found eight potential nest sites, six of which we later verified as active nests. All nests were in spruce (*Picea* spp.) trees 9-15 meters above ground, and 1-3 meters below the top of the tree. As of the end of June, each nest had hatched at least three young and one nest had fledged. Anecdotally, nest trees were often adjacent to roads and subject to high vehicle traffic or pedestrian activity. We plan to explore the landscape context of nest sites with respect to land cover and land use, canopy cover, tree density, building density, land zoning, distance to roads, and other landscape metrics. These preliminary findings will be used to plan further nest surveys in both urban and rural areas.

## **Lead Poisoning in Bald Eagles Admitted to Wildlife Rehabilitation Facilities in Iowa, 2004-2020**

KAY NEUMANN, SAVANNA JUDSON

SOAR- Saving Our Avian Resources, Dedham, USA

### **Abstract**

Lead Poisoning in Bald Eagles Admitted to Wildlife Rehabilitation Facilities in Iowa, 2004-2020

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Seventeen years (2004-2020) of Bald Eagle (*Haliaeetus leucocephalus*) data from state and federally permitted wildlife rehabilitators in Iowa were assessed for elevated lead levels in blood or tissue samples. In total, 653 Bald Eagles were admitted; 595 were tested for lead. 54 showed subclinical lead levels (>0.2 ppm in blood or >2.0 ppm in liver samples), 175 showed clinical lead levels (>0.6 ppm in blood or >6.0 ppm in liver samples). These data were analyzed over time showing an increase in the total number of Bald Eagles admitted to rehabilitation facilities and no change in the prevalence of lead poisoning cases. 342 radiographs of eagles with lead tests were taken in an attempt to determine the source of lead poisoning. Of these, 28 showed metallic opacities in the digestive tract. These objects were located and removed during necropsy; nine eagle digestive tracts contained lead shot, one contained steel shot, 16 contained shrapnel (irregular pieces of non-magnetic metal), and two contained identifiable .22 bullets. An analysis of morbidity and mortality found lead poisoning to be the primary cause of death, with traumatic fractures and soft tissue trauma being secondary and tertiary. A Venn diagram was constructed to show overlap of morbidity and mortality causes.

## Primary Feather Molt Patterns of Flammulated Owls in Central Colorado

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### Abstract

Molt in birds is energetically expensive, and consequently it has evolved in most species to avoid significant temporal overlap with other energy-taxing processes. Although molt sequences of flight feathers vary by species and age class, understanding a species' pattern can provide insight into energetic tradeoffs and facilitate conservation efforts. The Flammulated Owl (*Psiloscoops flammeolus*) is a small, migratory raptor that breeds in western North America and whose primary feather molt patterns have not been extensively studied. In analyzing 10 yr of observational data from a CO population, we sought to determine the general timeline and sequence of molt among sexes and breeding classes. Our results showed individuals exhibit one sequential prebasic molt annually beginning in the late breeding season and continuing just prior to fall migration. While this pattern appears the same regardless of sex and breeding status, these factors likely affect the proportion of individuals in molt. We observed 72% of non-breeding, non-territorial males molting primaries compared to 34% and 31% of breeding males and breeding females, respectively. We hypothesize this pattern to be the result of differences in energy allocation. Furthermore, since migratory behavior can impact aspects such as behavior, morphology, and energy allocation, understanding molt patterns can provide insight into evolutionary differences between migrant and resident populations.

## Is Ruppell's Vulture Colonizing Western Palearctic? A New Scenario for the Conservation of a Declining Species

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### Abstract

The Ruppell's Vulture (*Gyps rueppelli*) has a distribution throughout the African Sahel belt and has recently been listed as Critically Endangered worldwide by the IUCN due to the sharp decline that it suffers in most of its distribution, becoming extinct or rarefied from wide areas. Surprisingly, in recent decades there has been an increase in the occurrence of the species in the western Palearctic. In this context, the current situation of the species in North Africa and Europe has been evaluated, compiling records from: a) bibliography, blogs and portals; b) citizen science databases; c) scavenger experts; d) databases of banding centers; and e) censuses of birds of prey passing through the Strait of Gibraltar. A total of 1,668 records of Ruppell's vultures have been obtained between 1990 and 2020, especially since 2008, and standardized censuses carried out in the Strait of Gibraltar estimate 40-70 specimens crossing every year, with a significant increase of 22% annually between 1999-2019. The increase in the population of Iberian Griffon Vultures (*Gyps fulvus*) and their numbers migrating to Africa annually (> 10,000 ind), and the decline of African vultures (*G.rueppelli*, *G.africanus* ...), is modifying the proportions of scavengers in Africa and their relationships, so that migrating griffon vultures could be operating as conveyor belts of vultures between the Sahel and the Palearctic, attracting dispersal juveniles and immatures of Ruppells Vulture to the north of Africa and Europe. In addition, evidence of breeding of Ruppells Vulture has been found in Portugal, southern Spain and Algeria, in breeding colonies of Griffon Vultures, which opens a new scenario for the conservation of this endangered species, outside his former natural distribution.

## Post-hatch Development of an American Barn Owl (*Tyto furcata*) Population in the Sacramento Valley, California

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### Abstract

The American Barn Owl (*Tyto furcata*) is a well-known bird of prey for its commonality in urban and rural settings and use as natural pest control. In California agriculture, many farmers practice integrated pest management strategies by attracting Barn Owls to their properties with artificial nest boxes in an effort to control rodent pest populations while reducing usage of chemical pest controls (i.e., anticoagulant rodenticides). Barn Owl nest boxes provide Barn Owls nesting substrate in highly industrialized landscapes, where traditional nest sites may be limited, and provide opportunities to gain information on the ecology and biology of the species. Currently, there is limited information on growth and development of Barn Owl nestlings on industrial farms in California. We collected growth rates for Barn Owls throughout Yolo County, California between 2018 and 2020. We collected weekly measurements (hallux, culmen, wing chord, and mass) at 44 nest boxes from a total of 83 nestlings aged 1-week-old to fledged. Chicks later in the hatch order of a box were found to have a smaller hallux length. Nests with later hatch dates had lower peak body mass and mass at fledgling than nests hatched earlier in the breeding season. This study provides a foundation for future research on American Barn Owl nestling development in agricultural landscapes.

## Foraging Behavior and Success of American Kestrels (*Falco sparverius*) is Influenced by the Time of Day and Ambient Temperature in North Texas

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### Abstract

Recent monitoring has shown that American Kestrel populations are declining across North America despite being classified as a population of least concern by the International Union for Conservation of Nature (IUCN). Several researchers have suggested these declines are most likely attributed to unfavorable conditions during migration or on Kestrel wintering grounds. To begin to understand factors that may influence winter ecology and survival of American Kestrels, we quantified the foraging success of falcons during the daylight hours in Denton County, North Texas. We did intensive observations on focal Kestrels for 30-min time intervals throughout the day and recorded the number of foraging attempts and successful prey captures. Behavioral data were then analyzed using regression analysis with foraging attempts and number of successful captures related to time of day, temperature, and the month of the year. We collected foraging data during 216 observation sessions over three field seasons. Both foraging attempts and successful foraging attempts were significantly positively related to time of day ( $r^2 = 0.534$ ,  $P < 0.01$ , and  $0.666$ ,  $P < 0.01$ , respectively). Peak foraging activity occurred between 1500 and 1700 when Kestrels made a mean of 4.5 attempts/hr and success peaked at 62% per foraging attempt. There was also a positive linear relationship of foraging attempts and success with temperature ( $r^2 = 0.515$ ,  $P < 0.01$ , and  $0.581$ ,  $P < 0.01$ , respectively). Additionally, Kestrels exhibited a peak in foraging activity and success in the month of February, before migration, probably in response to the need to sequester fat in preparation for spring migration. February also was associated with the highest temperatures of the wintering months. We suggest these positive linear relationships can most likely be attributed to the increasing activity in arthropods as temperatures get warmer.

## Factors Affecting Acoustic Detection of Mexican Spotted Owls at Grand Canyon National Park

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### Abstract

Effective wildlife management and conservation rely on accurate estimates of species demographics, including their abundance and distribution. However, monitoring programs are seldom able to detect species perfectly. Cryptic or rare species are often missed, even when present. These false absences can lead to inaccurate assumptions that may misguide management. Therefore, quantifying our ability to accurately detect species is crucial in deriving accurate estimates of species demographics. Passive acoustic monitoring is an emerging technology for surveying ecological soundscapes in ways that have not been possible until recently. The use of acoustic recorders as monitoring tools have thus increased rapidly in the last decade. In the last three years (2019-2021), acoustic recorders were used at Grand Canyon National Park to supplement existing long-term monitoring of Mexican Spotted Owls (*Strix occidentalis lucida*) within their historical nesting territories. However, the factors that influence our ability to detect owls at the Grand Canyon are not yet fully understood. Using acoustic recordings from distance trials and owl surveys, we evaluate the effects of distance, habitat type, wind, and other noise sources on the detection of Mexican Spotted Owls. We predict that noise disturbances that occur during the owls' primary activity periods will have the greatest influence on detection, with wind being the most frequent source of noise. Our results should help guide future survey protocols to ensure that they minimize false absences and maximize overall detection accuracy. This approach can also be used elsewhere by agencies wanting to adapt acoustic recorders as monitoring tools for elusive wildlife species.

## Assessing Vocal Activity Patterns of Sympatric Owl Species in Grand Canyon National Park.

EMILY R SALCICCIA<sup>1,2</sup>, KIRSTEN FULLER<sup>1</sup>, JENNYFFER CRUZ<sup>1</sup>, VANESSA E RAMIREZ<sup>1,2</sup>

<sup>1</sup>Raptor Research Center, Boise State University, Boise, USA. <sup>2</sup>Humboldt State University, Arcata, USA

### Abstract

Environmental changes in the Anthropocene are causing rapid shifts to species' distributions, phenology and activity periods worldwide, with unknown consequences on local community dynamics. In stable communities, the time of day when species are active, should minimize their risk of encountering dominant competitors or predators. When species are active should also maximize species' access to food, as well as their ability to interact with conspecifics. Therefore, knowledge of species' active times can help quantify potential niche overlap. Our project focused on assessing the vocal activity patterns of three sympatric owl species (Mexican Spotted Owls (*Strix occidentalis lucida*), Flammulated Owls (*Psiloscoops flammeolus*), and Great Horned Owls (*Bubo virginianus*)) within Grand Canyon National Park. We described activity patterns using data collected from 2019, 2020 and 2021 with automated acoustic recorders, placed during the months of March to early July. We detected 52 Mexican Spotted Owls, 26 Flammulated Owls and six Great Horned Owl calls from six recorders. We predicted that owl species that overlap closely in space and breeding season phenology (i.e., other niche axes), were more likely to partition their nightly vocal activity to facilitate their coexistence. Owls vocalize during their breeding season to find mates, defend territories, and communicate with young. Knowledge of vocal activity patterns should facilitate management, guiding when to focus monitoring efforts that rely on auditory detections, and when to minimize disturbance from anthropogenic noises that may disrupt species' ability to communicate. We discuss how our results can guide monitoring and management of owls that inhabit Grand Canyon National Park.

## Impact of the 2020 Wildfires on Abundance of Prey Species Important to the Northern Goshawk within the Sawtooth National Forest

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### Abstract

Impact of the 2020 Wildfires on Abundance of Prey Species Important to the Northern Goshawk within the Sawtooth National Forest

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The Northern Goshawk (*Accipiter gentilis*) is an apex predator that is used as an indicator species for the Sawtooth National Forest in which a 90,000-acre wildfire burned in the fall of 2020. We studied the impact of the fire on this species by surveying prey abundance in burned and unburned territories. To estimate prey abundance, we utilized distance sampling in each territory and used the estimates as a response variable in a general liner model where average burn severity is the predictor. We expect that for most species, abundance will be significantly lower in severely burned areas. Should these predictions be correct, increasingly frequent and severe fires could lead to the extirpation of Northern Goshawks within this region of the Sawtooth National Forest. In the fall of 2021, prescribed burns are planned that may impact multiple goshawk territories. Although these burns are intended to improve the habitat, the pressure from declining prey populations could threaten this already vulnerable goshawk population. The implications of this study are important for forest management strategies as the threat of severe fires is predicted to increase within the Sawtooth National Forest.

## Illegal Killing of Non-game Wildlife and Recreational Shooting in Conservation Areas

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### Abstract

Illegal killing of non-game wildlife is a global yet poorly documented problem. The prevalence and ecological consequences of illegal killing are often underestimated or completely unknown. We review the practice of legal recreational shooting and present data gathered from telemetry, surveys, and observations on its association with illegal killing of wildlife (birds and snakes) within conservation areas in Idaho, USA. In total, 33% of telemetered long-billed curlews (*Numenius americanus*) and 59% of other bird carcasses found with known cause of death (or 32% of total) were illegally shot. Analysis of spatial distributions of illegal and legal shooting is consistent with birds being shot illegally in the course of otherwise legal recreational shooting, but snakes being intentionally sought out and targeted elsewhere, in locations where they congregate. Preliminary public surveys indicate that most recreational shooters find abhorrent the practice of illegal killing of wildlife. Viewed through this lens, our data may imply only a small fraction of recreational shooters is responsible for this activity. This study highlights a poorly known conservation problem that could have broad implications for some species and populations of wildlife.

## **A Quantitative Dietary Analysis of the White-Tailed Hawk in South Texas**

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### **Abstract**

The White-tailed Hawk (*Geranoaetus albicaudatus*) is a common raptor in Latin America and the southern tip of the USA. Only one of the three subspecies, *G. a. hypospodius*, resides in the northernmost extent of its range in coastal TX. The White-tailed Hawk is one of North America's least known bird of prey, and their life history and population demographics have received little empirical attention. The northern distribution of White-tailed Hawks in America historically was described as including the American Southwest. Lack of fire on the landscape in the end of the 19th century is thought to have resulted in range contraction due to woody encroachment. While there is insufficient data and a lack of reliable estimates for the White-tailed Hawk, current beliefs are that population numbers are stable or increasing in south TX. More research is needed as breeding and nesting habits remain obscure. Previous studies indicate that the White-tailed Hawk is sensitive to nesting disturbance and will quickly flee when approached. This discussion will cover a quantitative dietary analysis of food habits and an introduction to an ongoing study researching the nesting ecology of the White-tailed Hawk during the breeding season in south TX using nest cameras. Data collection is ongoing and the results will be presented October 2021.

## Model of Community-Based Conservation to protect the Harpy Eagle in Darien, Panama

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<sup>3</sup>The Peregrine Fund, Boise, Idaho, USA

### Abstract

The project is intended to conserve the Harpy Eagle (*Harpia harpyja*) and Darien's lowland moist tropical forest by designing a replicable model in four poor and remote rural communities to address and reduce the impacts of deforestation, uncontrolled cattle ranching, agricultural encroachment, bush meat, and timber extraction. Principal activities are to (1) increase the level of ecological knowledge towards biodiversity conservation through awareness and environmental education; (2) reduce agricultural encroachment and uncontrolled cattle ranching through a replicable model of reforestation by planting shade-grown coffee and native trees; (3) develop local capacity for community-based conservation action among local indigenous communities by training them in agroforestry, forest restoration, forest patrolling and conservation efforts; and (4) create four community-based organizations (CBOs) and develop local capacity. Despite the current COVID-19 pandemic, by following protocols and health security measures, our current achievements are: (1) increased the level of ecological knowledge in four communities using traditional environmental campaigns with the support of our indigenous local technicians by delivering face-to-face presentations and broadcasting radio messages with conservation themes to reach over 25,000 people in Darien; (2) expanded our reforestation efforts from two to four communities, supporting the conservation of 20 Harpy Eagle nests; (3) four tree nurseries established and maintained in each community to produce over 5,000 seedling of native trees and shade coffee annually; (4) trained 48 local people in agroforestry and forest restoration; (5) created three community-based organizations (CBO), and advanced by 50% the procedures to create a new one CBO; (6) constituted formal conservation alliances to get advice, and logistical and financial support with 19 entities to move forward with this long-lasting initiative.

## The Influence of Nesting Habitat and Migration Strategy on the Reproductive Pace of American Kestrels (*Falco sparverius*)

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### Abstract

Variation in reproductive pace (the time span from egg laying to fledging young) may be attributable to seasonal patterns in primary productivity and prey availability that affect both breeding season energetic investments and nonbreeding season migration strategies. As growing seasons shift in timing and duration, information on reproductive pace and its underlying mechanisms are necessary to predict how populations will respond to climate change. We studied breeding American kestrels with different migration strategies at two sites in southern Idaho with distinct seasonal resource patterns. At the site near Fairfield, ID, where the breeding Kestrels are migrants, the growing seasons are brief with high peaks in primary productivity, suggesting a short window of high prey abundance. In Kuna, ID, where the breeding Kestrels are partial migrants, the growing seasons are longer with low, prolonged peaks in habitat productivity, suggesting a long window of moderate prey abundance. We examined variation in reproductive pace and its dependence on site or migration strategy. We predicted that Kestrels nesting near Fairfield would have an accelerated nesting pace compared to Kestrels nesting in Kuna because of the short window of high prey availability they experience. Alternatively, we predicted that migratory Kestrels, regardless of site, would have an accelerated nesting pace because they arrive later at the breeding grounds and have a shorter nesting period than resident Kestrels. We collected information about the length and productivity of the growing season using NDVI values. We identified individual migration strategies of breeding adults based on stable hydrogen isotope analysis of talon tissue, and collected nesting event information with images taken by nest box cameras to determine the pace of each reproductive stage. Results will determine how resource availability and wintering decisions influence the nesting pace of Kestrels.

## Lead to the Bones: Andean Condor (*Vultur gryphus*) Acute and Chronic Exposure to High Lead Levels in South America

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### Abstract

Lead exposure is a threat for wildlife conservation that has been extensively investigated. However, in some areas of the world (for example, South America) and for certain species, research on the subject is scarce, or the access is restricted to local information. We analyzed lead exposure for a threatened and widely distributed species, the Andean Condor. The study included samples of birds in rehabilitation (alive or necropsy) in Argentina, and 2) literature review and extensive survey considering the exposure events for the species in South America. Wild condors of Argentina ( $n = 76$ ) presented high lead levels, consistent with recent and previous exposure (blood levels above  $104 \mu\text{g} / \text{dL}$ , with an average of  $15.47 \pm 21.21 \mu\text{g} / \text{dL}$ , and bone levels above  $148.20 \text{ ppm}$ , with an average of  $23.08 \pm 31.39 \text{ ppm}$ ). In contrast, captive-bred individuals - with no history of exposure to lead contamination - had much lower lead levels (blood levels with a mean of  $5.63 \pm 3.08 \mu\text{g} / \text{dL}$  and  $2.76 \pm 3.06 \text{ ppm}$  for bone). Condors were exposed to lead throughout its distribution in continental Argentina, which represents almost sixty percent ( $> 4000 \text{ km}$ ) of its geographical distribution. We also present evidence of lead exposure events in Chile, Ecuador and Peru. Lead poisoning is a major and widespread threat to the conservation of the Andean Condor, and probably to other sympatric carnivores in South America. The high number of condors with lead values and their wide distribution, compliments results for the California Condor and other scavengers in North America, suggesting that lead poisoning is a continental threat.

## Population Redux: Examining the Efficacy of Historic Bald Eagle Hacking Programs Through Simulation Models

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### Abstract

During the late 20<sup>th</sup> and early 21<sup>st</sup> centuries, Federal, state, and private organizations were motivated to advance the recovery of the bald eagle (*Haliaeetus leucocephalus*) in the Contiguous US through several reintroduction methods, including hacking, an adapted falconry technique involving the transplanting, conditioning, and releasing of nestlings. Beginning in NY in 1976 and continuing in other states over subsequent decades, wildlife managers and conservationists sourced hundreds of nestlings from breeding populations in AK, FL, Canada, and the portions of the Upper Midwestern USA and hacked them into local populations. Although subsequent monitoring confirmed the successful nesting of hacked birds and recent genetic analysis has suggested admixture related to hacking, the contributions of these efforts to observed eagle population growth rates have not been tested. Here, we used empirical data on bald eagle demographic rates to simulate population growth of eagles among states to compare management scenarios with and without hacking against observed population data. We examined state-level hacking programs based on published timeframes and numbers of released birds, as well as annually reported numbers of nesting territories. Overall, we found mixed support among states for the efficacy of bald eagle hacking. For example, in GA, MA, and NY, hacking showed no contribution to observed population growth. Alternatively, simulation results in NJ, IN, and VT suggested that hacking was important for supporting observed population growth rates. Whereas, in OK and PA, simulation results were less clear as to the contribution of hacking to population. In multiple instances, hacking appeared to advance achievement of state recovery goals by several years. Our results, which in some instances run counter to the generally-accepted thought that hacking has benefited eagle population recovery, highlight the importance of continually examining the efficacy of recovery methods used to support eagle populations, and species recovery programs in general.

## **A Simple and Effective Model of Northern Goshawk Nest Sites in Utah National Forests**

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### **Abstract**

Northern Goshawks (*Accipiter gentilis*) are important top predators that tend to nest in old-growth habitat within mountain forest systems. Since the 1982 Planning Rule, national forests throughout the west, including those in Utah, have designated goshawks as a Management Indicator Species (MIS), and, under an associated mandate, have conducted intensive monitoring of the species. As the national forest system in Utah undergoes forest plan revision based on the 2012 Planning Rule, the MIS model will no longer be used, and this will likely lead to less resources available to monitor and manage species such as the goshawk. Based on the monitoring and research efforts of the past several decades, we were able to create a simple and informative model of goshawk nesting habitat in Utah national forests and verify the model with existing occupancy data from monitoring efforts. This approach may provide a solution to effectively informing management of goshawks with fewer targeted resources and may be applicable to other species for which similar monitoring data exists.